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PART C PROTISTA 2 SARCODINA CHIEFLY "THECAMOEBIANS" AND FORAMINIFERIDA

By ALFRED R. LOEBLICH, Jr., and HELEN TAPPAN
with some systematic descriptions of Foraminiferida by R. WRIGHT BARKER, W. STORRS
COLE, R. C. DOUGLASS, MANFRED REICHEL, and M. L. THOMPSON

VOLUME 2

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PART C

PROTISTA 2

SARCODINA

CHIEFLY "THECAMOEBIANS" AND FORAMINIFERIDA

By ALFRED R. LOEBLICH, Jr., and HELEN TAPPAN
with additions by others

VOLUME 2

Suborder ROTALIINA Delage & Hérouard, 1896

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 219 (*pro* Rotalidae DELAGE & HÉROUARD, 1896, p. 143)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (²subclass, ³tribe, ⁴division, ⁵order, ⁶suborder, ⁷group); dagger(†) indicates *partim*]—[=¹Polythalamacea and ⁴Polythalamacés DE BLAINVILLE, 1825, p. 375; ⁴Cellulacea and ⁴Cellulacés DE BLAINVILLE, 1825, p. 368]—[=²Nantilites LATREILLE, 1825, p. 165; =²Poly-cyclia LATREILLE, 1825, p. 164; =²Milleporita LATREILLE, 1825, p. 166]—[=⁴Enalloteguest D'ORBIGNY in DE LA SAGRA, 1839, p. xxxix, 125 (*nom. neg.*); =⁴Stichostegues D'ORBIGNY in DE LA SAGRA, 1839, p. xxxvii, 5 (*nom. neg.*); =⁴Helicosteguest D'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 27 (*nom. neg.*); =⁴Cycloteguest D'ORBIGNY, 1851, p. 192 (*nom. neg.*); =⁵Helicoideat SCHULTZE, 1854, p. 53; =⁵Rhabdoidea SCHULTZE, 1854, p. 53; =⁵Nautiloidea REUSS, 1860, p. 151; =⁵Helicostegia REUSS, 1860, p. 151, 205; =⁵Turbinoida REUSS, 1860, p. 151]—[=⁴Monostegues D'ORBIGNY in DE LA SAGRA, 1839, p. xxxvii, 1 (*nom. neg.*); =⁵Monosomata EHRENBURG, 1839, table opposite p. 120; =⁴Monostega DIESING, 1848, p. 497; =⁴Monothalamiat SCHULTZE, 1854, p. 52; =³Monothalamiat MARRIOTT, 1878, p. 30; =⁴Monothalamia HAECKEL, 1894, p. 164; =⁴Monosomata COPELAND, 1956, p. 183]—[=⁴Foraminifera Monomera REUSS, 1862, p. 362; =⁴Foraminifera Polymera REUSS, 1862, p. 365; =⁵Vitrea CARPENTER, 1879, p. 375, 378; =⁵Canaliculata MÖBIUS, 1880, p. 104; =⁵Basistoma SCHUBERT, 1920, p. 148; =⁵Telostoma SCHUBERT, 1920, p. 172; =⁵Schizostomat SCHUBERT, 1920, p. 179; =⁴Flexostylidia CALKINS, 1926, p. 355; =⁵Sektion Neohellenoidae WEDEKIND, 1937, p. 72, 84; =⁵Hellenoida WEDEKIND, 1937, p. 79; =⁵Biloculinidae SIGAL in PIVETEAU, 1952, p. 157; =⁵Pluriloculinidae SIGAL in PIVETEAU, 1952, p. 160]—[=⁵Perforata CARPENTER, PARKER & JONES, 1862, p. 149; =⁵Perforata CLAUS, 1872, p. 108; =⁵Perforata CARPENTER, 1879, p. 375; =⁵Perforata LANKESTER, 1885, p. 847; =⁵Perforata (Foraminifera) HAECKEL, 1894, p. 164; =⁵Perforata DELAGE & HÉROUARD, 1896, p. 135; =⁵Perforina CALKINS, 1901, p. 108; =⁴Orthosili (Perforata) SILVESTRI, 1937, p. 89]—[=⁴Dentata HOFKER, 1951, p. 14; =⁵Protoforaminata HOFKER, 1951, p. 42; =⁵Biforaminata HOFKER, 1951, p. 306; =⁵Conorhida HOFKER, 1951, p. 307; =⁵Deuteroforaminata HOFKER, 1951, p. 412]—[=⁴Lagenidea LANKESTER, 1885, p. 847; =⁵Lagenidae DELAGE & HÉROUARD, 1896, p. 136; =⁴Lagenaceae HARTOG in HARMER & SHIPLEY, 1906, p. 59; =⁴Lagenida CALKINS, 1909, p. 39]—[=⁴Nodosalidia CALKINS, 1926, p. 355; =⁴Nodosaridia KÜHN, 1926, p. 135; =⁴Nodosarioidea WEDEKIND, 1937, p. 86; =⁵Cristellariaceat WEDEKIND, 1937, p. 93; =⁵Lenticulinacea WEDEKIND, 1937, p. 99; =⁵Poly-morphinacea WEDEKIND, 1937, p. 103; =⁵Rubulinacea WEDEKIND, 1937, p. 104]—[=⁴Buliminida FURSENKO, 1958, p. 24]—[=⁴Chilostomellidae LANKESTER, 1885, p. 847; =⁵Chilostomellidae DELAGE & HÉROUARD, 1896, p. 138; =⁵Chelostomellaceae HARTOG in HARMER & SHIPLEY, 1906, p. 59; =⁵Chilostomellida CALKINS, 1909, p. 39]—[=⁴Rotalida LANKESTER, 1885, p. 847; =⁵Rotalidae DELAGE & HÉROUARD, 1896, p. 143; =⁵Rotaliaceae HARTOG in HARMER

& SHIPLEY, 1906, p. 59; =⁴Rotalida CALKINS, 1909, p. 39; =⁴Rotaliaria KÜHN, 1926, p. 152; =⁵Rotaliaceae WEDEKIND, 1937, p. 85, 115; =⁴Rotaliida FURSENKO, 1958, p. 23]—[=⁴Globigerinidae LANKESTER, 1885, p. 847; =⁵Globigerinidae DELAGE & HÉROUARD, 1896, p. 141; =⁵Globigerinidae HARTOG in HARMER & SHIPLEY, 1906, p. 59; =⁵Globigerinida CALKINS, 1909, p. 39; =⁴Heterohellicida FURSENKO, 1958, p. 24]—[=⁴Nummulinidae LANKESTER, 1885, p. 848; =⁵Nummulitidae DELAGE & HÉROUARD, 1896, p. 147; =⁵Nummulitidae LISTER in LANKESTER, 1903, p. 146; =⁴Nummulitaceae HARTOG in HARMER & SHIPLEY, 1906, p. 59; =⁴Nummulitida CALKINS, 1909, p. 39; =⁵Nummulitacea WEDEKIND, 1937, p. 119; =⁴Nummulitinidae COPELAND, 1956, p. 188]—[=⁵Tinoporinae CALKINS, 1901, p. 109; =⁴Textulinida CALKINS, 1926, p. 356]

Wall calcareous, perforate. *Perm.-Rec.*

Superfamily NODOSARIACEA Ehrenberg, 1838

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 295 (*pro* superfamily Nodosariidea NØRVANG, 1957, p. 23, *nom. transl. ex* family Nodosarina EHRENBURG, 1838)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (²superfamily, ³group, ³family group) and a dagger(†) indicates *partim*]—[=²Lagenidae BÜTSCHLI in BRONN, 1880, p. 196; =²Titanostichostegia EIMER & FICKERT, 1899, p. 676; =¹Enclinosstegiat EIMER & FICKERT, 1899, p. 682 (*nom. nud.*); =³Nodosalidiat RHUMBLER in KÜENTHAL & KRUMBACH, 1923, p. 86; =¹Lagenidea GLAESSNER, 1945, p. 126; =¹Lagenicae EASTON, 1960, p. 65, 78]

Wall of finely perforate, radial laminated calcite; chambers planispirally coiled or uncoiled, or straight, or coiled about longitudinal axis; aperture peripheral or terminal, typically radiate, or may be slitlike or rounded. *Perm.-Rec.*

Family NODOSARIIDAE Ehrenberg, 1838

[*nom. correct.* LISTER in LANKESTER, 1903, p. 144 (*pro* family Nodosarina EHRENBURG, 1838, p. 200)]—[All names of family rank, a dagger(†) indicates *partim*]—[=²Polystomat LATREILLE, 1825, p. 161 (*nom. nud.*); =²Polythalamiat LATREILLE, 1825, p. 161 (*nom. nud.*); =⁵Helicosteguest D'ORBIGNY, 1826, p. 268 (*nom. nud., nom. neg.*); =⁵Stichosteguest D'ORBIGNY, 1826, p. 251 (*nom. nud., nom. neg.*); =⁵Stichostegiat REUSS, 1860, p. 151, 178]—[=⁵Equilateralidae D'ORBIGNY in DE LA SAGRA, 1839, p. xxxvii, 11 (*nom. nud.*); =⁵Aequilateralidae D'ORBIGNY, 1846, p. 28]—[=⁵Nautiloidae D'ORBIGNY in DE LA SAGRA,

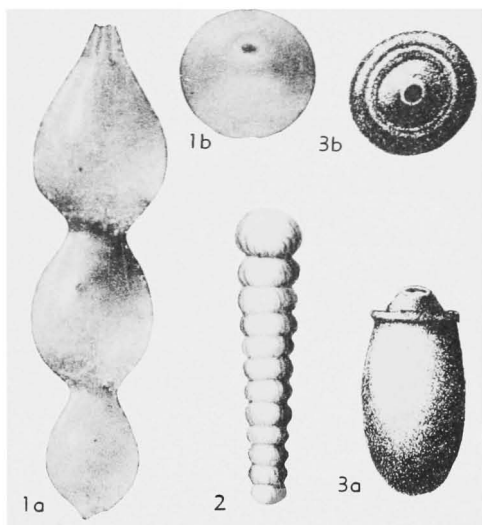


FIG. 400. Nodosariidae (Nodosariinae; 1-3, *Nodosaria*) (p. C512).

1839, p. xxxviii, 38 (*nom. nud.*); =Nautiloidae SCHULTZE, 1854, p. 53; =Nautiloidea REUSS, 1860, p. 151 (*nom. nud.*)
 —[=Rhizopodest DUJARDIN, 1841, p. 126, 240 (*nom. nud.*, *nom. neg.*); =Rhabdoidae REUSS, 1862, p. 365 (*nom. nud.*); =Rhabdoidat BÜTSCHLI in BRONN, 1880, p. 197 (*nom. nud.*)]
 —[=Fronicularidae REUSS, 1860, p. 151, 191; =Fronicularidae GÜMBEL, 1870, p. 53]
 —[=Vaginulinidae REUSS, 1860, p. 151; =Vaginulinidae GÜMBEL, 1868, p. 53]
 —[=Dentalinoidea SCHWAGER, 1877, p. 18; =Les Lenticulacées LAMARCK, 1809, p. 322 (*nom. neg.*); =Lenticulinidae CHAPMAN, PARR & COLLINS, 1934, p. 554; =Robulinidae WEDEKIND, 1937, p. 104; =Marginulinellidae WEDEKIND, 1937, p. 94; =Marginulinidae WEDEKIND, 1937, p. 99; =Hydromylinidae DE WITT PUYT, 1941, p. 54]
 —[=Lagenida REUSS, 1862, p. 305; =Lagenida CARPENTER, PARKER & JONES, 1859, p. 154; =Lagenidae GÜMBEL, 1870, p. 28; =Lagene SCHWAGER, 1876, p. 476; =Lagenoidea SCHWAGER, 1877, p. 18; =Lagenidae SCHULZE, 1877, p. 29; =Lagenina LANKSTER, 1885, p. 847; =Lagenetta HAECKEL, 1894, p. 164; =Lageninae DELAGE & HÉROUARD, 1896, p. 137; =Lagenides GADEA-BUISÁN, 1947, p. 18 (*nom. neg.*)]
 —[=Nodosaria SCHULTZE, 1854, p. 53; =Nodosariidae REUSS, 1860, p. 151, 178; =Nodosariidae GÜMBEL, 1870, p. 30; =Nodosarie SCHWAGER, 1876, p. 476; =Nodosaretta HAECKEL, 1894, p. 164; =Nodosariinae DELAGE & HÉROUARD, 1896, p. 137; =Arnodosariidae RHUMBLER, 1913, p. 342 (*nom. van.*); =Nodosariellidae WEDEKIND, 1937, p. 93; =Plectofroniculariidae MONTANARO GALLITELLI, 1957, p. 143]
 —[=Orthocera, and Orthocérés de BLAINVILLE, 1825, p. 376; =Orthocerataet BRODERIP, 1839, p. 321; =Radiolidaet CROUCH, 1827, p. 41 (*nom. nud.*); =Radiolididae BRODERIP, 1839, p. 321; =Orthocerinida SCHMARDT, 1871, p. 165; =Cristaceat & Cristacés de BLAINVILLE, 1825, p. 383; =Spherulacea and Sphérulacés de BLAINVILLE, 1825, p. 369]

Test free, one or more chambers in planispiral, biserial, uncoiling, curved or straight series; aperture simple, slitlike or radiate, peripheral in coiled forms, terminal in straight forms, may have apertural chamberlet, or may have elongate neck. *Perm.-Rec.*

Subfamily NODOSARIINAE Ehrenberg, 1838

[*nom. correct.* CHAPMAN, 1900, p. 30 (*pro* subfamily Nodosariidae REUSS, 1862, p. 334, *nom. transl. ex* family Nodosaria EHRENBURG, 1838)]
 —[All names of subfamily rank]
 —[=Vaginulinidae REUSS, 1862, p. 366; =Fronicularidae

REUSS, 1862, p. 307, 335, 366, 395; =Dentalinidae SCHWAGER, 1877, p. 18; =Lageninae BRADY, 1881, p. 44; =Nodosariinae BRADY, 1884, p. 69; =Glandulonodosariinae SILVESTRI, 1901, p. 109; =Froniculariinae GALLOWAY, 1933, p. 235; =Robulininae GALLOWAY, 1933, p. 250; =Lenticulininae CHAPMAN, PARR & COLLINS, 1934, p. 554; =Marginulininae NØRVANG, 1957, p. 83 (*nom. imperf.*); =Lenticulininae NØRVANG, 1957, p. 93 (*nom. imperf.*)

Test with one or more chambers arranged in straight, arcuate or enrolled series; aperture terminal, rounded or radiate. *Perm.-Rec.*

Nodosaria LAMARCK, 1812, *1087, p. 121 [**Nautilus radícula* LINNÉ, 1758, *1140, p. 711; SD (SM) LAMARCK, 1816, *1089, pl. 465] [=Orthocera MODEER in SOLDANI, 1789, *1809, p. 41 (*obj.*); SD MELVILLE, 1959, *1253, p. 21, *nom. reject.* ICZN pending, see MELVILLE, 1959, *1253; *Orthocera* LAMARCK, 1799, *1083, p. 80 (type, *Nautilus raphanus* LINNÉ, 1758, *1140, p. 711) (*non Orthocera* MODEER, 1789, *nom. reject.* ICZN pending, see MELVILLE, 1959, *1253); *Nodosarina* PARKER & JONES, 1859, *1417a, p. 477 (type, *Nautilus raphanus* LINNÉ, 1758); *Pyramidulina* COSTA in FORNASINI, 1894, *731, p. 224 (type, *Pyramidulina eptagona* COSTA, 1894); *Herrmannia* ANDREAE, 1895, *20, p. 172 (*nom. nud.*); *Nodosariopsis* RZEHA, 1895, *1605, p. 228 (type, *Nodosaria perforata* SEGUENZA, 1880, *1713, p. 332, SD LOEBLICH & TAPPAN, herein); *Lagena* (*Cidaria*) GRZYBOWSKI, 1896, *835, p. 267, 292 (type, *Lagena* (*Cidaria*) *cidarina* GRZYBOWSKI, 1896, SD LOEBLICH & TAPPAN, herein) (*non Cidaria* TREITSCHKE, 1825); *Glandulonodosaria* SILVESTRI, 1900, *1751, p. 4 (type, *Nodosaria ambigua* NEUGEBORN, 1856, *1351, p. 71; *Pseudoglandulina* CUSHMAN, 1929, *442, p. 87 (type, *Nautilus comatus* BATSCHE, 1791, *102, pl. i, fig. 2a,b; *Nodosariella* WEDEKIND, 1937, *2041, p. 93 (type, *Nautilus raphanus* LINNÉ, 1758)). Test free, multilocular, rectilinear, rounded in section, sutures distinct and commonly perpendicular to axis of test, surface smooth, costate, striate, hispid or tuberculate; aperture terminal, central basically radiate, may be produced on neck. *Perm.-Rec.*, cosmop.—FIG. 400.1. **N. radícula* (LINNÉ), U. Plio., Italy; 1a,b, side, top views, ×40 (*7).—FIG. 400.2. *N. ambigua* NEUGEBORN, Mio., Rumania; ×25 (*700).—FIG. 400.3. *N. cidarina* (GRZYBOWSKI), L.Oligo., Pol.; 3a,b, side, top views, ×45 (*835).

Alfredosilvestris ANDERSEN, 1961, *18, p. 71 [**A. levinsoni*; OD]. Test free, uniserial, chambers of microspheric form and early chambers of megalospheric form arched and compressed with chevron-shaped sutures, as in *Lingulina*, later chambers rounded in section, with straight and horizontal sutures; aperture terminal, radiate. [*Alfredosilvestris* resembles *Lingulina* in the compressed early stage, but differs in having a radiate instead of slitlike aperture.] *Rec.*, USA (La.).—FIG. 401.8. **A. levinsoni*; 8a,b, side, edge views of megalospheric holotype, ×66 (*18).

Amphicoryna SCHLUMBERGER in MILNE-EDWARDS, 1881, *1285, p. 881 [**Marginulina falx* JONES & PARKER, 1860, *998, p. 302; SD (SM) BRADY,

1884, *200, p. 556, = *Nautilus scalaris* BATSCH, 1791, *102, p. 1, 4] [= *Plesiocorine* SCHLUMBERGER in MILNE-EDWARDS, 1882, *1286, p. 31

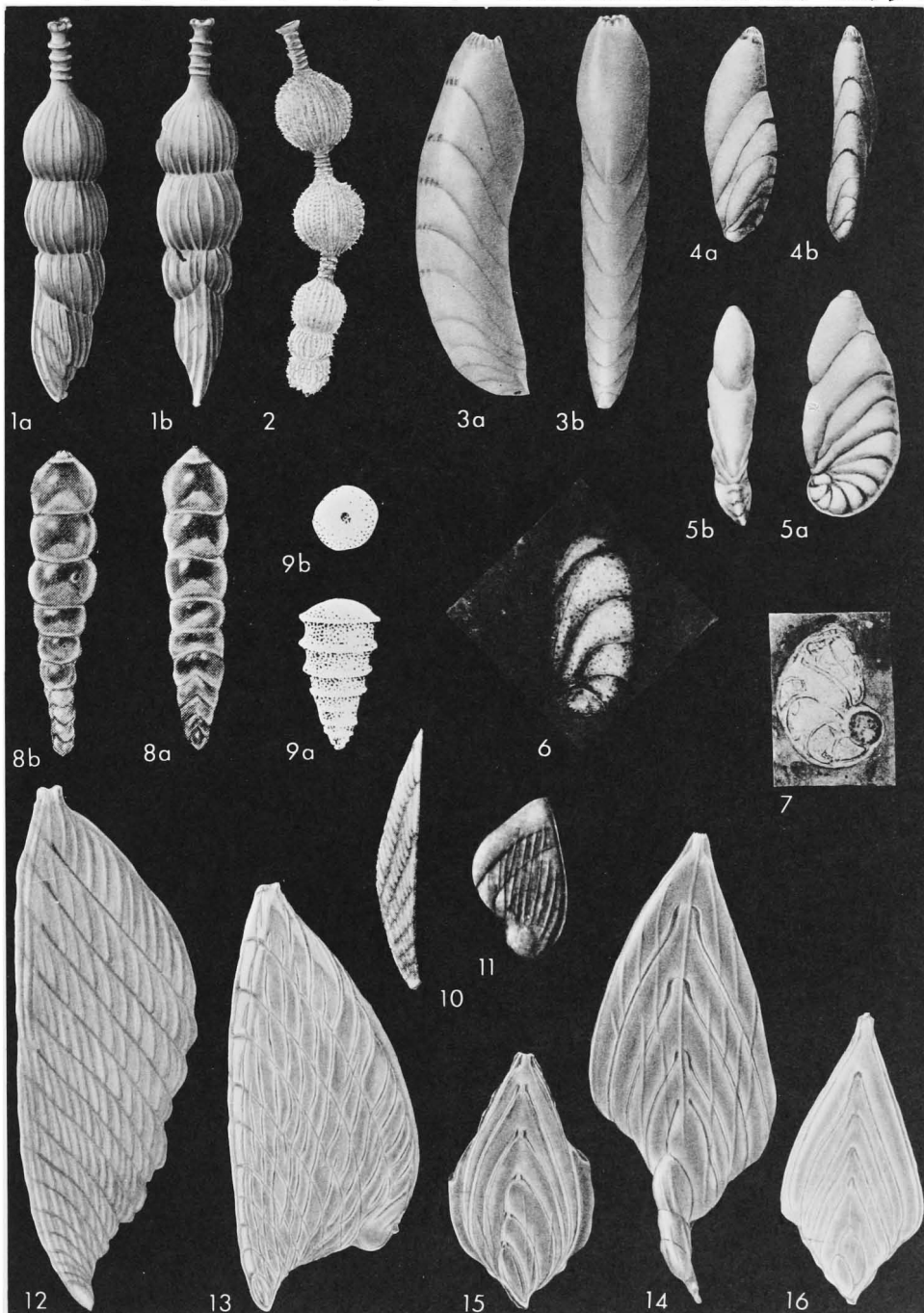


FIG. 401. Nodosariidae (Nodosariinae; 1,2, *Amphicoryna*; 3-7, *Astacolus*; 8, *Alfredosilvestris*; 9, *Austrocolomia*; 10-13, *Citharina*; 14-16, *Citharinella*) (p. C512-C516).

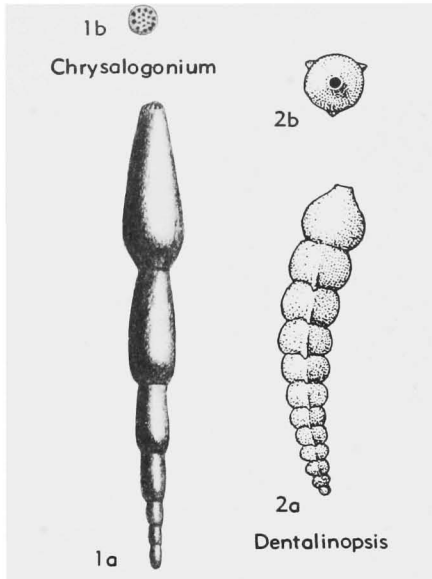


FIG. 402. Nodosariidae (Nodosariinae; 1, *Chrysalogonium*; 2, *Dentalinopsis*) (p. C514, C516).

(type, *P. edwardsi* SCHLUMBERGER, 1882); *Plesio-coryna* SCHLUMBERGER in MILNE-EDWARDS, 1882, *1286, p. 31 (nom. null.); *Amphicoryne* BRADY, 1884, *200, p. 556 (nom. van.); *Amphycorina* DE FOLIN & PERIER, 1887, *727Ab, p. 159 (nom. null.); *Lagenonodosaria* SILVESTRI, 1900, *1751, p. 3 (type, *Nodosaria scalaris* var. *separans* BRADY, 1884, *200, p. 510); *Nodosariopsis* SILVESTRI, 1902, *1755, p. 52 (type, *Marginulina falx* JONES & PARKER, 1860, SD LOEBLICH & TAPPAN, herein (obj.) (non *Nodosariopsis* RZEHA, 1895; =? *Vaginuloglandulina* SILVESTRI, 1906, *1764, p. 24 (type, *V. laevigata*)). Test free, elongate, early chambers compressed, in microspheric form arranged in loose coil as in *Astaculus*, later development uniserial; sutures oblique and flush in early stages, later constricted and horizontal; wall smooth or longitudinally costate; aperture terminal, radiate, at end of distinct neck. *Mio.-Rec.*, cosmop.—FIG. 401.1. *A. scalaris* (BATSCH), Rec., Syra Arch., Medit.; 1a,b, side, dorsal views, $\times 46$ (*2117).—FIG. 401.2. *A. separans* (BRADY), Rec., Pac.; $\times 17$ (*2117).

Astaculus DE MONTFORT, 1808, *1305, p. 262 [*Astaculus crepidulatus* DE MONTFORT, 1808, = *Nautilus crepidulus* FICHEL & MOLL, 1798, *716, p. 64; OD] [= *Chrysolus* DE MONTFORT, 1808, *1305, p. 26 (obj.); *Periples* DE MONTFORT, 1808, *1305, p. 270 (type, *P. elongatus* DE MONTFORT, 1808); *Crepidulina* DE BLAINVILLE, 1824, *141a, p. 188 (type, *C. astaculus* DE BLAINVILLE, 1824, = *Nautilus crepidulus* FICHEL & MOLL, 1798, SD LOEBLICH & TAPPAN, herein) (obj.);

Cochlidion ZALESSKY, 1926, *2099, p. 92 (type, *C. alexandrae* ZALESSKY, 1926); *Cochlea* ZALESSKY, 1926, *2099, p. 93 (type, *C. sapracolli* ZALESSKY, 1926, SD LOEBLICH & TAPPAN, herein) (non *Cochlea* DA COSTA, 1778; nec MARTYN, 1784; nec HITCHCOCK, 1888); *Polymorphinella* CUSHMAN & HANZAWA, 1936, *504, p. 46 (type, *P. vaginulinaeformis* CUSHMAN & HANZAWA, 1936); *Polymorphinoides* CUSHMAN & HANZAWA, 1936, *504, p. 48 (type, *P. spiralis* CUSHMAN & HANZAWA); *Sacculariella* WEDEKIND, 1937, *2041, p. 102 (type, *S. ensis* WEDEKIND, 1937); *Gladiaria* WEDEKIND, 1937, *2041, p. 105 (nom. nud.) (non WICK, 1939); *Gladiaria* WICK, 1939, *2059, p. 479 (type, *Cristellaria hermanni* ANDRAE, 1896, *21, p. 298); *Gladiaria* THALMANN, 1941, *1897e, p. 652 (type, *Cristellaria decorata* REUSS, 1855, *1544, p. 269) (non *Gladiaria* WICK, 1939); *Enantiovaginulina* MARIE, 1941, *1215, p. 160, 255 (type, *Cristellaria recta* D'ORBIGNY, 1840, *1394, p. 28)]. Test free, elongate, arcuate, compressed; chambers numerous, low, broad, added along slightly curved axis; sutures oblique, highest at outer margin, curved, straight or sinuate; aperture radiate, terminal, at peripheral angle. *Perm.-Rec.*—FIG. 401.3. *A. crepidulus* (FICHEL & MOLL), Plio., Italy; 3a,b, side, face views, $\times 33$ (*2117).—FIG. 401.4. *A. vaginulinaeformis* (CUSHMAN & HANZAWA), Pleist., Ryukyu Is.; 4a,b, side, dorsal views, $\times 33$ (*504).—FIG. 401.5. *A. spiralis* (CUSHMAN & HANZAWA), Pleist., Ryukyu Is.; 5a,b, side, face views, $\times 22$ (*504).—FIG. 401.6. *A. alexandrae* (ZALESSKY), Jur., USSR; $\times 73$ (*2099).—FIG. 401.7. *A. sapracolli* ZALESSKY, Jur., USSR; $\times 73$ (*2099).

[*Astaculus* differs from *Vaginulina* in having oblique sutures and a more distinctly curved axis. It differs from *Lenticulina* in having a curved axis, rather than a closely enrolled test, and in later chambers being added so as to touch only the chamber immediately preceding, and in not being involute. Slightly irregular forms have been described as *Enantiovaginulina*, *Polymorphinella*, and *Polymorphinoides*, but as some specimens of most nodosariid genera may show irregular chamber development, this is not regarded as of generic or even specific importance.]

Austrocolomia OBERHAUSER, 1960, *1384, p. 37 [*A. marschalli*; OD]. Similar to *Nodosaria*, but with rounded aperture and no neck; chambers considerably overlapping and in type-species with elevated "sutures"; wall single-layered. *U.Trias. (Carn.)*, Aus.—FIG. 401.9. *A. marschalli*; 9a,b, side, top views, $\times 45$ (*1384).

Chrysalogonium SCHUBERT, 1907 (separate of 1908), *1687, p. 243 [*Nodosaria polystoma* SCHWAGER, 1866, *1703, p. 217; OD (M)]. Test similar to *Nodosaria* but with series of pores taking place of radial apertural slits of *Nodosaria*. *U. Cret.-Rec.*, Pac.-N. Am.-Eu.-Atl.-Carib.—FIG. 402.1. *C. polystoma* (SCHWAGER), U.Tert., India (Kar Nicobar); 1a,b, side, top views, $\times 22.5$ (*700).

Citharina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. xxxvii [*Vaginulina (Citharina) strigillata* REUSS, 1846, *1538, p. 106; SD LOEBLICH & TAP-

PAN, 1949, *1156, p. 259] [= *Cytharina* D'AR-
CHAIC, 1843, *36, p. 333 (*nom. null.*); *Hy-*
bridina KÜBLER & ZWINGLI, 1866, *1060, p. 8

(type, *H. obliqua* KÜBLER & ZWINGLI, 1866, SD
LOEBLICH & TAPPAN, herein); *Pseudovaginulina*
WEDEKIND, 1937, *2041, p. 95 (type, *P. oxyacan-*

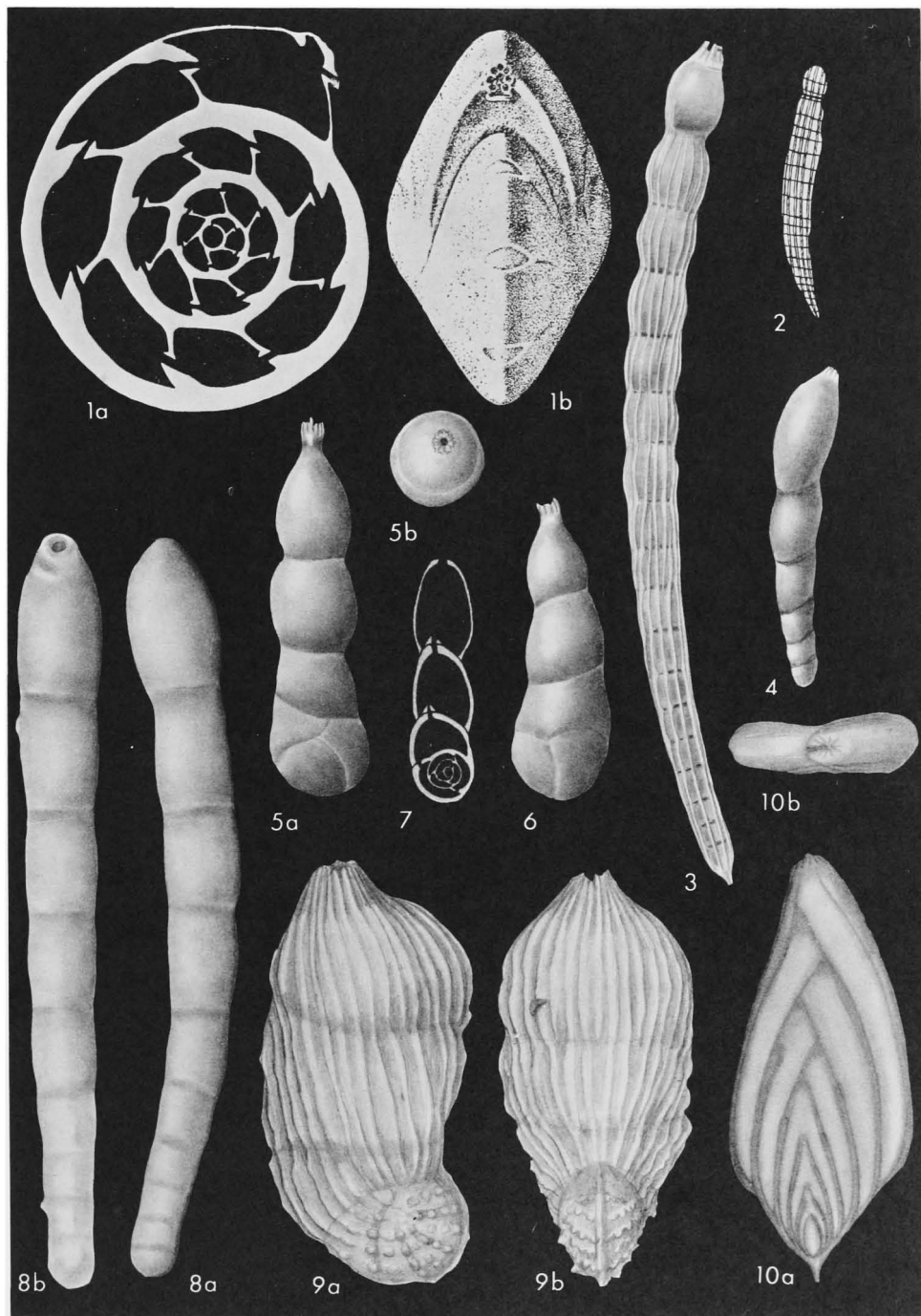


FIG. 403. Nodosariidae (Nodosariinae; 1, *Cribrorobulina*; 2-4, *Dentalina*; 5-7, *Dimorphina*; 8, *Dentalinoides*; 9, *Marginulinopsis*; 10, *Dyojronidularia*) (p. C516, C521-C522).

- tha* WEDEKIND, 1937); *Saccularia* WEDEKIND, 1937, *2041, p. 95 (type, *Marginulina inaequistriata* TERQUEM, 1864, *1885, p. 401); *Pseudocitharina* PAYARD, 1947, *1432, p. 118 (type, *Marginulina colliciei* TERQUEM, 1866, *1886, p. 430)]. Test flattened, subtriangular in outline, may be keeled; chambers numerous, extending nearly to base at inner margin; wall smooth, striate or costate; aperture radiate, at outer margin. *L.Jur.-Paleoc.*, cosmop.—FIG. 401,10. **C. strigillata* (REUSS), *Cret.*, Boh.; enlarged (*700).—FIG. 401,11. *C. inaequistriata* (TERQUEM), *L.Jur.* (Lias.), Ger.; $\times 20$ (*92).—FIG. 401,12. *C. colliciei* (TERQUEM), *L.Jur.* (U.Lias.), Fr.; lectotype here designated and refigured (specimen in TERQUEM Coll., Muséum Natl. Hist. Nat., Paris, *1886, pl. 17, fig. 10), $\times 48$ (*2117).—FIG. 401,13. *Citharina discors* (KOCH), *L.Cret.* (Gault), Eng.; $\times 46$ (*2117).
- Citharinella** MARIE, 1938, *1214, p. 99 [**Flabellina karreri* BERTHELIN, 1880, *133, p. 62; OD]. Test free, flattened, lanceolate to flabelliform, chambers low, broad, uniserial early ones arranged as in *Citharina*, extending backward toward ovate or fusiform proloculus at one side, later chambers chevron-shaped and symmetrical, as in *Fron-dicularia*; surface may be smooth, costate or striate; aperture terminal, slightly produced, radial. *Jur.-Cret.*, Eu.-N.Am.—FIG. 401,14. **C. karreri* (BERTHELIN), *L.Cret.* (Alb.), Eng.; $\times 100$ (*2117).—FIG. 401,15,16. *C. tarrantensis* (LOEBLICH & TAPPAN), *L.Cret.* (Alb.), USA (Tex.); 15,16, megalospheric and microspheric tests, $\times 44$ (*2117).
- Cribrorobulina** THALMANN, 1947, *1897g, p. 372 [**Robulina serpens* SEGUENZA, 1880, *1713, p. 143; OD] [= *Cribrorobulina* SELLI, 1941, *1716, p. 90 (*nom. nud.*)]. Test like *Lenticulina*, but aperture consisting of numerous small round openings instead of being radiate. *Mio.-Rec.*, Eu.—FIG. 403,1. **C. serpens* (SEGUENZA), *L.Plio.*, Italy; 1a,b, sec. and idealized apert. view, $\times 66$ (*1716).
- Dentalina** RISSO, 1826, *1579a, p. 16 [**Nodosaria (Dentaline) cuvieri* D'ORBIGNY, 1826, *1391, p. 255, OD (M)] [= *Les Dentalines* D'ORBIGNY, 1826, *1391, p. 254 (*nom. neg.*); *Svenia* BROTZEN, 1937, *238, p. 66 (type, *Nodosaria laevigata* NILSSON, 1826, *1358, p. 342); *Dentalinella* WEDEKIND, 1937, *2041, p. 94 (type, *D. cuneata* WEDEKIND, 1937); *Enantiodentalina* MARIE, 1941, *1215, p. 149, 255 (type, *Nodosaria (Dentaline) communis* D'ORBIGNY, 1826, *1391, p. 254)]. Test elongate, arcuate, uniserial; sutures commonly oblique; aperture radiate, terminal, may be eccentric or nearly central. [Differs from *Nodosaria* in being asymmetrical.] *Perm.-Rec.*, cosmop.—FIG. 403,2,3. **D. cuvieri*, Rec., Adriatic (2), Rec., Gulf Mex. (3); 2, enlarged (*700); 3, $\times 22$ (*2117).—FIG. 403,4. *D. trujilloi* LOEBLICH & TAPPAN [*nom. nov. pro Dentalina intermedia* REUSS, 1860, *1548, p. 186 (*non Dentalina intermedia* CORNUEL, 1848; *nec* HANTKEN, 1875)], *U.Cret.* (Cenom.), USA (Tex.); $\times 48$ (*2117).
- Dentalinoides** MARIE, 1941, *1215, p. 207, 256 [**D. canulina*; OD]. Test elongate, straight or slightly arcuate, uniserial, circular in section; sutures horizontal; wall calcareous, perforate; aperture large, rounded, slightly to one side of center and opening toward concave side of arcuate test. *U.Cret.*, Eu.-N.Am.—FIG. 403,8. **D. canulina*, Senon., Fr.; 8a,b, $\times 216$ (*2117).
- [This genus was originally placed in the Ellipsoidinidae (=Pleurostomellidae) because of the eccentric rounded aperture, but that family consists of perforate granular-walled forms with internal siphons between chambers, neither of which have been demonstrated for *Dentalinoides*. It is here placed with the Nodosariidae, differing from *Dentalina* in the rounded, rather than radiate aperture.]
- Dentalinopsis** REUSS, 1860, *1547, p. 81 [**D. semitriquetra*; OD (M)]. Test free, elongate, uniserial, straight or arcuate, early chambers angled or triangular in section, later rounded; aperture terminal, rounded. *L.Cret.*, cosmop.—FIG. 402,2. **D. semitriquetra*, Apt., Ger.; 2a,b, side, top views, enlarged (*762).
- [Placed in the family Buliminidae (subfamily Uvigerininae) by CUSHMAN (*486) and in the Uvigerinidae (subfamily Angulogerininae) by GALLOWAY (*762), the genus is here believed closely related to the Nodosariidae. It cannot be an end member of the above-mentioned subfamilies, as it is found only in the Lower Cretaceous, whereas these subfamilies are largely Cenozoic. The absence of phialine lip and internal tube also indicates that it is not related to these forms. Jurassic species previously placed here should be referred to *Tristix*.]
- Dimorphina** D'ORBIGNY, 1826, *1391, p. 264 [**D. tuberosa*; OD (M)] [= *Glandulodimorphina* A. SILVESTRI, 1901, *1752, p. 17 (type, *Dimorphina tuberosa* D'ORBIGNY, 1826, SD LOEBLICH & TAPPAN, herein (obj.))]. Test free, elongate, early portion close-coiled, later uncoiling and uniserial, as in *Marginulina*; aperture terminal, radiate, produced on neck, at the outer margin. [*Dimorphina* differs from *Marginulina* in having an enrolled early stage. Regarded previously as having an initial polymorphine stage (*486), it is now known to be lenticuline in early development (*1717).] *Jur.-Rec.*, cosmop.—FIG. 403,5-7. **D. tuberosa*, Plio., Italy (5,6), Rec., Adriatic (7); 5a,b, side, top views; 6, side view; all $\times 44$ (*2117); 7, sec. showing early coil, $\times 24$ (*1717).
- Dyofron-dicularia** ASANO, 1936, *46, p. 330 [**D. nipponica*; OD]. Test free, elongate, flattened, early chambers equitant, uniserially arranged, later broad, low chambers biserially arranged; aperture radiate. *Plio.*, Japan.—FIG. 403,10. **D. nipponica*; 10a,b, side, top views of holotype, refigured, $\times 48$ (*2117).
- Flabellinella** SCHUBERT, 1900, *1680, p. 551 [**Fron-dicularia tetschensis* MATOUSCHEK, 1895, *1235, p. 143; OD (M)]. Early stage as in *Vaginulina*, later chambers equitant as in *Fron-dicularia*; aperture radiate. *U.Cret.*, Eu.—FIG. 404,4. *F. zitteliana* (EGGER), *U.Cret.*, Bavaria, 4a,b, side, top views, $\times 44$ (*2117).
- Fron-dicularia** DEFRANCE in D'ORBIGNY, 1826, *1391,

p. 256 [**Renulina complanata* DEFRANCE, 1824, *141a, p. 178, SD CUSHMAN, 1913, *404c, p. 81] [= *Pleiona* FRANZENAU, 1888, *744, p. 146, 203

(type, *P. princeps* FRANZENAU, 1888) (non *Pleiona* DEYROLLE, 1864; nec PAETEL, 1875); *Frondo-vaginulina* SCHUBERT, 1912, *1691, p. 179 (type,

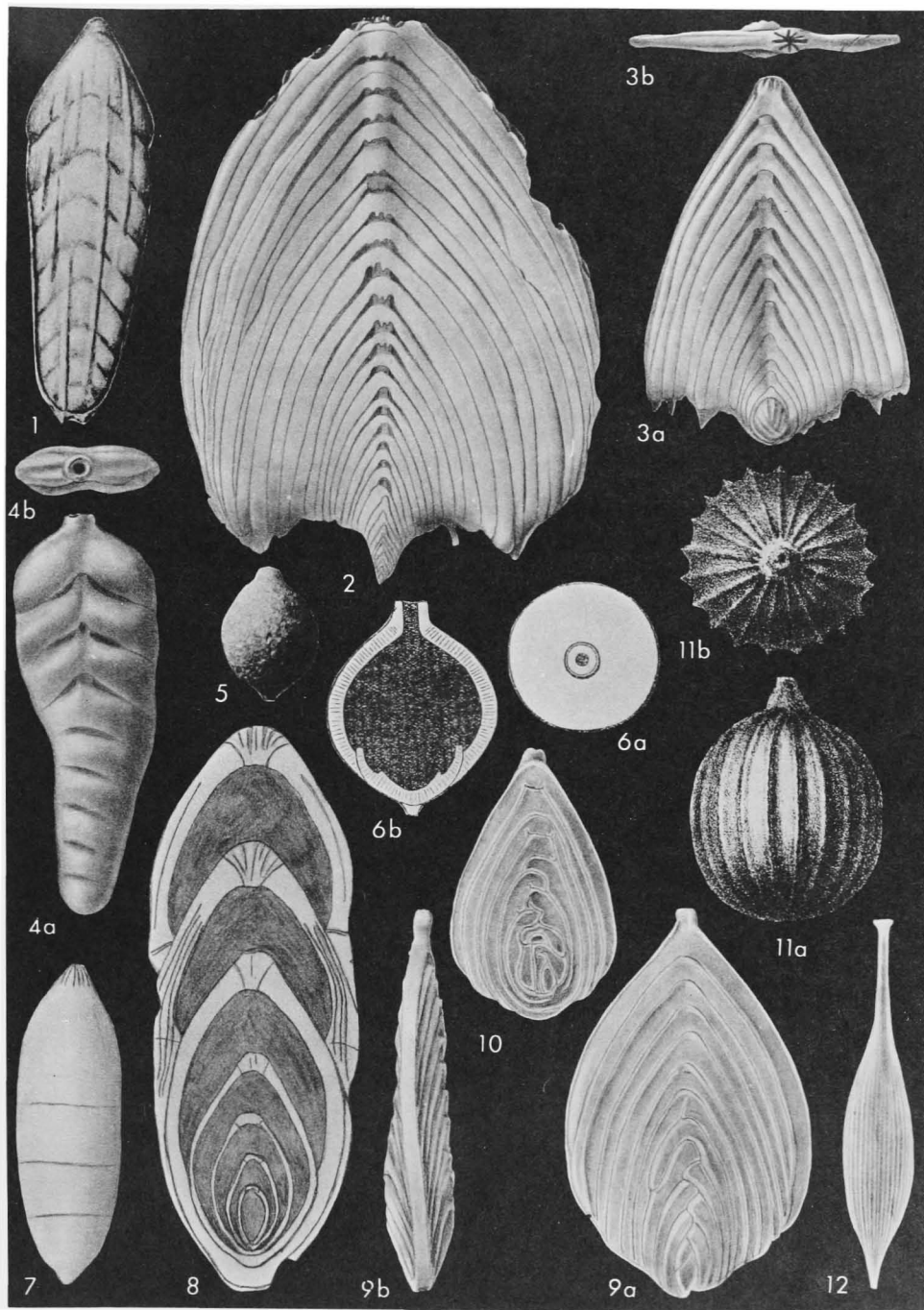


FIG. 404. Nodosariidae (Nodosariinae; 1-3, *Frondicularia*; 4, *Flabellinella*; 5, 6, *Lagenoglandulina*; 7, 8, *Involutaria*; 9, 10, *Kyphopyxa*; 11, 12, *Lagena*) (p. C516-C518).

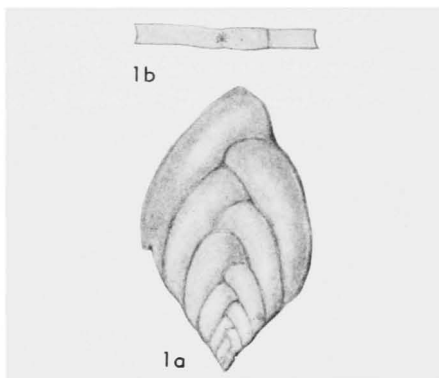


FIG. 405. Nodosariidae (Nodosariinae; 1, *Lankesterina*) (p. C518).

Fronicularia inversa REUSS, 1844, *1537, p. 211, SD LOEBLICH & TAPPAN, herein); *Ichthyolaria* WEDEKIND, 1937, *2041, p. 93 (type, *Fronicularia bicostata* D'ORBIGNY, 1850, *1397b, p. 242); *Pseudofronicularia* WEDEKIND, 1937, *2041, p. 94 (type, *Fronicularia carinata* BURBACH, 1886, *253a, p. 47); *Annulofronicularia* KEIJZER, 1945, *1030, p. 196 (type, *Fronicularia annularis* D'ORBIGNY, 1846, *1395, p. 59)]. Test free, elongate or palmate, flattened; chambers low, broad, and equitant; sutures strongly arched or angled at center of test; aperture terminal, radiate, may be produced on short neck. *Perm.-Rec.*—FIG. 404,1. *F. bicostata* D'ORBIGNY, L.Jur. (M. Lias.), Fr.; side view of holotype, $\times 36$ (*1198). —FIG. 404,2,3. **F. complanata* (DEFrance), M.Plio. (Piacenz.), Italy; 2, microspheric form, $\times 10$; 3a,b, megalospheric form, $\times 10$ (*2117).

Involutaria GERKE, 1957, *778, p. 33 [**I. triassica*; OD]. Test elongate, chambers uniserially arranged, similar to *Nodosaria* or *Pseudonodosaria*, but with early chambers (wall and chamber cavity) completely overlapping and only few final chambers not enclosing all previous ones; wall calcareous, finely perforate, hyaline, radial; aperture terminal, radiate. *U.Trias.*, USSR (Krasnodar). —FIG. 404, 7,8. **I. triassica*; 7, side view of holotype, $\times 45$; 8, long. sec., $\times 83$ (*778).

Kyphopyxa CUSHMAN, 1929, *440, p. 1 [**Fronicularia christneri* CARSEY, 1926, *282, p. 41; OD]. Test palmate, early chambers citharine in microspheric form, followed by biserial stage which occupies about half of test, final chambers uniserial, equitant, and strongly overlapping, random chambers may even envelop early stage and be cyclical; sutures commonly thickened and elevated; aperture terminal, radiate. *U.Cret.*, N.Am. —FIG. 404,9. **K. christneri* (CARSEY), USA (Tex.); 9a,b, side, edge views of topotype, $\times 28$; 10, side view, $\times 28$ (*2117).

Lagena WALKER & JACOB in KANMACHER, 1798, *1011, p. 634 [**Serpula* (*Lagena*) *sulcata* WALKER & JACOB, 1798; SD PARKER & JONES, 1859, *1417b,

p. 337] [= *Serpula* (*Lagena*) BOYS & WALKER, 1784 (publ. rejected, ICZN Op. 558, 1959); *Vermiculum* MONTAGU, 1803, *1298, p. 517 (type, *V. perlucidum* MONTAGU, 1803); *Lagenula* DE MONTFORT, 1808, *1305, p. 311 (type, *L. floscula* DE MONTFORT, 1808); *Amphorina* D'ORBIGNY, 1849, *1396, p. 666 (type, *A. gracilis* COSTA, 1856, *392, p. 121), non *Lagena gracilis* WILLIAMSON, 1848, = *Amphorina costai* ANDERSEN, 1961, *18, p. 78) (non *Amphorina* DE QUATREFAGES, 1844); *Phialina* COSTA, 1856, *392, p. 122 (type, *P. piriformis* COSTA, 1856, SD LOEBLICH & TAPPAN, herein) (non *Phialina* BORY DE ST. VINCENT, 1827); *Tetragonulina* SEGUENZA, 1862, *1712, p. 53 (type, *T. prima* SEGUENZA, 1862); *Capitellina* MARSSON, 1878, *1228, p. 122 (type, *C. multistriata* MARSSON, 1878); *Ectolagena* SILVESTRI, 1900, *1751, p. 4 (type, *Serpula* (*Lagena*) *sulcata* WALKER & JACOB, 1798, SD LOEBLICH & TAPPAN, herein (obj.); *Procerolagena* PURI, 1954, *1487, p. 104 (type, *Lagena gracilis* WILLIAMSON, 1848, *2064, p. 13)]. Test unilocular, rarely 2 or more chambers; surface variously ornamented; aperture on elongate neck which may have phialine lip, not radiate. [Differences in chamber shape are here regarded as of specific, not generic, value, hence the elongate forms (e.g., "*Amphorina*," "*Procerolagena*," FIG. 404,12), are considered congeneric.] *Jur.-Rec.*, cosmop.—FIG. 404,11. **L. sulcata* (WALKER & JACOB), Rec., S.Pac.; 11a,b, side, top views, $\times 80$ (*200). —FIG. 404,12. *L. mollis* CUSHMAN, Rec., Baffin Is.; $\times 102$ (*2117).

Lagenoglandulina SILVESTRI, 1923, *1775, p. 12 [**Glandulina subovata* STACHE, 1865, *1825, p. 185; OD (M)]. Test free, subovate, similar to *Pseudonodosaria* in development, but with final chamber completely overlapping earlier uniserial chambers, which are apparent only in section; aperture terminal, rounded. *Eoc.-Rec.*, N.Z.-Eu.-C.Am.—FIG. 404,5,6. **L. subovata* (STACHE), Eoc., Italy; 5, ext., $\times 15$; 6a,b, outline view of top and long. sec. showing strong overlap of uniserial chambers resulting in unilocular appearance, $\times 34$ (*1775).

Lankesterina LOEBLICH & TAPPAN, 1961, *1181, p. 219 [**Bolivina frondea* CUSHMAN, 1922, *417, p. 126; OD]. Test free, small, symmetrically biserial throughout, with flattened sides and truncate margins; chambers low and broad, as in later stage of *Dyofronicularia*, but without early uniserial stage; wall calcareous, finely perforate; aperture terminal, radial. *Oligo.*, N.Am.—FIG. 405,1. **L. frondea* (CUSHMAN), USA; 1a,b, side, top views, $\times 80$ (*514).

[Differs from *Polymorphina* in being completely symmetrical throughout and in having truncate margins, similar to the other palmate genera of the Nodosariinae, but differs from these in being biserial throughout. *Polymorphina* is somewhat asymmetrical, particularly in its early development, and may show traces of a sigmoid development.]

Lenticulina LAMARCK, 1804, *1085a, p. 186 [**Lenti-*

culites rotulata LAMARCK, 1804; SD CHILDREN, 1823, *337, p. 153] [= *Lenticulites* LAMARCK, 1804, *1085a, p. 187 (obj.); *Phonemus* DE MONT-

FORT, 1808, *1305, p. 11 (type, *Nautilus vortex* FICHTEL & MOLL, 1798, *716, p. 33); *Pharamum* DE MONTFORT, 1808, *1305, p. 34 (type, *Nautilus*

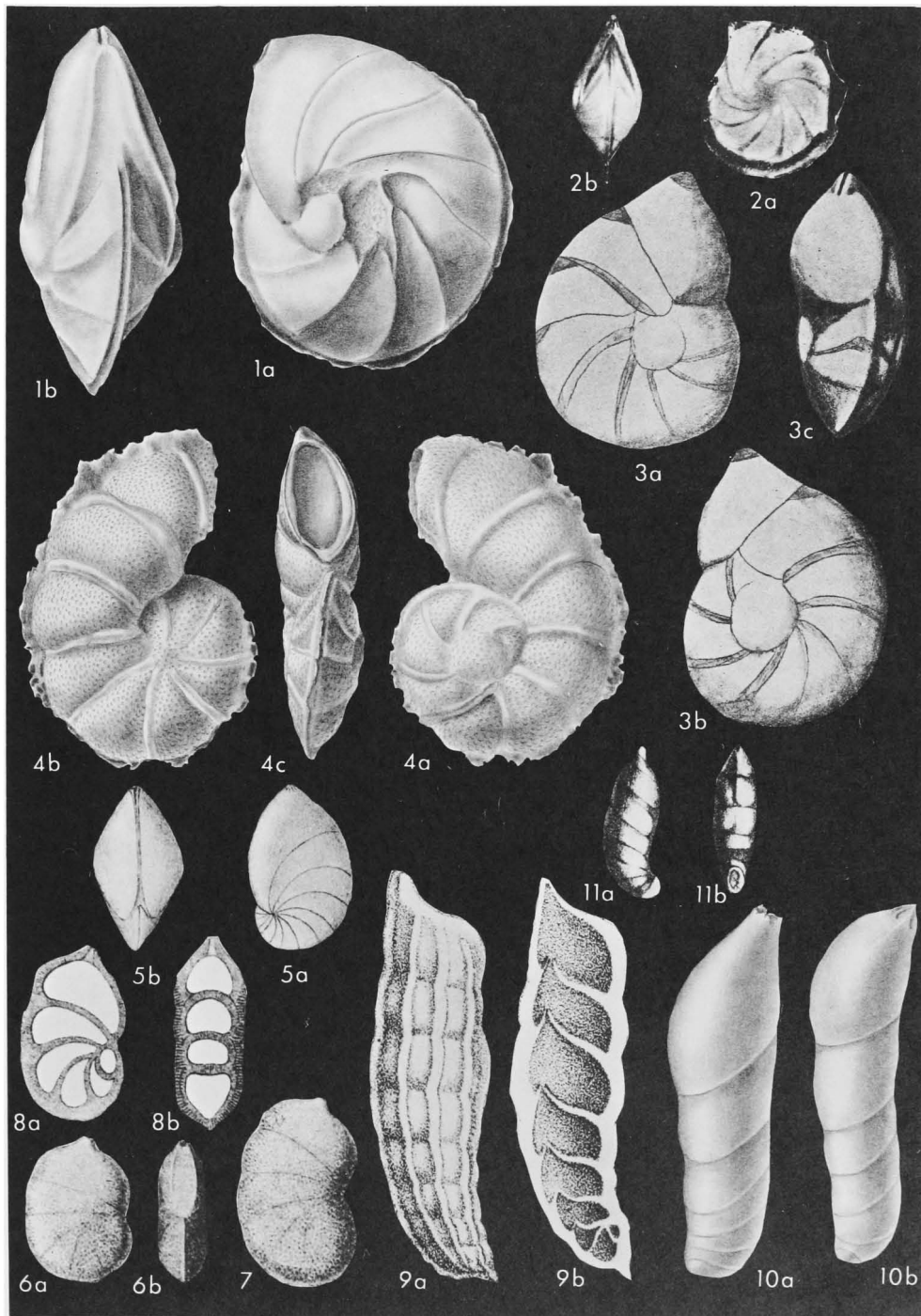


FIG. 406. Nodosariidae (Nodosariinae; 1-8, *Lenticulina*; 9-11, *Marginulina*) (p. C518-C521).

calcar LINNÉ, 1758, *1140, p. 709); *Antenor* DE MONTFORT, 1808, *1305, p. 70 (type, *A. diaphaneus* DE MONTFORT, 1808); *Oreas* DE MONTFORT, 1808, *1305, p. 94 (type, *O. subulatus* DE MONTFORT, 1808, = *Nautilus acutauricularis* FICHEL & MOLL, 1798, *716, p. 102) (non *Oreas* HUEBNER, 1807); *Robulus* DE MONTFORT, 1808, *1305, p. 214 (type, *R. cultratus* DE MONTFORT, 1808); *Patrocles* DE MONTFORT, 1808, *1305, p. 218 (type, *P. querelans* DE MONTFORT, 1808); *Spiniterules* DE MONTFORT, 1808, *1305, p. 222 (type, *Nautilus costatus* FICHEL & MOLL, 1798, *716, p. 47, non *Nautilus* (*Orthoceras*) *costatus* BATSCHE, 1791); *Clisiphontes* DE MONTFORT, 1808, *1305, p. 226 (type, *C. calcar* DE MONTFORT, 1808); *Herion* DE MONTFORT, 1808, *1305, p. 231 (type, *H. rostratus* DE MONTFORT, 1808); *Rhinocurus* DE MONTFORT, 1808, *1305, p. 234 (type, *R. araneosus* DE MONTFORT, 1808); *Macroditis* DE MONTFORT, 1808, *1305, p. 238 (type, *M. cucullatus* DE MONTFORT, 1808); *Lampas* DE MONTFORT, 1808, *1305, p. 242 (type, *L. trithemus* DE MONTFORT, 1808) (non *Lampas* MEUSCHEN, 1787); *Scortimus* DE MONTFORT, 1808, *1305, p. 250 (type, *S. navicularis* DE MONTFORT, 1808); *Linthuris* DE MONTFORT, 1808, *1305, p. 254 (type, *L. cassidatus* DE MONTFORT, 1808); *Robulina* D'ORBIGNY, 1826, *1391, p. 282, 283, 287 (type, *Robulus cultratus* DE MONTFORT, 1808); *Soldania* D'ORBIGNY, 1826, *1391, p. 281 (type, *S. carinata* D'ORBIGNY, 1826; SD LOEBLICH & TAPPAN, herein); *Nautilina* COSTA, 1856, *392, p. 370 (type, *N. puteolana* COSTA, 1856) (non *Nautilina* STEIN, 1850); *Clisiphontes* SCUDDER, 1882, *1709a, p. 77 (nom. van.); *Linthurus* SHERBORN, 1893, *1731a, p. 181, 182 (nom. van. pro *Linthuris* DE MONTFORT, 1808); *Cristellariopsis* RZEHA, 1895, *1605, p. 227 (type, *C. punctata* RZEHA, 1895); *Darbyella* HOWE & WALLACE, 1932, *972, p. 23 (type, *D. danvillensis* HOWE & WALLACE, 1932); *Perisphinctina* WEDEKIND, 1937, *2041, p. 105 (type, *Robulina depauperata* REUSS, 1851, *1541, p. 70) (erroneously cited as *R. pauperata* REUSS, 1851, by THALMANN, 1941, *1897e, p. 658); *Perisphinctina* WICK, 1939, *2059, p. 482 (type, *Cristellaria* (*Robulina*) *articulata* REUSS, 1863, *1553, p. 53, non *Cristellaria articulata* TERQUEM, 1862); *Enantioicristellaria* MARIE, 1941, *1215, p. 162, 255 (type, *Cristellaria navicula* D'ORBIGNY, 1840, *1394, p. 27); *Hydromylinina* DEWITT PUYT, 1941, *2069, p. 54 (type, *H. ruttenei* DEWITT PUYT, 1941); *Rimalina* PÉRÉBASKINE, 1946, *1444, p. 359 (type, *R. pinatensis* PÉRÉBASKINE, 1946); *Eoflabellina* PAYARD, 1947, *1432, p. 101 (type, *Peneroplis d'orbignyi* ROMER, 1839, *1582, p. 47); *Darbyellina* HARRIS & SUTHERLAND, 1954, *882, p. 207 (type, *D. hemptsteadensis* HARRIS & SUTHERLAND, 1954)]. Test free, planispiral or rarely slightly trochoid, lenticular, biumbonate, periphery angled or keeled; chambers increasing gradually in size, in general of greater breadth than height;

sutures radial, straight or curved and depressed, flush or elevated; surface may be variously ornamented with thickened, elevated sutures, bosses or sutural nodes; aperture radial at peripheral angle. *Trias-Rec.*, cosmop.—FIG. 406,1. **L. rotulata* (LAMARCK), U.Cret.(Senon.), Fr.; 1a,b, side, face views, $\times 30$ (*2117).—FIG. 406,2. *L. cultrata* (DE MONTFORT), L. Plio., Italy; 2a,b, side, face views, $\times 27$ (*7).—FIG. 406,3. *L. danvillensis* (HOWE & WALLACE), U.Eoc.(Jackson.), USA(La.); 3a-c, opposite sides and face views, $\times 40$ (*972).—FIG. 406,4. *L. hemptsteadensis* (HARRIS & SUTHERLAND), Paleoc.(Midway.), USA(Ark.); 4a-c, opposite sides and face view of holotype, refigured, $\times 47$ (*2117).—FIG. 406,5. *L. pinatensis* (PÉRÉBASKINE), U.Cret., Fr.; 5a,b, side, face views, $\times 33$ (*1444).—FIG. 406,6-8. *L. punctata* (RZEHA), L.Tert., Aus.; 6a,b, side, face views; 7, side view; 8a,b, long. secs. in plane of coiling and perpendicular to this plane, showing radial laminated wall characteristic of *Nodosariidae*, but described by RZEHA as characterizing *Cristellariopsis*; all $\times 28$ (*1605).

[*Robulus* is regarded as a synonym of *Lenticulina*, as considerable gradation in length of the radial apertural slits may occur. *Darbyella* is merely an abnormal asymmetrical form of *Lenticulina*, and in large assemblages of any species of this genus random asymmetrical, twinned, or even partially uncoiled specimens may be obtained. Similarly *Darbyellina* is represented by an abnormal specimen showing both a slight asymmetrical development and a final chamber which fails to reach the earlier whorl, and thus appears to be uncoiling. These aberrant forms do not warrant distinct generic assignments.]

Marginulina D'ORBIGNY, 1826, *1391, p. 258 [**M. raphanus* D'ORBIGNY, 1826, non *Nautilus raphanus* LINNÉ, 1758; SD DESHAYES, 1830, *590, p. 416 (LOEBLICH & TAPPAN, 1961, *1179, p.77)] [= *Buccinina* COSTA, 1861, *393, p. 53 (type, *B. subrecta* COSTA, 1861, SD LOEBLICH & TAPPAN, herein); *Hemicristellaria* STACHE, 1865, *1825, p. 222 (type, *H. procera* STACHE, 1865); *Ellipsomarginulina* A. SILVESTRI, 1923, *1774, p. 265 (type, *Marginulina raphanus* D'ORBIGNY, 1826, *1391, p. 258, SD LOEBLICH & TAPPAN, herein) (obj.); *Marginulinella* WEDEKIND, 1937, *2041, p. 94 (type, *Nautilus* (*Orthoceras*) *costatus* BATSCHE, 1791, *102, pl. i, fig. 1a-g); *Enantioarginulina* MARIE, 1941, *1215, p. 163, 255 (type, *E. d'orbignyi* MARIE, 1941); *Enantioamphicoryna* MARIE, 1956, *1221, p. B243 (type, *E. obesa* MARIE, 1956)]. Early portion slightly coiled but not completely enrolled, as in *Marginulinopsis*, later rectilinear; sutures oblique, especially in early portion; aperture of dorsal angle, somewhat produced. *Trias-Rec.*, cosmop.—FIG. 406,9. **M. raphanus*; 9a,b, side view and long. sec., enlarged (*1391).—FIG. 406,10. *M. glabra* D'ORBIGNY, Plio., Italy; 10a,b, side views, $\times 60$ (*2117).—FIG. 406,11. *M. procera* (STACHE), L.Tert., N.Z.; 11a,b, $\times 13$ (*700).

[*Marginulina glabra* D'ORBIGNY, 1826, was cited as type of the genus by CUSHMAN (1913, *404c, p. 79), despite the fact that the type had previously been fixed by DESHAYES (1830 *590, p. 416) as *Nautilus raphanus* LINNÉ (= *Mar-*

ginulina raphanus D'ORBIGNY, *590, p. 418). The status of the genus as based on the type-species is discussed by LOEBLICH & TAPPAN (1961, *1179).]

Marginulinopsis A. SILVESTRI, 1904, *1760, p. 253

[**M. densicostata* THALMANN, 1937; SD THALMANN, 1937, *1899a, p. 348]. Test with early stage as in *Lenticulina*, later uncoiling and rec-

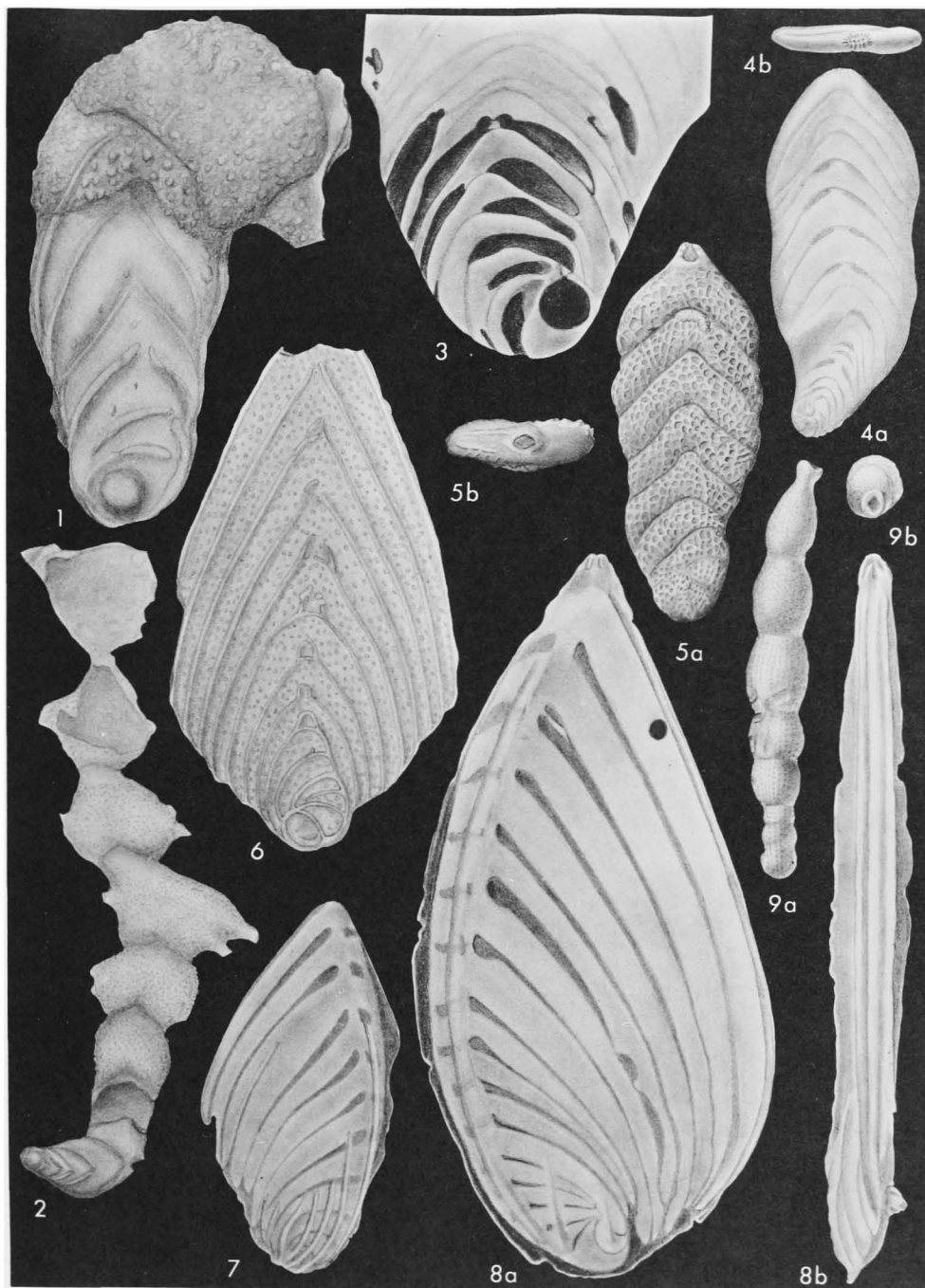


FIG. 407. Nodosariidae (Nodosariinae; 1,2, *Tentifrons*; 3-5, *Palmula*; 6, *Neoflabellina*; 7,8, *Planularia*; 9, *Orthomorpha*) (p. C522, C524).

tilinear as in *Marginulina*; aperture terminal, radiate. [*Marginulinopsis* is similar to *Dimorphina*, but differs in having a keeled or angular periphery in the coiled portion.] *Jur.-Rec.*, cosmop.—FIG. 403,9. **M. densicostata* THALMANN, Rec., *Challenger* Sta. 24, off Culebra Is., W. Indies, 390 fathoms; holotype (BMNH-ZF 1808) refigured, originally described as *Marginulina costata* BATSCH by BRADY (*200, pl. 65, fig. 11), 9a,b, $\times 50$ (*2117).

Neoflabellina BARTENSTEIN, 1948, *90, p. 122 [**Flabellina rugosa* D'ORBIGNY, 1840, *1394, p. 23; SD CUSHMAN, *433, p. 189] [= *Flabellina* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 42 (obj.) (non VOIGHT, 1834; nec FORBES & HANLEY, 1851; nec DE GREGORIO, 1930)]. Test large, palmate, similar to *Palmula* but with flattened, parallel sides, and angular or keeled margins, thickened and elevated sutures, surface commonly highly ornamented with ribs, reticulations or nodes. *U.Cret.-Paleoc.*, cosmop.—FIG. 407,6. **N. rugosa* (D'ORBIGNY), *U.Cret.*, Fr.; lectotype (MNHN) here designated and refigured, $\times 48$ (*2117).

Orthomorphina STAINFORTH, 1952, *1833, p. 8 [**Nodogenerina havanensis* CUSHMAN & BERMUDEZ, 1937, *491, p. 14; OD]. Test rectilinear, uniserial; chambers inflated; wall calcareous, perforate, surface smooth or costate; aperture terminal, rounded, and may have slight neck or everted rim. [Differs from *Nodosaria* in having rounded, rather than radiate, aperture, and from *Siphonodosaria* in lacking apertural tooth. Originally placed in the Heteroheliciidae, this form seems to have no relation to those planktonic genera and is here transferred to the Nodosariidae.] *Eoc. - Rec.*, Carib.-Eu.-N. Am.-Pac.-Asia-Atl.—FIG. 407,9. **O. havanensis* (CUSHMAN & BERMUDEZ), *Eoc.*, Cuba; 9a,b, side, top views of paratype, $\times 44$ (*2117).

Palmula LEA, 1833, *1099, p. 219 [**P. sagittaria*: OD (M)] [= *Planularia* NILSSON, 1826, *1358, p. 342 (type, *P. elliptica* NILSSON, 1826, SD LOEBLICH & TAPPAN, herein) (non *Planularia* DEFRANCE, 1826); *Fronidulina* VON MÜNSTER in ROEMER, 1838 (non LAMARCK, 1816), *1581, p. 382 (type, *F. obliqua* VON MÜNSTER, 1838, SD LOEBLICH & TAPPAN, herein); *Falsopalmula* BARTENSTEIN, 1948, *90, p. 124, 127 (type, *Flabellina tenuistriata* FRANKE, 1936, *741, p. 93); *Phalsopalmula* AGALAROVA, 1960, *3A, p. 79 (nom. van.)]. Test free, flattened, elongate or palmate, early portion planispirally coiled in microspheric forms, or arcuate in megalospheric forms, later becoming uncoiled and rectilinear, with low, broad, arched, and equitant chambers, as in *Fronidularia*; sutures radial in early portion, later strongly arched or angled at center of test; aperture terminal, radiate. [Certain of the geologically older species were separated as *Falsopalmula*, being somewhat smaller, and considered

to be more closely related to ancestral *Lenticulina*. The differences are here regarded as specific only, as early forms of most nodosariid genera show their close interrelationship.] *L.Jur.-Rec.*, N.Am.-Eu.—FIG. 407,3,4. **P. sagittaria*, Paleoc., USA (N.J.); 4a,b, side and top views, $\times 5$; 3, early portion of test partially acid-treated to show coil, $\times 22$ (*2117).—FIG. 407,5. *P. tenuistriata* (FRANKE), *L.Jur.* (U.Lias.), Ger.; 5a,b, side, top views of toptotype, $\times 65$ (*2117).

Pandaglandulina LOEBLICH & TAPPAN, 1955, *1167, p. 7 [**P. dinapolii*; OD] [= *Pandoglandulina* GERKE, 1957, *778, p. 36 (nom. null.)]. Test free, uniserial, chambers strongly overlapping, and with slightly arcuate axis; sutures very slightly radiate in early portion, later horizontal, may be slightly depressed; aperture terminal, radiate. *Mio.-Rec.*, Eu.—FIG. 408,1,2. **P. dinapolii*, L.Plio., Italy; 1, paratype; 2a,b, side, top views of holotype; all $\times 45$ (*2117).

Planularia DEFRANCE in DE BLAINVILLE, 1826, *141c, p. 244 (non NILSSON, 1826) [**Peneroplis auris* DEFRANCE in DE BLAINVILLE, 1824, *141a, p. 178; OD (M)] [= *Megathyra* EHRENBURG, 1843, *672, p. 409 (type, *M. planularia*, SD LOEBLICH & TAPPAN, herein)]. Similar to *Astacolus*, but with compressed sides and carinate margins. *Mio.-Rec.*, cosmop.—FIG. 407,7,8. **P. auris* (DEFRANCE), Plio., Italy; 7,8a, side views; 8b, edge view; all $\times 33$ (*2117).

Pseudarcella SPANDEL, 1909, *1823, p. 199 [**P. rhumbleri*; OD] [= *Arpseudarcelloum* RHUMBLER, 1913, *1572b, p. 349 (nom. van.) (obj.)]. Test free, consisting of single conical or plano-convex chamber; wall calcareous, finely perforate, lamellar character and microstructure unknown, surface smooth or reticulate; aperture a large round opening in center of flat to concave surface of test. [The systematic position is doubtful. Because of the calcareous wall it is not considered to be related to the pseudochitinous Arcellidae. Petrographic and X-ray studies of the test wall are needed to aid in its placement, but none have been made to date. At least a superficial similarity to the tests of the Nodosariidae has been noted, and as all known perforate calcareous unilocular hyaline foraminifers are currently placed in the Nodosariaceae, the present genus is also tentatively included.] *Eoc. - Mio.*, Eu. (Fr.-Ger.-Belg.-Italy)-Carib. (Puerto Rico).—FIG. 409,1. **P. rhumbleri*, M.Oligo., Ger.; 1a-c, side and apert. views and axial sec., approx. $\times 55$ (*1823).—FIG. 409,2. *P. feugueuri* Y. LE CALVEZ, *Eoc.*, Belg.; 2a,b, oblique side and apert. views, $\times 90$ (*1115).—FIG. 409,3. *P. campanula* Y. LE CALVEZ, *Eoc.*, Belg.; 3a,b, oblique side and apert. views, $\times 84$ (*1115).—FIG. 409,4. *P. patella* GALLOWAY & HEMINWAY, U.Oligo., Carib. (Puerto Rico); 4a,b, side and apert. views, $\times 56$ (*764).

Pseudonodosaria BOOMGAART, 1949, *173, p. 81 [**Glandulina discreta* REUSS, 1850, *1540, p. 366;

OD] [= *Rectoglandulina* LOEBLICH & TAPPAN, 1955, *1167, p. 3 (type, *R. appressa* LOEBLICH & TAPPAN, 1955)]. Test free, uniserial and rec-

tilinear throughout, chambers embracing strongly, at least in early portion, later chambers may be inflated and less embracing; sutures horizontal;

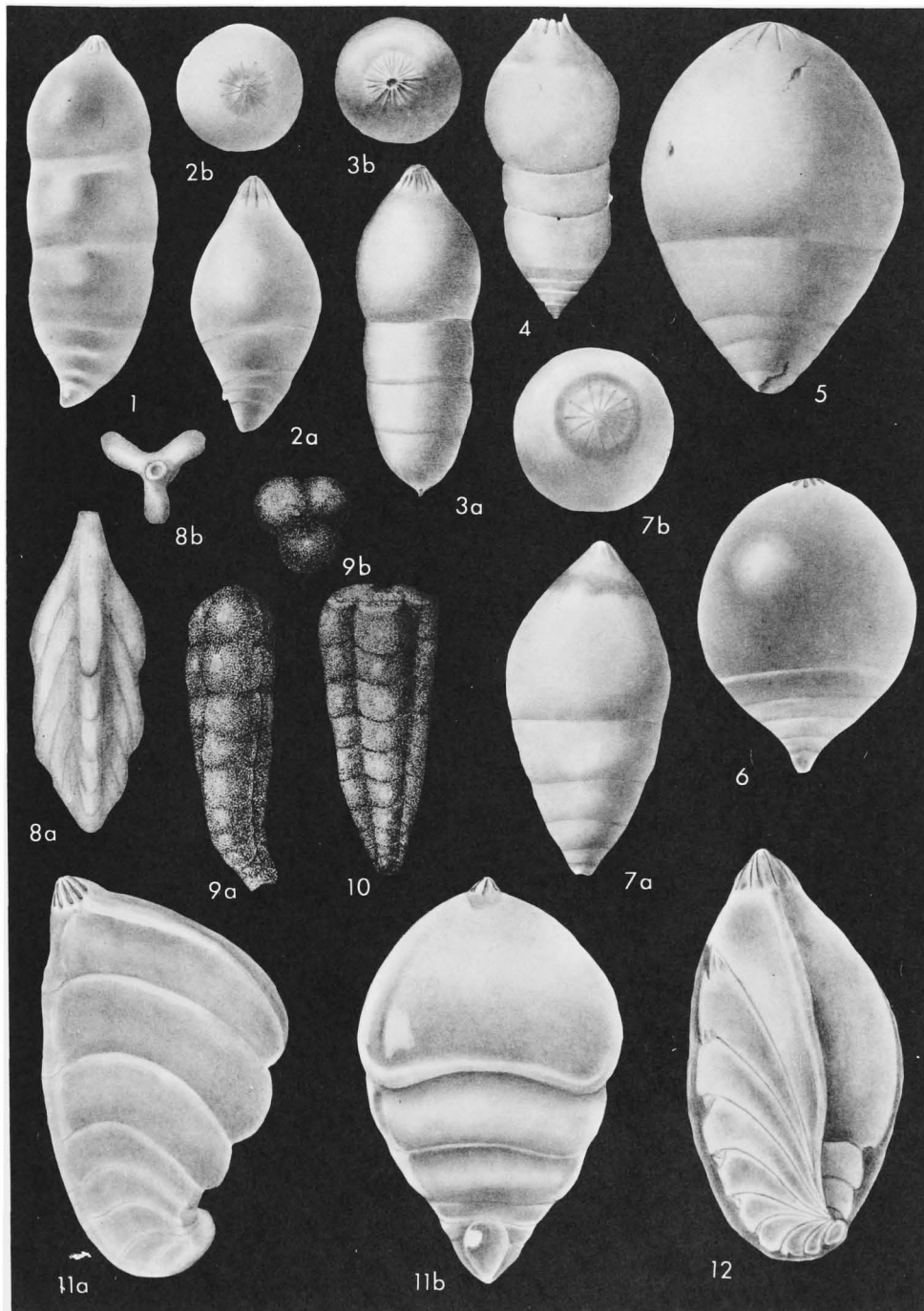


FIG. 408. Nodosariidae (Nodosariinae; 1,2, *Pandaglandulina*; 3-7, *Pseudonodosaria*; 8, *Tribrachia*; 9,10, *Pseudotrictix*; 11,12, *Saracenaria*) (p. C522-C524).

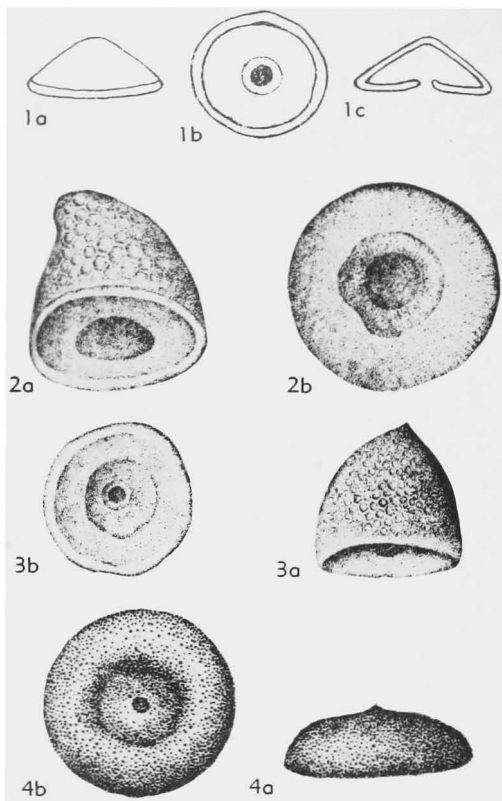


FIG. 409. Nodosariidae (Nodosariinae; 1-4, *Pseudarcella*) (p. C522).

aperture terminal, radiate. *Perm.-Rec.*, Eu.-N.Am.-Australia-Asia-Pac.-Atl.—FIG. 408,3,4. **P. discreta* (REUSS), *U.Tert.*, Java; 3a,b, side, top views, $\times 62$; 4, side view, $\times 53$ (*2117).—FIG. 408, 5,6. *P. obesa* (LOEBLICH & TAPPAN), *U.Cret.*, USA(Ark.); microspheric and megalospheric specimens, $\times 116$ (*2117).—FIG. 408,7. *P. appressa* (LOEBLICH & TAPPAN), *U.Cret.*, USA(Ark.); 7a,b, side, top views, $\times 107$ (*2117).

Pseudotristix K. V. MIKLUKHO-MAKLAY, 1960, *1279, p. 156 [**Tristix* (*P.*) *tcherdynzevi*; OD] [= *Pseudotristix* K. V. MIKLUKHO-MAKLAY, 1958, *1278, p. 481, 484 (*nom. nud.*); *Tristix* (*P.*) K. V. MIKLUKHO-MAKLAY, 1960, *1279, p. 156 (obj.)]. Test uniserial, chambers low, gradually enlarging, trilobate in section, not overlapping; sutures straight, horizontal; wall calcareous; aperture terminal, radiate. *U.Perm.* (Kazan.), Russian Platform.—FIG. 408,9,10. **P. tcherdynzevi*; 9a,b, side, apert. views, $\times 66$; 10, side view, $\times 71$ (*1279).

Saracenaria DEFRANCE in DE BLAINVILLE, 1824, *141a, p. 176 [**S. italica* DEFRANCE, 1824; OD (M)] [= *Hemirobulina* STACHE, 1865, *1825, p. 227 (type, *H. arcuatula* STACHE, 1865); *Saracene-*

la FRANKE, 1936, *741, p. 87 (type, *Marginulina trigona* TERQUEM, 1866, *1886, p. 435)]. Test free, planispiral in early stage, later with tendency to uncoil; triangular in section, with broad flat apertural face, the outer margin and 2 angles of face may be acute and keeled to somewhat rounded; aperture at peripheral angle, radiate. *Jur.-Rec.*, cosmop.—FIG. 408,11. **S. italica*, *Rec.*, Carib.; 11a,b, side, face views, $\times 35$ (*2117). —FIG. 408,12. *S. sp.*, *Rec.*, Gulf Mex.; $\times 44$ (*2117).

Tentifrons LOEBLICH & TAPPAN, 1957, *1172, p. 225 [**T. barnardi* LOEBLICH & TAPPAN, 1957; OD]. Test free in early stages, with chambers in citharine arrangement, loosely coiled, becoming uniserial, flattened and palmate, with smooth and centrally excavated chevron-shaped chambers; attached in later stages with equitant chambers slightly inflated, extremely papillose and fistulose; sutures raised and thickened in early portion, slightly depressed in irregular attached portion; aperture as in *Citharinella* in early stages, later stage with numerous apertures at ends of fistulose extensions. *U.Cret.*, Eu.—FIG. 407,1,2. **T. barnardi*, Senon., Eng., 1, paratype, $\times 57$; 2, holotype, $\times 21$ (*1172).

Tribrachia SCHUBERT, 1912, *1691, p. 183 [**T. inelegans* LOEBLICH & TAPPAN, 1950; SD LOEBLICH & TAPPAN, 1950, *1157, p. 15]. Test free, elongate, tapering, chambers triangular to trifoliate in section, low, broad, extending backward toward proloculus at angles, strongly arched upward on concave faces of test; sutures distinct, strongly arched on sides of test, curving downward at angles; aperture terminal, radiate, may be produced on neck. *M.Jur.-Cret.*, N.Am.-Eu.—FIG. 408,8. **T. inelegans*, *M.Jur.* (Callov.), Wyo.; 8a,b, side, top views, $\times 48$ (*1157).

Vaginulina D'ORBIGNY, 1826, *1391, p. 257 [**Nautilus legumen* LINNÉ, 1758, *1140, p. 711; SD CUSHMAN, 1913, *404c, p. 80] [= *Vaginulinella* KAPTARENKO-CHERNOUSOVA, 1956, *1017, p. 68 (*nom. null. pro Vaginulina*); *Vaginula* RISSO, 1826, *1579a, p. 16 (obj.)]. Test straight to arcuate as in *Dentalina*, but compressed or ovate in section; aperture at dorsal angle, radiate. *Trias.-Rec.*, cosmop.—FIG. 410,1,2. **V. legumen* (LINNÉ), *Rec.*, Adriatic; 1a,b, side, edge views; 2, side view; all $\times 15$ (*2117).

Vaginulinopsis SILVESTRI, 1904, *1760, p. 251 [**Vaginulina soluta* SILVESTRI var. *carinata* SILVESTRI, 1898, *1750, p. 166; = *Vaginulinopsis inversa* (COSTA) var. *carinata* (SILVESTRI), 1904, = *Vaginulinopsis carinata* (SILVESTRI); SD THALMANN, 1937, *1899a, p. 347]. Test close-coiled, as in *Lenticulina*, in early stage, later uncoiling, slightly compressed as in *Vaginulina*, aperture at dorsal angle, radiate. [The type-species was not fixed by original designation, as was erroneously stated by THALMANN (1937, *1899a, p. 347). *Vaginulina soluta* SILVESTRI, 1898, was stated to

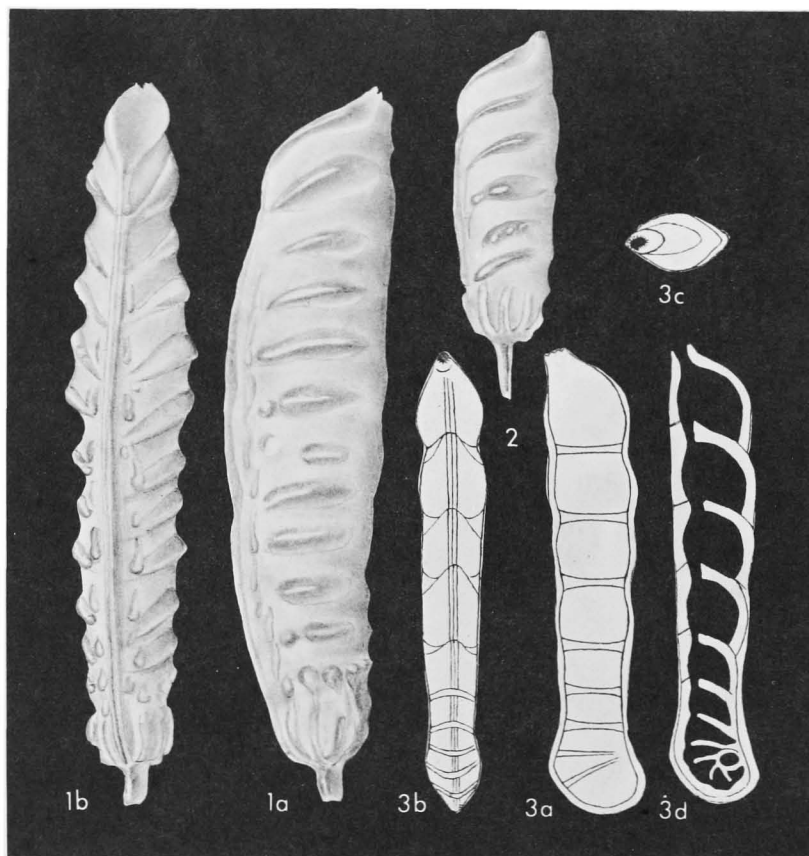


FIG. 410. Nodosariidae (Nodosariinae; 1, 2, *Vaginulina*; 3, *Vaginulinopsis*) (p. C524-C525).

be a synonym of *Marginulina inversa* COSTA (1856, *392, p. 183) and the variety *carinata* was transferred to *Vaginulinopsis inversa* (COSTA) by SILVESTRI, 1904. *M. inversa* was a homonym of *M. inversa* NEUGEBOREN, 1851, hence the specific name *soluta* should be retained for the non-carinate species described by SILVESTRI. If regarded solely as a subspecies, the present type-species should be referred to *V. soluta* subsp. *carinata*. However, as the types of *V. soluta* do not show the early coil, we regard the present form as a distinct species]. *Trias.-Rec.*, cosmop.—FIG. 410, 3. **V. carinata*, Mio., Sicily; 3a-d, side, edge, and top views and long. sec., $\times 30$ (*1899a).

Subfamily PLECTOFRONDICULARIINAE Cushman, 1927

[Plectofrondiculariinae CHAPMAN & PARR, 1936, p. 143 (*nom. correct. pro* Plectofrondiculariinae CUSHMAN, 1927, p. 62)]

Test biserial to uniserial; aperture terminal, dentate or cribrate. *Eoc.-Rec.*

Plectofrondicularia LIEBUS, 1902, *1134, p. 76 [**P. concava*; SD CUSHMAN, 1928, *439, p. 238] [= *Parafrondicularia* ASANO, 1938, *49, p. 187, 189 (type, *P. japonica*)]. Test elongate, com-

pressed, biserial in early stage, later uniserial, sutures limbate; aperture terminal, radial with elevated margin at outer edge, projecting laminae between grooves of aperture may fuse centrally, as in *Amphimorphina*, so that aperture consists of one or more small, irregularly distributed, elliptical openings. [As shown by MONTANARO GALLITELLI (1957, *1303, p. 144), this genus does not have an early coiled stage and no internal apertural modifications and is not related to the Heterohelicidae or Buliminidae.] *Eoc.-Rec.*, Eu.-N. Am.-N. Z.-Japan-S. Am.-Carib.-Sumatra-Cyprus.—FIG. 411, 1. *P. floridana* CUSHMAN, U.Oligo., Dominican Republic; 1a,b, side, top views of microspheric form, $\times 65$ (*1303).—FIG. 411, 2. **P. concava*, Tert., Ger.; 2a-d, side and edge views, long. and transv. secs., $\times 44$ (*1134).—FIG. 411, 3. *P. japonica* (ASANO), Plio., Japan; 3a,b, side, top views of holotype, $\times 48$ (*2117).

Amphimorphina NEUGEBOREN, 1850, *1349, p. 125 [**A. haueriana*; OD (M)] [= *Amphimorphinella* KEIJZER, 1953, *1031, p. 274 (type, *A. butonensis*)]. Test elongate, early stage may be compressed, uniserial in megalospheric form, with

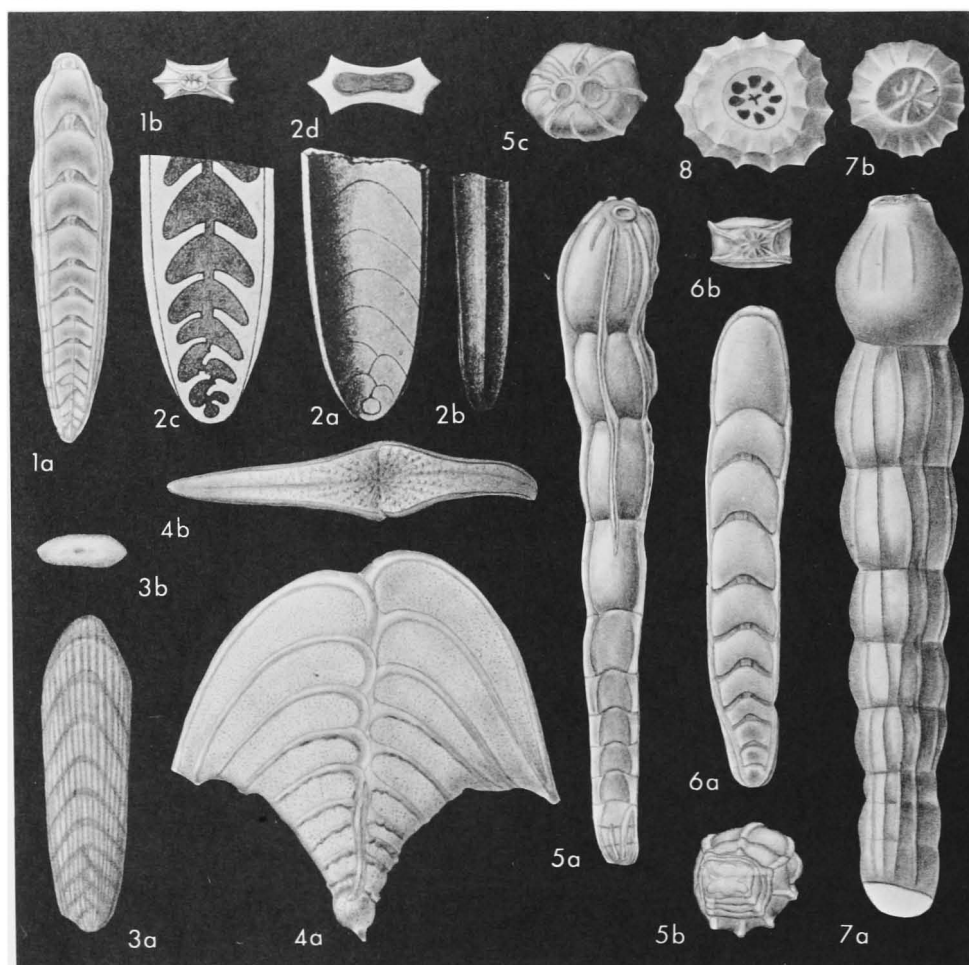


FIG. 411. Nodosariidae (Plectofrondiculariinae; 1-3, *Plectofrondicularia*; 4, *Bolivinella*; 5-8, *Amphimorphina*) (p. C525-C528).

6 to 10 biserially arranged chambers in microspheric form, chambers equitant in early stage, then may be inflated; aperture in early stage radial, ribs between radial grooves converging in later growth to meet centrally, leaving 3 to 6 pores open between strong radial costae, forming cribrate aperture; apertural chamberlet may be present, as in other Nodosariidae. *M.Eoc.-Rec.*, Eu.-N.Am.-Carib.—FIG. 411,5,6. **A. haueriana*, Mio., Hung. (5), L.Mio., Fr. (6); 5a-c, side, basal and top views, $\times 52$; 6a,b, side and apert. views of megalospheric form, $\times 74$ (*1303).—FIG. 411,7,8. *A. butonensis* (KEIJZER), Mio.-Plio., Malay Arch.; 7a,b, side, top views of holotype; 8, top view of broken paratype showing intercameral openings; all $\times 47$ (*1031).

Bolivinella CUSHMAN, 1927, *428, p. 79 [*Textularia folium* PARKER & JONES, 1865, *1418, p. 370, 420; OD]. Test compressed, flabelliform, biserial throughout, with no trace of coiling present; cham-

bers broad, low, sutures may be limbate; aperture indistinct, but apparently basal and cribrate, apertural face obscured by numerous papillae commonly aligned in series radiating from apertural area. *Eoc.-Rec.*, Australia-Carib.-N.Am.-Eu.-Pac.

—FIG. 411,4. **B. folia* (PARKER & JONES), Rec., Fiji; 4a,b, side and apert. views, $\times 130$ (*1303).

[*Bolivinella* was placed by GALLOWAY (*762) and CUSHMAN (*486) near *Bolivinella* in the Bolivininae. SIGAL in PIVETEAU (*1458) placed it in the Heterohellicidae (superfamily Buliminidea). POKORNÝ (*1478) assigned it to the superfamily Buliminidea but in the subfamily Plectofrondiculariinae, which MONTANARO GALLITELLI (*1303) elevated to family rank. The genus is here transferred to the Nodosariidae, since no trace of internal apertural modifications are seen, for example, internal tubes or tooth plates such as are characteristic of the Buliminacea. According to MONTANARO GALLITELLI (1957, *1303, p. 144), "the aperture in some specimens seems to consist of a cribrate lamina, with four or six minute openings and is covered by numerous papillae, sometimes hirsute and aligned in radiating rows. . . . An open elongate aperture, as described by Cushman and figured by Parker and Jones is only visible when the specimen is damaged. . . ." The original types of the genotype species in the PARKER & JONES collection in the British Museum (Natural History) were

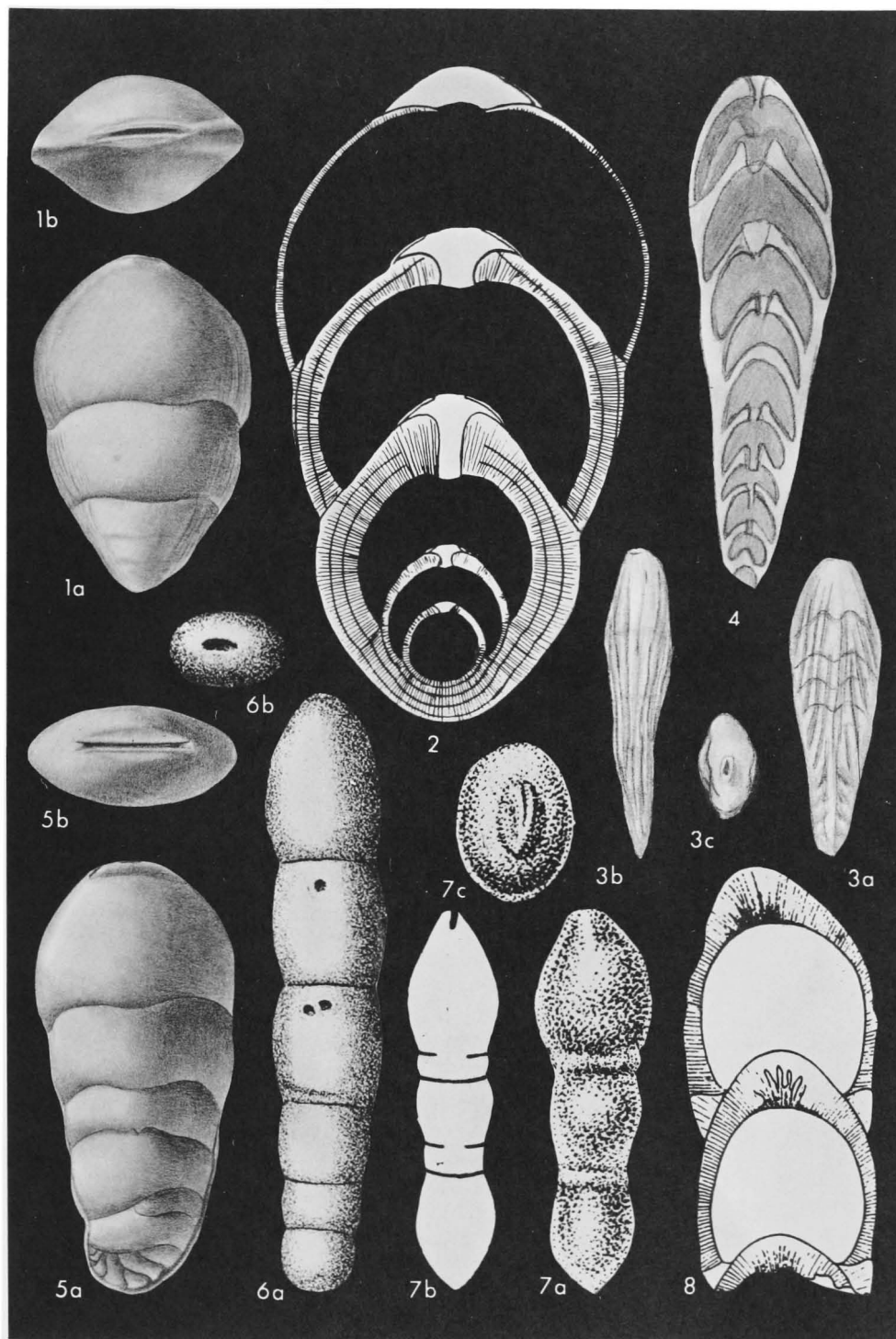


FIG. 412. Nodosariidae (Lingulininae; 1-4, *Lingulina*; 5, *Lingulinopsis*; 6-8, *Lingulonodosaria*) (p. C528).

isolated by us in 1953. A lectotype was selected (BMNH-ZF3595, ex 94.4.3.1521) and paratypes isolated (BMNH-ZF3594), all from beach sand, Melbourne, Australia.]

Subfamily LINGULININAE Loeblich & Tappan, 1961

[Lingulininae LOEBLICH & TAPPAN, 1961, p. 298]

Test multilocular, chambers arranged in straight or arcuate series; aperture terminal, single elongate slit. *Perm.-Rec.*

Lingulina D'ORBIGNY, 1826, *1391, p. 256 [**L. carinata*; SD CUSHMAN, 1913, *404c, p. 61] [= *Fronidicularia* (*Fronidulina*) GERKE, 1957, *778, p. 43 (type, *F. (F.) dubiella*) (*non Fronidulina* LAMARCK, 1816; *nec* MUENSTER, 1835); *Fronidulinia* GERKE, 1961, *782, p. 74 (*nom. nov. pro Fronidularia* (*Fronidulina*) GERKE, 1957)]. Test free, elongate, uniserial and compressed, with succeeding chambers strongly overlapping, as in *Pseudonodosaria*; aperture an elongate terminal slit in plane of compression. *Perm.-Rec.*, cosmop.—FIG. 412,1,2. **L. carinata*, Rec., Carib. (1), Rec., Sicily (2); 1*a,b*, side, top views, $\times 15$ (*2117); 2, long. sec., $\times 48$ (*700).—FIG. 412,3,4. *L. dubiella* (GERKE), L.Jur.(M.Lias.), USSR; 3*a-c*, side, edge, and top views, $\times 68$; 4, sec., $\times 124$ (*778).

Berthelinella LOEBLICH & TAPPAN, 1957, *1172, p. 225 [**Fronidularia paradoxa* BERTHELIN, 1879, *132, p. 33; OD]. Test free, elongate palmate, flattened; proloculus followed by reduced biserial stage of 1 or 2 pairs of chambers, later chambers uniserial and equitant; aperture slitlike. [*Berthelinella* resembles *Plectofronidularia* in chamber arrangement and *Lingulina* in the slitlike aperture.] *Jur.*, Fr.-Alaska.—FIG. 413,1,2. **B. paradoxa* (BERTHELIN), L.Jur.(L.Pliensbach.), Fr.; 1, side view; 2*a,b*, side and top views; all $\times 137$ (*2117).

Daucinoides DE KLASZ & RÉRAT, 1962, *1043, p. 181 [**D. circumtegens*; OD]. Test uniserial, subcircular in section, elongate proloculus followed by completely enveloping uniserial chambers, each succeeding one enclosing all previously formed; wall calcareous, finely perforate, microstructure not described, surface may be finely striate; aperture terminal, commonly a rectilinear slit or more rarely irregular in form. *L.Mio.*, W.Afr.(Gabon-Cameroon-Nigeria).—FIG. 413,3,4. **D. circumtegens*, Cameroon; 3*a*, side view of holotype; 3*b-d*, apert. views of different specimens; 4, median sec. showing overlapping chambers; all $\times 27$ (*1043).

[Originally placed in the Ellipsoidinidae (=Pleurostomellidae), the genus is here classed in the Lingulininae of the family Nodosariidae, because of the absence of an internal tube connecting successive apertures. As topotype specimens examined by us are pyritized, no evidence as to the wall structure is available. *Daucinoides* is similar to *Involuntaria*, but differs in having a slitlike, rather than radial, aperture.]

Ellipsocristellaria SILVESTRI, 1920, *1773, p. 57 [**Lingulinopsis sequana* BERTHELIN, 1880, *133, p. 63; OD (M)]. Test enrolled as in *Lenticulina*,

but with slitlike terminal aperture, as in *Lingulina*. *L.Cret.*, Fr.—FIG. 413,5. **E. sequana* (BERTHELIN), Alb., Fr.; 5*a-c*, side, edge, and top views, $\times 80$ (*133).

Gonatosphaera GUPPY, 1894, *843, p. 651 [**G. prolata*; OD] [= *Linguloglandulina* SILVESTRI, 1903, *1756, p. 49 (type, *L. laevigata* SILVESTRI, 1903)]. Test free, uniserial, with strongly overlapping chambers, chambers circular in section, but with bilaterality shown in some species by development of marginal keel which extends from proloculus up sides of test to merge into apertural lips at apex of test; aperture a terminal, elongate, narrow slit, with distinctly projecting apertural lips or flanges which pass laterally into marginal keel when present. [Differs from *Lingulina* in being rounded in section, rather than compressed. Placed in the Pleurostomellinae by CUSHMAN (*431), it differs in having a perforate radial wall and a symmetrical aperture.] *Eoc.-Mio.*, Carib.-S.Am.-Eu.—FIG. 413,7. **G. prolata*, Mio., Trinidad; 7*a-c*, side, edge, and top views, $\times 40$ (*2117).—FIG. 413,8. *G. laevigata* (SILVESTRI), Rec., Sicily; 8*a,b*, top view and long. sec., $\times 29$, $\times 32$ (*700).

Lingulinopsis REUSS, 1860, *1545, p. 23 [**Lingulina bohemica* REUSS, 1846, *1538, p. 108; OD (M)]. Early stage enrolled as in *Lenticulina*, later uniserial as in *Lingulina*, compressed to slightly ovate in section; aperture a single terminal elongate slit in plane of compression. *U. Cret.-Rec.*, Eu.-S.Pac.—FIG. 412,5. *L. carlofortensis* BORNEMANN, Rec., Ki Is.; 5*a,b*, side, top views, $\times 20$ (*2117).

Lingulonodosaria SILVESTRI, 1903, *1756, p. 48 [**Lingulina nodosaria* REUSS, 1863, *1554, p. 59; SD GALLOWAY, 1933, *762, p. 252] [= *Lingulinella* GERKE, 1952, *777, *fide* GERKE, 1960, *780 (type, *L. arctica*)]. Test elongate, uniserial, ovate in section, with very little overlap of chambers; aperture a terminal slit; differs from *Lingulina* as *Nodosaria* does from *Pseudonodosaria*. *L.Perm.-L.Cret.*, Eu.-N.Am.-Sib.—FIG. 412,6. **L. nodosaria* (REUSS), L.Cret.(Gault), Eng.; 6*a,b*, side, top views, $\times 120$ (*311).—FIG. 412,7,8. *L. arctica* (GERKE), Perm., Sib.; 7*a,b*, side, edge views; 7*c*, apert. view of holotype; all $\times 100$; 8, long. sec., $\times 132$ (*780).

Mucronina EHRENBERG, 1839, *667, table opposite p. 120 [**Nodosaria (Mucronina) hasta* D'ORBIGNY, 1826, *1391, p. 256; SD (SM) PARKER, JONES & BRADY, 1865, *1419, p. 27] [= *Les Mucronines* D'ORBIGNY, 1826, *1391, p. 256 (*nom. neg.*); *Nodosaria (Mucronina)* PARKER, JONES & BRADY, 1865, *1419, p. 27; *Staffia* SCHUBERT, 1911, *1689b, p. 78 (type, *Nodosaria tetragona* COSTA, 1855, *391, p. 116); *Nodomorphina* CUSHMAN, 1927, *428, p. 80 (type, *Nodosaria compressiuscula* NEUGEBOREN, 1852, *1350, p. 59)]. Test elongate, narrow, uniserial, strongly carinate margins, later chambers becoming increasingly compressed;

aperture a terminal slit; differs from *Lingulonodosaria* in compressed sides and keeled margins.
Mio.-Rec., Eu.—FIG. 414, 1. *M. tetragona*

(COSTA), Plio., Italy; 1a, side view; 1b-f, secs. of successive test stages, $\times 15$ (*1899a).

Rimulina D'ORBIGNY, 1826, *1391, p. 257 [*R.

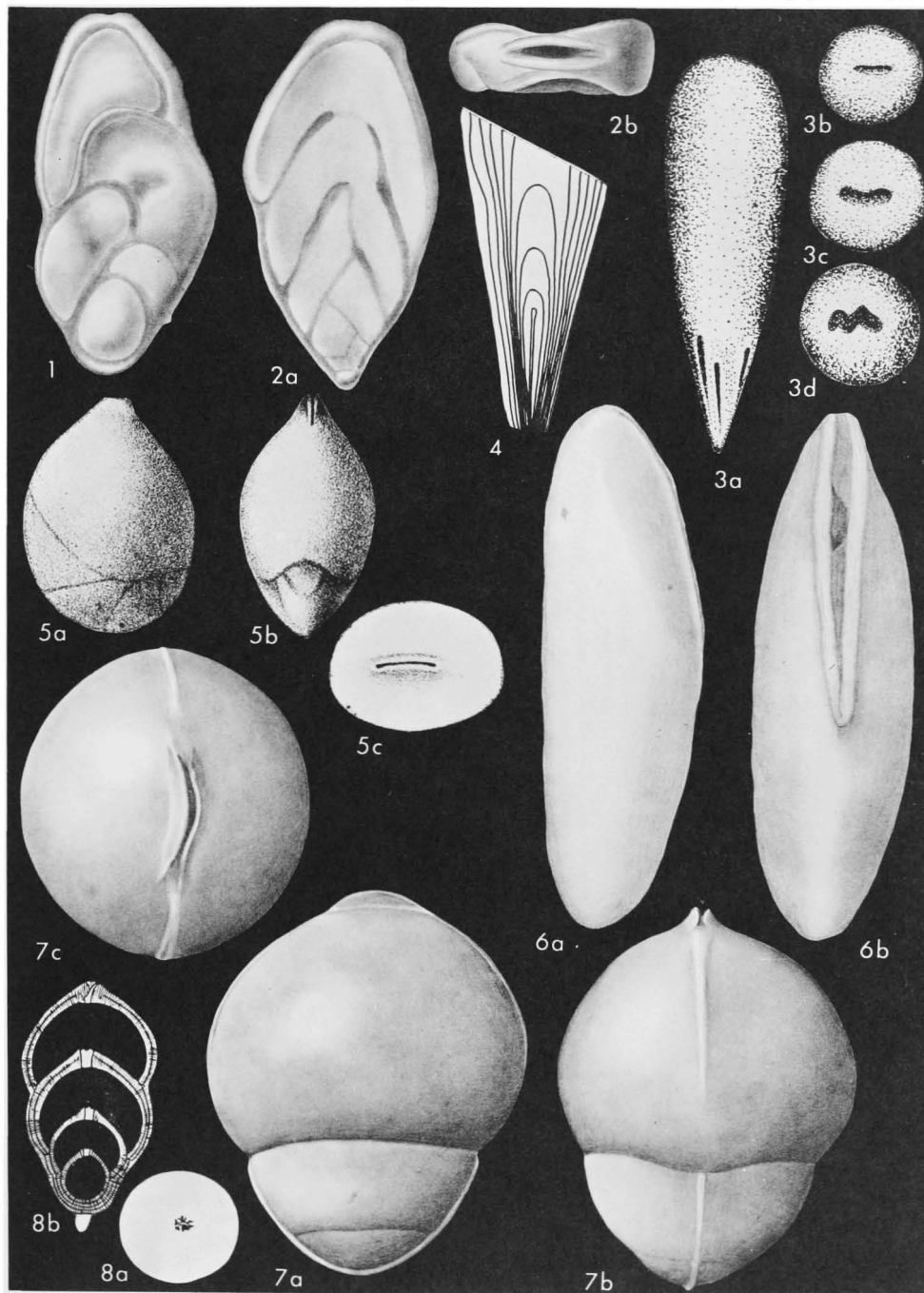


FIG. 413. Nodosariidae (Lingulininae; 1, 2, *Berthelinella*; 3, 4, *Daucinoides*; 5, *Ellipsocristellaria*; 6, *Rimulina*; 7, 8, *Gonatosphaera*) (p. C528-C530).

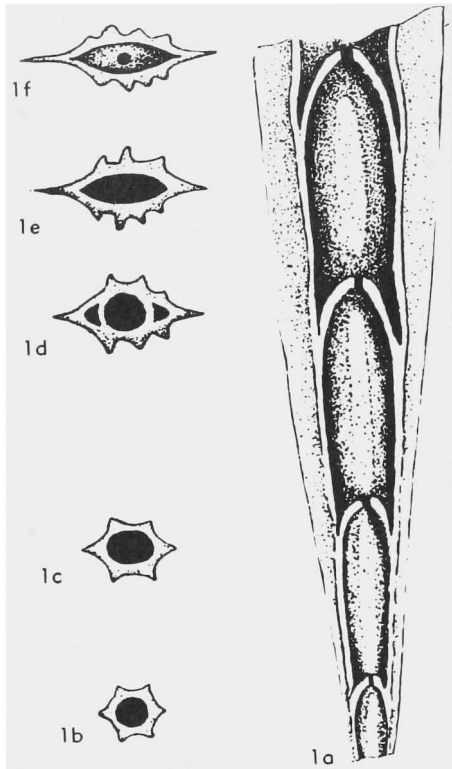


FIG. 414. Nodosariidae (Lingulininae; 1, *Mucronina*) (p. C528-C529).

glabra; OD (M)]. Test elongate single chamber with elongate slit aperture extending from apex about half length of one edge. *Rec.*, Adriatic.—FIG. 413,6. **R. glabra*; 6a,b, side, edge views of holotype, refigured, $\times 77$ (*2117).

Family POLYMORPHINIDAE d'Orbigny, 1839

[Polymorphinidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxix, 131]—[All names of family rank and a dagger(†) indicates *partim*]—[=Polymorphinidées d'ORBIGNY, 1840, p. 9 (*nom. neg.*); =Polymorphinidae REUSS, 1860, p. 230; =Polymorphinidae REUSS, 1860, p. 151; =Polymorphinida JONES in GRIFFITH & HENFREY, 1875, p. 320; =Polymorphinidae SCHWAGER, 1876, p. 479; =Polymorphinina BÜTSCHLI in BRONN, 1880, p. 200; =Polymorphinae DELAGE & HÉROUARD, 1896, p. 138]—[=Enallosteguest d'ORBIGNY, 1826, p. 260 (*nom. nud.*, *nom. neg.*); =Turbinoidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =Uvellina EHRENBERG, 1839, table opposite p. 120 (*nom. nud.*); =Enantiomorphinidae MARIE, 1941, p. 142]—[=Ramulinina LANKESTER, 1885, p. 847; =Ramulininae DELAGE & HÉROUARD, 1896, p. 138; =Ramulinidae LISTER in LANKESTER, 1903, p. 145]

Test multilocular, chambers in spiral or sigmoidal coil about longitudinal axis of growth, or biserial or uniserial, typically somewhat overlapping; aberrant forms may be irregular and attached; apertures all develop in same direction, terminal, radiate. *Trias.-Rec.*

Subfamily POLYMORPHININAE d'Orbigny 1839

[*nom. transl.* BRADY, 1881, p. 44 (*ex* family Polymorphinidae d'ORBIGNY, 1839)]—[=Enantiomorphininae LOEBLICH & TAPPAN, 1961, p. 298]

Test free, chambers arranged in spiral, sigmoidal, biserial or asymmetrically alternating series; aperture terminal, radiate. *Trias.-Rec.*

Polymorphina d'ORBIGNY, 1826, *1391, p. 265 [**P. burdigalensis*; SD GALLOWAY & WISSLER, 1927, *766, p. 53] [=Les Polymorphines d'ORBIGNY, 1826, *1391, p. 265 (*nom. neg.*); *Rostrolina* VON SCHLICHT, 1870, *1648, pl. 25, 26 (type, *Polymorphina burdigalensis* d'ORBIGNY, 1826, *1391, p. 265, SD LOEBLICH & TAPPAN, herein) (obj.); *Glandulopolymorphina* A. SILVESTRI, 1901, *1752, p. 17 (type, *Polymorphina burdigalensis* d'ORBIGNY, 1826, SD LOEBLICH & TAPPAN, herein) (obj.)]. Test elongate, somewhat compressed, commonly twisted; chambers biserial, early ones may be somewhat sigmoid. *Paleoc.-Rec.*, cosmop.—FIG. 415,1. **P. burdigalensis*, Mio.(Burdigal.), Fr.; 1a,b, $\times 49$ (*2117).

Enantiomorphina MARIE, 1941, *1215, p. 144 [**E. lemoinei*; OD]. Test elongate, ovate to subcylindrical with chambers overlapping in alternating series, unequally inclined on longitudinal axis, although not completely biserial; sutures flush; aperture terminal, radiate. *U.Cret.(Senon.)*, Eu.—FIG. 415,5. **E. lemoinei*, Fr.; 5a,b, opposite sides; 5c, edge view, $\times 87$ (*2117).

Eoguttulina CUSHMAN & OZAWA, 1930, *514, p. 16 [**E. anglica*; OD]. Test with chambers added in elongate spiral series in planes less than 90° apart, each succeeding chamber farther from base. *Jur.-U.Cret.*, Eu., N.Am.—FIG. 415,2. **E. anglica*. *U.Cret.(Cenoman.)*, Eng.; 2a-c, opposite sides and base of holotype, $\times 90$ (*2117).

Falsoguttulina BARTENSTEIN & BRAND, 1949, *94, p. 671 [**F. wolburgi*; OD]. Test with chambers arranged in low spiral series, in planes approximately 120° apart; aperture a simple curved slit, not radiate. *L.Cret.(Valangin.)*, Ger.—FIG 415,9. **F. wolburgi*; 9a-d, opposite sides, top, and basal views, $\times 156$ (*2117).

Glandulopleurostomella SILVESTRI, 1903, *1757, p. 217 [**Polymorphina subcylindrica* HANTKEN, 1875, *863, p. 60; OD (M)] [=Hantkenopolymorphina CUSHMAN & OZAWA, 1930, *514, p. 12, 112 (type, *Polymorphina pleurostomelloides* FRANKE, 1928, *740, p. 121)]. Test elongate, early chambers spiral, later ones biserially arranged. *Jur.-Oligo.*, Eu.-N.Am.—FIG. 415,3. **G. subcylindrica* (HANTKEN), L.Oligo., Hung.; $\times 20$ (*863).—FIG. 415,4. *G. pleurostomelloides* (FRANKE), U.Cret.(Cenoman.), Ger.; 4a-c, side, edge, and top views, $\times 56$ (*2117).

Globulina d'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 134 [**Polymorphina (Globulina) gibba* d'ORBIGNY, 1826, *1391, p. 266; SD CUSHMAN,

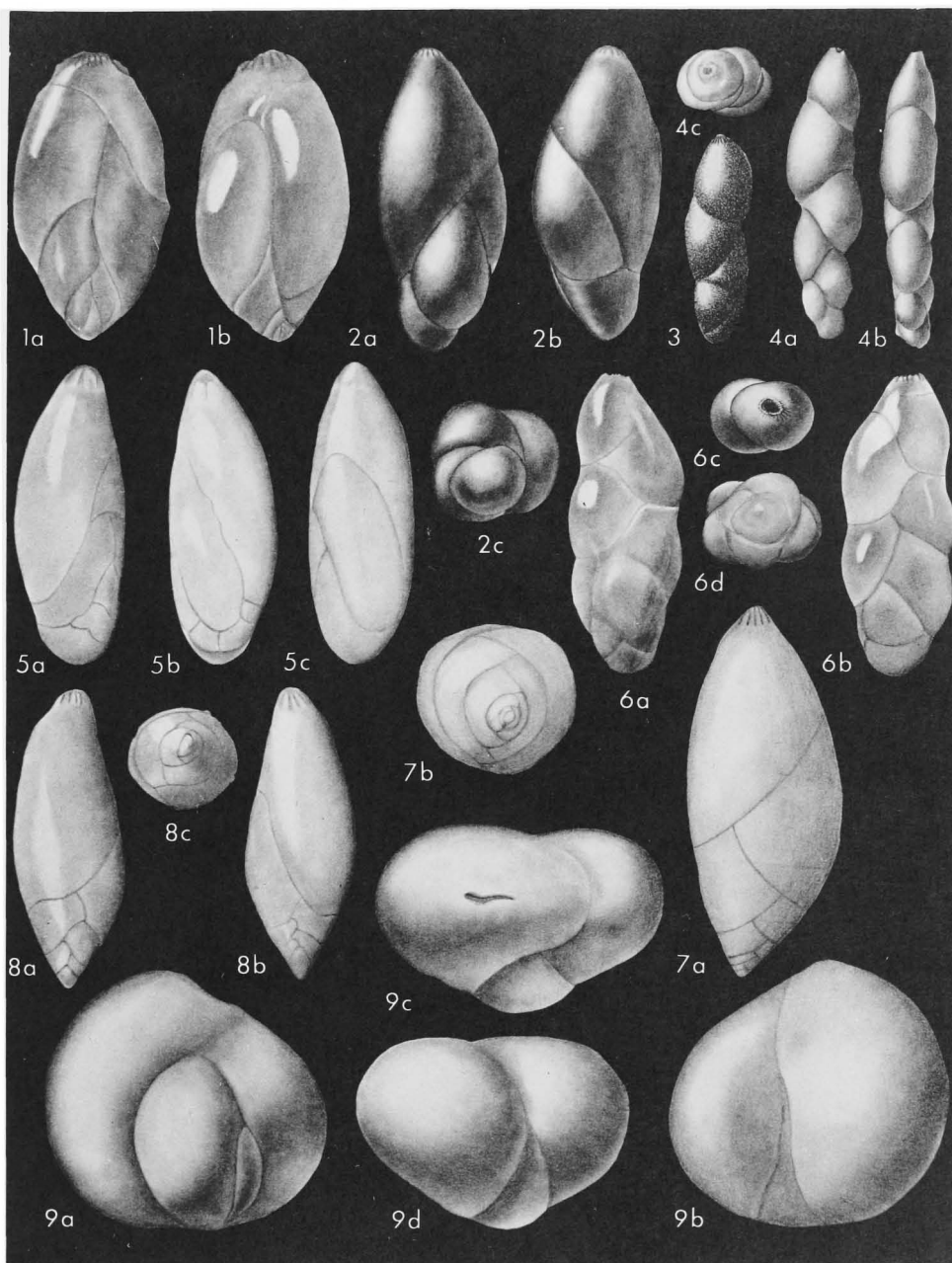


FIG. 415. Polymorphinidae (Polymorphininae; 1, *Polymorphina*; 2, *Eoguttulina*; 3, 4, *Glandulopleurostomella*; 5, *Enantiomorphina*; 6, *Pseudopolymorphina*; 7, 8, *Pyrulinoides*; 9, *Falsoguttulina*) (p. C530, C533).

1927, *433, p. 189] [= *Polymorphina* (*Les Globulines*) D'ORBIGNY, 1826, *1391, p. 266 (*nom. van.*); *Guttulina* (*Globulina*) D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 134 (*obj.*); *Aulostomella* ALTH, 1850, *13, p. 263 (type, *A. pediculus* ALTH, 1850, SD LOEBLICH & TAPPAN, herein)]. Test globular to ovate, chambers strongly overlapping,

added in planes approximately 144° apart; sutures flush, not depressed, aperture radiate, but commonly obscured by fistulose growth. *U. Jur.-Rec.*, cosmop.—FIG. 416.1. **G. gibba*, Mio. (Torton.), Aus.; 1a, b, side, basal views, $\times 45$ (*514).

Guttulina D'ORBIGNY in DE LA SAGRA, 1839, *1611,

p. 132 [**Polymorphina (Guttulina) communis* D'ORBIGNY, 1826, *1391, p. 266; SD GALLOWAY & WISSLER, 1927, *766, p. 56] [= *Polymorphina*

(*Les Guttulines*) D'ORBIGNY, 1826, *1391, p. 266 (*nom. neg.*); *Guttulina (Guttulina)* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 132 (obj); *Sig-*

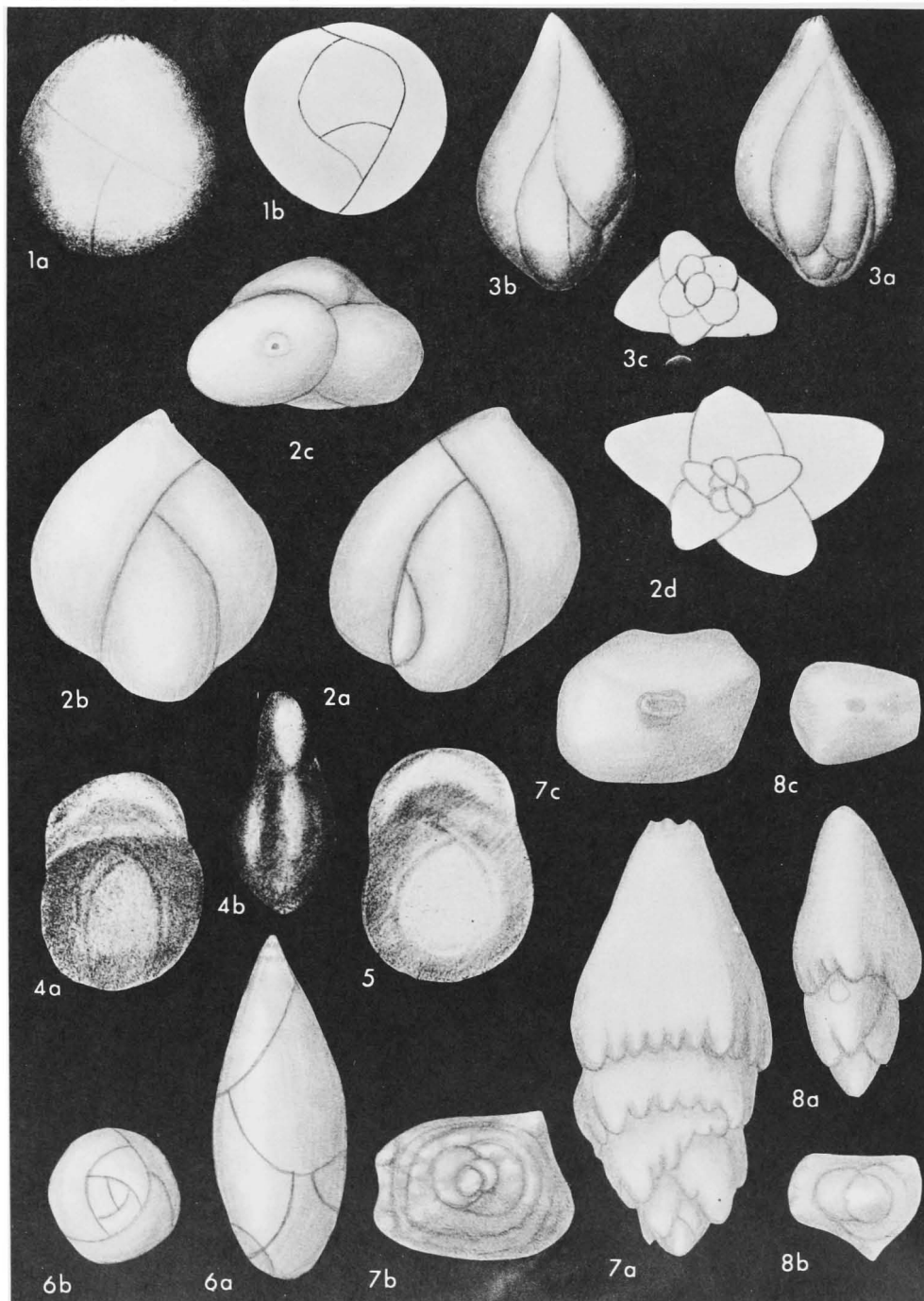


FIG. 416. Polymorphinidae (Polymorphininae; 1, *Globulina*; 2,3, *Guttulina*; 4,5, *Pseudopolymorphinoides*; 6, *Pyrulina*; 7,8, *Sagoplecta*) (p. C530-C533).

momorpha CUSHMAN & OZAWA, 1928, *513, p. 17 (type, *S. sadoensis* CUSHMAN & OZAWA, 1928)]. Test ovate to elongate; inflated chambers added in quinqueloculine spiral series, in planes 144° apart, each successive chamber extending farther from base but strongly overlapping; sutures depressed; aperture radiate. *Jur.-Rec.*, cosmop.—FIG. 416,2. **G. communis* (D'ORBIGNY), Plio., Italy; 2a-d, opposite sides, top view, and diagram. sec., enlarged (*1611).—FIG. 416,3. *G. sadoensis* (CUSHMAN & OZAWA), U.Plio., Japan; 3a-c, opposite sides and basal view, ×45 (*514).

Paradentalina UCHIO, 1960, *1961, p. 60 [*Enantiodontalina muraii* UCHIO, 1953, *1960, p. 152; OD]. Like *Dentalina*, but with early chambers definitely biserial. [The Cretaceous species placed in *Enantiodontalina* are not congeneric with the Recent *Dentalina communis* D'ORBIGNY, which was selected as type of *Enantiodontalina*. As *Enantiodontalina* is thus a synonym of *Dentalina*, *Paradentalina* was proposed for species with an early biserial stage]. *Cret.-Rec.*, N.Am.-Eu.-Japan.—FIG. 417,1,2. **P. muraii* (UCHIO), Plio.-Pleist., Japan; 1, holotype, ×70; 2a,b, side, face views of paratype, ×65 (*1960).

Pseudopolymorphina CUSHMAN & OZAWA, 1928, *513, p. 15 [**P. hanzawai*; OD]. Test elongate; early chambers in quinqueloculine arrangement, later biserial; chambers high and overlapping only slightly; sutures depressed; aperture radiate. *Jur.-Rec.*, Japan-Pac.-Australia-Atl.-N.Am.-S.Am.-Eu.-Carib.—FIG. 415,6. **P. hanzawai*, Plio., Japan; 6a-d, opposite sides, top, and basal views, ×15 (*2117).

Pseudopolymorphinoides VAN BELLEN, 1946, *113, p. 41 [**P. limburgensis*; OD]. Early stage inflated, with chambers in quinqueloculine arrangement, final chamber terminal and compressed; sutures flush; aperture an elongate slit. [Differs from *Falsoguttulina* in being quinqueloculine, rather than triloculine, in early stage]. *M.Eoc.*, Eu.(Neth.).—FIG. 416,4,5. **P. limburgensis*; 4a,b, side, edge views of holotype; 5, side view of paratype; all ×35 (*113).

Pyrulina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 107 [**Polymorphina* (*Pyrulina*) *gutta* D'ORBIGNY, 1826, *1391, p. 267, 310; OD (M)] [= *Polymorphina* (*Les Pyrulines*) and *Polymorphina* (*Pyruline*) D'ORBIGNY, 1826, *1391, p. 267, 310 (subgeneric names=*nom. neg.*); *Pirulina* BRONN & ROEMER, 1853, *214a, p. 88 (*nom. van.*); *Pyrulinella* CUSHMAN & OZAWA, 1928, *513, p. 16 (type, *Polymorphina lanceolata* REUSS, 1851, *1541, p. 83)]. Test fusiform; early chambers arranged in spiral series approximately 120° apart, later chambers biserial; sutures flush; aperture radiate. *Jur.-Rec.*, cosmop.—FIG. 416,6. **P. gutta* (D'ORBIGNY), Plio., Italy; 6a,b, side, basal views, enlarged (*1391).

Pyrulinoides MARIE, 1941, *1215, p. 169, 255 [**Pyrulina acuminata* D'ORBIGNY, 1840, *1394,

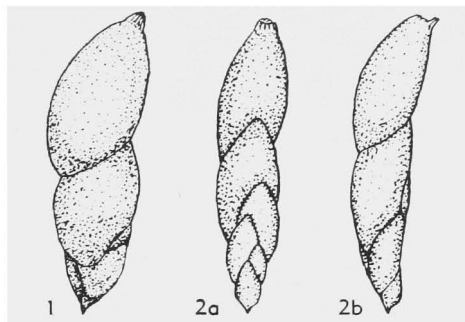


FIG. 417. Polymorphinidae (Polymorphininae; 1,2, *Paradentalina*) (p. C533).

p. 43; OD]. Test free, elongate, fusiform; chambers biserially arranged, much embracing; sutures oblique, flush; aperture terminal, radiate. [*Pyrulinoides* differs from *Pyrulina* in being biserial throughout, and in lacking the early spiral stage.] *Trias.-U.Cret.*, Eu.-N.Am.—FIG. 415,7,8. **P. acuminata* (D'ORBIGNY), U.Cret.(Senon.), Fr.; 7a,b, lectotype (MNHN), side, and basal views, ×36 (*2117); 8a-c, opposite sides and basal view of hypotype, ×48 (*2117).

Sagoplecta TAPPAN, 1951, *1873, p. 14 [**S. goniata*; OD]. Test free, elongate, early portion biserial, later portion uniserial and quadrate or flattened with later chambers equitant and chevron-shaped, overhanging earlier chambers at angles of test; wall calcareous; aperture terminal, radiate. [*Sagoplecta* differs from *Spirofrondicularia* in having a distinctly biserial, rather than tetraloculine, early stage.] *U.Trias.*, N.Am.(Alaska).—FIG. 416, 7,8. **S. goniata*; 7a-c, side, basal, and top views of microspheric holotype, ×95 (*1873); 8a-c, side, basal, and top views of megalospheric paratype, ×95 (*1873).

Sigmoidella CUSHMAN & OZAWA, 1928, *513, p. 18 [**S. kagaensis*; OD] [= *Sigmoidella* (*Sigmoidina*) CUSHMAN & OZAWA, 1928, *513, p. 18 (type, *S. (S.) pacifica* CUSHMAN & OZAWA, 1928)]. Test compressed, chambers arranged in sigmoid series, those on each side reaching to base and covering earlier chambers on one side. *M.Eoc.-Rec.*, Japan-Formosa-Indon.-N.Am.-N.Z.—FIG. 418,1. **S. kagaensis*, U.Plio., Japan; 1a,b, opposite sides of paratype, ×49 (*2117).—FIG. 418,2. *S. pacifica*, Rec., Philip.; 2a-c, opposite sides and basal view, ×24 (*514).

Sigmomorphina CUSHMAN & OZAWA, 1928, *513, p. 17 [**Sigmomorpha* (*Sigmomorphina*) *yokoyamai*; OD] [= *Sigmomorpha* (*Sigmomorphina*) CUSHMAN & OZAWA, 1928, *513, p. 17 (obj.); *Ellisina* LALICKER, 1950, *1082, p. 18 (type, *Ellisina spatula* LALICKER, 1950) (non *Ellisina* NORMAN, 1903); *Pealerina* LALICKER in THALMANN, 1950, *1902, p. 43, *nom. subst. pro Ellisina* LALICKER, 1950 (non *Ellisina* NORMAN, 1903); *Sigmomorphina* (*Sigmomorphinoides*) ROUVIL-

LOIS, 1960, *1589, p. 62 (type, *Sigmomorphina* (*Sigmomorphinoides*) *parisiensis* ROUVILLOIS, 1960)]. Test elongate, compressed, chambers

added in planes slightly less than 180° apart, forming sigmoid series, each chamber farther removed from base but strongly overhanging at

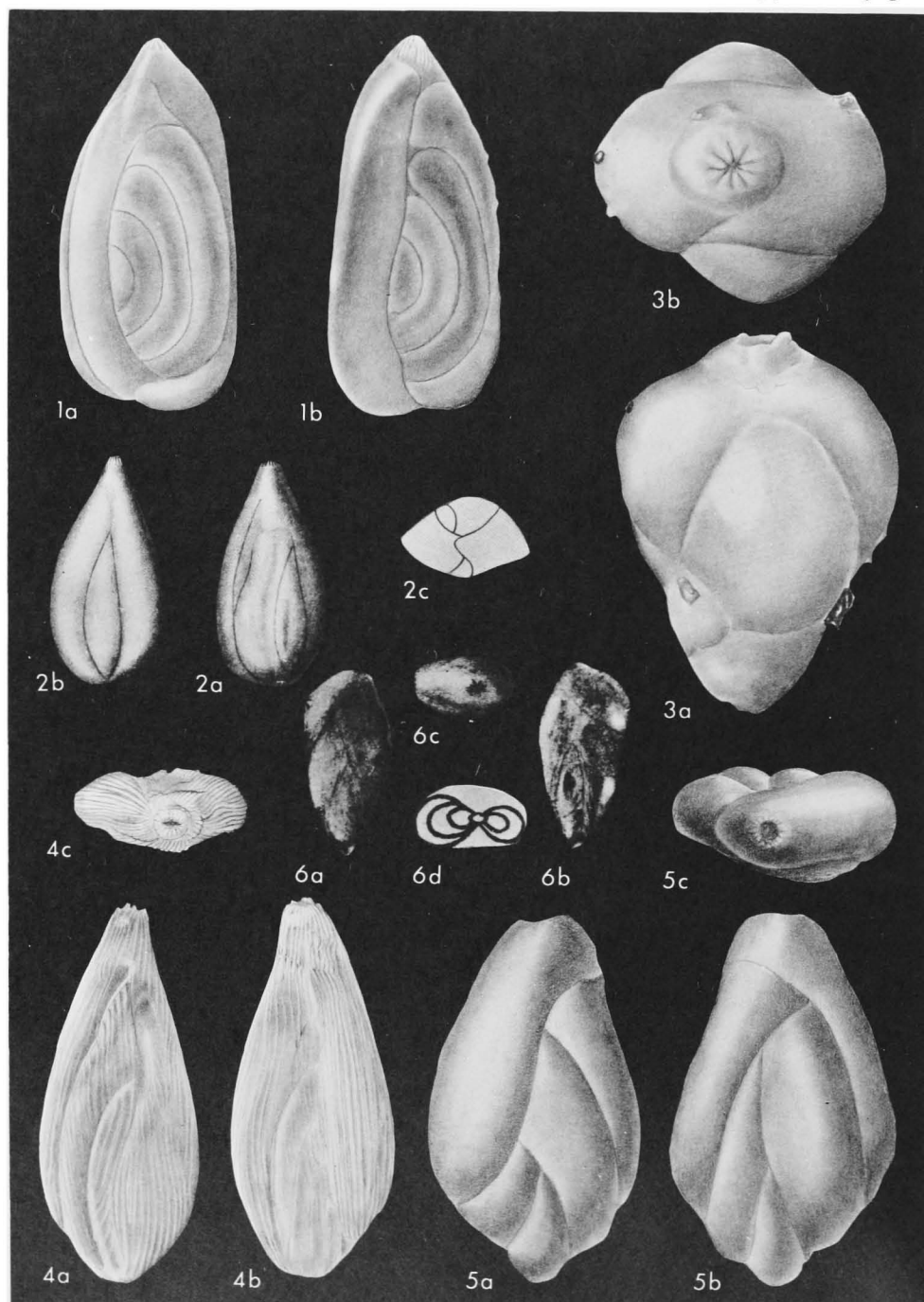


FIG. 418. Polymorphinidae (Polymorphininae; 1, 2, *Sigmoidella*; 3, *Spirofrondicularia*; 4-6, *Sigmomorphina*) (p. C533-C535).

edges of test; sutures depressed; aperture radiate. [*Sigmomorphinoides* was separated by the presence of 2 apertures on the final chamber, apparently an accidental occurrence in abnormal specimens and not here regarded as of generic importance.] *Jur.-Rec.*, Japan-Eu.-N. Am.-S. Am.-Cuba-Trinidad-N.Z.-Australia-Antarctic. — FIG. 418,4. **S. yokoyamai*, Plio., Japan; 4a-c, opposite sides and top view, $\times 61$ (*2117). — FIG. 418,5. *S. spatula* (LALICKER), Jur., USA (Mont.); 5a-c, opposite sides and top view of holotype, $\times 119$ (*2117). — FIG. 418,6. *S. parisiensis* ROUVILLOIS, L.Eoc. (Thanet.), Fr.; 6a-d, opposite sides, top, and basal view of holotype, $\times 30$ (*1589).

Spirofrondicularia SCHUBERT, 1902, *1681, p. 16 [**Polymorphina frondicularioides* CHAPMAN, 1894, *310, p. 716; SD GALLOWAY, 1933, *762, p. 262] [= *Quadrulina* CUSHMAN & OZAWA, 1930, *514, p. 12, 18 (type, *Polymorphina rhabdogonioides* CHAPMAN, 1894, *310, p. 716)]. Test with early chambers tetraloculine, added in planes 90° apart; sutures depressed; aperture terminal, radiate. *L. Jur.-L.Cret.*, Eu. — FIG. 418,3. **S. frondicularioides* (CHAPMAN), L.Cret. (Apt.), Eng.; 3a,b, side, top views, $\times 192$ (*2117).

Tobolia DAIN in N. K. BYKOVA *et al.*, 1958, *265, p. 39 [**T. veronikae* = *T. veronica* E. V. BYKOVA, DAIN & FURSENKO in RAUZER-CHERNOUSOVA & FURSENKO, 1959, *1509, p. 17 (*nom. van.*); OD]. Test globular, chambers added in planes 140° apart, as in *Guttulina*, strongly overlapping, sutures flush to slightly depressed; slitlike aperture somewhat produced. *U.Cret. (Maastricht.)*, Sib. — FIG. 419,1. **T. veronikae*; 1a-c, opposite sides, edge, and basal views, $\times 72$ (*265).

Subfamily WEBBINELLINAE Rhumbler, 1904

[Webbinellinae Rhumbler, 1904, p. 224] [= *Arwebbina* RHUMBLER, 1913, p. 346 (*nom. van.*)]

Test attached, one or more chambers connected by stolons, early portion may be globular or polymorphine, with attachment rounded or irregularly spreading. *Jur.-Rec.*

Webbinella RHUMBLER, 1904, *1569, p. 228 [**Trochammina (Webbina) irregularis hemisphaerica* JONES, PARKER & BRADY, 1865, *1002, p. 26, = *Webbina hemisphaerica* JONES, PARKER & BRADY, 1865, *1002, p. 27; SD CUSHMAN, 1918, *411a, p. 61] [= *Arwebbinum* RHUMBLER, 1913, *1572b, p. 346 (obj.) (*nom. van.*)]. Test attached, early multilocular polymorphine or pyruiline stage surrounded by flangelike chamber spreading on surface of substratum; wall calcareous, perforate, no apparent aperture. [Restudy of the holotype of the type-species showed it to be a calcareous perforate polymorphinid and not an attached arenaceous single-chambered form (*1172). *L.Cret.-Rec.*, cosmop. — FIG. 420,7. **W. hemisphaerica* (JONES, PARKER & BRADY), Plio. (L.Crag), Eng.; $\times 48$ (*1172).

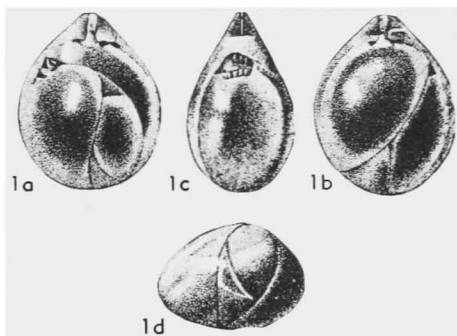


FIG. 419. Polymorphinidae (Polymorphininae; I, *Tobolia*) (p. C535).

Bullopore QUENSTEDT, 1856, *1495, p. 292 [**B. rostrata* QUENSTEDT, 1857; SD (SM) QUENSTEDT, 1857, *1495, p. 580]. [= *Arperneroum* RHUMBLER, 1913, *1572b, p. 444 (type, *Webbina irregularis* D'ORBIGNY, 1850, *1397b, p. 111); *Placopsum* RHUMBLER, 1913, *1572b, p. 445 (type, *Webbina breoni* TERQUEM & PIETTE in TERQUEM, 1862, *1883, p. 458); *Arplacopsum* RHUMBLER, 1913, *1572b, p. 445 (type, *Webbina breoni* TERQUEM & PIETTE in TERQUEM, 1862) (*nom. van.*)]. Test attached, composed of single series of hemispherical chambers, rounded to ovate in outline, earlier chambers may be closely appressed, later ones connected by more or less well-developed stoloniferous necks as in type-species; in microspheric forms chambers increase rapidly in size, but chambers may all be of approximately equal size in megalospheric forms; wall calcareous, perforate; aperture at open end of stolon-like neck. *Jur.-Cret.*, cosmop. — FIG. 420,1. **B. rostrata*, U.Jur. (Malm alpha), Ger.; 1a-d, $\times 19$ (*2117). — FIG. 420,2,3. *B. breoni* (TERQUEM & PIETTE), L.Jur. (Lias.), Fr.; 2,3a,b, $\times 10$ (*1572b). — FIG. 420,4. *B. irregularis* (D'ORBIGNY), U.Cret., Czech.; 4a, side view, $\times 10$; 4b, view of detached specimen, $\times 22$; 4c, long. sec., $\times 28$ (*1445).

[*Bullopore* was originally named and figured (QUENSTEDT, 1856, fasc. 2, p. 292, pl. 41, fig. 26 and 1856, fasc. 3, p. 554, pl. 72, fig. 35) with no species named. In 1857, (fasc. 4, p. 580, pl. 73, fig. 28) *B. rostrata* was named, automatically becoming the type of the genus by subsequent monotypy. Much confusion concerning the type-species is found, for it has been variously regarded as a calcareous imperforate form (*1200, p. 25), considered to be a senior synonym of *Nubeculinella* and *Nodobacularia* (*1200, p. 27), belonging to the Ophthalimididae (*1200, p. 25, *1478, p. 254), Nubeculariidae (*64, p. 838), Nodosinellidae (*762, p. 167) or as a calcareous perforate form belonging to the Polymorphinidae (*486, p. 230, *1509, p. 264) and including *Vitriwebbina* as a junior synonym. LOEBLICH & TAPPAN in 1954, with Drs. E. BUCH & K. FEIFEL collected at the type locality, which is an erosional slope exposing the Upper Jurassic (Malm alpha), middle *Impressa* Mergel, in the valley of Fils, between Unter Böhringer and Reichenbach i. T., northeast of Reichenbach, Württemberg, Germany. The type-species was clearly stated by QUENSTEDT to be from the lower Weisse Jura alpha (explanation of pl. 73), not the Oberer Lias, Zeta zone, *Aulensis* Mergel, as reported by ELLIS & MESINA (*700). The *Bullopore* recorded from the Lias Zeta

(p. 292, pl. 41, fig. 26) and from the Brauner Jura Zeta (p. 554, pl. 72, fig. 35) was never given a specific name, and does not show the stoloniferous necks which QUENSTEDT stated to be characteristic of the species *B. rostrata*.]

Histopomphus LOEBLICH & TAPPAN, 1949, *1156, p. 262 [**Globulina redriverensis* TAPPAN, 1943, *1872, p. 505; OD]. Test large, early portion

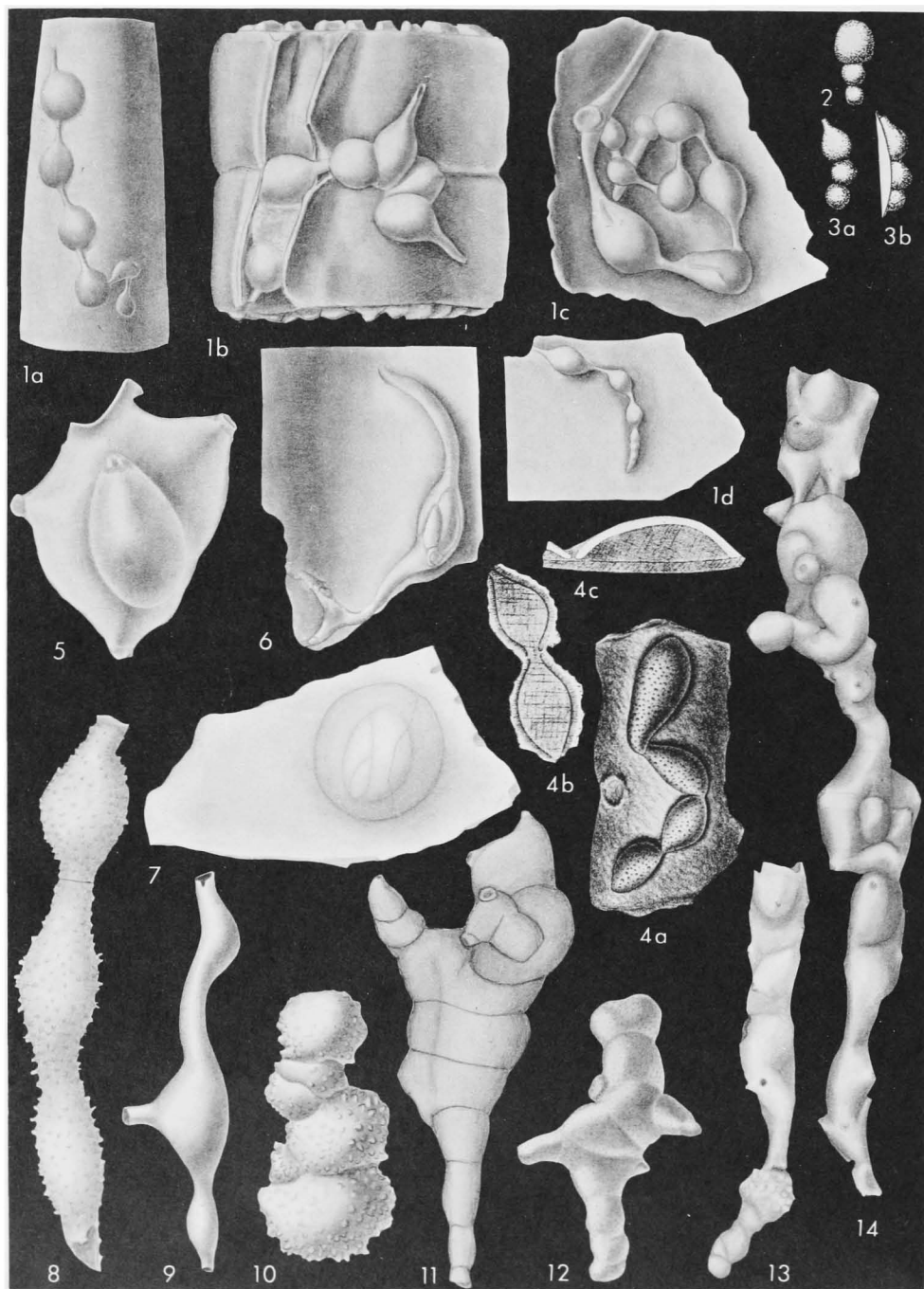


FIG. 420. Polymorphinidae (Webbinellinae: 1-4, *Bullopora*; 5, *Vitruellina*; 6, *Histopomphus*; 7, *Webbinella*; Ramulininae: 8,9, *Ramulina*; 10, *Ramulinella*; 11,12, *Washitella*; 13,14, *Sporadogenerina*) (p. C535-C537).

polymorphine, later attached portion consisting of branching or bifurcating undivided tubular chamber; wall calcareous, perforate; aperture rounded or low arch at ends of tubular chamber. [Differs from *Vitriwebbina* in possessing a multilocular early polymorphine stage, followed by an elongate branching tubular attached stage, and from *Webbinella* in having an irregular branching attachment, instead of the circular disclike attachment.] *L.Cret.*, N.Am.—FIG. 420,6. **H. red-riverensis* (TAPPAN), *L.Cret.* (Alb.), USA (Okla.); $\times 20$ (*2117).

Vitriwebbina CHAPMAN, 1892, *309, p. 52, 53 [**V. sollasi* CHAPMAN, 1892; SD CUSHMAN, 1927, *433, p. 189]. Differs from *Bullopore* in having central initial chamber surrounded by broad flange-like chamber rather than uniserial series of simple chambers; may also have additional chambers after bilocular beginning; apertures at open ends of tubular projections from flange. [Lectotype of *V. sollasi* here designated, specimen figured by CHAPMAN (*309, pl. 2, fig. 1). CHAPMAN's specimen of fig. 3 is a *Bullopore*.] *Cret.*, Eu.-N.Am.—FIG. 420,5. **V. sollasi*, *L.Cret.* (Gault), Eng.; specimen broken free of substratum to which it had been attached, $\times 70$ (*2117).

Subfamily RAMULININAE Brady, 1884

[Ramulininae BRADY, 1884, p. 71]

Test free, with one or more chambers connected by stolons. *Jur.-Rec.*

Ramulina JONES in WRIGHT, 1875, *2079, p. 88 [**R. laevis*; OD]. Test consisting of globular or irregular chambers loosely connected by stolon-like necks, or by straight or branching tube with local irregular chamber-like swellings; apertures rounded, at open ends of tube or stoloniferous necks. [Because of confusion concerning the generic status of *R. aculeata* (D'ORBIGNY), which has been referred to both *Dentalina* and *Ramulina*, even in a single publication (*484, p. 67, 100), it was restudied by us in Paris and found to represent a true *Ramulina*.] *Jur.-Rec.*, cosmop.—FIG. 420,9. **R. laevis*, *U.Cret.*, Ire., $\times 17$ (*2079).—FIG. 420,8. *R. aculeata* (D'ORBIGNY), *U.Cret.*, Fr.; lectotype, here designated and refigured (MNHN), $\times 20$ (*2117).

Ramulinella PAALZOW, 1932, *1405, p. 135 [**R. suevica*; OD (M)]. Similar to *Ramulina* but with closely appressed irregularly arranged chambers and without intercameral stolons. *U.Jur.* (Oxford), Eu.-N.Am. (USA).—FIG. 420,10. **R. suevica*, Ger.; side view, $\times 42$ (*1405).

Sporadogenerina CUSHMAN, 1927, *430, p. 95 [**S. flintii* CUSHMAN, 1927 (= **Ramulina proteiformis* FLINT, 1899, *723, p. 321); OD]. Test elongate, with irregular early portion and later uniserial or branching stage; chambers inflated, somewhat overlapping; aperture radiate, terminal in early stage, later with multiple radiate apertures, ir-

regularly placed. *Rec.*, Gulf Mex.—FIG. 420, 13,14. **S. proteiformis* (FLINT); 13, side view of holotype of *S. flintii*; 14, side view of hypotype; both $\times 25$ (*2117).

Washitella TAPPAN, 1943, *1872, p. 515 [**W. typica*; OD]. Test free, consisting of well-defined but very irregularly arranged chambers, which may be in linear or slightly coiled series or variously branched; apertures simple, rounded, at ends of series of chambers, commonly more than one per chamber. [*Washitella* differs from *Sporadogenerina* in having rounded, rather than radiate, apertures and more regular chambers.] *L.Cret.* (Alb.)-*U.Cret.* (Cenoman.), USA (Okla.-Tex.).—FIG. 420,11,12. **W. typica*, *L.Cret.*, Tex. (11), Okla. (12); 11, hypotype, $\times 75$; 12, holotype, $\times 75$ (*2117).

Family GLANDULINIDAE Reuss, 1860

[Glandulinidae REUSS, 1860, p. 151] [=Stichostegues D'ORBIGNY, 1826, p. 251 (*partim*) (*nom. nud.*, *nom. neg.*); =Ovulinida HAECKEL, 1894, p. 185 (*nom. nud.*)]

Test unilocular or with chambers in biserial, uniserial or polymorphine arrangement; aperture terminal, radial or slitlike, with simple, straight or curved internal (entosolenian) tube. *Jur.-Rec.*

Subfamily GLANDULININAE Reuss, 1860

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 299 (*pro* subfamily Glandulininae REUSS, 1862, p. 307), *nom. transl. ex* family Glandulinidae REUSS, 1860] [=Glandulina HANTKEN, 1875, p. 41]

Test biserial, uniserial or polymorphine; aperture terminal, radial or slitlike, with internal tube. *Jur.-Rec.*

Glandulina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 12 [**Nodosaria* (Glanduline) *laevigata* D'ORBIGNY, 1826, *1391, p. 252; SD CUSHMAN, 1927, *433, p. 189] [=Pseudadium NEUGEBOREN, 1856, *1351, p. 99 (type, *P. ellipticum*); Encorycium EHRENBURG, 1858, *683, p. 12 (type, *E. nodosaria*); Atractolina VON SCHLICHT, 1870, *1648, p. 69 (type, *Nodosaria* (Glanduline) *laevigata* D'ORBIGNY, 1826, SD LOEBLICH & TAPPAN, herein) (obj.)]. Test free, elongate, circular in section, early portion biserial, later uniserial; chambers strongly overlapping and increasing in size; sutures distinct, flush; aperture terminal, central, radiate, with entosolenian tube. [Although superficially resembling *Pandaglandulina*, type material of the type-species of *Pseudadium* was stated by CUSHMAN (*486, p. 228) to be biserial in the early stage and thus belongs with *Glandulina*.] *Paleoc.-Rec.*, cosmop.—FIG. 421,1,2. **G. laevigata* (D'ORBIGNY), *Rec.*, Can. (1), Greenl. (2); 1, side view; 2, specimen showing internal tube, $\times 49$ (*1162).

Dainita LOEBLICH & TAPPAN, herein [*nom. nov. pro Mariella* DAIN in N. K. BYKOVA, *et al.*, 1958, *265, p. 41 (*non* NOWAK, 1916; *nec* MÖRCH, 1865, *nom.*

null. pro *Mariella* GRAY, 1855)] [**Mariella sibirica* DAIN in N. K. BYKOVA *et al.*, 1958, *265, p. 41, here designated as type-species)]. Similar to

Siphoglobulina but with later stage biserial; aperture radiate, with tube attached to one wall of final chamber. *L.Cret.*(*Hauteriv.*)-*U.Cret.*(*Maas-*



FIG. 421. Glandulinidae (Glandulininae; 1, 2, *Glandulina*; 3, 4, *Esosyrinx*; 5, *Siphoglobulina*; 6-8, *Tristix*; 9, *Laryngosigma*; 10, *Globulotuba*) (p. C537, C539-C540).

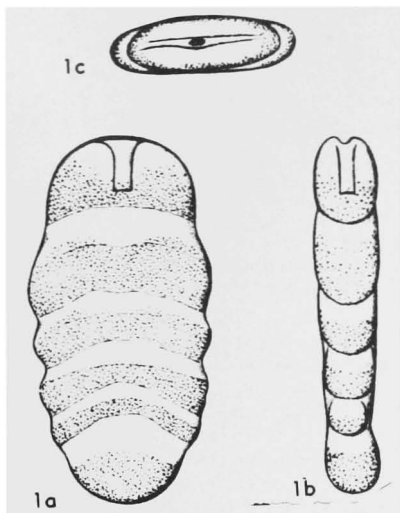


FIG. 422. Glandulinidae (Glandulininae; 1, *Entolingulina*) (p. C539).

tricht.), Eu.-Sib.—FIG. 423,1. **D. sibirica* (DAIN), U.Cret.(Maastricht.), Sib.; 1a-d, opposite sides, edge, and basal views, $\times 47$ (*265).

Entolingulina LOEBLICH & TAPPAN, 1961, *1181, p. 220 [*Lingulina aselliiformis* BUCHNER, 1942, *250, p. 121; OD]. Test free, elongate, compressed, of 2 or more chambers in rectilinear series, commonly with considerable overlap of earlier chambers; wall calcareous, finely perforate, hyaline; aperture ovate or elongate slit, with distinct entosolenian tube projecting into final chamber. Rec., Eu.-Antarctic.—FIG. 422,1. **E. aselliiformis* (BUCHNER), Rec., Italy; 1a-c, side, edge, and top views, $\times 200$ (*250).

Eosyrinx LOEBLICH & TAPPAN, 1953, *1162, p. 85 [*Pseudopolymorphina curta* CUSHMAN & OZAWA, 1930, *514, p. 105; OD]. Test free, chambers biserially arranged throughout and in single plane; aperture terminal, radiate, with internal tube. [*Eosyrinx* differs from *Pseudopolymorphina* in being biserial throughout and in having an internal tube, and from *Laryngosigma* in having chambers in a single plane rather than a sigmoid series.] Rec., Atl.—FIG. 421,3,4. **E. curta* (CUSHMAN & OZAWA); 3a,b, side and basal views of holotype, 4, side view of hypotype; all $\times 48$ (*1162).

Globulotuba COLLINS, 1958, *375, p. 385 [*G. entosoleniformis*; OD] Test ovate, circular in section; chambers in triloculine arrangement, sutures flush; aperture radiate, with short, free, internal entosolenian tube. Rec., Australia.—FIG. 421,10. **G. entosoleniformis*; 10a,b, side and basal views, $\times 150$ (*375).

Laryngosigma LOEBLICH & TAPPAN, 1953, *1162, p. 83 [*L. hyalascidia*; OD]. Test free, somewhat compressed; chambers biserially arranged,

added in planes slightly less than 180° apart, forming sigmoid series with each succeeding chamber farther removed from base; aperture terminal, radiate, with entosolenian tube. Rec., Atl.-Arctic-Antarctic-Australia.—FIG. 421,9. **L. hyalascidia*, Alaska; 9a-c, opposite sides and basal view, $\times 100$ (*1162).

[*Laryngosigma* is similar to *Sigmomorphina* but differs in possessing an entosolenian tube within the aperture. It differs from *Eosyrinx* in being sigmoid and biserial, and from *Siphoglobulina* in being biserial rather than triserial, and in having a free entosolenian tube which is not attached to the interior chamber wall.]

Oolitea MAKIYAMA & NAKAGAWA, 1941, *1206, p. 242, 243 [*O. irregularis*, OD]. Test with irregularly arranged inflated chambers; wall thin, finely perforate; aperture terminal, rounded, with entosolenian tube. Pleist., Japan.—FIG. 424,1-3. **O. irregularis*; 1, holotype, showing entosolenian tube; 2,3, paratypes; all $\times 100$ (*1206).

Siphoglobulina PARR, 1950, *1429, p. 332 [*S. siphonifera*; OD]. Test elongate-ovate to subfusiform; chambers in triloculine series, strongly overlapping but each farther removed from base; aperture radiate, with entosolenian tube extending downward along inner wall of final chamber and opening to exterior in short slit at its lower end, relict slits of earlier chambers remaining visible. L.Tert.-Rec., Australia-Antarctic.—FIG. 421,5. **S. siphonifera*, Mio., Australia; 5a-c, side, face, and basal views, $\times 44$ (*2117).

Tristix MACFADYEN, 1941, *1200, p. 54 [*Rhabdogonium liasinum* BERTHELIN, 1879, *132, p. 35; OD] [= *Tricarinnella* TEN DAM & SCHIJFSMA, 1945, *558, p. 233 (type, *Rhabdogonium excavatum* REUSS, 1863, *1554, p. 91; *Quadratina*

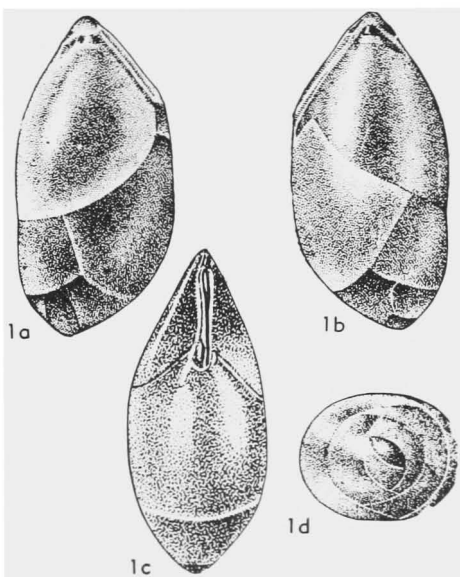


FIG. 423. Glandulinidae (Glandulininae; 1, *Dainita*) (p. C537-C539).

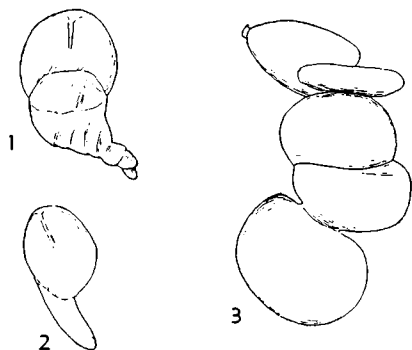


FIG. 424. Glandulinidae (Glandulininae; 1-3, *Oolitella*) (p. C539).

TEN DAM, 1946, *552, p. 65 (type, *O. depressula* TEN DAM, 1946)]. Test free, uniserial, generally triangular in section, but rarely quadrate; wall calcareous, hyaline; aperture terminal, rounded to radiate, with entosolenian tube in at least some species. [Differs from *Glandulina* in being uniserial throughout, angular in section and with less overlapping chambers.] *L.Jur.-Eoc.*, Eu. N.Am.—FIG. 421,6. *T. liasina* (BERTHELIN), *L.Jur.* (L.Pleinsbach.), Fr.; side view, $\times 146$ (*2117).—FIG. 421,7,8. *T. reesidei* LOEBLICH & TAPPAN, *U.Jur.*, USA; 7a,b, side and top views of normal triangular form, $\times 48$; 8a,b, side and top views of rarer quadrate form, $\times 64$ (*2117).

Subfamily SEABROOKIINAE Cushman, 1927

[Seabrookiinae CUSHMAN, 1927, p. 86]

Test compressed, early stage with proloculus and 2 chambers to whorl, later chambers added 180° from preceding and completely enveloping earlier formed chambers; aperture terminal, oval to slitlike, commonly with thickened lip. *U.Cret.-Rec.*

Seabrookia BRADY, 1890, *202, p. 570 [*S. pellucida*; OD (M)] [= *Cerviciferina* GODDARD & JENSEN, 1907, *799, p. 305 (type, *C. hilli* GODDARD & JENSEN, 1907)]. Test free, elongate ovate, compressed, early stage with 3 chambers to whorl, rapidly enlarging chambers 2 per coil in later stages, completely involute, aperture of successive chambers at opposite ends of test, as in miliolids; wall calcareous, perforate, radial in structure, may have peripheral keel, in type-species aboral end ornamented with small blunt spines along keel; aperture a terminal slit bordered by distinct lip. *U.Cret.-Rec.*, Eu.-Atl.-Pac.-Cuba.—FIG. 425,1. *S. pellucida*, Rec., Pac.; 1a-c, opposite sides and apert. view, $\times 140$ (*2117).

[*Seabrookia* has been included in the Chilostomellidae (*486, *762, *1458) but has a perforate radial wall, whereas tests of chilostomellid genera are granular. It resembles some of the Miliolidae in alternation of the aperture to opposite ends of the test in successive cham-

bers, but differs from these in having a perforate radial wall. This wall character and the entosolenian tube places *Seabrookia* in the family Glandulinidae.]

Subfamily OOLININAE Loeblich & Tappan, 1961

[Oolininae LOEBLICH & TAPPAN, 1961, p. 299]

Test unilocular, with slitlike or radiate aperture and entosolenian tube. *Jur.-Rec.*

Oolina D'ORBIGNY, 1839, *1393, p. 18 [*O. laevigata*; SD GALLOWAY & WISSLER, 1927, *766, p. 50] [= *Ovulina* EHRENBERG, 1845, *675, p. 358 (non *Ovulina* SCHULTZE, 1854; nec GRUBER, 1884) (nom. van. pro *Oolina* D'ORBIGNY, 1839) (obj.); *Cenchridium* EHRENBERG, 1845, *675, p. 357 (type, *C. sphaerula* EHRENBERG, 1845); *Entosolenia* WILLIAMSON, 1848, *2064, p. 16 (type, *E. lineata* WILLIAMSON, 1848); *Entosolenia* PARKER & JONES, 1857, *1416, p. 278 (nom. van.) (obj.); *Obliquina* SEGUENZA, 1862, *1712, p. 75 (type, *O. acuticosta* SEGUENZA, 1862); *Lagenulina* TERQUEM, 1876, *1888, p. 67 (type, *L. sulcata* TERQUEM, 1876, SD LOEBLICH & TAPPAN, herein); *Entolagena* SILVESTRI, 1900, *1751, p. 4 (type, *Vermiculum globosum* MONTAGU, 1803, *1298, p. 523); *Lagena* (*Reussoolina*) COLOM, 1956, *376, p. 71 (type, *Oolina apiculata* REUSS, 1851, *1542, p. 22)]. Test single globular to ovate chamber, rarely somewhat asymmetrical; surface may be smooth or ornamented with striae, reticulations or costae; aperture rounded and may have radiating grooves surrounding aperture on exterior, internally provided with entosolenian tube; mononucleate; at least some species ectoparasitic on other foraminifers, having reproductive cycle reduced to only asexual generation, with small size and single nucleus suggesting that haploid stage is represented. *Jur.-Rec.*, cosmop.—FIG. 425,2. *O. lineata* (WILLIAMSON), Rec., Alaska; 2a,b, side and top views, $\times 75$ (*1162).—FIG. 425,3. *O. striatopunctata* (PARKER & JONES), Rec., Alaska; chamber broken, showing entosolenian tube, $\times 75$ (*1162).—FIG. 425,4. *O. laevigata*, Rec., Falk. Is.; 4a,b, side and top views of holotype (MNHN), $\times 58$ (*2117).—FIG. 425,5. *O. apiculata* REUSS, U. Cret., Pol.; side view, $\times 54$ (*700).—FIG. 425,6. *O. acuticosta* (SEGUENZA), Mio., Sicily; 6a-c, side and opposite edges, $\times 30$ (*700).

[*Oolina marginata* is an ectoparasite on *Discorbis*, and during its reproductive stage moves to margin of the host, constructs a chitinous cyst around the aperture into which the protoplasm moves after dissolution of the entosolenian tube. The protoplasm and nucleus then divide asexually into 2 to 6 parts, each reorganizes, secretes a calcareous test, leaves the cyst, and returns to the host (*1109).]

Fissurina REUSS, 1850, *1540, p. 366 [*F. laevigata*; OD (M)] [= *Hyaleina* COSTA, 1856, *392, p. 366 (type, *Fissurina laevigata* REUSS, 1850, SD LOEBLICH & TAPPAN, herein) (obj.); *Trigonulina* SEGUENZA, 1862, *1712, p. 74 (non D'ORBIGNY, 1846) (type, *T. oblonga* SEGUENZA, 1862); *Ellipsolagena* A. SILVESTRI, 1923, *1774, p. 265, 268 (type, *Lagena acutissima* FORNASINI, 1890, *729, p. 1; *Ellip-*

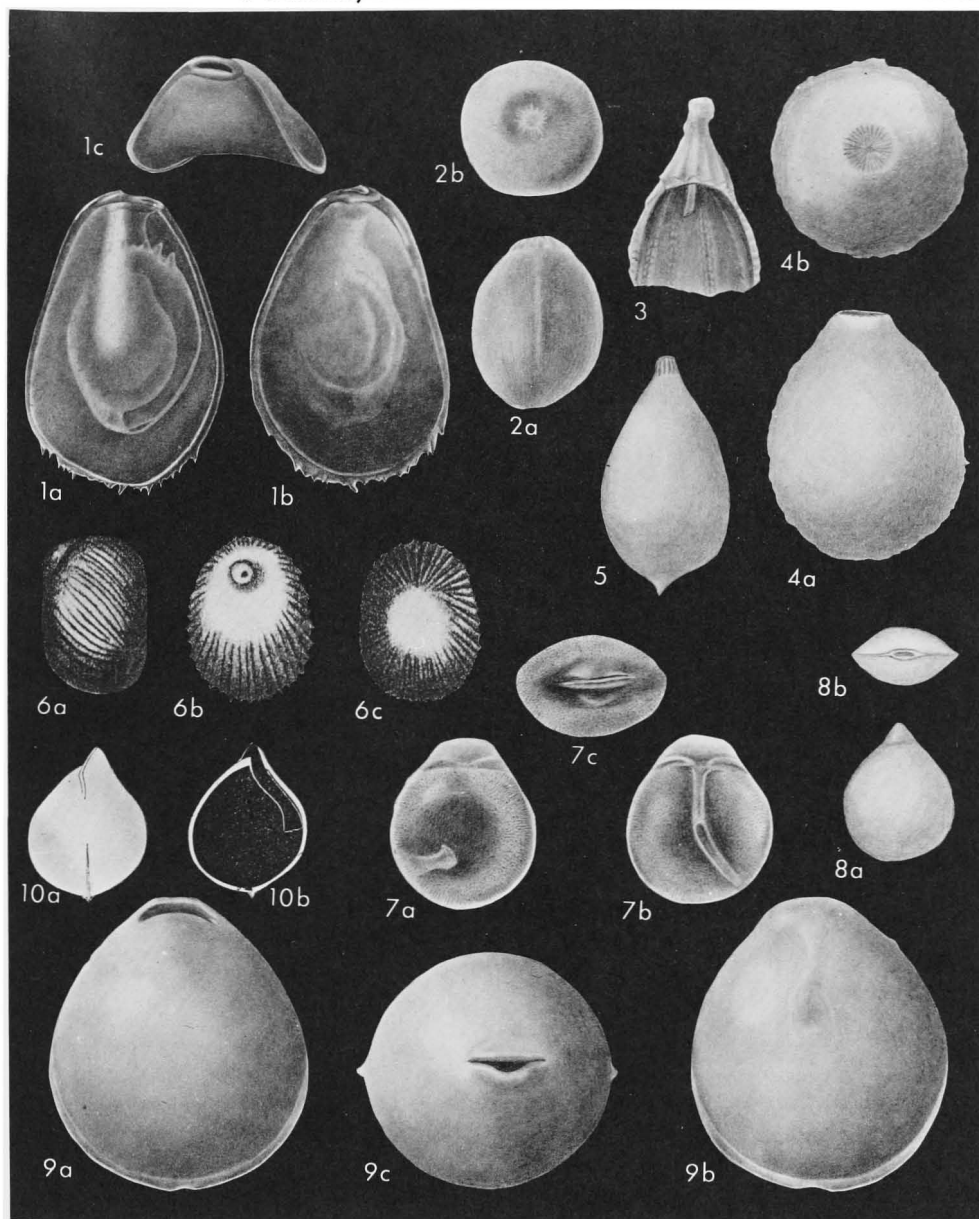


FIG. 425. Glandulinidae (Seabrookiinae; 1, *Seabrookia*; Oolininae; 2-6, *Oolina*; 7, 8, *Fissurina*; 9, 10, *Parafissurina*) (p. C540-C543).

sofissurina A. SILVESTRI, 1923, *1774, p. 265 (type, *Fissurina laevigata* REUSS, 1850, SD LOEBLICH & TAPPAN, herein) (obj.).] Test rounded to ovate in outline; compressed, trigonal or tetragonal in section, and may be keeled; surface smooth, costate, beaded, pitted or reticulate; aperture slitlike to oval or rounded, in center of fissure-like cavity at one end of test; entosolenian tube projecting inward from aperture into chamber cavity. [*Elipsolagena* is a synonym of *Fissurina* (*1428)

with the type-species *Lagena acutissima* FORNASINI, 1890, by monotypy, and not with *Lagena ventricosa* SILVESTRI, 1904, as type by subsequent designation of CUSHMAN (1927, *431, p. 72).] *Cret.-Rec.*, cosmop.—FIG. 425, 7. *F. marginata* (MONTAGU), *Rec.*, Alaska; 7a-c, side, edge, and top views, $\times 75$ (*1162).—FIG. 425, 8. **F. laevigata* REUSS, *Tert.*, Ger.; 8a, b, side, apert. views, $\times 60$ (*1540).

Parafissurina PARR, 1947, *1428, p. 123 [**Lagena*

ventricosa SILVESTRI, 1904, *1758, p. 10; OD].
Test single ovate chamber, commonly compressed;
surface smooth or rarely keeled; aperture arched

or crescentic subterminal opening at one side of
test, with overhanging hoodlike extension of wall;
entosolenian tube as in *Oolina* and *Fissurina*.

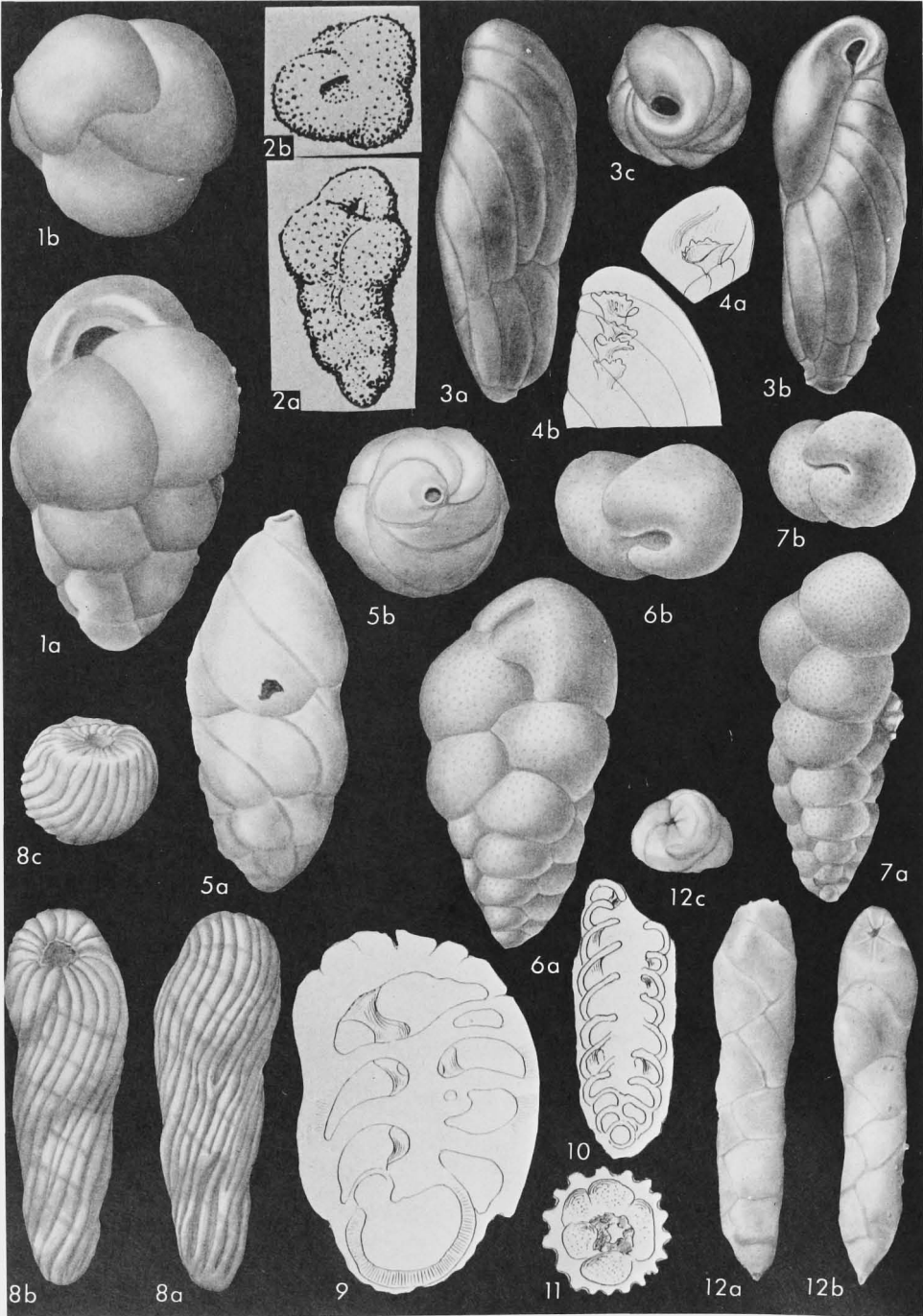
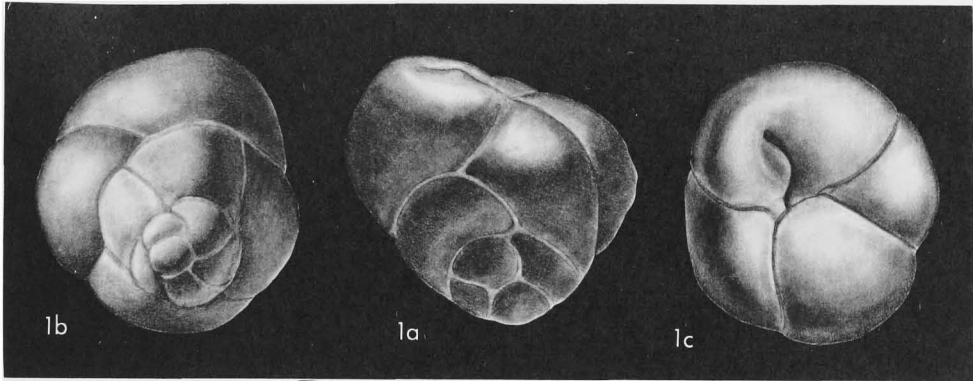


FIG. 426. Turrilinae (Turrilinae; 1,2, *Turrilina*; 3,4, *Buliminella*; 5, *Buliminellita*; 6,7, *Neobulimina*; 8-12, *Buliminoides*) (p. C543-C545).

FIG. 427. Turrilinae (Turrilinae; 1, *Baggatella*) (p. C543).

[The hooded aperture is reminiscent of the Pleurostomellidae, but the radially built wall shows relationship with the Oolininae.] *M.Eoc.-Rec.*, cosmop.—FIG. 425,9,10. **P. ventricosa* (SILVESTRI), Mio., Italy; 9a, side view showing hooded aperture; 9b, opposite side showing entosolenian tube; 9c, top view; all $\times 111$ (*2117); 10a,b, profile and cross sec., $\times 55$ (*1758).

Superfamily BULIMINACEA Jones, 1875

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 299 (pro superfamily Buliminidea GLAESSNER, 1945, p. 134, and Buliminacea EASTON, 1960, p. 65, 79)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹superfamily, ²family group); dagger (†) indicates *partim*]—[=¹Enclinoestegiat EIMER & FICKERT, 1899, p. 682 (*nom. nud.*); =²Textulinidiat RHUMBLER in KÜEN-THAL & KRUMBACH, 1923, p. 88]

Test high trochospiral or modified to biserial or uniserial; wall finely or coarsely perforate, of radially built calcite; aperture primary, basal slit, or in apertural face, or terminal; may have internal tooth plate or tube, and aperture may be on neck. *U. Trias.-Rec.*

Family TURRILINIDAE Cushman, 1927

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 300 (ex subfamily Turrilinae CUSHMAN, 1927)] [=Buliminellidae HOFKER, 1951, p. 121]

Test high trochospiral, with more than 3 chambers to whorl, or may be reduced to biserial; wall of radially lamellar calcite; apertural face poreless, formed by outgrowth from tooth plate, may be radially grooved. *M.Jur.-Rec.*

Subfamily TURRILININAE Cushman, 1927

[Turrilinae CUSHMAN, 1927, p. 65] [=Buliminellinae N. K. BYKOVA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 323; =Baggatellinae N. K. BYKOVA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 325]

Test high-spired, with 3 or more chambers to whorl; aperture loop-shaped, in face of last-formed chamber. *M.Jur.-Rec.*

Turrilina ANDREAE, 1884, *19, p. 120 [**T. alsatica*; OD (M)] [=Corrosina NYIRÖ, 1954, *1382, p. 68, 71, 73 (type, *C. pupoides*)]. Test free, elongate, high-spired, 3 or more chambers to whorl; wall calcareous, finely perforate, monolamellar, microstructure unknown, surface smooth or roughened; aperture a small, basal arch in final chamber, presence or absence of internal tooth plate unknown. [Originally *Corrosina* was placed in the Heterohelicidae, as related to *Guembelitria*, but more prismatic in form. Both *Turrilina* and *Corrosina* were first described from the Oligocene of western and central Europe, respectively. More information is needed as to wall structure and the presence or absence of an internal tooth plate.] *Eoc.(Ypres.)-U.Oligo.*, Eu.—FIG. 426,1. **T. alsatica*, M.Oligo., Fr.; 1a,b, side, top views, $\times 235$ (*2117).—FIG. 426,2. *T. pupoides* (NYIRÖ), U.Oligo.(Chatt.), Fr.; 2a,b, side, apert. views of holotype, $\times 115$ (*1382).

Baggatella HOWE, 1939, *971, p. 79 [**B. inconspicua*; OD]. Test free, tiny, with relatively low spire, 4 or 5 chambers to whorl; aperture loop-shaped, extending up face of final chamber. *M. Eoc.-U.Oligo.*, N.Am.-Carpathians.—FIG. 427,1. **B. inconspicua*, M.Eoc.(Cook Mountain), USA (La.); 1a-c, side, basal, and apert. views, $\times 300$ (*2117).

Buliminella CUSHMAN, 1911, *404b, p. 88 [**Buliminella elegantissima* D'ORBIGNY, 1839, *1393, p. 51; OD]. Test free, elongate, with high close spiral formed by numerous very high, narrow chambers, commonly with many chambers to whorl and few whorls; wall calcareous, perforate, radial in structure, apertural face just above aperture poreless to sharp angle of apertural ridge, surface smooth to striate, rarely spinose; aperture loop-shaped, with upper end relatively broad, internal tooth plate connecting aperture with that of previous chamber. [Early Cretaceous species referred to *Buliminella* belong to *Praebuliminella* or *Caucasina*.] *U.Cret.(Maastricht.)-Rec.*, cosmop.—FIG. 426,3,4. **B. elegantissima* (D'ORBIGNY), Rec., Brazil (3), Peru (4); 3a-c, opposite sides and apert. view, $\times 208$ (*2117); 4a, optical sec.

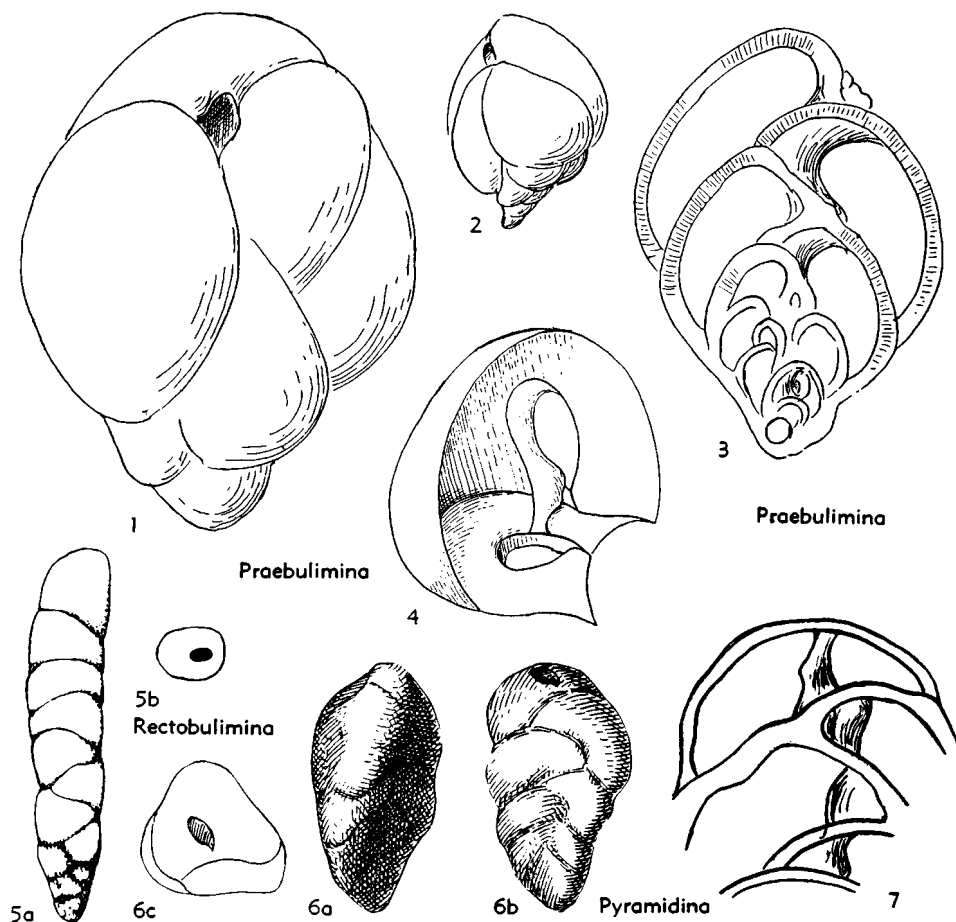


FIG. 428. Turrilinae (Turrilinae; 1-4, *Praebulimina*; 5, *Rectobulimina*; 6,7, *Pyramidina*) (p. C545-C546).

showing tooth plate in final chamber from apert. side, $\times 333$; 4b, successive tooth plates in optical sec. from opposite side, $\times 333$ (*928c).

Buliminellita CUSHMAN & STAINFORTH, 1947, *526, p. 78 [*B. mirifica*; OD]. Test elongate, chambers arranged in high trochospiral coil, approximately 3 to 5 high, narrow chambers to whorl; aperture in early stage as in *Buliminella* but terminal and rounded in adult and produced on neck. *U.Eoc.-Mio.*, Ecuad.-Afr.—FIG. 426,5. *B. mirifica*, *U.Eoc.*, Ecuad.; 5a,b, side, top views of holotype, $\times 116$ (*2117).

Buliminoides CUSHMAN, 1911, *404b, p. 90 [*Bulimina williamsoniana* BRADY, 1881, *196c, p. 56; OD] [= *Elongobula* FINLAY, 1939, *717c, p. 321 (type, *E. chattonensis*)]. Test free, elongate, early chambers in low trochospiral coil, then spire increasing rapidly in height with coiling around open umbilicus, about 5 chambers to whorl, aligned oblique to axis, septal walls partially resorbed internally so that chambers open into um-

bilical hollow; wall calcareous, perforate radial in structure; surface smooth or with prominent longitudinal costae which cross sutures obliquely and obscure structure externally; aperture umbilical, with simple tooth plate. [As *Elongobula chattonensis* differs only in the absence of ornamentation from typical *Buliminoides*, the genus is here regarded as synonymous. The Upper Cretaceous *Elongobula creta* FINLAY apparently belongs to *Buliminella*.] *Oligo.-Rec.*, Indo-Pac.-W.trop. Atl.—FIG. 426,8-11. *B. williamsoniana* (BRADY), *Rec.*, Fiji (8), Indon. (9-11); 8a-c, opposite sides and apert. view, $\times 94$ (*2117); 9, long. sec. showing tooth plates, $\times 210$; 10, long. sec. showing resorbed internal walls, $\times 150$; 11, transv. sec. showing chambers around hollow umbilical axis, $\times 150$ (*928c).—FIG. 426,12. *B. chattonensis* (FINLAY), *L.Oligo.* (Duntroon.), N.Z.; 12a-c, opposite sides and apert. view, $\times 94$ (*2117).

Neobulimina CUSHMAN & WICKENDEN, 1928, *541, p. 12 [*N. canadensis*; OD]. Test free, elongate,

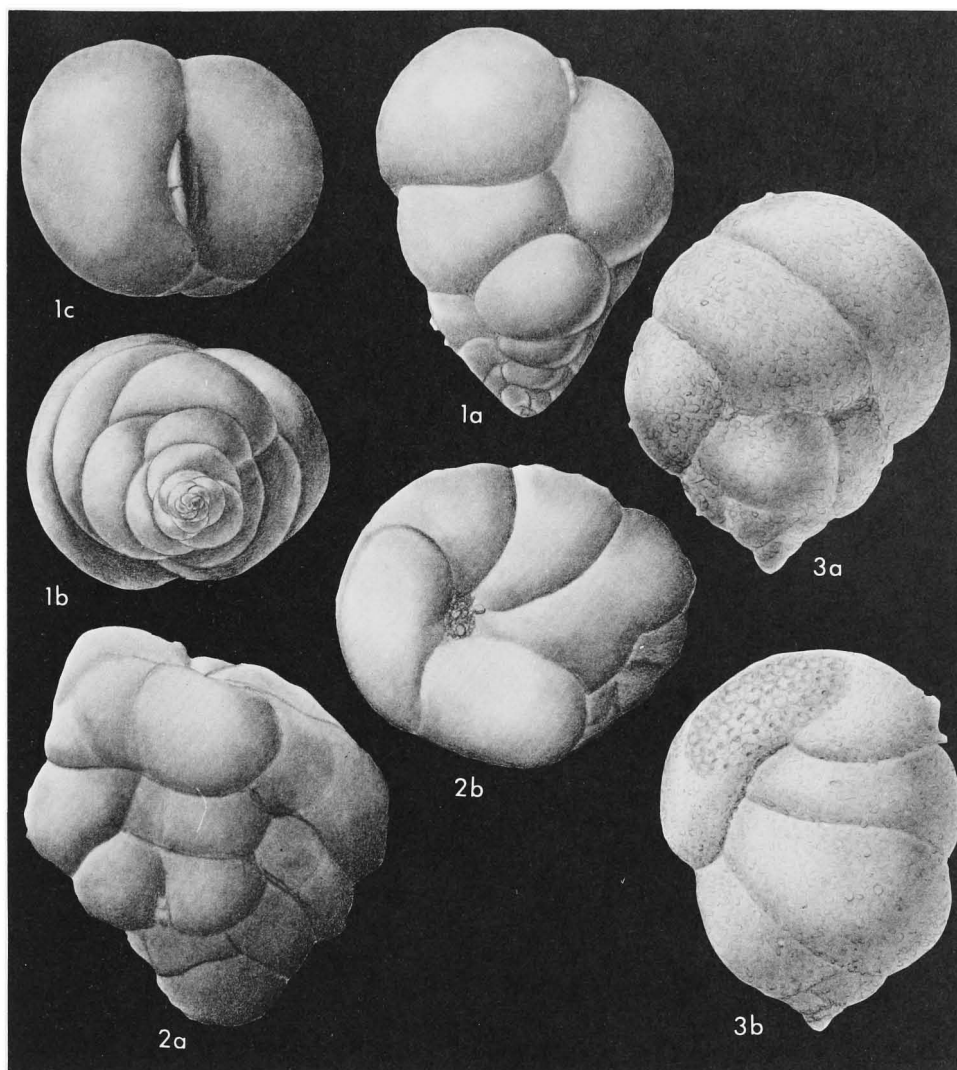


FIG. 429. Turrilinae (Turrilinae; 1, *Tosaia*; 2, *Quadratobuliminella*; 3, *Sporobuliminella*) (p. C546-C547).

early stage triserial, later biserial, not compressed; chambers inflated; aperture loop-shaped opening extending up terminal face. *L.Cret.(Alb.)-U.Cret.(Maastricht.)*, cosmop.—FIG. 426,6,7. **N. canadensis*, U.Cret., Can.; 6a,7a, side views; 6b,7b, apert. views; all $\times 208$ (*2117).

Praebulimina HOFKER, 1953, *939, p. 27 [**Bulimina ovulum* REUSS, 1844, *1537, p. 215 (non *Bulimina ovula* D'ORBIGNY, 1839) = *Bulimina reussi* MORROW, 1934, *1319, p. 195; OD] [= *Praebulimina* HOFKER, 1951, *928c, p. 144, *935, p. 6 (nom. nud.); *Praebulimina* THALMANN, 1952, *1897j, p. 979 (type, *Praebulimina* sp. HOFKER, 1951, *928c, p. 145, nom. nud.)]. Test flaring, inflated, chambers triserially arranged, externally

similar to *Bulimina*; wall calcareous, perforate, thick and opaque in appearance; aperture loop-shaped, with simple internal tooth plate, instead of complex projecting one of *Bulimina*. *M.Jur.(Bathon.)-U.Cret.(Maastricht.)*, cosmop.—FIG. 428,1-3. *P. reussi* (MORROW), U.Cret.(U.Turon.), Sweden; 1, ext. of megalospheric form, $\times 268$; 2, ext. of microspheric test, $\times 43$; 3, long. sec. of microspheric test, showing successive tooth plates, $\times 268$ (*935).—FIG. 428,4. *P. sp.*, U.Cret., Neth.; opened final chamber showing simple tooth-plate bordering side of apert. opening and extending to margin of previous septal foramen, $\times 220$ (*928c).

[Although a generic description was given for *Praebuli-*

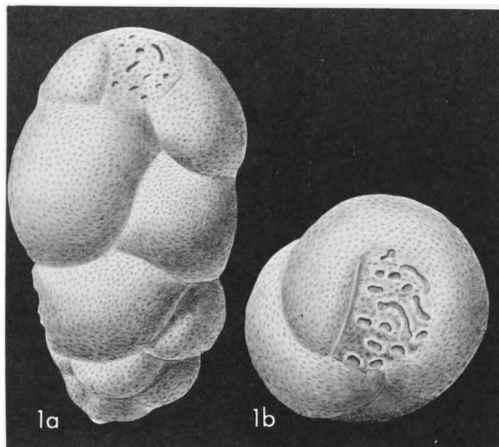


FIG. 430. Turriliminidae (Turrilimininae; 1, *Sporobulimina*) (p. C546).

mina in 1951 (*928c) the genus was a *nomen nudum* as no type-species was designated, though various species of "*Bulimina*" were discussed under the generic heading. Another publication in the same year (*935) discussed only *P. ovula*, but did not state it to be the type-species. THALMANN (1952, *1897) cited the *Præbulimina* sp. figured by HOFKER (*928c) as type-species, but as this was not a valid named species, *Præbulimina* remained a *nomen nudum* until the designation by HOFKER in 1953 of *Bulimina ovulum* REUSS, 1844, as type-species. As *B. ovulum* REUSS was a homonym of *B. ovula* D'ORBIGNY, the former had been renamed by MORROW, 1934, as *B. reussi*, which is thus the valid name for the European species. HOFKER (1957, *948, p. 184, 187) recognized both *Præbulimina ovulum* (REUSS) and *P. reussi* (MORROW), including the original reference of REUSS in both synonymies, but regarding the American species as distinct from the European one. If so, the American species would require a different name, as *B. ovulum* REUSS cannot be resurrected for the European species and *B. reussi* MORROW was proposed only as a *nom. nov.* for *B. ovulum* REUSS. However, HOFKER regarded *Bulimina brevis* FRANK [=*B. brevis* D'ORBIGNY?] as a synonym of *B. reussi* MORROW from the Niobrara formation and the *B. reussi* from the American Gulf Coast as synonymous with *B. ventricosa* BROTZEN, all species being transferred to *Præbulimina*. Many of the Cretaceous species previously placed in *Bulimina*, *Buliminella*, and *Reussella* should be referred to *Præbulimina* or *Pyramidina*.]

Pyramidina BROTZEN, 1948, *241, p. 62 [**Bulimina? curvisuturata* BROTZEN, 1940, *239, p. 29; OD] [= *Pyramidina* BROTZEN, 1940, *239, p. 29 (*nom. nud.*)]. Test free, flaring, subtriangular in section, chambers broad, low, triserially arranged and subangular; wall calcareous, finely perforate, surface may be somewhat nodose; aperture a high loop-shaped opening which has tendency to close at basal part, remaining only as more or less defined suture connecting subterminal aperture to base of chamber. *U.Cret.* (Santon.)-Paleoc. (Dan.), Eu.-N.Am.—FIG. 428,6. **P. curvisuturata* (BROTZEN), Paleoc. (U.Dan.); 6a-c, opposite sides and apert. view, $\times 100$ (*239).—FIG. 428,7. *P. cushmani* (BROTZEN), *U.Cret.* (L.Campan.), Ger.; apert. portion of long. sec. showing tooth plates, $\times 160$ (*948).

[In 1940, *Bulimina? curvisuturata* was described by BROTZEN (*239) with the statement that it did not wholly agree with that genus because of a tendency to terminal development of the aperture, and that it probably should

be placed in a new genus, *Pyramidina*. In the discussion he referred to this species as "*Bulimina (Pyramidina) curvisuturata*," but also discussed "*Reussella (Pyramidina) cushmani*," and since no type-species was designated and 2 species were discussed, the generic name proposed was invalid until 1948, when type designation was made. Although the main generic features given by BROTZEN were the subangular test shape and tendency for the loop-shaped aperture to close at the lower part, with only a suture connecting the opening to the chamber base, the same apertural characters were shown in *Præbulimina* sp. of HOFKER (*928c) from the Upper Cretaceous of the Netherlands. In the diagnosis of *Præbulimina* (*928c, p. 144) HOFKER stated that he included "those Buliminidae found in the Upper Cretaceous of Sweden (Brotzen) and the Netherlands," and cited the publication in which *Bulimina? curvisuturata* was described. In 1957 HOFKER (*948) regarded *Pyramidina* as a synonym of *Reussella*, discussing BROTZEN's *Reussella (Pyramidina) cushmani*, but did not mention the type-species. As noted by HOFKER (*948, p. 202), the Cretaceous species are finely perforate and the tooth plate less complex, in contrast to the more coarsely perforate true *Reussella* of the Cenozoic. *Pyramidina* is therefore here recognized for the subangular finely perforate species particularly characteristic of the Upper Cretaceous, differing from the more coarsely perforate, sharply angular or keeled Cenozoic *Reussella*. It differs from *Præbulimina* in its low, broad and angular rather than rounded or inflated chambers. *Pseudovigierina* differs in having a distinctly terminal aperture in the adult.]

Quadratobuliminella DE KLASZ, 1953, *1041, p. 435 [**Q. pyramidalis*; OD]. Test similar to *Buliminella* but quadrate in section, chambers elongate, quadriserially arranged; aperture low and umbilical as in *Buliminoides*. Paleoc. (Dan.), Bav.-Fr.—FIG. 429,2. **Q. pyramidalis*, Bav.; 2a,b, side, top views, $\times 174$ (*2117).

Rectobulimina MARIE, 1956, *1221, p. B249 [**R. carpenteriae*; OD]. Test similar to *Siphogenerina* in being triserial in early stage, later biserial and finally uniserial; wall calcareous, perforate; aperture terminal, rounded to oval, flush with surface and not produced into phialine lip, presence or absence of internal tooth plates not known. [*Rectobulimina* is tentatively placed in the Turriliminidae, but information as to the internal structure is lacking.] *U.Cret.* (Maastricht.), Belg.—FIG. 428,5. **R. carpenteriae*; 5a,b, side, apert. views of holotype, $\times 77.5$ (*1221).

Sporobulimina STONE, 1949, *1842, p. 82 [**S. perforata*; OD]. Test elongate, triserial, wall calcareous, perforate, primary aperture narrow elongate slit extending from base of chamber about half distance up apertural face, supplementary apertures consist of numerous irregular openings in face of chamber at one side and adjacent to primary aperture. *U.Cret.*, Peru.—FIG. 430,1. **S. perforata*; 1a,b, side and apert. views of holotype, $\times 82$ (*2117).

Sporobuliminella STONE, 1949, *1842, p. 81 [**S. stainforthi*; OD]. Test tightly coiled in low spire; with about 4 inflated chambers to whorl; primary aperture low interiomarginal opening with narrow lip, with numerous small supplementary apertures over nodose or pustulose roughly circular area or pore plate extending up terminal face from primary aperture. *U.Cret.*, Peru.—FIG. 429,3. **S. stainforthi*; 3a,b, opposite sides of holotype, $\times 93$ (*2117).

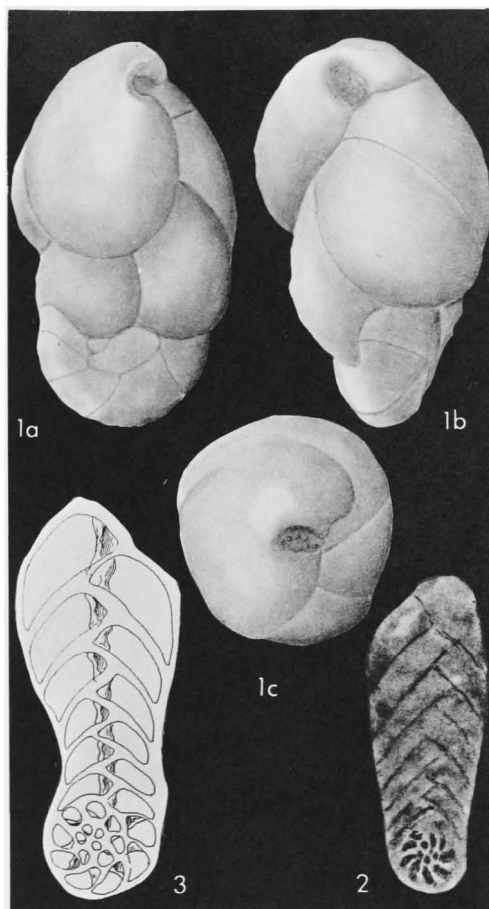


FIG. 431. Turriliniidae (Lacosteinae; 1, *Lacosteina*; 2, 3, *Spirobolevina*) (p. C547).

Tosaia TAKAYANAGI, 1953, *1862, p. 30 [*T. hanzawai*; OD]. Test free, small, flaring, early stage obscure, triserial completely or through most of development, rarely with last few chambers in biserial arrangement; wall calcareous, smooth, finely perforate, microstructure not known; aperture basal, relatively small, with a narrow bordering lip. [Originally regarded as belonging to the Heterohelicoidea, *Tosaia* was later questionably referred to the Buliminidae by MONTANARO GALLITELLI (*1303). Additional information is required as to wall character and presence or absence of apertural tooth plate.] *Plio.*, Japan.—FIG. 429, 1. *T. hanzawai*; 1a-c, side, basal and apert. views, $\times 99$ (*1303).

Subfamily LACOSTEININAE Sigal, 1952

[Lacosteinae SIGAL in PIVETEAU, 1952, p. 220]

Early portion planispirally coiled, later changing abruptly to elongate growth axis with 2, 3, or 4 chambers to whorl; aperture

loop-shaped, in face of final chamber. *U. Cret.-U. Eoc.*

Lacosteina MARIE, 1945, *1216, p. 295 [*L. gouskovi*; OD]. Test free, elongate; early portion in planispiral coil of few chambers, later changing direction of coiling and forming high spire of about 2 volutions with 3 or 4 chambers to whorl, chambers inflated; sutures distinct, depressed; wall calcareous, finely perforate, surface smooth; aperture loop-shaped, at inner margin of final chamber. *U. Cret. (Campan.)*, Morocco-USA (Alaska-Calif.). —FIG. 431, 1. *L. gouskovi*, Morocco; 1a-c, side, edge, and apert. views, $\times 166$ (*2117).

[*Lacosteina* differs from *Bulimina* and *Praebulimina* in having the early planispiral coil perpendicular to the plane of coiling of its later high-spined part of the test. MARIE (1945, *1216, p. 295) stated that the genus resembled *Bulimina* in the later stage and the Heterohelicoidea in its initial stage, and accordingly suggested that *Lacosteina* represents the ancestral genus of the Buliminidae, which was therefore derived from a planispiral ancestry, rather than from the high-spined *Terebralina*, as CUSHMAN had earlier concluded. Although the ontogeny might suggest such an ancestry, the geological record does not bear out this relationship, since the earliest Buliminidae occur in the Jurassic. *Lacosteina* is apparently a specialized offshoot occurring in the Upper Cretaceous.]

Spirobolevina HOFKER, 1956, *945, p. 915 [*Bolivinaopsis pulchella* CUSHMAN & STAINFORTH, 1947, *526, p. 78; OD]. Test free, elongate, with early planispiral stage of about 1.5 volutions, later biserial, compressed; wall thin, calcareous, finely perforate; aperture a loop-shaped opening, with small internal tooth plate similar to *Bolovina*, tooth plates of successive chambers differing in orientation by 180° . [*Spirobolevina* was proposed for calcareous perforate species with internal tooth plate, previously placed erroneously in *Bolivinaopsis*, which is an agglutinated form.] *Paleoc.-U. Eoc.*, S. Am.-N. Am.—FIG. 431, 2, 3. *S. pulchella* (CUSHMAN & STAINFORTH), U. Eoc., S. Am. (Ecuador); 2, holotype, side view, $\times 80$ (*526); 3, long. sec., $\times 120$ (*945).

Family SPHAEROIDINIDAE Cushman, 1927

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 300 (ex subfamily Sphaeroidinidae CUSHMAN, 1927)] [= *Uvella* EHRENBERG, 1839, table opposite p. 120 (*partim*) (*nom. nud.*)]

Early portion trochospiral, later streptospiral, with chambers embracing most of preceding ones; aperture interiomarginal, with rounded tooth, or with later secondary sutural openings. *U. Cret.-Rec.*

Sphaeroidina D'ORBIGNY, 1826, *1391, p. 267 [*S. bulloides*; OD (M)] [= *Saxoculina* ČZJŽEK, 1848, *545, p. 138 (type, *S. haueri*); ?*Bolbodium* EHRENBERG, 1872, *687, p. 276 (type, *B. sphaerula*)]. Test subglobular, coiling variable, depending on fluctuation in position of aperture; chambers hemispherical, few, number depending on changes of apertural position and relative size and placement of chambers, each placed centrally about previous aperture, strongly embracing, me-

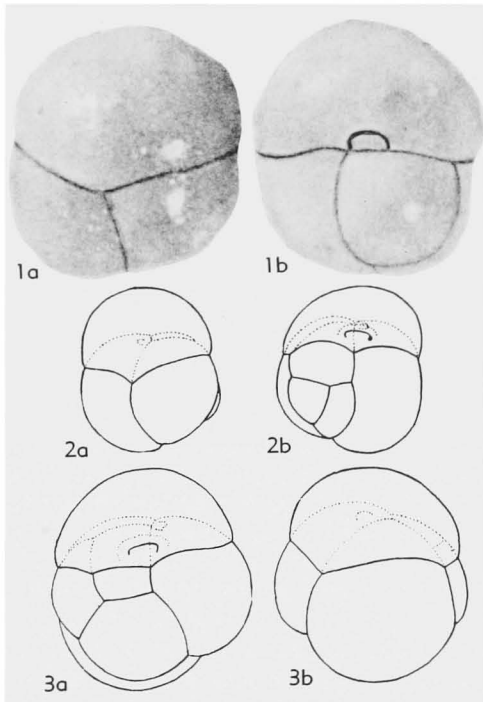


FIG. 432. Sphaeroidinidae; 1-3, *Sphaeroidina* (p. C547-C548).

dian apertural planes of later chambers diverging from those of earlier ones alternating to left and right, or constantly to one side, or irregularly to right and left by angle up to 180° , commonly 90° , in latter case resulting in relatively regular spiral; wall of calcite, very finely perforate, radial in structure, surface smooth or faintly roughened near aperture, which is crescentic slit near suture and may occur above junction of 3 chambers, bordered by lip, also may have simple or bifid tooth. [Placed in the Chilostomellidae by CUSHMAN (1948, *486, p. 321), it was transferred to the Cassidulinidae by VAŠÍČEK (1956, *1983, p. 160). However, as both the Chilostomellidae and Cassidulinidae are characterized by a perforate granular wall structure, the radially built Sphaeroidininae have been elevated to a separate family by us (*1177, p. 300) and placed in the superfamily Buliminacea.] *U.Eoc.-Rec.*, cosmop.—FIG. 432, 1-3. **S. bulloides*, Rec., Italy (1), Mio.(Torton.), Czech.(Morav.) (2,3); 1a,b, opposite sides of topotype, $\times 73$ (*530); 2a,b, 3a,b, diagram. figures showing chamber arrangement, opposite sides seen through sides of final chamber with preceding whorl indicated by dotted lines, $\times 44$ (*1983). **Pullenoides** HOFKER, 1951, *935, p. 10 [**P. senoniensis*; OD]. Test free, subglobular, early stage trochospiral, later chambers planispiral and embracing, with tendency to biseriality; wall calcareous, very finely perforate, as in *Sphaeroidina*,

opaque, surface smooth, microstructure not determined; aperture a loop-shaped opening in early stage, later with numerous, small supplementary sutural openings, no internal tooth plate. *U.Cret.* (*U.Senon.*), Neth.—FIG. 433, 1-3. **P. senoniensis*; 1a-c, opposite sides and edge view, $\times 74$ (*2117); 2,3, horiz. and transv. secs., $\times 53$ (*935).

Family BOLIVINITIDAE Cushman, 1927

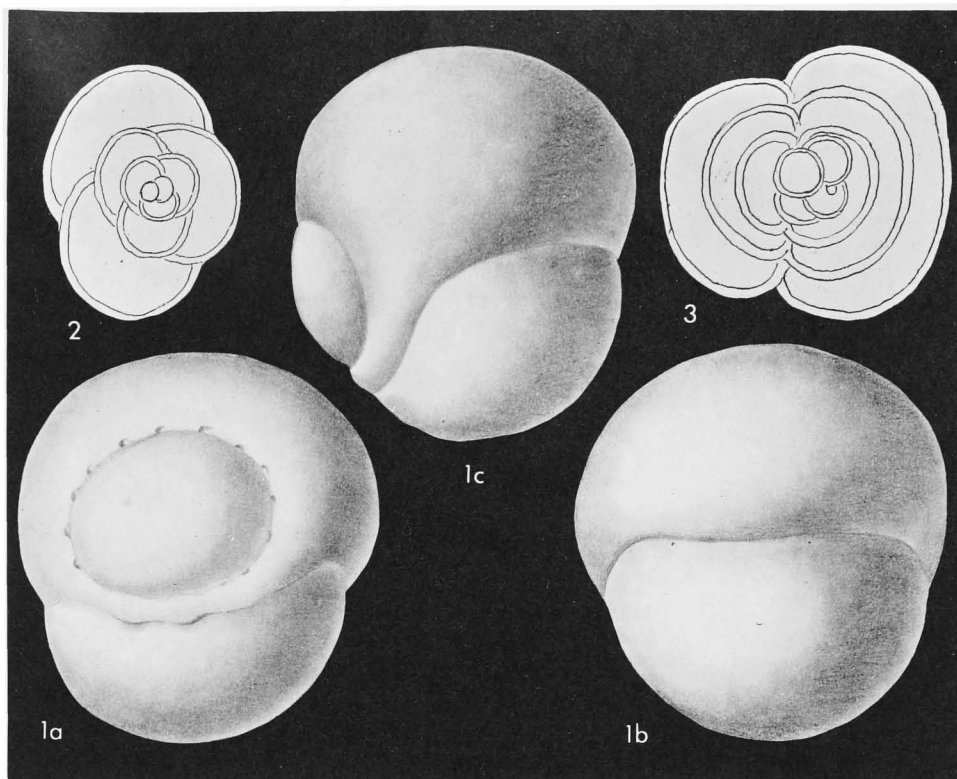
[*nom. transl.* GLASSNER, 1936, p. 127 (ex subfamily Bolivinitidae CUSHMAN, 1927, p. 61)] [=Bolivininae GLAESSNER, 1937, p. 420; Bolivinidae HOFKER, 1951, p. 48]

Test biserial at least in young stage, aperture comma-shaped, parallel to compression of test, basal or terminal, with internal tooth plate. *U.Trias.-Rec.*

Bolivinita CUSHMAN, 1927, *429, p. 90 [**Textilaria quadrilatera* SCHWAGER, 1866, *1703, p. 253; OD]. Test free, compressed, broad sides flat to concave, rectangular in transverse section, 4 angles of test with strongly developed axial costae; chambers biserial throughout, gradually increasing in relative breadth, proloculus may have one or more spines; sutures straight, depressed on lateral edges, oblique and may be limbate on broader faces; wall thin, calcareous, perforate radial in structure, completely covered by minute pores and sporadic larger ones, surface of early portion may be spinose or vertically costate; aperture basal, subcircular, elliptical, perpendicular to suture and with bordering lip, tooth plate may project slightly, somewhat arched at upper surface, flaring and curved internally and may be spatulate at free lower end, those of successive chambers alternating in direction. *Mio.-Rec.*, Atl.-Pac.-Kar Nicobar-N.Z.-N. Am.-Java-Sumatra-Australia. — FIG. 434, 1-3. **B. quadrilatera* (SCHWAGER), Rec., Philip; 1a,b, side, edge views of microspheric form; 2a,b, side, edge views of megalospheric form; 3, edge view of megalospheric form with portion of final chamber removed to show tooth plate; all $\times 65$ (*1303).

[*Bolivinita* closely resembles *Bolivina* in chamber arrangement and apertural features, differing in its marginal keels, quadrate section, and absence of retral processes. Although regarded as a synonym of *Bolivina* by HOFKER (1951, *928c, p. 106), *Bolivinita*, as here understood, has a more restricted geologic occurrence, and therefore its retention seems to be useful. Such a taxonomic modification, with specialized morphology and limited geologic occurrence, may be afforded generic or subgeneric status by different workers, but is here regarded as of generic status.]

Altistoma DE KLASZ & RÉRAT, 1962, *1043, p. 180 [**A. scalaris*; OD]. Test biserial, strongly overlapping chambers with lobulate lower margin, sutures depressed; wall calcareous, finely perforate, surface smooth; aperture large, high symmetrical arch bordered by thickened lip, in laterally compressed apertural face. *Eoc.-L.Mio.*, W.Afr. (Gabon).—FIG. 434, 4. **A. scalaris*, L.Mio.; 4a-c, side, edge, and apert. views of holotype, $\times 133$ (*1043).

FIG. 433. Sphaeroidinidae; 1-3, *Pullenoides* (p. C548).

Bolivina D'ORBIGNY, 1839, *1393, p. 60 [**B. plicata*; SD CUSHMAN, 1911, *404b, p. 31] [= *Grammostomum* EHRENBERG, 1839, *667, table opposite p. 120 (type, *G. tenue*); *Proroporus* EHRENBERG, 1844, *673, p. 75 (type, *P. lingua*); *Clidostomum* EHRENBERG, 1845, *675, p. 358 (type, *C. poly stigma*); *Afroboivina* REYMENT, 1959, *1557, p. 19 (type, *A. afra*)]. Test elongate, may be somewhat compressed; chambers broad, low, biserially arranged throughout, basal margins of chambers with retral processes or backward directed chamber overlaps; wall calcareous, perforate, radial in structure, smooth, striate, or costate and may have marginal keel; aperture a narrow, elongate loop up chamber face, one margin ending blindly or bent upward as collar, opposite border attached to one side of doubly folded internal tooth plate (U-shaped in section), attached half of tooth plate projecting inward to coalesce with free half of tooth plate of previous foramen, free half of tooth plate projecting through aperture at one extremity and bisecting it, narrowing rapidly inward, tooth plate thus being trough-shaped structure with concave portion alternately turning from one side to opposite in successive chambers. *U. Cret.-Rec.*, cosmop.—FIG. 434,7. **B. plicata*, Rec., Panama; 7a,b, side, apert. views, $\times 99$ (*2117).—FIG. 434,8,9. *B. afra* (REYMENT),

U. Cret. (Maastricht.), Nigeria; 8a,b, side and top views of microspheric test showing surface ribs and chamber overlaps, $\times 40$; 9, dissected final chamber showing rear side of tooth plate (*t*), intercameral foramen (*f*), lip of preceding tooth plate (*l*), apertural depression (*d*), crenulated terminal wall of penultimate chamber (*c*) and crenulations from interior (*cr*), $\times 147$ (*1557).

[Although it has been stated that *Bolivina* and *Virgulina* [= *Fursenkoina*] are intergradational (*472), *Bolivina*, as all Buliminacea, has a perforate radial wall structure, and *Fursenkoina* has a perforate granular wall structure. HOFKER (*928c), REYMENT (*1557) and others have regarded *Bolivinita* and *Bolivinoidea* as synonyms of *Bolivina*, but they are here considered to be distinct, although all are biserial in chamber arrangement and possess internal tooth plates. The differing geologic ranges of these distinct morphologic types seem to indicate their generic validity. *Bolivina* is therefore restricted to include biserial species with internal tooth plates, basal aperture, radially built perforate hyaline walls, and chamber retral projections or overlaps, varying from a few broad lobes, as in the type-species, to the numerous smaller projections, as in *Afroboivina afra*. As the so-called secondary vertical septa described for *Afroboivina* are merely internal indentations of the wall between chamber overlaps, *Afroboivina* is regarded as a synonym of *Bolivina*. Species without chamber overlaps, commonly keeled and strongly compressed, are placed by us in *Brizalina*.]

Bolivinoidea CUSHMAN, 1927, *429, p. 89 [**Bolivina draco* MARSSON, 1878, *1228, p. 157; OD]. Test free, rhomboidal, flaring, compressed; chambers low and broad, biserially arranged throughout; septa thick, sutures oblique, obscured externally

by strong ornamentation; wall calcareous, single-layered, lamellar, finely perforate, radial in structure, interior tuberculate, exterior surface with

strong longitudinal costae and tuberculate; aperture elongate, loop-shaped, basal, extending up face of final chamber with bordering lip and in-

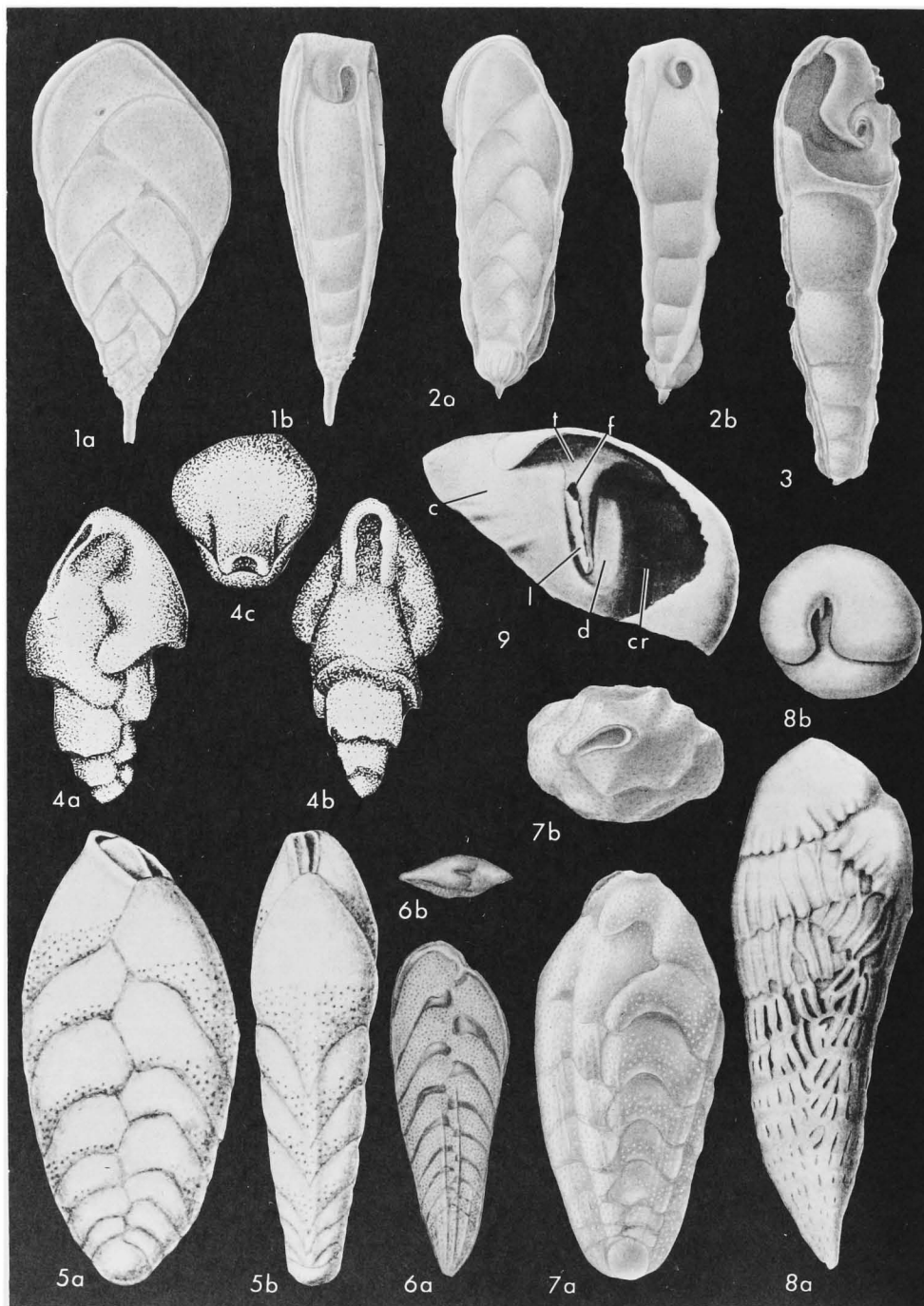


FIG. 434. Bolivinitidae; 1-3, *Bolivinita*; 4, *Altistoma*; 5, 6, *Brizalina*; 7-9, *Bolivina* (p. C548-C549, C552).

ternal tooth plate. [*Bolivinooides* may have an internal tuberculate wall, but does not show the

exterior chamber overlaps or retral processes found in *Bolivina*, as here restricted. It is also char-

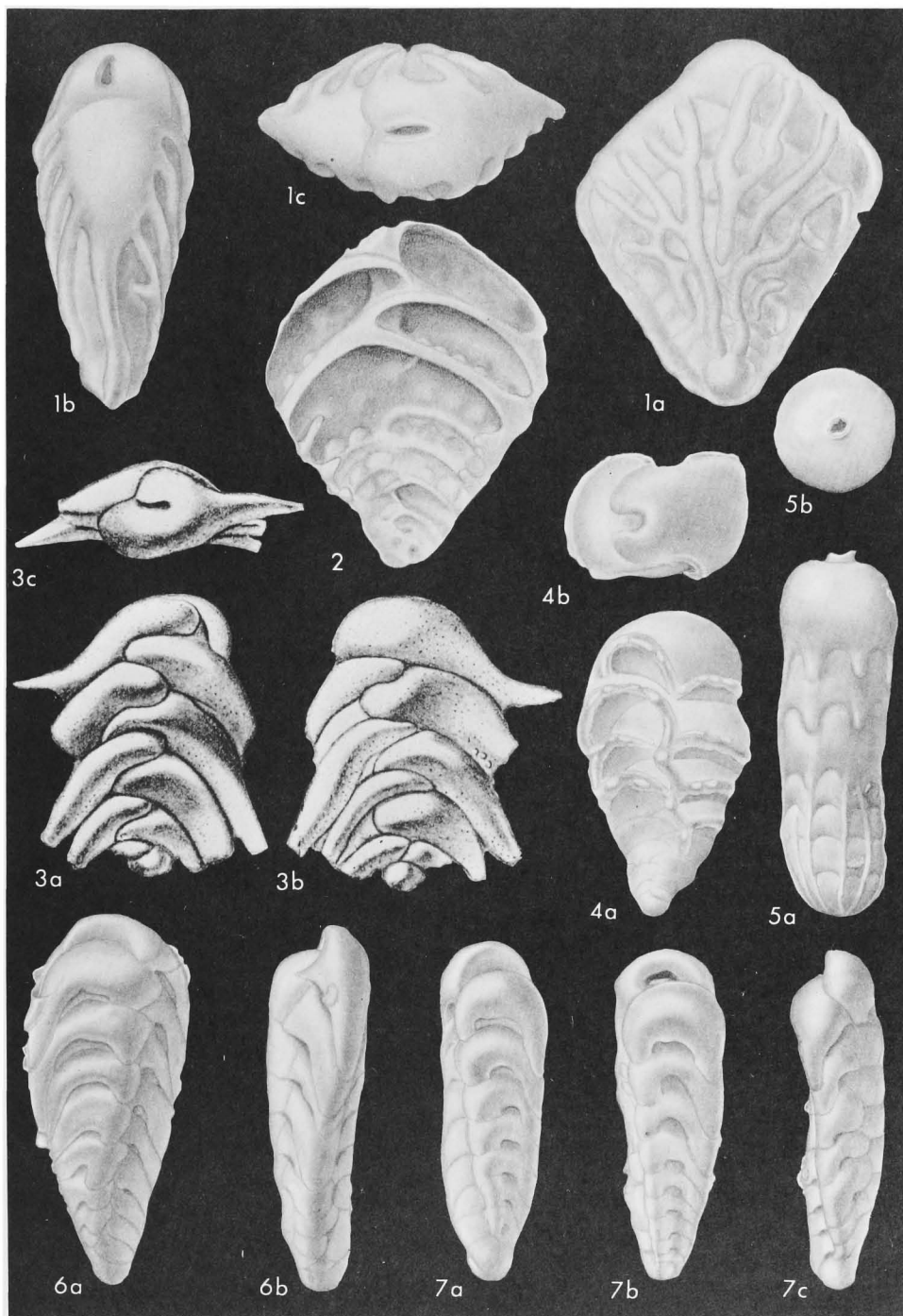


FIG. 435. Bolivininitidae; 1,2, *Bolivinooides*; 3, *Grimsdaleinella*; 4, *Tappanina*; 5, *Unicosiphonia*; 6,7, *Gabonella* (p. C549-C555).

acterized by heavy longitudinal ornamentation.] *U. Cret. (U. Santon.)-Paleoc.*, Eu.-N. Am.-Carib.-S. Am.-Australia-N.Z.-Indon.—FIG. 435,1,2. **B. draco* (MARSSON), *U. Cret. (Campan.)*, Ger.; 1a-c, side, edge, and top views, $\times 97$; 2, dissected specimen showing thick septa, internally tuberculate wall, and apert. tooth plate in later chambers, $\times 100$ (*1303).

Brizalina COSTA, 1856, *392, p. 296 [**B. aenariensis*; OD (M)]. Test elongate, tapering, commonly compressed and laterally carinate, biserial throughout, lacking basal chamber lobes, crenulations or retral processes of *Bolivina* but having straight or curved, commonly limbate sutures; wall calcareous, perforate, radially built, with ornamentation consisting of variously arranged pores, longitudinal costae, carinae, and marginal or apical chamber spines; aperture loop-shaped, extending up from base of final chamber, with tooth plate as in *Bolivina*. *U. Trias.-Rec.*, cosmop.—FIG. 434,5; 436,1. **B. aenariensis*, Rec., Ire. (434,5), Plio., Italy (436,1); 434,5a,b, side and apert. views, $\times 75$ (*472); 436,1a,b, holotype, side, edge views, approx. $\times 60$ (*700).—FIG. 434,6. *B. sp. cf. B. vadeszens* (CUSHMAN), Rec., Sweden; 6a,b, side view and edge view showing projecting tooth plate, $\times 140$ (*924).—FIG. 436,2. *B. pseudopunctata* (HÖGLUND), Rec., Sweden; 2a, optical sec. of apert. end showing internal tooth plate in alternating arrangement; 2b, transv. sec. of final chamber through aperture showing U-shaped sec. of tooth plate fastened at one border to chamber wall, $\times 500$ (*924).

[*Brizalina*, as here emended, includes many species previously placed in *Bolivina* that do not show retral chamber processes or crenulations, such as are found in *Bolivina plicata*. The original description of *Brizalina* erroneously described the presence of a neck; this was on the basis of a broken specimen in which only the axis and tooth plates of the final pair of chambers were preserved. Similar preservation has been noted in many specimens of the type-species.]

Gabonella DE KLASZ, MARIE & MEIJER, 1960, *1042, p. 167 [**G. elongata* DE KLASZ & MEIJER; OD]. Test free, elongate, biserial, chambers broad and low, plane of biseriality somewhat twisted; sutures strongly depressed, commonly with strong reentrant toward center of chamber margins; wall calcareous, finely perforate, radial in structure; aperture hook-shaped, extending upward from base of final chamber, then curving sharply to run nearly parallel to suture, with narrow bordering lip. [*Gabonella* differs from *Grimsdaleinella* in its distinctly twisted test, low hook-shaped aperture, and small tooth, instead of high comma-shaped aperture. It differs from *Bolivina* in lacking crenulated sutures or retral chamber processes and distinctive tooth plate.] *U. Cret. (Santon.-Maastricht.)*, ?*Paleoc. (Dan.)*, Afr.—FIG. 435, 6,7. **G. elongata*, *U. Cret. (Maastricht.)*, Gabon; 6a,b, side and edge views showing twisted test and deeply incised sutures; 7a-c, opposite sides and edge of specimen in which twisting results

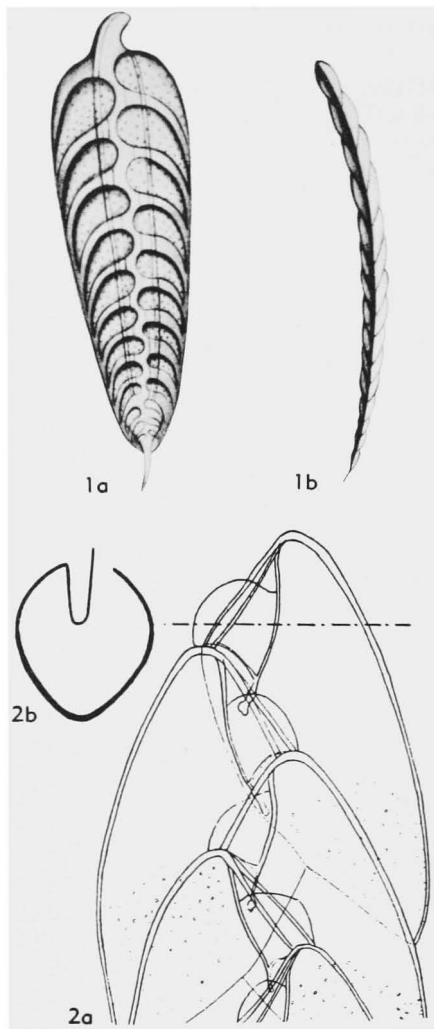


FIG. 436. Bolivinitidae; 1,2, *Brizalina* (p. C552).

in nearly quadrate test, apert. tooth visible; all $\times 62$ (*2117).

Grimsdaleinella BOLLI, 1959, *162, p. 1 [**G. spinosa*; OD]. Test free, chambers biserially arranged, inflated, and laterally produced into spine-like extensions; wall calcareous, finely perforate, surface smooth, hispid or striate; aperture an asymmetrical arch or slit extending up face, presence or absence of tooth plate unknown. *U. Cret. (Turon.-Coniac.)*, Trinidad.—FIG. 435,3. **G. spinosa*; 3a-c, opposite sides and top view of holotype, $\times 73$ (*162).

[Originally regarded as belonging to the Heterohellicidae, and differing from *Chiloguembelina* in having lateral spines, the genus is here judged to belong probably to

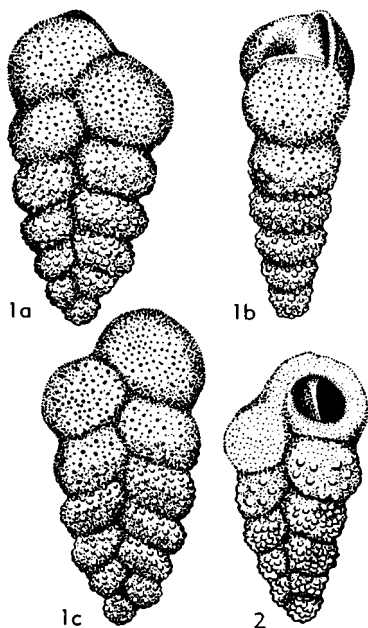


FIG. 437. Bolivinitidae; 1, 2, *Laterostomella* (p. C553).

the Bolivinitidae, as indicated by its loop-shaped aperture and broad low chambers, although no information is available as to the presence of an internal tooth plate. The original generic description stated "biserially arranged throughout or planispiral in early stage," but the description of the type-species of the monotypic genus stated "biserial throughout," further suggesting the possibility of a relationship with the Bolivinitidae.]

Laterostomella DE KLASZ & RÉRAT, 1962, *1043, p. 177 [**L. guembeliniformis*; OD]. Test elongate, biserial, chambers inflated; sutures depressed; wall calcareous, finely to coarsely perforate, with rugose or striate surface; aperture elongate, with bordering lip, situated in cavity at one side of apertural face, outer margin somewhat flaring and infolded to form tooth plate. *Mio.*, W.Afr.(Gabon).—FIG. 437, 1, 2. **L. guembeliniformis*, Burdigal.; 1a-c, opposite sides and edge view of holotype; 2, dissected specimen showing tooth plate; all $\times 133$ (*1043).

Loxostomoides REISS, 1957, *1528a, p. 241 [**Bolivina applini* PLUMMER, 1927, *1461, p. 69 (*recte* = *B. applinae*); OD] [= *Bolivina* (*Loxostomoides*) REYMENT, 1959, *1557, p. 16 (obj.)]. Test free, narrow, elongate, oval in section; chambers biserial, with tendency to become uniserial in later stage; sutures with retral processes or crenulations of base of chambers; wall calcareous, perforate, radial in structure; aperture an elongate loop extending from base of chamber in early stages, becoming areal in later stages although never central and completely terminal, internal tooth plate present. *U.Cret.*(*Senon.*)-*Paleoc.*, N.Am.-Israel.—FIG. 438, 1. **L. applinae* (PLUMMER), Paleoc.

(Midway.), USA(Tex.); 1a-c, side, edge, and apert. views, $\times 50$ (*472).

Rectobolivina CUSHMAN, 1927, *431, p. 68 [**Sagrina bifrons* BRADY, 1881, *196c, p. 64; OD] [= *Geminaricta* CUSHMAN, 1936, *468, p. 61 (type, *Bolivinnella virgata* CUSHMAN, 1929, *441, p. 33)]. Test elongate, may be slightly compressed or circular in section, in early stage biserial, later uniserial, biserial stage much reduced in megalospheric generation and may consist of only slightly eccentric second chamber; wall calcareous, finely perforate, radial in structure, surface smooth, nodose, or more commonly longitudinally costate; aperture terminal, rounded to elongate, with internal twisted tooth plate, those of successive chambers alternating in position in planes 180° apart. *M.Eoc.-Rec.*, cosmop.—FIG. 438, 2-5. **R. bifrons* (BRADY), Rec., Pac.; 2a,b, side and apert. views of microspheric test; 3a,b, side and apert. views of megalospheric test, $\times 65$ (*2117); 4, sec. showing tooth plates; 5a,b, side and edge views of isolated tooth plate, enlarged (*928c).—FIG. 438, 6-8. *R. virgata* (CUSHMAN), Mio., Fr.; 6a,b, side and apert. views of holotype with only biserial stage; 7a,b, 8a,b, side and apert. views of hypotypes, $\times 102$ (*2117).—FIG. 438, 9-11. *R. raphana* (PARKER & JONES), Rec., Ind.O.; 9-11a,b, side and apert. views of paratypes showing variation in degree of biserial development, $\times 55$ (*2117).

[As shown by HOFKER (1951, *928c), many species previously have been placed incorrectly in *Siphogenerina*, *Loxostomum*, and *Bifarina* that should be assigned to *Rectobolivina*, as they are unlike the type-species of those genera. The present generic definition of *Rectobolivina* also includes the type-species of *Geminaricta*, hence the latter is a junior synonym. The type-specimens of *Uvigerina* (*Sagrina*) *raphanus* PARKER & JONES were examined by us in 1953 in the British Museum (Natural History); a lectotype was selected and is here designated (BMNH-ZF3582), together with paratypes (BMNH-ZF3581), on Recent *Chama hippopus* from the Indian Ocean. As the type-specimens of this species have up to 22 ribs and are either biserial in the early stage or uniserial throughout, they are regarded as specifically and generically distinct from *Siphogenerina costata* SCHLUMBERGER for which the species had been considered a senior synonym. *S. costata* has 5 or 6 costae, an early triserial microspheric stage, and a biserial early stage in the megalospheric form. It was also regarded as a *Rectobolivina* by HOFKER (1951, *928c, p. 62). The "double aperture" of *Geminaricta* was illustrated only on broken specimens. Complete specimens show only an elongate aperture. Probably an erroneous interpretation of the fragmentary remains of the tooth plate led to separating *Geminaricta* as a distinct genus.]

Tappanina MONTANARO GALLITELLI, 1955, *1301, p. 190 [**Bolivinita selmensis* CUSHMAN, 1933, *459, p. 58; OD]. Test biserial, flaring, sides flattened, resulting in transverse section; chambers cuneiform, apparently concave on broad sides, more or less inflated laterally, with well-developed horizontal or arched rib across chambers and along zigzag suture and lateral margins; sutures depressed, straight or arched; wall calcareous, finely perforate, surface appearing rough owing to development of ridges; aperture narrow, elongate, at base of final chamber, with tooth plate as in *Bolivina*. [*Tappanina* is characterized by its strong

horizontal carinae, narrow incised sutures, and degeneration into discontinuous thickenings of the 4 axial lamellar sutural costae which are char-

acteristic of *Loxostomum*, but it differs in the bolivine character of the aperture.] *U.Cret.-Paleoc.*, N.Am.-Eu.—FIG. 435,4. **T. selmensis* (CUSH-

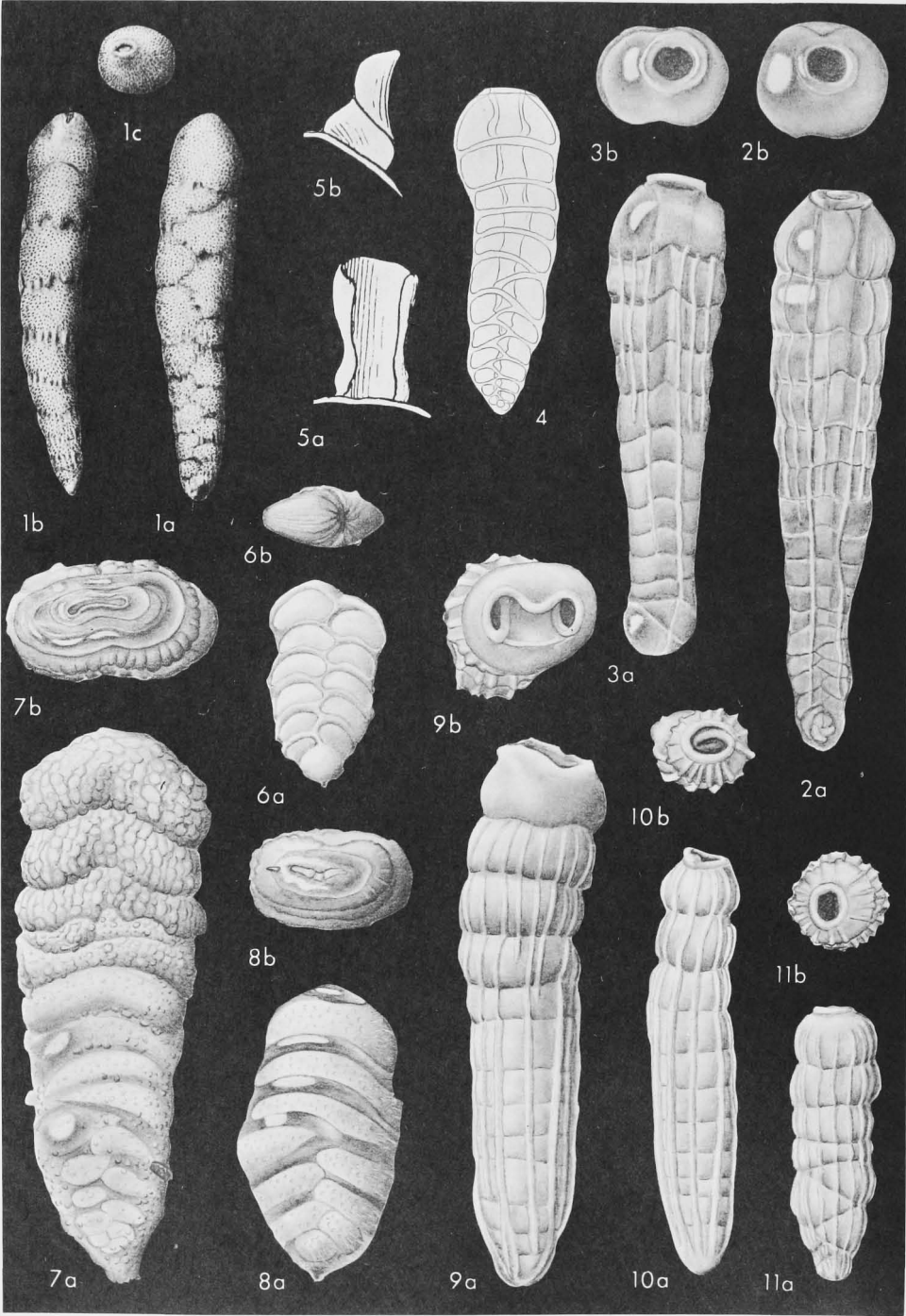


FIG. 438. Bolivinitidae; 1, *Loxostomoides*; 2-11, *Rectobolivina* (p. C553).

MAN), U.Cret., USA(Tenn.); 4a,b, side, apert. views of holotype, $\times 130$ (*1302).

Unicosiphonia CUSHMAN, 1935, *465, p. 81 [*U.

crenulata; OD]. Test similar to *Rectobolivina* but chambers with basal crenulations or retral processes as in *Bolivina* and *Loxostomoides*; aperture ter-

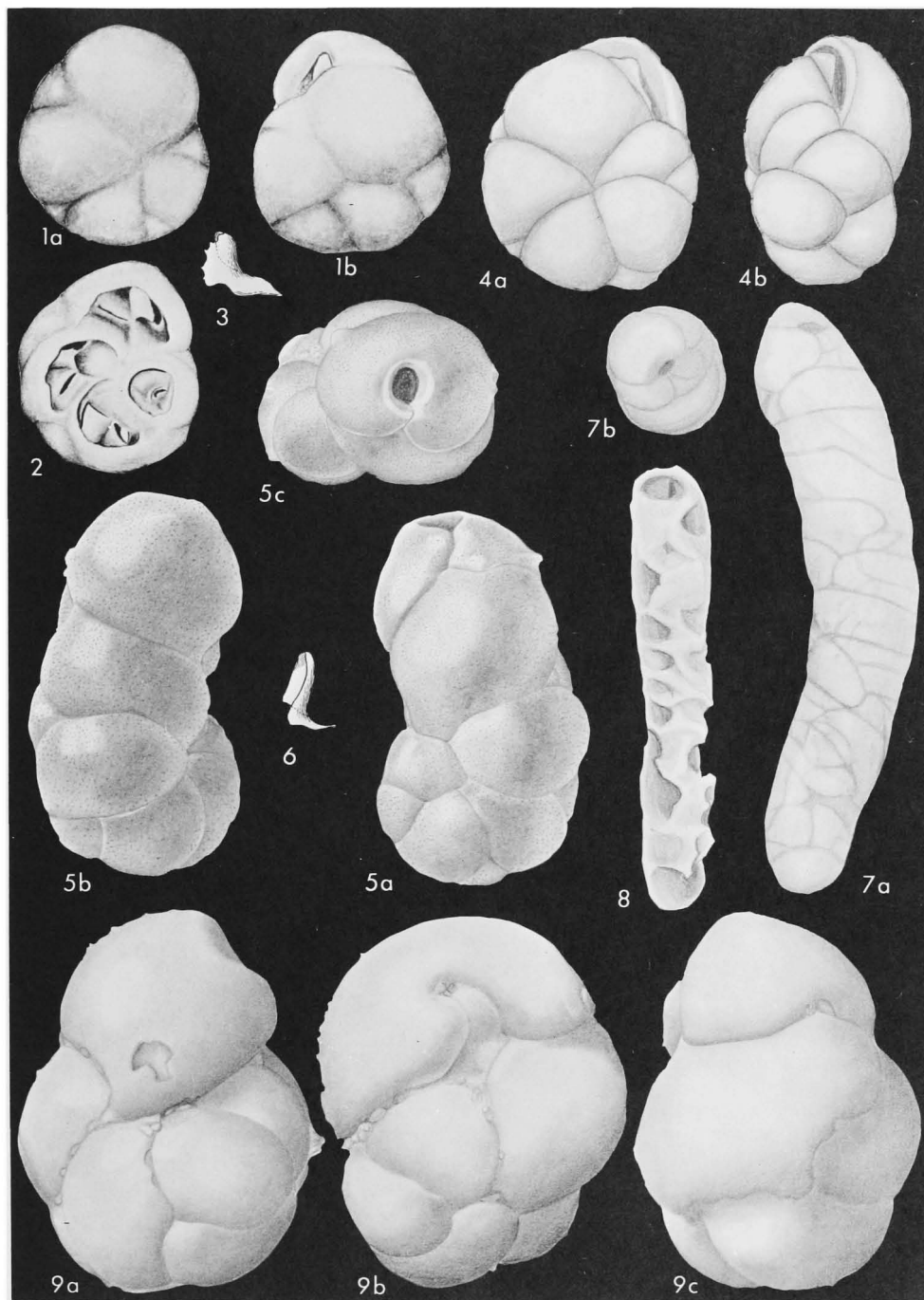


FIG. 439. Islandiellidae; 1-4, *Islandiella*; 5,6, *Cassidulinoides*; 7,8, *Orthoplecta*; 9, *Stichocassidulina* (p. C556).

minal, rounded, with internal columellar process or tooth plate. *Tert.*, Atl. (Georges Bank).—FIG. 435,5. **U. crenulata*; 5a,b, side, top views of holotype, $\times 64$ (*2117).

Family ISLANDIELLIDAE

Loeblich & Tappan, n.fam.

Test with biserially arranged enrolled chambers, at least in early stage, or derived from such, later stage may uncoil; as in Cassidulinidae, but with calcareous, perforate, radiate fibrous wall and primary aperture provided with internal tooth plate extending inward from aperture to previous foramen. ?*U.Cret.*, *Paleoc.-Rec.*

Islandiella NØRVANG, 1958, *1361, p. 26 [**Cassidulina islandica* NØRVANG, 1945, *1359, p. 41; OD] [= *Cassilamellina* VOLOSHINOVA, 1960, *2020, p. 59 (type, *Cassidulina californica* CUSHMAN & HUGHES, 1925, *508, p. 12)]. Test relatively large, lenticular to subglobular, periphery rounded, umbilicus closed; chambers biserially arranged and planispirally enrolled, sutures slightly depressed; wall calcareous, thick, perforate, lamellar, radiate, fibrous in microstructure, surface smooth; aperture elongate, interiomarginal opening, with internal platelike tooth extending from posterior edge of aperture to anterior corner of preceding foramen and with free margin projecting from aperture and partially closing it. [*Islandiella* differs from *Cassidulina* in having a radiate, instead of granular, wall structure and in the presence of an internal tooth plate.] ?*U.Cret.*, *Paleoc.-Rec.*, cosmop.—FIG. 439,1-3. **I. islandica* (NØRVANG), Rec., Iceland; 1a,b, opposite sides, showing elongate aperture and projecting tooth plate; 2, partially dissected specimen showing free tongue of internal platelike tooth at base of open chambers; all $\times 33$ (*1361); 3, isolated tooth plate, enlarged (*928c).—FIG. 439,4. *I. californica* (CUSHMAN & HUGHES), Pleist., USA (Calif.); 4a,b, side, edge views, $\times 37$ (*766).

Cassidulinoides CUSHMAN, 1927, *431, p. 84 [**Cassidulina parkeriana* BRADY, 1881, *196c, p. 59; OD]. Test free, elongate, robust, early stage subglobular with chambers biserially arranged and enrolled as in *Cassidulina*, later uncoiling, but continuing biserial development; wall calcareous, perforate, radial in structure; aperture in adult loop-shaped, extending upward from base of chamber into rounded opening at its summit. *U.Eoc.-Rec.*, Atl.-Pac.-N. Am.-Australia-S. Am.-Carib.-Indon.-Japan-Eu.—FIG. 439,5,6. **C. parkeriana* (BRADY), Falk. Is.; 5a-c, opposite sides and top view, $\times 153$ (*2117); 6, isolated tooth plate, enlarged (*928c).

Orthoplecta BRADY, 1884, *200, p. 355, 428 [**Cassidulina* (*Orthoplecta*) *clavata*; OD (M)] [= *Cassidulina* (*Orthoplecta*) BRADY, 1884, *200, p. 355,

428 (obj.)]. Test free, elongate, narrow, slightly arcuate, of nearly equal diameter throughout, no regular chamber arrangement, but with spiraling internal column, which gives extremely irregular septation as it spirals and in places touches exterior wall; wall calcareous, finely perforate, radial in structure; aperture subterminal, ovate, just above sutural junction. [Although originally considered a subgenus of *Cassidulina*, *Orthoplecta* has a perforate radial rather than a granular wall structure, and is neither cassiduline nor biserial in the early stage.] *Rec.*, Pac.—FIG. 439,7,8. **O. clavata*; 7a,b, side, top views of holotype; 8, dissected hypotype, $\times 146$ (*1166).

Stichocassidulina STONE, 1946, *1841, p. 59 [**S. thalmanni*; OD]. Test subglobular, periphery rounded; chambers inflated, biserial and enrolled as in *Islandiella*, involute; sutures depressed; wall calcareous, finely perforate, microstructure unknown; aperture large loop-shaped opening in apertural face, perpendicular to basal suture, partially covered by toothlike plate, numerous small, secondary, sutural openings also occurring along all sutures of test. [*Stichocassidulina* is here placed with *Islandiella* because of the presence of the apertural tooth. Confirmation of its placement requires information as to the wall microstructure.] *U.Eoc.*, S.Am.—FIG. 439,9. **S. thalmanni*, Peru; 9a-c, opposite sides and edge view of holotype, $\times 80$ (*2117).

Family EOUVIGERINIDAE Cushman, 1927

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 300 (ex subfamily Eouvigerininae CUSHMAN, 1927, p. 63)] [= *Stilosotomellinae* FINLAY, 1947, p. 275]

Test biserial in young, later may become uniserial; aperture terminal, with internal siphon, and may have everted phialine lip. *L.Cret.-Rec.*

Eouvigerina CUSHMAN, 1926, *424, p. 4 [**E. americana* (= *Loxostomum aculeatum* EHRENBERG, 1854, *680, p. 22); OD] [= *Zeauvigerina* FINLAY, 1939, *717a, p. 541 (type, *Z. zelandica*)]. Test biserial throughout, but may be slightly twisted, final chamber nearly central in position; sutures depressed; wall calcareous, finely perforate, surface may be smooth, carinate or hispid; aperture terminal, with neck and phialine lip, commonly with crenulated margin, internally with thin columellar tooth plate. [Although the presence of an internal apertural tooth plate has not been demonstrated in the type-species of *Zeauvigerina*, owing to unfavorable preservation and lack of sufficient material for sectioning, it is here regarded as congeneric with *Eouvigerina* because of the similarity in chamber arrangement and apertural characters, including the crenulated phialine lip.] *L.Cret.* (*Alb.*)-*U.Eoc.*, N.Am.-N.Z.-Eu.—FIG. 440,1-3. **E. aculeata* (EHRENBERG),

U.Cret.(Campan.), USA (Tex.) (1,2), Neth. or Ger. (3); 1*a,b*, side, apert. views of holotype of *E. americana*, $\times 162$; 2, dissected specimen showing

internal tooth plate, $\times 162$ (*1303); 3*a,b*, vert. secs. through breadth and thickness showing character of tooth plates, $\times 106$ (*948).—FIG. 440,

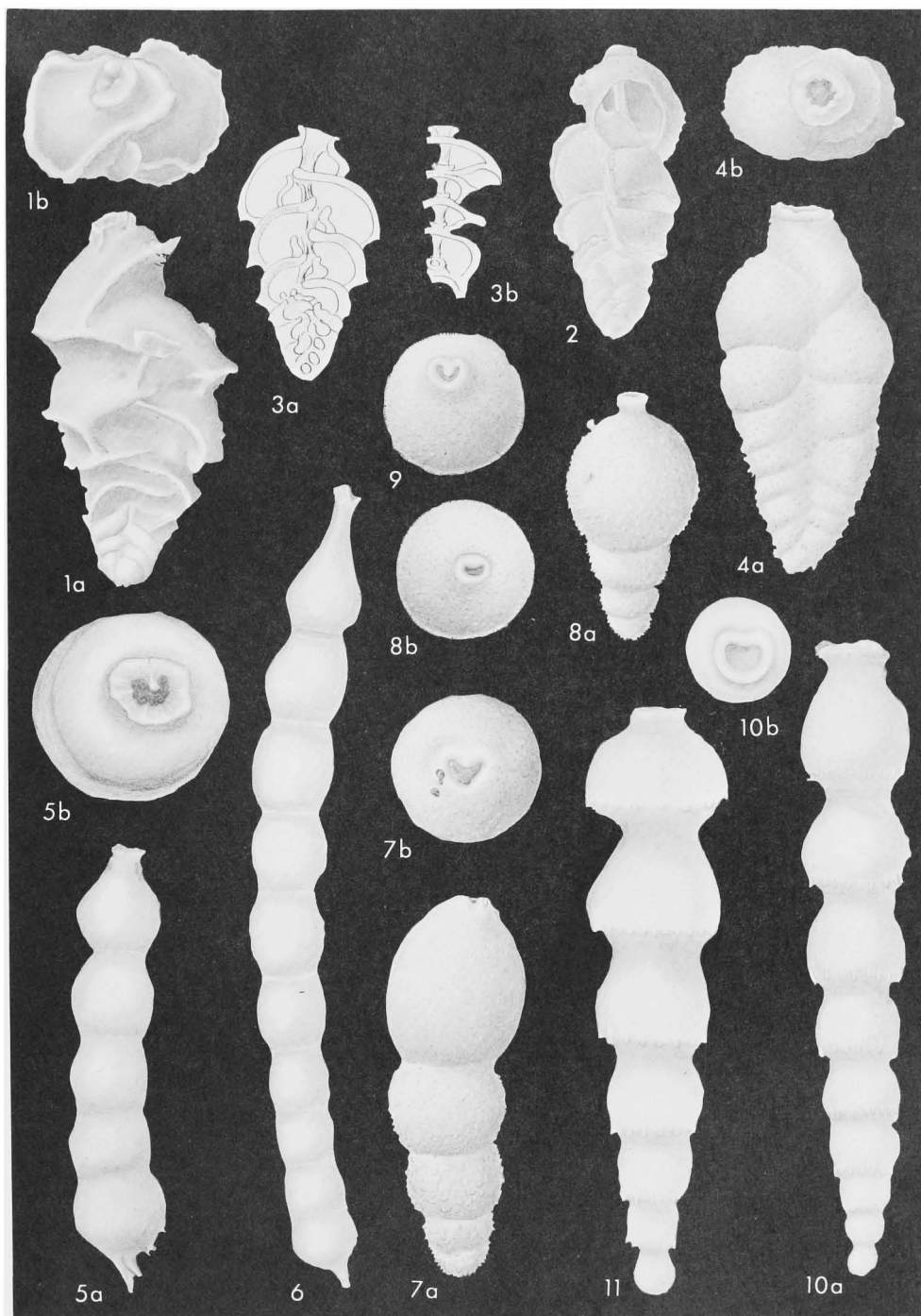


FIG. 440. Eouvigerinidae; 1-4, *Eouvigerina*; 5,6, *Siphonodosaria*; 7-11, *Stilostomella* (p. C556-C559).

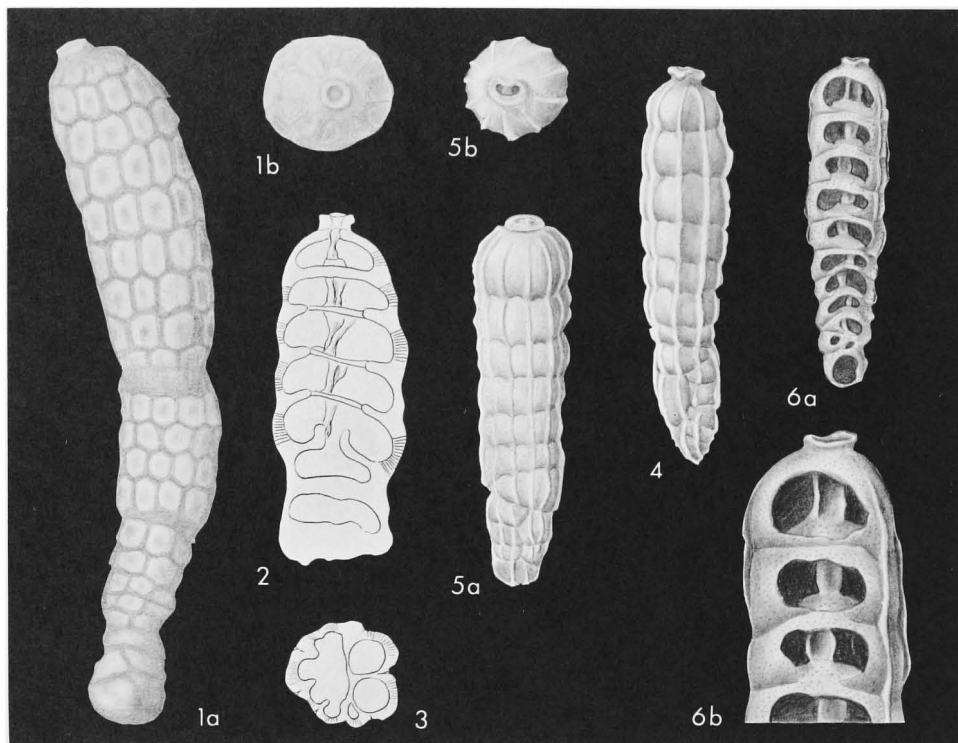


FIG. 441. Eouvigerinidae; 1-3, *Millettia*; 4-6, *Siphogenerinoides* (p. C558).

4. *E. zelandica* (FINLAY), Up.M.Eoc., N.Z.; 4a,b, side, top views of paratype, $\times 180$ (*1303).

Millettia SCHUBERT, 1911, *1689b, p. 89 [non SHERBORN, 1893, *1731a, p. 206, *nom. correct. pro Millettia* WRIGHT, 1889, *2080, p. 448 (*nom. nud.*); non *Millettia* DUNCAN, 1889] [**Sagrina? tessellata* BRADY, 1884, *200, p. 85; SD SCHUBERT, 1911, *1689a, p. 320] [= *Schubertia* A. SILVESTRI, 1912, *1772, p. 68 (non *Schubertia* GISTL, 1848) (*nom. subst. pro Millettia* SCHUBERT, 1911) (obj.)]. Test free, elongate, narrow, arcuate, very early portion biserial, later portion consisting of few elongate subcylindrical chambers. rapidly increasing in height and subdivided into chamberlets by vertical and horizontal partitions in honeycomb pattern, chamberlets arranged in regular transverse rows; wall calcareous, perforate radial in structure; surface marked into hexagonal patterns by junction of chamberlet walls with outer wall; aperture terminal, rounded with slight lip and internal tooth plate. *Rec.*, Pac.—FIG. 441, 1-3. **M. tessellata* (BRADY), Admiralty Is. (1), Indon. (2,3); 1a,b, side, top views of lectotype (BMNH-ZF2359), $\times 146$ (*1166); 2, long. sec., showing tooth plates, $\times 160$; 3, horiz. sec. showing vertical partitions and chamberlets, $\times 210$ (*928c).

[HOFKER (1951, *928c, p. 67) incorrectly restricted the genus *Sagrina* to *S. tessellata*, but the type of *Sagrina* is *S. pulchella* by monotypy. Furthermore, *S. tessellata* had

been made the type-species for *Millettia* and *Schubertia*. *Schubertia* was proposed as a replacement for *Millettia* SCHUBERT (non SHERBORN; non *Millettia* WRIGHT; nec *Millettia* DUNCAN), but *Schubertia* is also preoccupied by the molluscan genus *Schubertia* GISTL, 1848. Furthermore, *Millettia* SHERBORN (*nom. correct.*) and *Millettia* WRIGHT were both *nomina nuda*, hence have no standing in zoological nomenclature. *Millettia* DUNCAN, 1889, is an echinoid genus, but according to the Rules of Nomenclature (Art. 56) a difference in spelling of even one letter is sufficient to prevent generic homonymy; hence *Millettia* SCHUBERT is here reinstated.]

Siphogenerinoides CUSHMAN, 1927, *431, p. 63 [**Siphogenerina plummeri* CUSHMAN, 1926, *422, p. 18; OD]. Test elongate, biserial in early stage in both microspheric and megalospheric forms, later uniserial, with straight, nearly horizontal sutures; wall calcareous, perforate, surface with numerous longitudinal costae; aperture terminal, elliptical or reniform, with internal tooth plate of spoutlike shape, those of successive chambers with concave side facing in alternate directions, each apertural foramen except that of final chamber connecting to terminal end of tooth plate of its own chamber and also to that of succeeding chamber, convex surface of both sections being oriented toward opening. *U.Cret.-Paleoc.*, N.Am.-Afr.—FIG. 441, 4-6. **S. plummeri* (CUSHMAN), *U.Cret.*(Maastricht.), USA(Tex.); 4, side view of microspheric form, $\times 66$ (*2117); 5a,b, side, top views of megalospheric form, $\times 66$; 6a,b, long. sec. showing tooth plates, $\times 66$ and $\times 133$ (*1303).

Siphonodosaria A. SILVESTRI, 1924, *1779, p. 18 [**Nodosaria abyssorum* BRADY, 1881, *196c, p. 63; SD (SM) CUSHMAN, 1927, *431, p. 67] [= *Sagrinnodosaria* JEDLITSCHKA, 1931, *985, p. 125 (type, *Nodosaria abyssorum* BRADY, 1881, SD LOEBLICH & TAPPAN, herein) (obj.)]. Test free, narrow, elongate, uniserial, straight to arcuate; chambers subglobular, proloculus may have basal spines; sutures constricted; wall calcareous, thick, perforate, radial in structure; aperture rounded, produced on slight neck, bordered with phialine lip, and with distinct teeth projecting into aperture. *Eoc.-Rec.*, Eu.-N.Am.-S.Am.-Carib.-Atl.-Pac. —FIG. 440,5,6. **S. abyssorum* (BRADY), Rec., S.Pac.; *5a,b*, side, apert. views of lectotype, here designated (BRADY, 1884, *200, pl. 63, fig. 8) (BMNH-ZF3649), *5a*, $\times 22$, *5b*, $\times 48$; 6, paratype (BMNH-ZF1926), one of unfigured syntypes, $\times 22$ (*2117).

[GALLOWAY (1933, *762, p. 376) regarded *Nodogenerina* as a synonym of *Siphonodosaria* and STAINFORTH (1952, *1833, p. 7) also stated that "no difference is readily apparent between *Siphonodosaria* SILVESTRI and *Nodogenerina* CUSHMAN." *Siphonodosaria* is here restricted to forms with completely crenulate or dentate phialine lip, in addition to the distinct apertural tooth, whereas *Stilostomella* (including *Nodogenerina*) has a simple lip and single tooth.]

Stilostomella GUPPY, *843, p. 649 [**S. rugosa*; OD] [= *Nodogenerina* CUSHMAN, 1927, *428, p. 79 (type, *N. bradyi* = *Sagrina virgula* BRADY, 1884, *200, p. 583, *partim*)]. Test free, elongate, uniserial and rectilinear, with gradually enlarging subglobular chambers; wall calcareous, hyaline, finely perforate, surface may be spinose, or spines may be restricted to lower chamber margin; aperture terminal, may be produced on neck, with phialine lip and slight indentation at one side owing to surface reflection of internal spatulate tooth. *Cret.-Rec.*, Pac.-Atl.-Carib.-N.Z. —FIG. 440,7-9. **S. rugosa*, Mio., Trinidad; 7-8*a,b*, 9, side and top views, of paratypes, $\times 33$ (*2117). —FIG. 440,10,11. *S. bradyi* (CUSHMAN), Rec., Brazil (off Pernambuco); 10*a,b*, side, top views of lectotype of *Sagrina virgula* BRADY (1884, *200, pl. 76, fig. 8) here designated, BMNH-ZF2363; 11, megalospheric paratype, $\times 146$ (*2117).

[*Stilostomella* was regarded as unrecognizable by CUSHMAN (1948, *486, p. 277) and he placed *Nodogenerina* in the Heterohelidae. *Stilostomella* was regarded as a valid genus in the Pleurostomellidae by GALLOWAY (1933, *762, p. 384) and *Nodogenerina* was considered a synonym of *Siphonodosaria* in the Uvigerinidae. FINLAY (1947, *717e, p. 273) regarded *Nodogenerina* and *Siphonodosaria* both as junior synonyms of *Stilostomella*, placing the latter genus in the Lagenidae [= *Nodosariidae*] in a new subfamily Stilostomellinae. *Stilostomella* is here separated from *Siphonodosaria* in having a single tooth or indentation of the phialine lip, whereas *Siphonodosaria* has a more prominent tooth and the entire inner margin of the lip is crenulate or dentate. The prominent apertural tooth, instead of a radial or slit aperture, separates it from the Nodosariidae.]

Family BULIMINIDAE Jones, 1875

[*nom. correct.* EIMER & FICKERT, 1899, p. 680 (pro family Buliminida JONES in GRIFFITH & HENFREY, 1875, p. 320)] — [All names cited are of family rank; dagger (†) indicates *partim*] — [= *Stichostegæ* D'ORBIGNY, 1826, p. 251

(*nom. neg.*; *nom. nud.*); = *Hélicostegæ* D'ORBIGNY, 1826, p. 268 (*nom. neg.*; *nom. nud.*); = *Uvellinatæ* EHRENBURG, 1839, table opposite p. 120 (*nom. nud.*); = *Hélicosorinatæ* EHRENBURG, 1839, table opposite p. 120 (*nom. nud.*); = *Equilateralidæ* D'ORBIGNY in DE LA SAGRA, 1839, p. xxxvii, 11 (*nom. nud.*); = *Turbinoidæ* D'ORBIGNY in DE LA SAGRA, p. xxxviii, 71 (*nom. nud.*); = *Aequilateralidæ* D'ORBIGNY, 1846, p. 28 (*nom. nud.*); = *Uvelliidæ* REUSS, 1860, p. 225 (*nom. nud.*)] — [= *Buliminidæ* SCHWAGER, 1876, p. 479; = *Buliminidæ* SCHWAGER, 1877, p. 19; = *Buliminina* LANKSTER, 1885, p. 847; = *Buliminæ* DELAGE & HÉROUARD, 1896, p. 140] — [= *Pavoninidæ* EIMER & FICKERT, 1899, p. 678; = *Globobuliminidæ* HOFKER, 1956, p. 908; = *Hyalovirgulinidæ* HOFKER, 1956, p. 45 (*nom. nud.*)]

Test high trochospiral, with not more than 3 chambers to whorl, may reduce to biserial; aperture a loop in apertural face, with platelike internal tooth connecting successive chambers, or aperture may be indistinct and represented only by pores in terminal chamber face. *Paleoc.-Rec.*

Subfamily BULIMININAE Jones, 1875

[*nom. correct.* BRADY, 1881, p. 44 (pro subfamily Buliminidæ SCHWAGER, 1877, p. 19)] [= *Buliminæ* RHUMBLER, 1895, p. 89; = *Globobulimininae* HOFKER, 1951, p. 248]

Test triserial throughout; aperture loop-shaped, with distinctive tooth plate. *Paleoc.-Rec.*

Bulimina D'ORBIGNY, 1826, *1391, p. 269 [**B. marginata*; SD CUSHMAN, 1911, *404b, p. 76]. Test triserial in early stage, may tend to reduce to uniserial in later portion; wall calcareous, finely to coarsely perforate, radial in structure; aperture extending up from base of apertural face, with free border that may have elevated rim and fixed border attached to internal folded tooth plate, which with fixed shank is attached to internal chamber wall below aperture, with free shank that may be dentate or smooth, flaring or enrolled and sub-tubular. [*Bulimina* differs from *Praebulimina* in having a tooth plate with developed border, and from *Globobulimina* in one shank of the tooth plate free, instead of both fixed, and in lacking strongly embracing chambers.] *Paleoc.-Rec.*, cosmop. —FIG. 442,1-3. **B. marginata*, Rec., Italy (1), Rec., Sweden (2); 1*a,b*, side, apert. views, $\times 50$ (*519); 2*a,b*, apert. end showing tooth plate (*t*), aperture lip (*l*), and free shank of tooth plate (*s*), $\times 105$ (*924); 3, isolated tooth plate, enlarged (*928c).

Globobulimina CUSHMAN, 1927, *431, p. 67 [**G. pacifica*; OD] [= *Bulimina* (*Desinobulimina*) CUSHMAN & PARKER, 1940, *518, p. 19 (type, *Bulimina auriculata* BAILEY, 1851, *65, p. 12)]. Test globular to ovate, chambers triserially arranged, strongly overlapping earlier ones; wall calcareous, thin, finely perforate, radial in structure, surface smooth; aperture loop-shaped, with tendency to become terminal, tooth plate doubly folded pillar-like trough joined to apertural border at one side, upper part with projecting fanlike tip, lower portion extending into chamber cavity as arched trough, then curving forward, free shank coalescing with free border of aperture,

lower part of tooth plate touching projected tip of tooth plate of preceding chamber. [The modified definition of the genus by HÖGLUND (*924)

based on apertural features, includes *Desinobulimina*.] *Paleoc.(Dan.)-Rec.*, cosmop.—FIG. 442,4. **G. pacifica*, Rec., Pac.; 4a-c, opposite

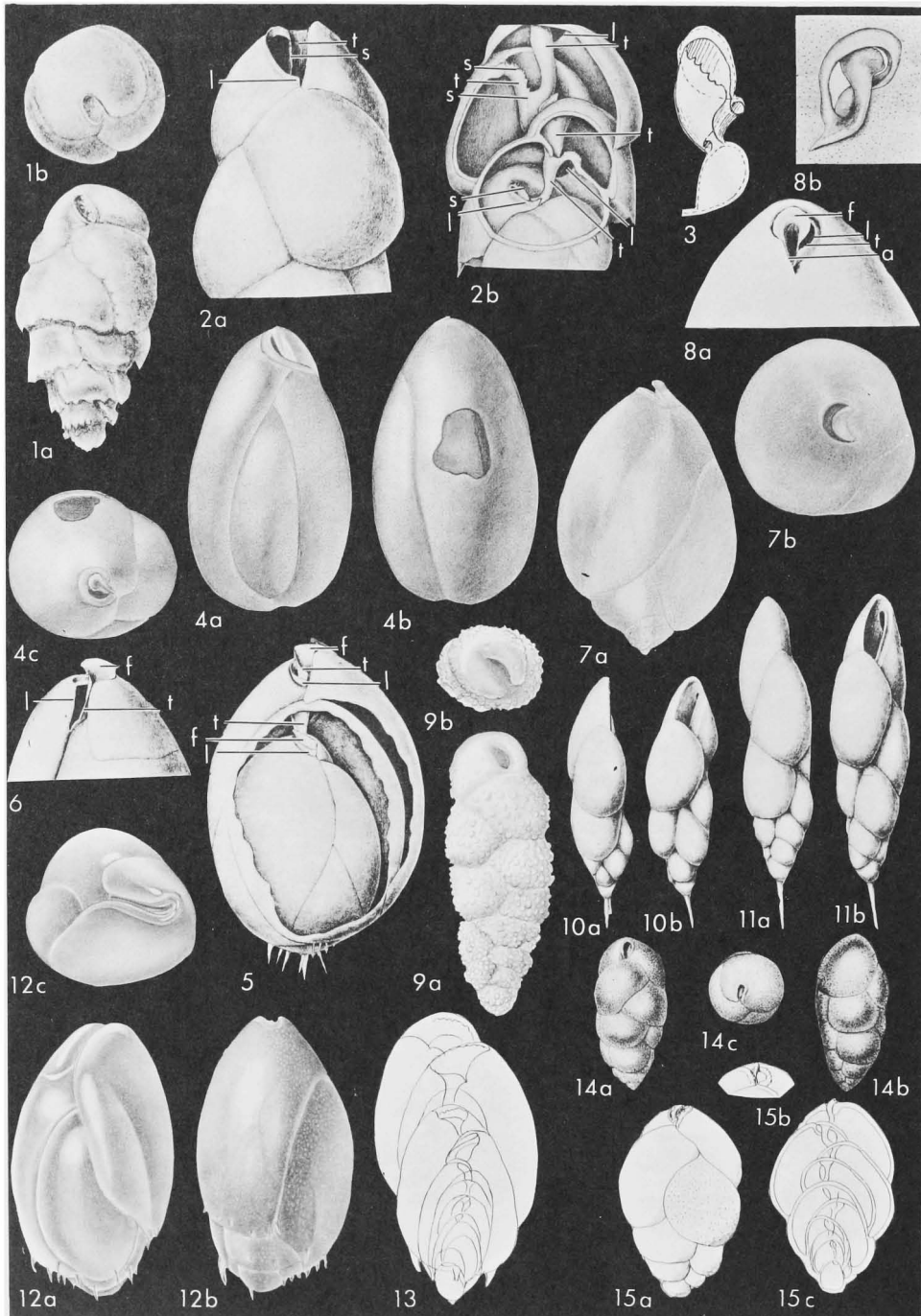


FIG. 442. Buliminidae (Bulimininae; 1-3, *Bulimina*; 4-8, *Globobulimina*; 9, *Virgulopsis*; 10-11, *Stainforthia*; 12-15, *Praeglobobulimina*) (p. C559-C561).

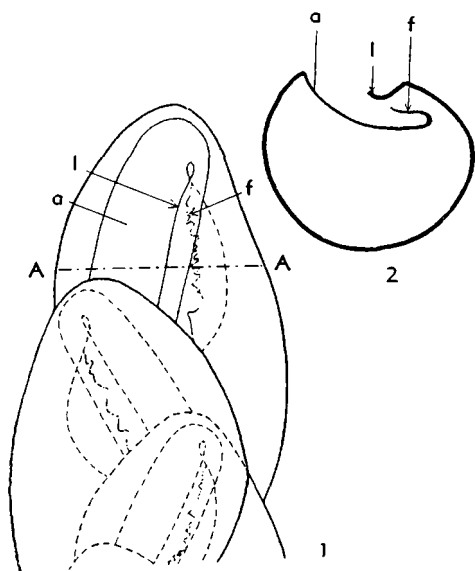


FIG. 443. Buliminidae (Bulimininae; 1,2, *Stainforthia*) (p. C561).

sides and apertural views of holotype, $\times 56$ (*2117).—FIG. 442,5. *G. turgida* (BAILEY), Rec., Sweden; dissected specimen showing tooth plate (*t*), fanlike tip (*f*), and apert. lip (*l*) in 2 successive chambers, $\times 70$ (*924).—FIG. 442,6. *G. sp.*, Rec., Gulf Mex.; apert. region, as in fig. 5, $\times 22$ (*924).—FIG. 442,7. *G. auriculata* (BAILEY), Rec., N.Atl.; 7*a,b*, side, apert. views, $\times 51$ (*2117).—FIG. 442,8. *G. auriculata gullmarensis* HÖGLUND; 8*a,b*, apert. region showing tooth plate attachment (*a*) and apert. features as in fig. 5, 8*a*, $\times 70$, 8*b*, $\times 105$ (*924).

Praglobobulimina HOFKER, 1951, *928c, p. 248 [*Bulimina pyrula* var. *spinescens* BRADY, 1884, *200, p. 400; OD] [= *Protoglobobulimina* HOFKER, 1951, *928c, p. 252 (type, *Bulimina pupoides* D'ORBIGNY, 1846, *1395, p. 185)]. Test free, elongate, triserial with strongly overlapping chambers; wall calcareous, perforate radial in structure; aperture elongate, extending up from base of final chamber toward its apex, successive chambers connected internally by tooth plate with simple fold and fixed shank joined to anterior wall below aperture and wide free shank joined to chamber wall only at anterior end of aperture, free shank may be dentate and basal part reduced, small tip protruding through aperture. *Paleoc.-Rec.*, cosmop.—FIG. 442,12,13. **P. spinescens* (BRADY), Rec., Pac.; 12*a-c*, opposite sides and apert. view of topotype, $\times 62$ (*2117); 13, sec. showing tooth plates, $\times 125$ (*928c).—FIG. 442,14,15. *P. pupoides* (D'ORBIGNY), Mio., Aus. (14), Rec., Italy (15); 14*a-c*, opposite sides and apert. view of microspheric specimen, $\times 25$ (*516); 15*a,b*,

side view and opposite side of apert. region showing tooth plate, 15*c*, long. sec. showing successive tooth plates, all $\times 83$ (*928c).

[HAYNES (1954, *886) emended the original diagnosis but incorrectly cited the type-species as *Praglobobulimina spinescens* HOFKER. Since the type-species was designated by HOFKER as *P. spinescens* (BRADY) this cannot be changed. HOFKER regarded *Praglobobulimina* as characterized by elongate pores, and *Protoglobobulimina* as having elongate pores with fine pores between. The apertural tooth plate has a flaring free tip in the type (and only species) originally placed in *Praglobobulimina*, and it is straight and collar-like in *Protoglobobulimina*. As shown by HAYNES (1954, *886, p. 185) generic separations based on pore size and distribution do not agree in many cases with those based on apertural features and (p. 188) the observation that pores are of greater length (through the wall) than their diameter may result in ovate appearance when seen on the convex test surface. Thus, the feature of pore shape does not seem to be valid for generic distinction, although pore patterns may have specific value. The actual proportions of the tooth plates also are here regarded as specific rather than generic in importance, and Recent species with flaring free tip are not regarded as generically distinct from those with less complex free tip.]

Stainforthia HOFKER, 1956, *945, p. 908 [*Virgulinella concava* HÖGLUND, 1947, *924, p. 257; OD]. Test narrow, elongate, early stage triserial, at least in microspheric generation, later with twisted biserial development; chambers inflated, laterally overlapping; wall calcareous, hyaline, finely perforate, radial in structure, surface smooth or longitudinally costate, may have one or more apical spines; aperture loop-shaped in face, with narrow incurved lip at one side and broad tooth plate at opposite side bending under lip and partially closing opening, tooth plate with serrated free folded portion, lower portion of tooth plate attached to preceding chamber wall. *Eoc.-Rec.*, Eu.-S.Am.—FIG. 442,10,11; 443,1,2. **S. concava* (HÖGLUND), Rec., Sweden; 442,10*a,b*, 11*a,b*, side and edge views, $\times 93$; 443,1,2, later portion in optical sec. and cross sec. showing apert. features with narrow incurved lip at one side (*l*), and folded tooth plate with serrate free shank (*f*), and attached opposite border (*a*), $\times 340$ (*924).

Virgulopsis FINLAY, 1939, *717c, p. 321 [*V. pustulata*; OD]. Test free, elongate, early stage triserial, later biserial; wall calcareous, finely perforate, surface plicate or pustulose; aperture loop-shaped, extending up face, internal features unknown. [Details of the inner structure and character of the tooth plate are needed for accurate placement of this genus. It may prove to be a junior synonym of *Uvigerinella* or of *Neobulimina*, or a senior synonym of *Stainforthia*.] *M. Mio.*, N.Z.—FIG. 442,9. **V. pustulata*; 9*a,b*, side, apert. views, $\times 82$ (*2117).

Subfamily PAVONININAE Eimer & Fickert, 1899

[*nom. transl.* CUSHMAN, 1927, p. 59 (ex family Pavoninidae EIMER & FICKERT, 1899)] [= *Reussinae* CUSHMAN, 1927, p. 68 (pro *Reussia* SCHWAGER, 1877) (non *Reussia* M'COY, 1854); = *Reussellinae* CUSHMAN, 1933, p. 223 (*nom. subst.*)]

Test triserial in early stage, rarely biserial, later uniserial; aperture loop-shaped or re-

presented by pores on terminal chamber face. [Simple forms such as *Reussella* have an apertural tooth plate, whereas other

genera show a tooth plate in early stages (*Chrysalidinella*) and a majority apparently show no tooth plates but may have sec-

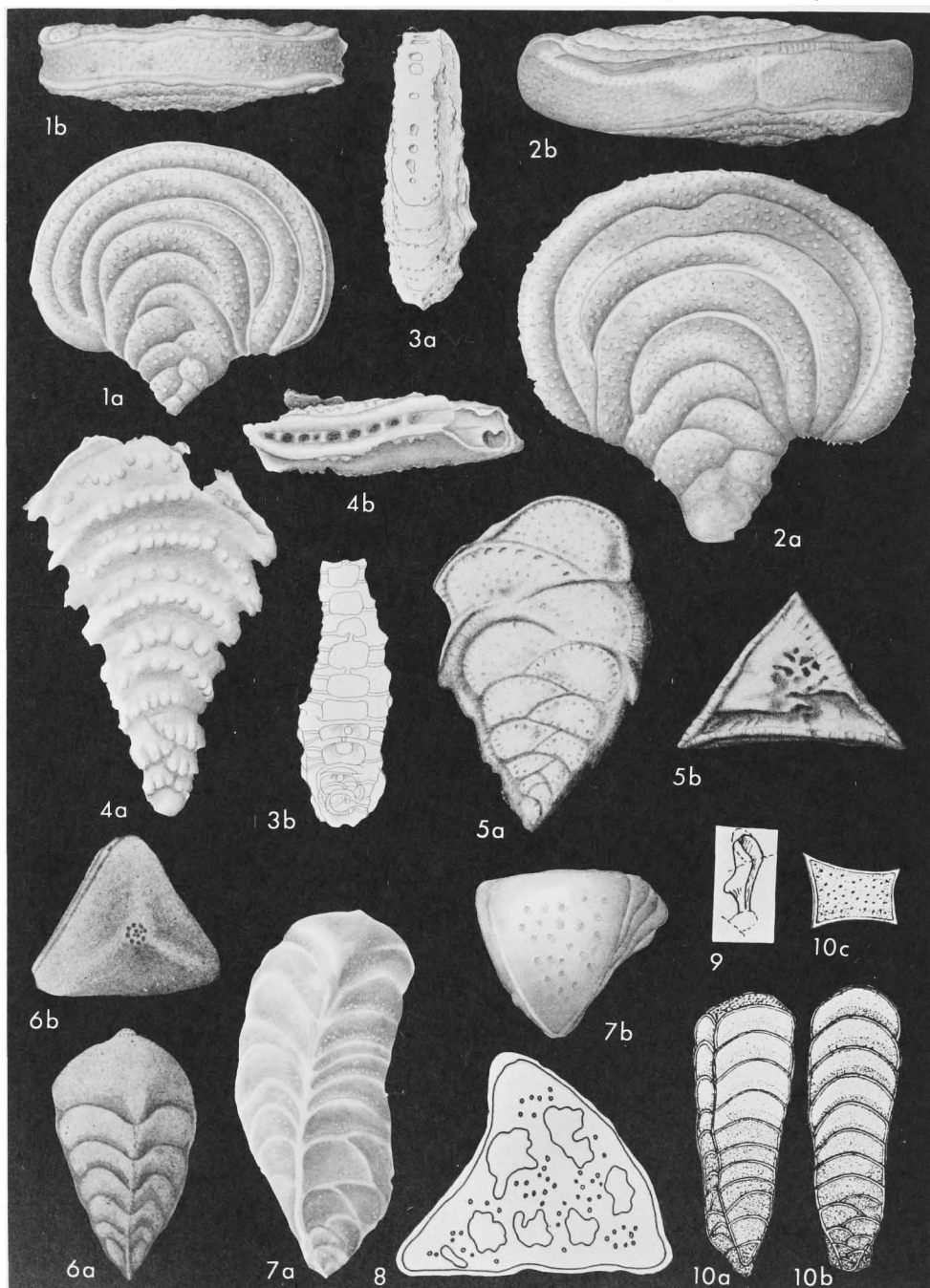


FIG. 444. Buliminidae (Pavonininae; 1-4, *Pavonina*; 5, *Fijiella*; 6, *Acostina*; 7-10, *Chrysalidinella*) (p. C563).

ondary resorption of the terminal face to form irregular intercameral openings. Restudy of the ontogeny and internal morphology of all genera may later result in separating the forms with tooth plates (Reussellinae CUSHMAN, 1933) from the Pavonininae, but meanwhile they are retained together.] *Eoc.-Rec.*

Pavonina D'ORBIGNY, 1826, *1391, p. 260 [**P. flabelliformis*; OD (M)] [= *Bifarinella* CUSHMAN & HANZAWA, 1936, *504, p. 46 (type, *B. ryukyuensis*); *Valvopavonina* HOFKER, 1951, *928c, p. 35 (obj.)]. Test with reduced triserial stage of 3 chambers, later biserial, and finally uniserial, spreading with low broad arched chambers, strongly recurved at margins; wall calcareous, radial in structure, coarsely perforate; no distinct aperture, terminal face of final chamber merely coarsely perforate like remainder of test, large rounded openings originally reported and since mentioned by various authors not found to be present on well-preserved specimens, possibly due to secondary resorption. *Mio.-Rec.*, Pac.-Atl.-Afr.-N.Am.-Madag.—FIG. 444,1-3. **P. flabelliformis*, Rec., Kerimba Arch. (1), Rec., Mauritius (2,3); 1a,b, side, top views, $\times 82$; 2a,b, side, top views, $\times 82$ (*2117); 3a,b, edge view, showing pores, and long. sec. of same specimen showing septal openings, large pores through walls and fine pores through one side of proloculus, and reduced triserial stage, $\times 80$ (*928c).—FIG. 444,4. *P. ryukyuensis* (CUSHMAN & HANZAWA), Pleist., Ryukyu Is.; 4a,b, side and top views of holotype, showing early biserial stage, later uniserial stage with spreading test, and large septal perforations with intervening pillars, $\times 48$ (*2117).

[The early triserial stage mentioned has not been confirmed by us, as all specimens of the type-species observed show only a biserial stage. It is possible that ornamentation may have been mistaken for additional chambers in some reports, the wall being secondarily thickened and laminar. Nevertheless, PARR found a distinctly triserial base in *P. trifloris* (*1422) and HOFKER illustrated a reduced triserial stage in *P. flabelliformis* (*928c). Well-preserved specimens of *P. flabelliformis* examined at high magnification show numerous irregularly scattered pores on the terminal face, identical in appearance to those on sides of the test, but no large regularly aligned apertural pores have been seen by us in either wet or dry or stained tests. The systematic placement has also varied, PARR (*1422) placing *Pavonina* near *Reussella* and *Chrysalidinella* in the Buliminidae, although *Pavonina* has no apertural tooth plate, and HOFKER (*928c) placing it in the Valvulinidae because of absence of a tooth plate and presence of coarse pores in the wall, although other representatives of that family are agglutinated. *Bifarinella* was placed in the Virgulininae by CUSHMAN (1937, *472), a group with perforate granular walls and apertural tooth plate, and *Pavonina* was placed in the Reussellinae, a group with perforate radial walls and apertural tooth plate. Both the holotype of *B. ryukyuensis* (in the CUSHMAN collection) and paratype are broken specimens, no terminal face being preserved. The "slitlike aperture" and everted lip consist merely of fragments of the final chamber wall. Not previously mentioned is the fact that the final septum preserved has numerous pores, with only narrow bridges remaining across the test, so that it has the identical large septal pores found in *Pavonina*, and there described as a multiple aperture. The early biserial stage and later uniserial stage both occur in most specimens and species of *Pavonina*, the less flabelliform test of *B. ryukyuensis* being here regarded as only of specific value.]

Acostina BERMÚDEZ, 1949, *124, p. 152 [**Chrysalogonium pyramidale* ACOSTA, 1940, *3, p. 4; OD]. Test elongate pyramidal, triangular in section, with carinate angles, chambers uniserial throughout; aperture terminal, consisting of numerous small pores in protruding portion of terminal face. *U.Oligo.-Rec.*, Cuba-Dominican Republic.—FIG. 444,6. **A. pyramidale* (ACOSTA), Rec., Cuba; 6a,b, side, apert. views of holotype, $\times 37$ (*3).

Chrysalidinella SCHUBERT, 1908, *1687, p. 242 [**Chrysalidina dimorpha* BRADY, 1881, *196c, p. 54; OD (M)] [= *Chrysalidinoides* UCHIO, 1952, *1959, p. 154 (type, *C. pacificus*)]. Test elongate, commonly pyramidal, early portion triserial and triangular, later uniserial and triangular in section or rarely quadrangular; sutures arched; wall smooth, calcareous, coarsely perforate, radial in structure; aperture basal in early stage as in *Reussella* with small tooth plates, in uniserial stage consisting of numerous scattered pores on terminal face, without tooth plates, early septa showing some larger irregular openings, probably due to resorption. *Eoc.-Rec.*, Cuba-Kerimba Arch.-Pac.-N.Am.-Carib.-Indon.—FIG. 444,7-9. **C. dimorpha* (BRADY), Rec., Pac. (7), Rec., Sumatra (8,9); 7a,b, side, top views, $\times 74$ (*2117); 8, outline view of septum, showing apert. pores and secondary irregular openings due to resorption, $\times 80$; 9, isolated tooth plate, enlarged (*928c).—FIG. 444,10. *C. pacifica* (UCHIO), Rec., Japan; 10a-c, lat. and terminal views of holotype, $\times 56$ (*1959).

[*Chrysalidinoides* was based on a single specimen which became quadrate in the adult, although early development was triserial and triangular. As many triangular genera have occasional aberrant quadrate specimens (e.g., *Tristix*, *Triplasia*) the present form is regarded as adventitious.]

Fijiella LOEBLICH & TAPPAN, 1962, *1185, p. 109 [**Trimosina simplex* CUSHMAN, 1929, *443, p. 158; OD]. Test triserial and triangular throughout; wall calcareous, coarsely perforate, surface smooth, lateral margins carinate and may be spinose; primary aperture a narrow elongate basal slit with terminal supplementary cribrate openings. [*Fijiella* differs from *Reussella* and *Trimosina* in having the supplementary cribrate terminal aperture, and from *Chrysalidinella* in lacking a uniserial stage.] *Rec.*, Pac.—FIG. 444,5. **F. simplex* (CUSHMAN), Fiji; 5a,b, side, apert. views, $\times 60$ (*476).

Mimosina MILLETT, 1900, *1284e, p. 547 [**M. histrix*; SD CUSHMAN, 1927, *433, p. 190]. Test in early stage triserial, later biserial, each chamber in later stage ornamented with spine; wall calcareous, surface ornamented with very fine longitudinal ridges with fine pores between, radially built; aperture in 2 parts, one nearly terminal, second marginal and tending to be more oval in outline. *Rec.*, Malay Arch. Tropical Pac.-Kerimba Arch.-Atl.-Medit.—FIG. 445,1,2. **M. histrix*, Malay Arch.; 1a,b, 2a,b, side and top views, $\times 104$ (*2117).

Reussella GALLOWAY, 1933, *762, p. 360 [*pro*

Reussia SCHWAGER, 1877, *1705, p. 21 (non M'COY, 1854)) [**Verneulina spinulosa* REUSS, 1850, *1540, p. 374; OD]. Test triserial and

triangular throughout, gradually enlarging; wall calcareous, coarsely perforate; aperture basal in final chamber, with internal tooth plate. [*Reussella* is

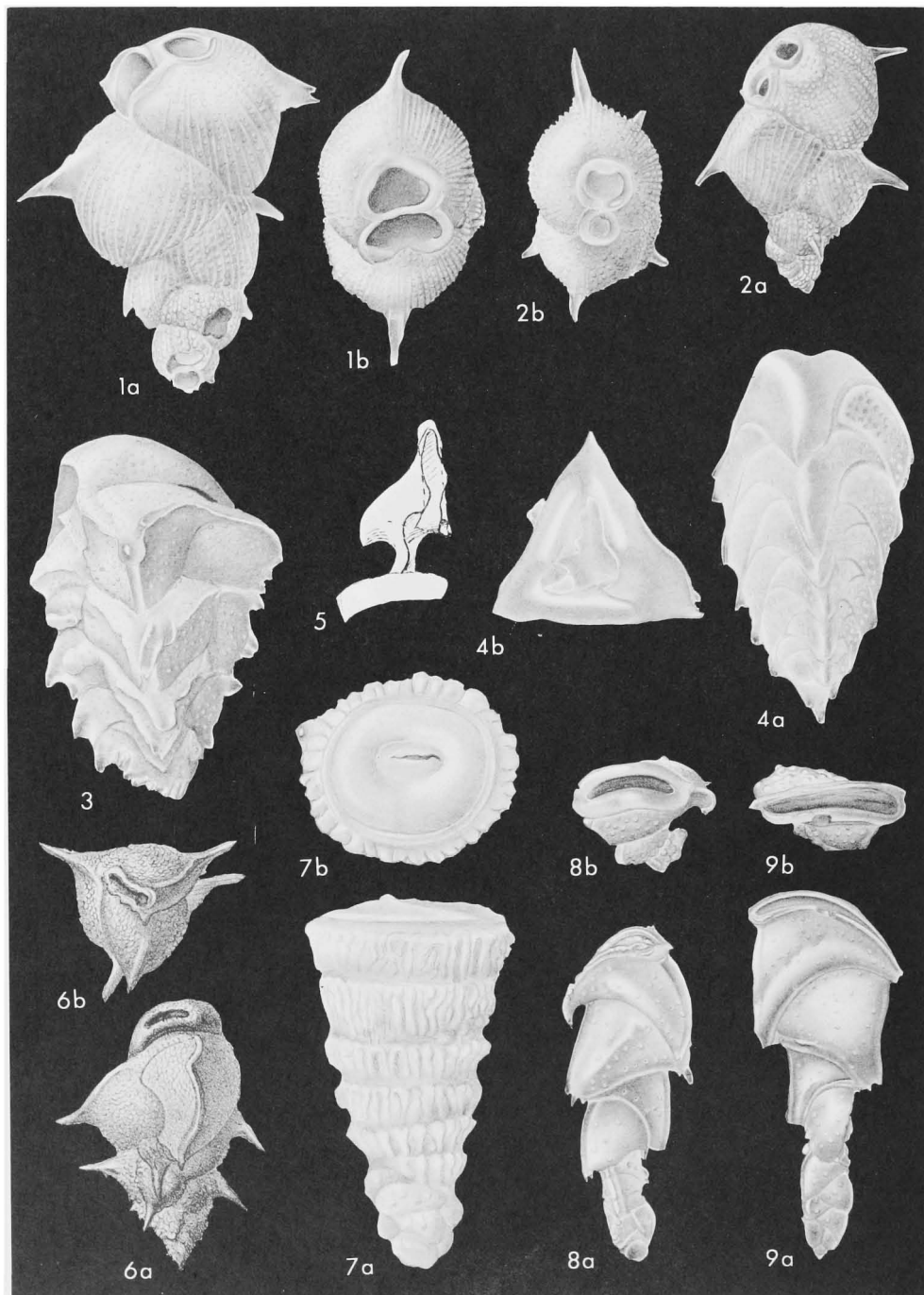


FIG. 445. Buliminidae (Pavonininae; 1,2, *Mimosina*; 3-5, *Reussella*; 6, *Trimosina*; 7, *Tubulogenerina*; 8,9, *Valvobifarina*) (p. C563-C565).

restricted here to include only sharply angular species, commonly with carinate or spinose angles, coarsely perforate wall, and complex tooth plate. Upper Cretaceous species that have been previously referred to *Reussella* are here regarded as belonging to *Pyramidina*, differing in their less angular margins, finely perforate walls, and simpler tooth plate.] *M.Eoc.(Lutet.)-Rec.*, cosmop.—FIG. 445,3-5. **R. spinulosa* (REUSS), Mio., Aus.; 3, side view, $\times 100$; 4a,b, side, apert. views, $\times 94$ (*2117); 5, apertural tooth plate, magnified (*928c).

Trimosina CUSHMAN, 1927, *431, p. 64 [**T. milletti* = *Mimosina spinulosa* var. MILLETT, 1900, *1284e, p. 548; OD]. Test triserial, similar to *Mimosina* but without later biserial development; wall calcareous, perforate, radial in structure; aperture an elongate slit, in face of final chamber and paralleling its base. *Rec.*, Indo-Pac.—FIG. 445,6. **T. milletti*, Malay Arch.; 6a,b, side, top views, $\times 90$ (*1284e).

Tubulogenerina CUSHMAN, 1929, *428, p. 78 [**Textularia (Bigerina) tubulifera* PARKER & JONES, 1863, *1417e, p. 94; OD]. Test elongate, early stage triserial in microspheric form, followed by short biserial stage, later chambers uniserial and compressed or rounded in section; wall calcareous perforate, surface may be distinctly nodose or longitudinally costate; aperture a narrow, elongate, crescentic slit in terminal face, with internal tooth plate. *M.Eoc.(Lutet.)-Oligo.*, ?Mio., Eu.-N.Am.-Australia.—FIG. 445,7. **T. tubulifera* (PARKER & JONES), *M.Eoc.(Lutet.)*, Fr.; 7a,b, side, apert. views of topotype, $\times 109$ (*2117).

Valvobifarina HOFKER, 1951, *928c, p. 39 [**Bifarina mackinnoni* MILLETT, 1900, *1284d, p. 281; OD]. Test in early portion triserial, triangular in section, later changing abruptly to twisted biserial arrangement of cuneate chambers; wall ornamented with numerous calcareous knobs, each with large pore and commonly with spines at chamber margins; aperture terminal, narrow and elongate, occupying width of chamber and surrounded by everted rim. *Rec.*, Malay Arch.-Timor Sea.—FIG. 445,8,9. **V. mackinnoni* (MILLETT), Timor Sea (8), Macassar Straits (9); 8a,b, 9a,b, side and top views, $\times 74$ (*2117).

[HOFKER (1951, *928c, p. 42) originally placed *Valvobifarina* in the agglutinated family Valvulinidae, because of its scattered large pores and knobs of "somewhat arenaceous chalky matter." He regarded both this genus and *Bolivinitella* (= *Loxostomum*) as closely related to *Siphogaudryina*. As correctly stated by HOFKER, neither *Loxostomum* nor *Valvobifarina* are related to the "Bolivininae," the former having a granular wall and lacking a tooth plate and *Valvobifarina* having a triserial, rather than biserial, early development.]

Family UVIGERINIDAE Haeckel, 1894

[*nom. correct.* GALLOWAY & WISSLER, 1927, p. 74 (pro family Uvigerinida HAECKEL, 1894, p. 185)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹family, ²subfamily); dagger (†) indicates *partim*]—[= ¹Uvellerin† EHRENBURG, 1839, table opposite p. 120 (*nom. nud.*); = ²Turbinoideat D'ORBIGNY in DE LA

SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); = ²Angulogerininae GALLOWAY, 1933, p. 377; = ²Uvigerininae CUSHMAN, 1913, p. 91]

Test triserial to biserial in early stage, later may become biserial or uniserial; aperture terminal, with neck and internal tooth plate connecting apertures of successive chambers. *U.Cret.-Rec.*

Uvigerina D'ORBIGNY, 1826, *1391, p. 268 [**U. pygmaea*; SD PARKER, JONES & BRADY, 1865, *1419, p. 36] [= *Uvigerina (Uhlagina)* SCHUBERT, 1899, *322, p. 222 (type, *U. (U.) uhligi*) (*non Uhlagina* YABE & HANZAWA, 1922); *Aluvigerina* HOFKER, 1951, *928c, p. 201 (*nom. nud.*); *Aluvigerina* THALMANN, 1952, *1897j, p. 970 (obj.); *Miniuva* VELLA, 1961, *2002, p. 480 (type, *M. minima*)]. Test elongate, triserial, rounded in section, chambers inflated, wall calcareous, perforate, surface smooth, hispid or costate; aperture terminal, rounded with nonperforate neck and may have phialine lip, internal tooth plate with distinct wing at one side. [The type-species was spelled *pigmaea* in the text (*1391, p. 269) but *pygmaea* on the plate explanation (*1391, pl. 12, p. 310). *Miniuva* was separated for an extremely small costate species with short neck, features here regarded as of specific value.] *Eoc.-Rec.*, cosmop.—FIG. 446, 1,2. **U. pygmaea*, Plio., Italy (1), *Rec.*, Italy (2); 1a,b, side, apert. views, $\times 94$ (*2117); 2, sectioned specimen, showing tooth plates with wings (shaded portion), $\times 104$ (*928c).

Clavelloides DE KLASZ & RÉRAT, 1962, *1043, p. 182 [**C. tenuistriata*; OD]. Test elongate, tapering, with broad, low, slightly enveloping, uniserially arranged chambers; sutures horizontal, slightly depressed; wall calcareous, microstructure unknown, surface longitudinally striate; aperture terminal, in slight depression, subelliptical; interior with columellar process connecting foramina of adjacent chambers. *L.Eoc.-M.Eoc.*, W.Afr.(Gabon).—FIG. 446,3,4. **C. tenuistriata*; 3, ext. holotype, $\times 27$; 4, long. sec., $\times 27$ (*1043).

[This genus was originally placed in the Ellipsoidinidae (=Pleurostomellidae), but differs from characteristic genera of that family in the ornate surface and very large size. It is here tentatively referred to the Uvigerinidae, though the wall microstructure is unknown. If granular, it should be placed with the Pleurostomellidae; if radial, the present position would be correct. Additional details as to the character of the columellar process or tooth plate would aid in determining the systematic position.]

Compressigerina BERMÚDEZ, 1949, *124, p. 219 [**Uvigerina coartata* D. K. PALMER, 1941, *1410b, p. 304 (= *U. compressa* PALMER, 1941, *1410a, p. 182) (*non U. compressa* CUSHMAN, 1925); OD]. Test free, small, with early stage triserial, later biserial with twisted axis as in *Sigmavirgulina* and finally tending to become uniserial, peripheral margins angled or keeled; wall calcareous, finely perforate, radial in structure, may have longitudinal carinae and fine spines at chamber angles; aperture terminal, ovate, produced on slight neck, with internal tooth plate. *Oligo.-Rec.*, Carib.—FIG. 446,

6. **C. coartata* (D. K. PALMER), M.Mio., Dominican Republic; 6a-c, side, edge, and top views, $\times 143$ (*2117).

Euuvigerina THALMANN, 1952, *1897j, p. 974
[**Uvigerina aculeata* D'ORBIGNY, 1846, *1395, p. 191; OD] [= *Euuvigerina* HOFKER, 1951, *928c,

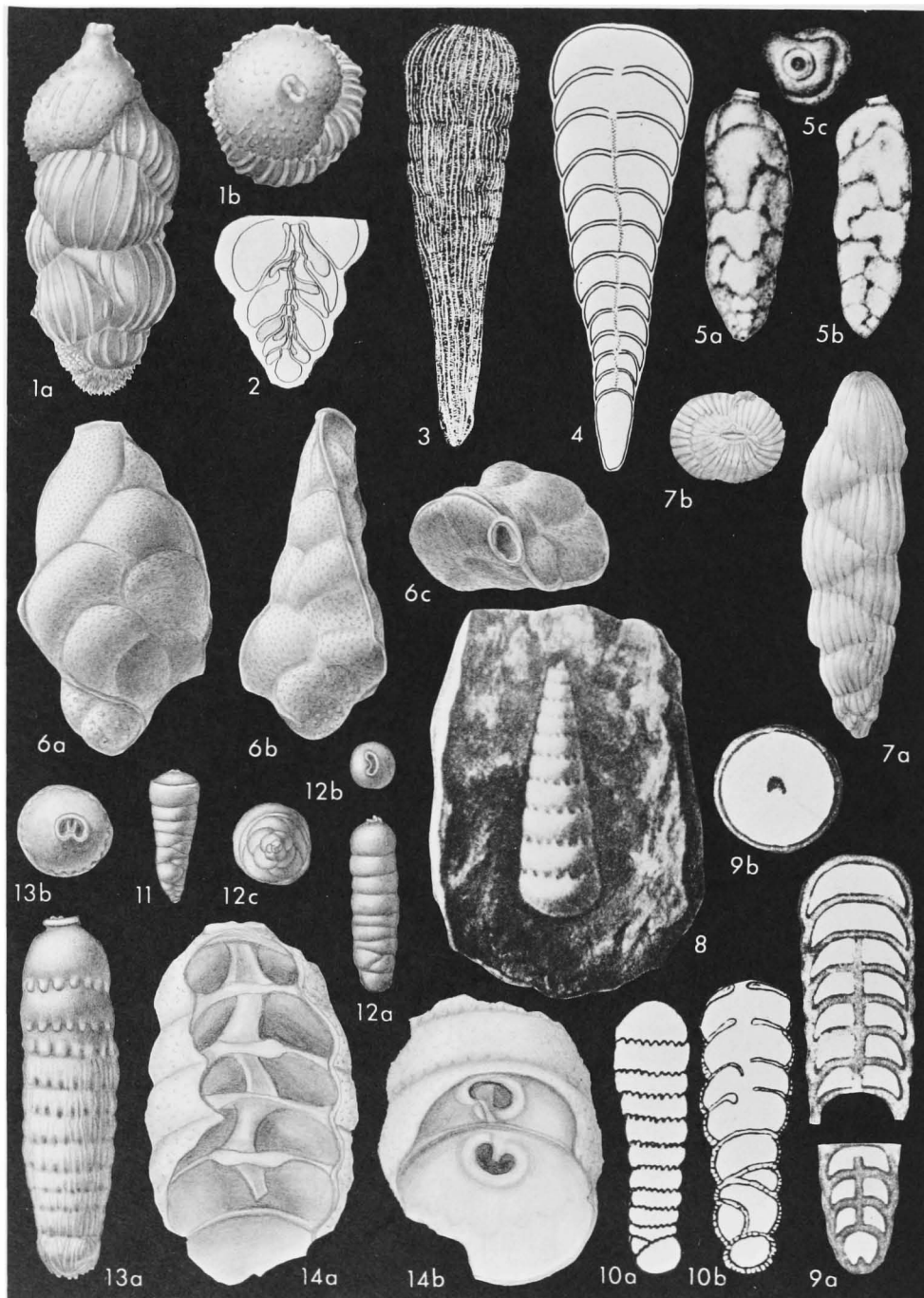


FIG. 446. Uvigerinidae; 1,2, *Uvigerina*; 3,4, *Clavellooides*; 5, *Kolesnikovella*; 6, *Compressigerina*; 7, *Hopkinsina*; 8-14, *Orthokarstenia* (p. C565-C568).

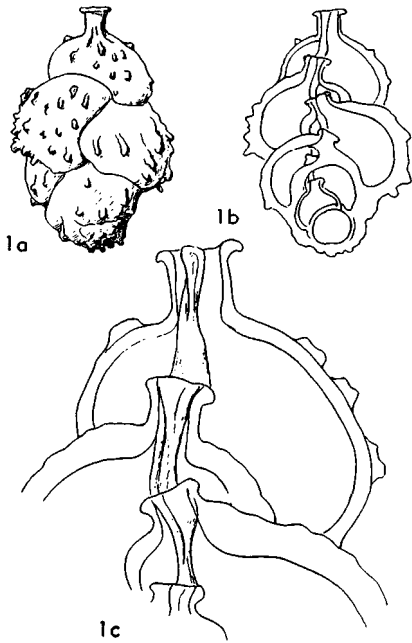


FIG. 447. *Uvigerinidae*; 1, *Euuvigerina* (p. C566-C567).

p. 217 (*nom. nud.*); *Hofkeruwa* (*Hofkeruwa*) VELLA, 1961, *2002, p. 473 (type, *H. (H.) mata*); *Hofkeruwa* (*Laminiuwa*) VELLA, 1961, *2002, p. 474 (type, *H. (L.) tutamoea*); *Hofkeruwa* (*Tereuwa*) VELLA, 1961, *2002, p. 475 (type, *Uvigerina paeniteres* FINLAY, 1939, *717b, p. 103); *Hofkeruwa* (*Trigonouwa*) VELLA, 1961, *2002, p. 476 (type, *H. (T.) zeacuminata*). Test similar in appearance to *Uvigerina*, with chambers triserially arranged, rounded in section; thick-walled and finely perforate, with surface commonly spinose and apertural neck nonperforate; with simple straight, narrow tooth plate, base of which is attached to margins of previous foramen, lacking broad wing of tooth plate of *Uvigerina*. *Eoc.-Rec.*, cosmop.—FIG. 447, 1. **E. aculeata* (D'ORBIGNY), *Rec.*, Indon.; 1a,b, ext. and long. sec. showing simple tooth plates, $\times 32$; 1c, apert. area, $\times 153$ (*928c).

[VELLA (1961, *2002) subdivided the uvigerine forms on the basis of surface ornamentation into many genera and subgenera. Although distinct lineages of costate or spinose species can be demonstrated, we do not regard them to require generic separation, for which characters recognized are those of chamber arrangement and apertural position and modifications, including tooth plates. VELLA stated (*2002, p. 473) that *Hofkeruwa* and its subgenera have tooth plates identical to those of *Euuvigerina aculeata*; hence, they are here regarded as congeneric.]

Hopkinsina HOWE & WALLACE, 1932, *972, p. 61 [**H. danvillensis*; OD]. Test elongate, early stage triserial, later biserial, wall calcareous, perforate, surface smooth or more commonly longitudinally striate or costate; aperture terminal, with

lip or may be slightly produced on neck, apertural tooth plate not described in type-species. [Differs from *Uvigerina* in its later biserial stage, from *Uvigerinella* in its terminal aperture, and from *Trifarina* in being rounded in section and in being biserial rather than uniserial in the adult.] *Eoc.-Rec.*, N.Am.-Eu.—FIG. 446, 7. **H. danvillensis*, U.Eoc.(Jackson.), USA(La.); 7a,b, side, top views of topotype, $\times 130$ (*2117).

Kolesnikovella N. K. BYKOVA, 1958, *265, p. 68 [**Tritaxia elongata* HALKYARD, 1918, *861, p. 45; OD]. Test similar to *Trifarina*, triserial in early stage with tendency to become uniserial, lower chamber margins with retral processes and sinuous margin; wall calcareous perforate; aperture terminal, rounded, produced on neck, commonly with phialine lip. *Eoc.*, W.Eu.-USSR-Cuba-USA(Calif.)-W.Indies.—FIG. 446, 5. **K. elongata* (HALKYARD), *Eoc.*, Fr.; 5a-c, opposite sides and apert. view, $\times 97$ (*861).

Orthokarstenia DIETRICH, 1935, *597, p. 80 [**Orthocera ewaldi* KARSTEN, 1856, *1025, p. 114; OD] [= *Siphogenerita* FURRER, 1961, *757, p. 271 (type, *Siphogenerinoides clarki* CUSHMAN & CAMPBELL, 1936, *499, p. 91)]. Test free, elongate, gradually enlarging from rounded base, early stage of microspheric form triserial, then short biserial stage, megalospheric form with proloculus followed by biserial stage, adult uniserial in both generations; adult chambers subcylindrical, somewhat inflated, lower margin commonly with re-entrants, resulting in appearance of lobulate sutures, sutures distinct, straight, depressed; wall calcareous, finely perforate, surface smooth or with ornamentation of longitudinal costae or striae; aperture terminal, elliptical to reniform, with short neck and distinct lip, internally provided with a spoutlike columellar process, semi-cylindrical spout arising from apertural lip and extending inward with concave side toward opening, those of successive chambers discontinuous, orientation of convex side changing from 120° to 180° in successive chambers, spout may terminate in small circular opening adjacent to concave side of true aperture but is not connected to it. *U.Cret.(Turon.-Maastricht.)*, N.Am.-S.Am.-Afr.—FIG. 446, 8-10. **O. ewaldi* (KARSTEN), Turon., S.Am.(Colom.); 8, ext., approx. $\times 17$; 9a,b, vert. and cross secs. showing internal semi-cylindrical siphon, approx. $\times 30$ (*1025); 10a,b, ext. and vert. sec. showing early triserial stage, approx. $\times 20$ (*597).—FIG. 446, 11, 12. **O. clarki* (CUSHMAN & CAMPBELL), U.Cret.(Campan.), USA(Calif.); 11, microspheric test, $\times 21$; 12a,b, megalospheric test, side, and apert. views, $\times 21$; 12c, basal view showing chamber arrangement, $\times 41$ (*757).—FIG. 446, 13, 14. *O. whitei* (CHURCH), U.Cret.(Maastricht.), USA(Calif.); 13a,b, side and apert. views of megalospheric test, $\times 21$; 14a,b, dissected test showing

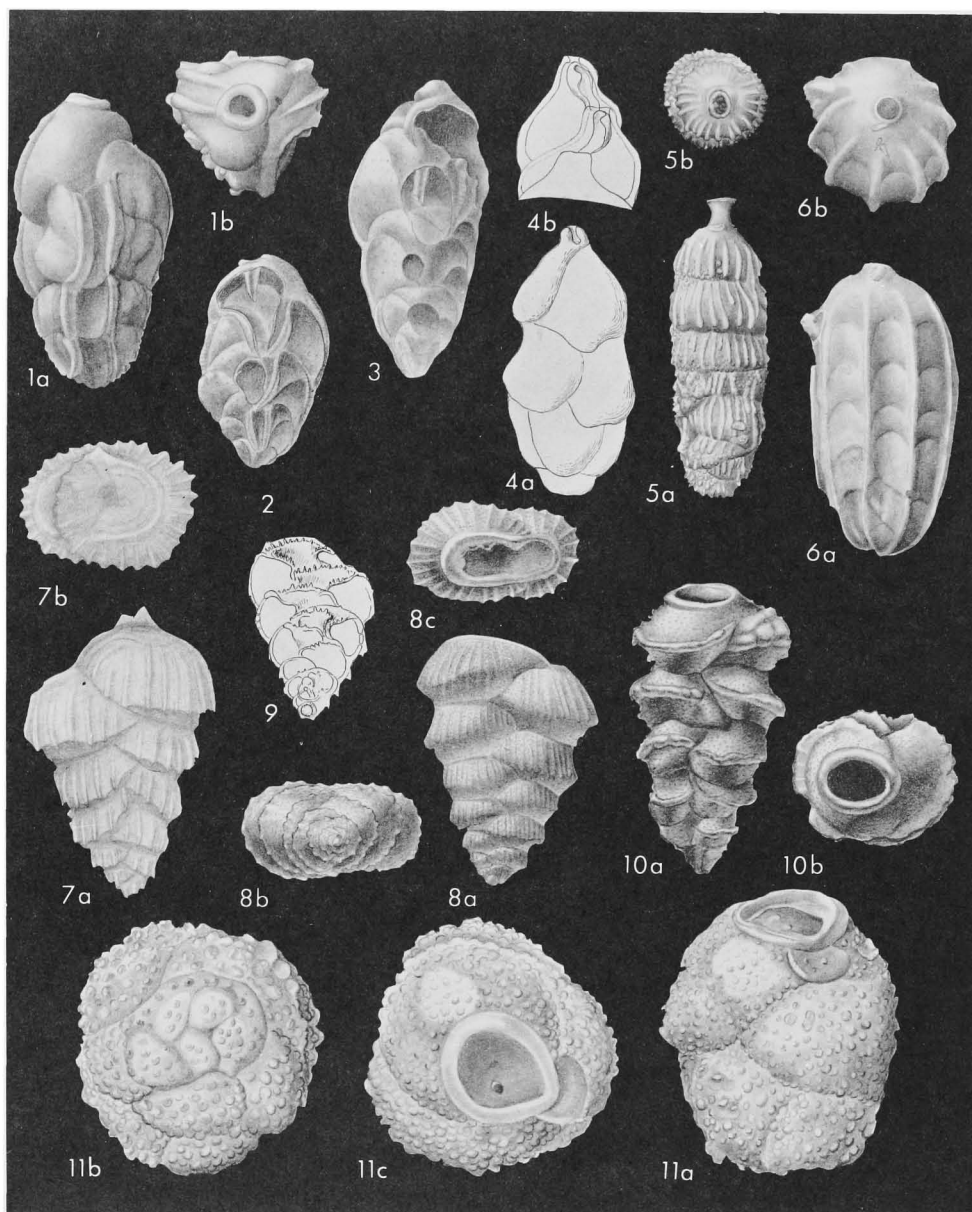


FIG. 448. Uvigerinidae; 1-4, *Pseudouvigerina*; 5,6, *Rectouvigerina*; 7-11, *Sagrina* (p. C568-C569).

alternating position of internal process in successive chambers, $\times 48$ (*757).

Pseudouvigerina CUSHMAN, 1927, *428, p. 81 [**Uvigerina cristata* MARSSON, 1878, *1228, p. 150; OD] [= *Praeuuigerina* HOFKER, 1951, *928c, p. 188 (type, *Uvigerina westfalica* FRANKE, 1912, *738, p. 280)]. Test small, triserial throughout, rounded, triangular or trihedral in section; wall calcareous, finely perforate, surface may be smooth or tuberculate, angles of test may have double vertical costae; aperture circular or subelliptical,

with short neck provided internally with narrow columellar tooth plate. *U.Cret.*, Eu.-N.Am.—FIG. 448, 1-3. **P. cristata* (MARSSON), Maastricht, Ger.; 1a,b, side, apert. views of topotype, *U.Cret.*, Ger., $\times 111$; 2,3, acid-dissected specimens showing internal tooth plate, $\times 107$ (*1303).—FIG. 448, 4. *P. westfalica* (FRANKE), *U.Cret.* (Senon.), Neth.; 4a,b, side view and sec. of apert. region showing tooth plates, $\times 125$ (*928c).

[*Pseudouvigerina* may have arisen from early *Pyramidina* and given rise to *Trifarina*. HOFKER (1957, *948, p. 220)

regarded *Pseudovigenerina* as synonymous with *Reussella*, but recognized the younger name as the valid one. *Pseudovigenerina* is here separated on the basis of its terminal aperture, whereas *Pyramidina* and *Reussella* have basal apertures.]

Rectuvigenerina MATHEWS, 1945, *1234, p. 590, 598, 601 [**Siphogenerina multicostrata* CUSHMAN & JARVIS, 1929, *509, p. 14; OD] [= *Rectuvigenerina* (*Rectuvigenerina*) MATHEWS, 1945, *1234, p. 590, 598, 601 (obj.); *Rectuvigenerina* (*Transversigenerina*) MATHEWS, 1945, *1234, p. 599 (type, *Siphogenerina raphanus* (PARKER & JONES) var. *transversus* CUSHMAN, 1918, *409, p. 64); *Ruatoria* VELLA, 1961, *2002, p. 480 (type, *R. ruatoria*); *Ciperozea* VELLA, 1961, *2002, p. 481 (type, *Siphogenerina ongleyi* FINLAY, 1939, *717b, p. 111)]. Similar to *Siphogenerina* but with triserial to uniserial chamber arrangement in both megalospheric and microspheric generations, whereas *Siphogenerina* has biserial to uniserial megalospheric generation. *M.Eoc.-Rec.*, cosmop.—FIG. 448,5. **R. multicostrata* (CUSHMAN & JARVIS), Mio. (originally recorded as Eoc.), Trinidad; *5a,b*, side, apertural views of holotype, $\times 44$ (*2117).—FIG. 448,6. *R. transversa* (CUSHMAN), Oligo., Panama C.Z.; *6a,b*, side, apert. views of holotype, $\times 49$ (*2117).

[*Ruatoria* was stated to differ from *Rectuvigenerina* in being smaller, with "staggered" terminal chambers and broad neck. *Ciperozea* was stated to have a more elongate triserial portion and cuneate, rather than truly rectilinear, chambers and low longitudinal ribs. Although slightly cuneate in *Ruatoria* and *Ciperozea*, these terminal chambers are nevertheless uniserial and they are regarded as synonymous with *Rectuvigenerina*.]

Sagrina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 149 [**S. pulchella*; OD (M)] [= *Sagrana* BRONN & ROEMER, 1853, *214a, p. 92 (nom. van.); *Bitubulogenerina* HOWE, 1934, *970, p. 420 (type, *B. vicksburgensis*); *Tritubulogenerina* HOWE, 1939, *971, p. 69 (type, *T. mauricensis*, = *Bitubulogenerina mauricensis* HOWE, 1934, *970, p. 421)]. Test free, elongate, circular to ovate in section, triserial in early stage, later biserial; chambers commonly with angular lower margin; wall calcareous, hyaline, coarsely perforate, radial in structure, surface variously ornamented with longitudinal costae, prominent nodes; aperture elongate, bordered with distinct lip, extending up face from base of chamber beyond middle of chamber, outer portion of penultimate aperture visible also, but partially filled by tooth plate; flaring, folded tooth plate extending upward from border of previous foramen, then flaring back through chamber to attach at one side of aperture and in part forming apertural border overlapping previous chamber, entire inner margin of tooth plate serrated, forming fringed border to interior of aperture. *M.Eoc.-Rec.*, Cuba-Carib.-N.Am.-Atl.—FIG. 448,7-9. **S. pulchella*, Rec., Cuba (7), Atl. (8), W.Indies (9); *7a,b*, side, apert. views of lectotype (MNHN, Paris), $\times 109$ (*2117); *8a-c*, side, basal, apert. views, $\times 107$ (*2117); 9, long. sec. of megalospheric form showing tooth plates, $\times 117$ (*946).—FIG. 448,10. *S. vicksburgensis* (HOWE), Oligo., USA (Miss.); *10a,b*,

side, apert. views, $\times 130$ (*2117).—FIG. 448, 11. *S. mauricensis* (HOWE), M.Eoc., USA (La.); *11a-c*, side, basal, and apert. views, $\times 227$ (*2117).

[*Sagrina* described by D'ORBIGNY, 1839, was monotypic, including only *S. pulchella*. PARKER & JONES (1863, *1417e, p. 95) incorrectly emended the genus on the basis of the arenaceous *S. rugosa* D'ORBIGNY, 1840, adding that "the other *Sagrina* (*S. pulchella* d'Orb. . .) (biserial, ribbed and not sandy) is a *Uvigerina*." BRADY (1884, *200, p. 580) stated, "The generic term *Sagrina* was introduced by d'Orbigny for a biserial or Textulariform variety of *Uvigerina* with longitudinal costae." As D'ORBIGNY later also included an arenaceous species, BRADY concluded that while it would have been better to allow the name to lapse, it had been revived by PARKER & JONES for a "group of dimorphous *Uvigerina*, usually biserial in the arrangement of their early segments and Nodosariform in their later growth, and it is to this particular set of forms that the genus is now restricted." CUSHMAN (1928, *439, p. 249) placed *Sagrina* in the synonymy of *Bolivina* but did correctly consider the type-species to be *S. pulchella*. GALLOWAY (1933, *762, p. 348) recognized *Sagrina* as a distinct genus, placing it in the Heterohellicidae. HOWE (1934, *970, p. 420) defined *Bitubulogenerina*, comparing it to the similar *Tubulogenerina*, which has a uniserial adult stage but without mention of *Sagrina*. HOFKER (1951, *928c, p. 67) incorrectly restricted *Sagrina* to *S. tessellata* (which is the type-species of *Milletina*) and placed *S. pulchella* in *Bitubulogenerina*. As *Sagrina* has priority, *Bitubulogenerina* is the junior synonym. A lectotype of *S. pulchella*, here designated and redrawn, and paratypes were selected by us from the D'ORBIGNY collection in the Muséum National d'Histoire Naturelle, Paris, France. They are Recent, off Cuba. The monotypic *Tritubulogenerina* was based on a small completely triserial form, *T. mauricensis*, which was described from the same strata and locality as *Bitubulogenerina mauricensis* HOWE, 1934, a form with early triserial stage and later biserial development. As *Tritubulogenerina mauricensis* appears merely to represent a young form or the megalospheric generation of the earlier-described species, it is a junior synonym of *Bitubulogenerina* and of *Sagrina*.]

Siphogenerina SCHLUMBERGER in MILNE-EDWARDS, 1882, *1286, p. 51 [**Siphogenerina costata* SCHLUMBERGER, 1883, *1650, p. 26; SD CUSHMAN, 1927, *433, p. 190] [= *Ellipsosiphogenerina* A. SILVESTRI, 1902, *1754, p. 101 (type, *Siphogenerina costata* SCHLUMBERGER, 1883, *1650, p. 26, SD LOEBLICH & TAPPAN, herein) (obj.); *Ellipsosiphogenerina* A. SILVESTRI, 1923, *1774, p. 265 (nom. null.)]. Test free, early stage biserial, later uniserial, or rarely with early triserial stage (probably microspheric); wall calcareous, hyaline, finely perforate, radial in structure, surface smooth or variously ornamented with longitudinal costae, striations or pits; aperture terminal, rounded with short neck or rim and phialine lip; apertural tooth plates projecting inward, those of successive chambers added in planes 120° apart. *Eoc.-Rec.*, cosmop.—FIG. 449,1-4. **S. costata*, Rec., Tahiti (1), Fiji (2,3), W.Indies (+); 1, holotype, $\times 28$ (*1650); *2a,b*, side, apert. views of microspheric hypotype; 3, side view of megalospheric hypotype; all $\times 32$ (*476); 4, sec. of apert. end showing tooth plates in 2 successive chambers, probably $\times 160$ (originally stated to be $\times 240$, but magnification of figures and measurements of specimens do not agree) (*946).

[*Siphogenerina* was originally defined (1882, *1286) without included species. A subsequent article by the same author (1883, *1650) included 3 species (*S. glabra*, *S. costata*, *S. ocracea*), but none was designated as type-species. CUSHMAN (1913, *404c, p. 104) incorrectly designated *Uvigerina* (*Sagrina*) *raphanus* PARKER & JONES as the type-species of *Siphogenerina*, although this was not one of the 3 species originally included. Later CUSHMAN (1927, *433,

p. 190) corrected this, designating *S. costata* SCHLUMBERGER as the type-species, although stating that it was a synonym of *S. raphanus*. MATHEWS (1945, *1234, p. 589) cited the type as *S. costata* and regarded it as specifically distinct

from *S. raphanus*. BANDY & BURNSIDE (1951, *76, p. 14) stated that CUSHMAN was in error in designating *S. costata* as type and that *S. glabra* as the first species included should be the type. However, any of the 3 species de-

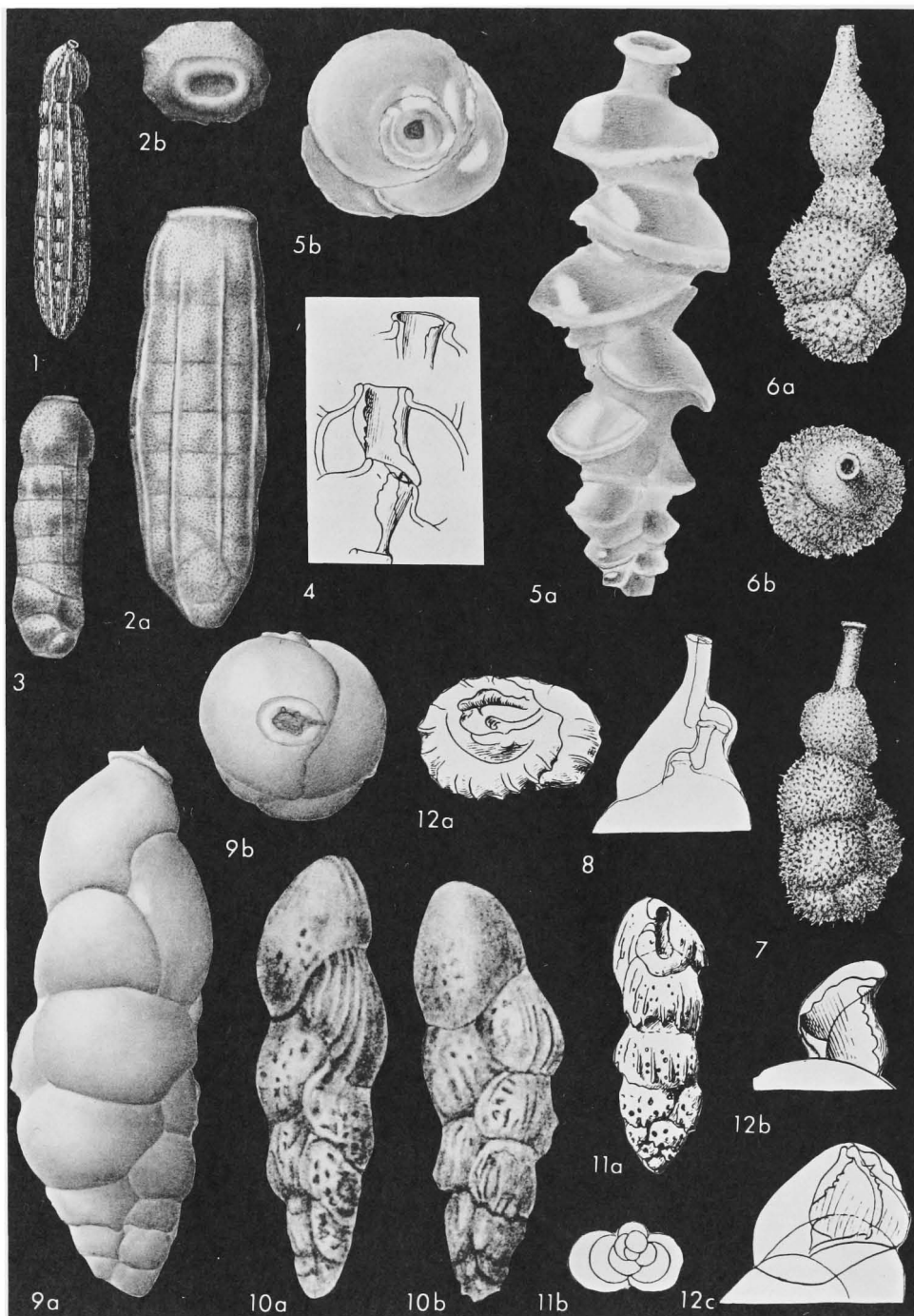
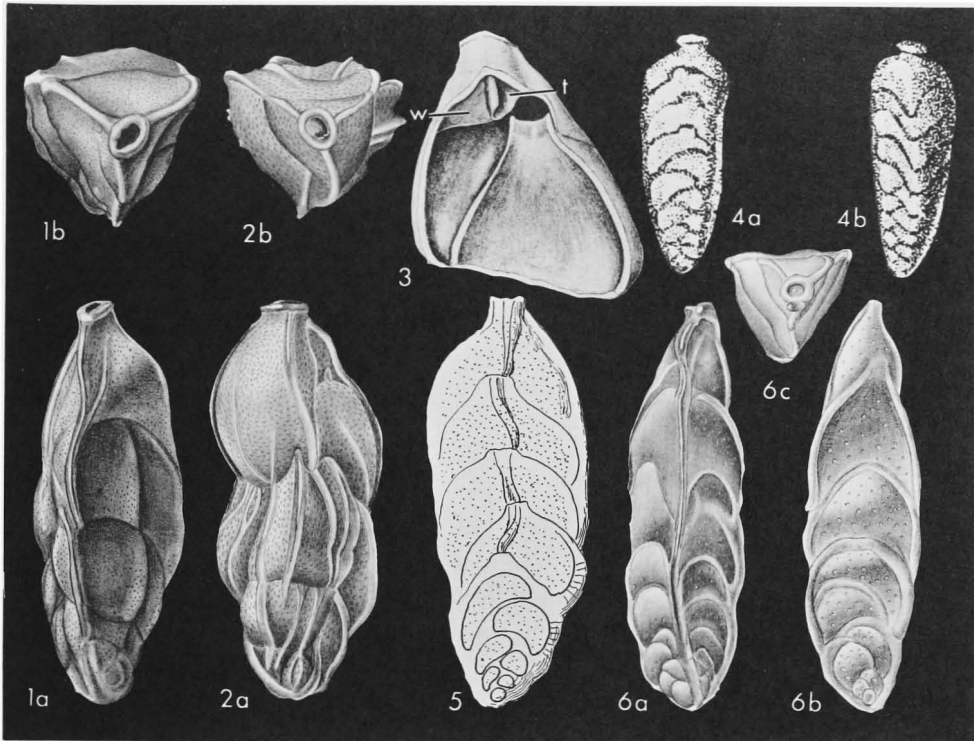


FIG. 449. Uvigerinidae; 1-4, *Siphogenerina*; 5-8, *Siphouvigerina*; 9, *Uvigerinella*; 10-12, *Virgulinopsis* (p. C569-C572).

FIG. 450. *Uvigerinidae*; 1-6, *Trifarina* (p. C571-C572).

scribed in 1883 was available for designation as type. BANDY (1952, *72, p. 17) later agreed with CUSHMAN that *S. costata* was a synonym of *S. raphanus* and stated that the latter was therefore the type-species. The type area given for *S. costata* by SCHLUMBERGER was Tahiti and New Caledonia. BANDY stated (1952, *72, p. 18) that some specimens of *S. costata* from Tahiti have a triserial early stage and others have a biserial early stage. We examined the types of *S. raphanus* in the British Museum (Natural History), and regard it as distinct from *S. costata*. *Siphogenerina* is here regarded as including only species which are triserial in the microspheric early stage and biserial in the megalospheric stage. As *S. raphanus* is biserial to uniserial in the microspheric form and only uniserial in the megalospheric stage it has been transferred to *Rectobolivina*.]

Siphouvigerina PARR, 1950, *1429, p. 342 [**Uvigerina porrecta* BRADY var. *fimbriata* SIDEBOTTOM, 1918, *1741, p. 147; OD] [= *Neouvigerina* HOFKER, 1950, *932, p. 67 (nom. nud.); *Neouvigerina* HOFKER, 1951, *928c, p. 206 (nom. nud.); *Neouvigerina* THALMANN, 1952, *1897j, p. 977 (type, *Uvigerina asperula* var. *ampullacea* BRADY, 1884, *200, p. 579)]. Test elongate, chambers triserial and closely appressed in the early stage, later tending to uniseriality, with chambers loosely attached and sutures deeply incised; wall calcareous, surface hispid or with granulations which may coalesce into costae; aperture terminal, rounded, with perforate neck and phialine lip, tooth plate straight and simple, attached to outer margin of previous foramen. *Oligo.-Rec.* cosmop.—FIG. 449,5. *S. fimbriata* (SIDEBOTTOM), Rec., Australia; 5a,b, side, top views, $\times 185$ (*2117).—FIG. 449,6-8. *S. ampullacea* (BRADY), Rec., S.Atl. (6,7),

Sumatra (8); 6a,b, side, apert. views, $\times 64$; 7, side view, $\times 64$ (*200); 8, optical sec. of terminal portion showing tooth plates, approx. $\times 100$ (*928c).

Trifarina CUSHMAN, 1923, *411d, p. 99 [**T. bradyi*; OD] [= *Angulogerina* CUSHMAN, 1927, *431, p. 69 (type, *Uvigerina angulosa* WILLIAMSON, 1858, *2065, p. 67); *Candela* N. K. BYKOVA, in N. K. BYKOVA *et al.*, 1958, *265, p. 70 (type, *Trifarina labrum* SUBBOTINA, 1953, *1846, p. 247 (non *Candela* HERRMANNSEN, 1846); *Dymia* N. K. BYKOVA, 1962, *264, p. 22 (nom. subst. pro *Candela* N. K. BYKOVA, 1958, non HERRMANNSEN, 1846); *Norcottia* VELLA, 1961, *2002, p. 478 (type, *Hopkinsina mioindex* FINLAY, 1947, *717e, p. 282)]. Test free, elongate, triangular in section; chambers triserially arranged, early ones closely appressed, later ones more loosely appressed and tending to become uniserial; wall calcareous, finely perforate, radial in structure, commonly with longitudinal costae; aperture terminal, ovate, on short neck with thickened rim, tooth plate with wing at dorsal side. *Eoc.-Rec.*, cosmop.—FIG. 450,1-3. *T. angulosa* (WILLIAMSON), Rec., Br.I.; 1a,b, side, apert. views of paratype, $\times 83$ (*2117); 2a,b, side, apert. views, $\times 99$ (*2117); 3, apert. end dissected to show tooth plate (*t*) and its wing (*w*), $\times 123$ (*924).—FIG. 450,4. *T. labrum* (SUBBOTINA), U.Eoc., Ukraine; 4a,b, opposite sides of holotype, $\times 96$ (*1509).—FIG. 450,5,6. *T. bradyi*, Rec., Indon. (5), Atl. (6);

5, long. sec. showing tooth plates, $\times 160$ (*928c); 6a-c, opposite sides and apert. view of paratype, $\times 94$ (*2117).

[*Trijarina* differs from *Uvigerina* in being angular in section and in the tendency to become uniserial in the adult. The synonymy of *Angulogerina* with *Trijarina* was shown by HOFKER (1956, *946, p. 77), although he recognized the junior name as valid. The original types of *Uvigerina angulosa* WILLIAMSON were studied by us in the British Museum (Natural History), and a lectotype here designated (BMNH-ZF3576) with paratypes (BMNH-ZF3575) (all ex 96.8.13.32, WILLIAMSON collection, Recent, off Great Britain). *Norcottia* was proposed to include a finely costate Miocene species, as *VELIA* utilized surface ornamentation for generic separation. In chamber arrangement and other features it resembles *Trijarina*; hence *Norcottia* is here considered a synonym of *Trijarina*.]

Uvigerinella CUSHMAN, 1926, *426, p. 58 [**Uvigerina* (*Uvigerinella*) *californica*; OD] [= *Uvigerina* (*Uvigerinella*) CUSHMAN, 1926, *426, p. 58 (obj.)]. Test similar to *Uvigerina*, triserial; wall calcareous, perforate, surface smooth or longitudinally costate; aperture slitlike, extending up face of final chamber, rather than terminal in position, and may have elevated rim or collar, but without neck and phialine lip, character of tooth plate not described in type-species. [Additional study is needed of the type-species of this and other genera. Possibly *Virgulopsis* or *Virgulinopsis* may be synonyms of the present genus, but evidence for determining this is insufficient as yet.]. *Eoc.-Rec.*, N.Am.-W.Indies.—FIG. 449, 9. **U. californica*, Mio., USA (Calif.); 9a,b, side, apert. views of paratype, $\times 97$ (*2117).

Virgulinoopsis HOFKER, 1956, *946, p. 47 [**Bolivina cubana* BERMUDEZ, 1935, *117, p. 196; OD]. Test with short triserial early stage, later biserial; wall calcareous, finely perforate, surface commonly striate or costate, apertural face poreless; aperture elongate, nearly terminal in position, with flaring tooth plate, attached portion folded, and irregularly lobed, free folded part narrow, with fimbriate margin, occurring in an excavation of upper apertural margin. *Rec.*, Carib.—FIG. 449, 10-12. **V. cubana* (BERMUDEZ), Cuba; 10a,b, opposite sides, $\times 120$ (*472); 11a,b, edge view showing aperture and basal view showing triserial base, $\times 160$ (*946); 12a, top view showing aperture, $\times 210$; 12b,c, views of tooth plate, one showing chamber outline, $\times 210$ (*946).

[*Virgulinoopsis* differs from *Bolivina* in its early triserial development, and from *Stainforthia* in its coarser perforations, longitudinal ornamentation, and more highly developed tooth plate. It is possibly intermediate between *Stainforthia* and *Sagrina*. The magnifications here given are corrected, as the figures given by HOFKER (*946) apparently were reduced to two-thirds the size stated in the figure explanations.]

Superfamily DISCORBACEA Ehrenberg, 1838

[*nom. correct.* LOEBLICH & TAPPAN, herein (*pro* Discorbidea SMOUT, 1954, p. 81)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹superfamily, ²family group); dagger (†) indicates *partim*]—[=†*Orthoklinostegia* EIMER & FICKERT, 1899, p. 685 (*nom. nud.*); =†*Rotaliariidae* RHUMBLER in KÜENHALL & KRUMHALL, 1923, p. 88; =†*Discorbidea* SMOUT, 1954, p. 81; =†*Monolamellidea* REISS, 1957, p. 128 (*nom. nud.*)]—[=†*Asterigerinacea* LOEBLICH & TAPPAN, 1961, p. 302]

Test trochospiral or derived from such; wall of radial laminated calcite, perforate, noncanaliculate, single walls and septa; aperture interiomarginal or areal, or derived from such. *M.Trias.-Rec.*

Family DISCORBIDAE Ehrenberg, 1838

[*nom. correct.* GLAESSNER, 1945, p. 145 (*pro* Discorbina EHRENBURG, 1838, p. 200)]—[All names cited are of family rank; dagger (†) indicates *partim*]—[=†*Polystomat* LATREILLE, 1825, p. 161 (*nom. nud.*); =†*Cristacea*, and *Cristacést* DE BLAINVILLE, 1825, p. 383 (*nom. nud.*); =†*Héli-costéguest* D'ORBIGNY, 1826, p. 268 (*nom. nud.*); =†*Uvellina* EHRENBURG, 1839, table opposite p. 120 (*nom. nud.*); =†*Turbinoidea* D'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =†*Valvulineriidae* BOETZEN, 1942, p. 16; =†*Laticarinidae* HOFKER, 1951, p. 307; =†*Valvulineriidae* HOFKER, 1951, p. 484; =†*Marginolamellidae* HOFKER, 1951, p. 485 (*nom. nud.*); =†*Discorbidae* POKORNÝ, 1954, p. 215 (*nom. van.*); =†*Conorbinidae* HOFKER, 1954, p. 167; =†*Discorbinidae* HOFKER, 1954, p. 167; =†*Pseudoparrellidae* SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 272; =†*Discorbidae* HORNIBROOK, 1961, p. 97 (*nom. van.*)]

Test free, trochospiral; chambers simple; wall calcareous, perforate, radial in structure, monolamellid; aperture basal or areal. *M.Trias.-Rec.*

Subfamily DISCORBINAE Ehrenberg, 1838

[*nom. correct.* GALLOWAY, 1933, p. 285 (*pro* subfamily Discorbininae CUSHMAN, 1927, p. 75; *nom. transl. ex* family Discorbina EHRENBURG, 1838)]—[=†*Discorbininae* SCHUBERT, 1921, p. 156; =†*Pseudoparrellinae* VOLOSHINOVA in VOLOSHINOVA & DAIN, 1952, p. 81; =†*Discorbinellinae* SIGAL in PIVETEAU, 1952, p. 228; =†*Discorbinidae* POKORNÝ, 1954, p. 215 (*nom. van.*); =†*Discorbininae* HORNIBROOK, 1961, p. 97 (*nom. van.*)]

Test free, trochospiral, low- to high-spired, umbilical region open; aperture basal, umbilical. *M.Trias.-Rec.*

Discorbis LAMARCK, 1804, *1085a, p. 182 [**Discorbites vesicularis*; OD (M)] [=†*Discorbites* LAMARCK, 1804, *1085a, p. 182 (obj.); *Discorbites* RAFINESQUE, 1815, *1496, p. 140 (*nom. van.*); Les Discorbes D'ORBIGNY, 1826, *1391, p. 274 (*nom. neg.*); Les Trochulines D'ORBIGNY, 1826, *1391, p. 274 (*nom. neg.*); *Trochulina* D'ORBIGNY in EHRENBURG, 1839, *667, chart following p. 120 (type, *Rotalia turbo* D'ORBIGNY, 1826, *1391, p. 274); *Cyclodiscus* EHRENBURG, 1839, *667, chart opposite p. 120 (*nom. subst. pro* *Discorbis* LAMARCK, 1804) (obj.); *Allothea* EHRENBURG, 1843, *672, p. 407 (type, *A. megathyra*); *Aristerspira* EHRENBURG, 1858, *683, p. 11 (type, *A. isoderma*); *Discorbina* PARKER & JONES in CARPENTER, PARKER & JONES, 1862, *281, p. 200, 203 (type, *Rotalia turbo* D'ORBIGNY, 1826, *1391, p. 274); *Rotalinella* BANDY, 1944, *69, p. 372 (type, *R. colliculus*); *Biapertorbis* POKORNÝ, 1956, *1477, p. 262 (type, *B. biaperturata*)]. Test free, trochospiral, plano-convex, flattened on umbilical side, periphery angled; all chambers visible on umbonate spiral side, only chambers of final whorl visible on umbilical side, with a flap extending from basal portion of each chamber toward umbilical region, opening extending along proximal side of each radial umbilical flap, connecting through cavity beneath flaps to interior of cham-

bers themselves; primary aperture an interiomarginal, extraumbilical arch, secondary sutural openings at opposite side of chamber flap remaining

open as later chambers are formed; biflagellate gametes occur. *Eoc.-Rec.*, Eu.-N.Am.-Pac.-N.Z.-Australia-Atl.—FIG. 451, 1-3. **D. vesicularis*,

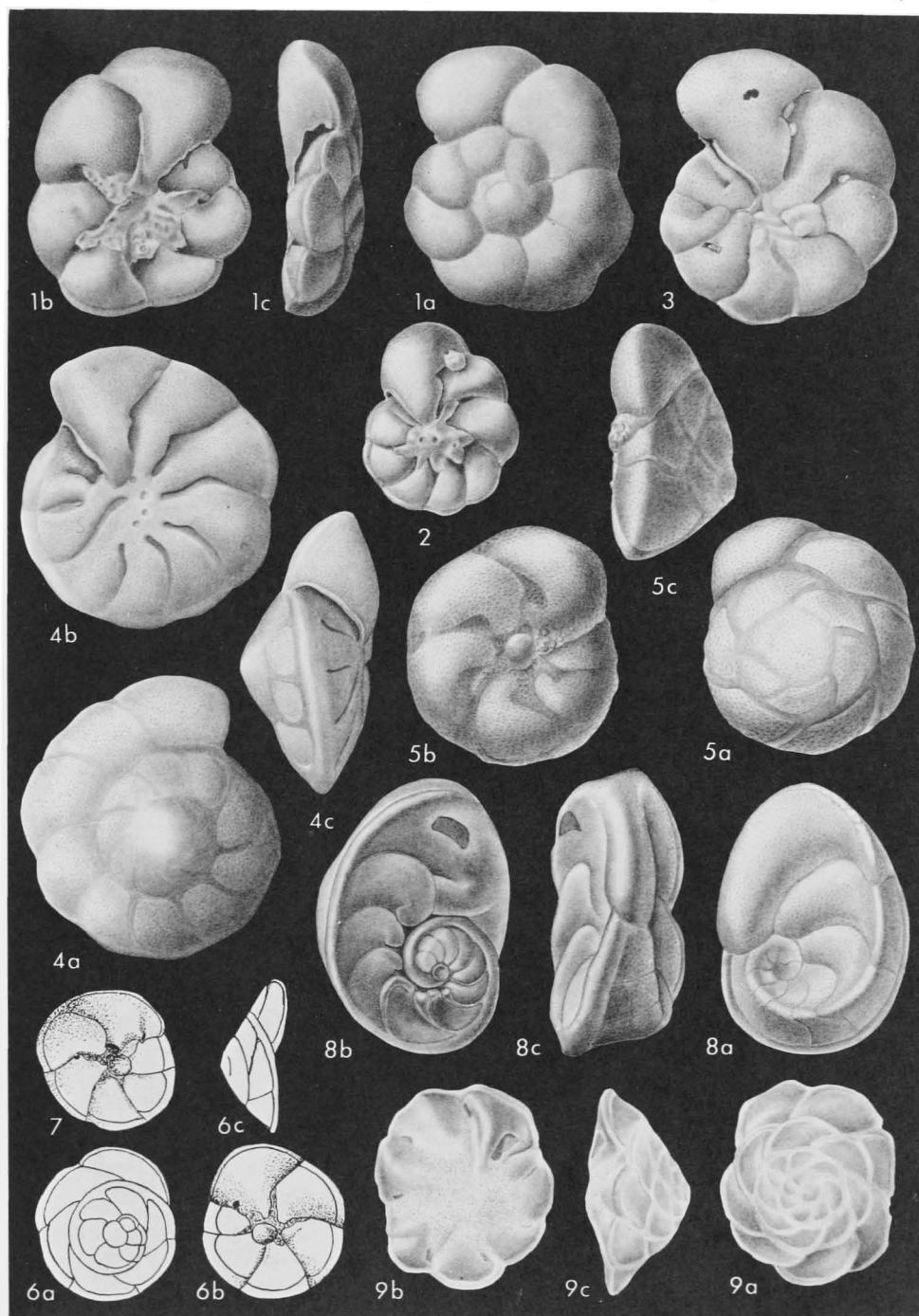


FIG. 451. Discorbidae (Discorbinae; 1-7, *Discorbis*; 8, *Bronnimannia*; 9, *Buccella*) (p. C572-C575).

M.Eoc.(Lutet.), Fr.; 1a-c, opposite sides and edge view of well-preserved toptype, showing flange-like umbilical flaps with openings at each extremity, $\times 17$; 2, umbilical side of smaller toptype, with less well-preserved flaps coalescing centrally and with a few central perforations, $\times 17$; 3, umbilical side of somewhat abraded toptype, umbilical flaps being destroyed and secondary apertures showing as sutural slits, $\times 25$ (*2117).

—FIG. 451,4. *D. turbo* (D'ORBIGNY), M.Eoc. (Lutet.), Fr.; 4a-c, opposite sides and edge view of specimen compared with and nearly identical to lectotype in Paris, $\times 28$ (*2117).—FIG. 451, 5. *D. colliculus* (BANDY), Eoc., USA (Ore.); 5a-c, opposite sides and edge view, $\times 74$ (*2117).—FIG. 451,6,7. *D. biaperturata* (POKORŇÝ), U.Eoc., Czech.; 6a-c, opposite sides and edge view of paratype, $\times 85$; 7, umbilical view of holotype, $\times 85$ (*1477).

[Many dissimilar forms have been placed in *Discorbis*, as, unfortunately, no characteristic illustrations were available for the type-species until approximately 1950. The original figure given by LAMARCK was extremely diagrammatic, the vesicular portion of the umbilical side being indicated only by the slightly angled sutures. CUSHMAN (1927, *432, pl. 24, fig. 1a-c) illustrated a toptype specimen; although the spiral and edge views given are recognizable, the drawing of the umbilical side does not show the "alar projections" referred to in the discussion. Y. LE CALVEZ (1949, *1112, pl. 3, figs. 36-38) has illustrated the central vesicular area much better. The preservation and degree of abrasion of the specimens cause a considerable degree of variation in the lateral extent of these projections, from narrow radial projections to approximately continuous flaps which almost overlap. Most texts have copied either the original figures of *Discorbis* or the misleading illustrations of CUSHMAN just cited; others have illustrated different species, some of which are not even congeneric with the type-species. Many unrelated forms thus have been placed in *Discorbis*, some of them completely lacking essential features of the genus. For these reasons, during the last 15 years there has been a great proliferation of generic names proposed for various discorbinine species. Many of these are currently recognized, whereas others are here regarded as synonyms of one genus or another. In some instances the same species has been cited as type or placed within 3 or 4 different generic taxa. The species *Rotalia* (Trochulinea) *turbo* D'ORBIGNY, 1826, has been designated as the type-species of *Trochulina* D'ORBIGNY, 1839, by subsequent monotypy, BASSET (1885, *101, p. 162); also it has been defined as the type-species of *Discorbina* PARKER & JONES, 1862, was included by BROTZEN (1936, *237, p. 141) in *Conorbina* but by HOFKER at various times in *Discopulvinulina* (1951, *928c) and *Rotorbinella* (1954, *942, p. 34). *Trochulina* was named by D'ORBIGNY in EHRENBERG, 1839, but no species were cited, although 3 species had been mentioned by D'ORBIGNY in 1826 (*1391, p. 274) under the French vernacular subgeneric term "Les Trochulines." Two were *nomina nuda* but the third, *Rotalia* (Trochulinea) *turbo*, was valid. The latter name was first used in combination with the Latin subgeneric name *Trochulina* by BASSETT, 1885, thus automatically becoming the type of *Trochulina* by subsequent monotypy. This type designation thus validated the generic name *Trochulina*, which therefore takes precedence over the later name *Discorbina* PARKER & JONES, 1862. HORNIBROOK & VELLA (1954, *960, p. 26) discussed the genus *Discorbina* (type, *Rotalia turbo*) and considered *Rotorbinella* BANDY, 1944, to be a synonym, stating (p. 27), "The main diagnostic features of *Rotorbinella* are the prominent umbilical plug and channeled ventral sutures, characters that are strongly indicated in d'Orbigny's figure of *Rotalia* (Trochulinea) *turbo*. Specimens of what we believe to be *Rotalia turbo*, from the Paris Basin Lutetian, are very close to *Discorbis finlayi* Doreen, 1948, which Bermúdez regards as a typical *Rotorbinella*. *Rotorbinella* is thus a synonym of *Discorbis* in the strict sense." HOFKER (1951, *928c) included *R. turbo* in his new genus *Discopulvinulina* but later (1954, *942, p. 34) stated that *turbo* should be placed in *Rotorbinella*, adding, "*Rotorbinella turbo* (d'Orbigny) does not occur in the Lutetian of the Paris Basin, as

Hornibrook and Vella believe; the species which they had at hand must have been *Rotorbinella perovalis* (Terquem)" He also stated that perhaps the species should be called *Conorbina turbo*. Apparently D'ORBIGNY did not illustrate *R. turbo*, but included it in his models (No. 73). A figure of this was given by PARKER, JONES & BRADY (1865, *1419, pl. 2, fig. 68). However, this figure does not agree with D'ORBIGNY's specimens. Commonly D'ORBIGNY's models, and his illustrations as well, were not intended to portray a type-specimen exactly, but instead were a composite, much-generalized illustration which sometimes combined features of more than a single species. This fact makes reference to his type-specimens absolutely imperative, and the only reliable basis for systematic work. In 1954, we examined the D'ORBIGNY types in the Muséum National d'Histoire Naturelle in Paris, among them several specimens of *Rotalia turbo*, the type-specimens of which are from the Paris Basin Lutetian. HOFKER was thus mistaken in stating that *R. turbo* does not occur in the Lutetian of the Paris Basin. One of D'ORBIGNY's original specimens of *R. turbo* is here designated as lectotype and this specimen is now so labeled on a separate slide in the Museum in Paris. The specimen of *R. turbo* here figured is from the Lutetian at the classic locality of Chaussey, Seine-et-Oise, France, and was compared to the lectotype in Paris, and found to be identical in all features. It is a true *Discorbis*. Of the genera to which *R. turbo* has been referred, *Conorbina* is regarded as a valid genus, on the basis of its type-species; *Discopulvinulina* is a synonym of *Discorbina*; and *Trochulina*, *Discorbina*, and *Rotorbinella* are regarded as synonyms of *Discorbis*. In addition, *Biapertorbis* is regarded as a synonym of *Discorbis*, the type-species showing the umbilical flap separating the 2 apertures characteristic of *Discorbis*, and an umbilical "plug" like that found in some species of *Discorbis* but varying considerably in the degree of development.]

Aboudaragina NAKKADY, 1955, *1345, p. 261 [*A. eponidelliformis*; OD]. Test trochospiral, ventrally umbilicate; wall calcareous, finely perforate, microstructure and lamellar character unknown; aperture a large, rounded, interior marginal equatorial opening in depressed terminal face. [This genus and type-species are known only from the original publication, in which the figures are generalized, and at least the spiral view apparently incorrect, as it does not show a trochospiral coil, but concentric whorls.] *M.Jur.*, Egypt.—FIG. 452,1. *A. eponidelliformis*, U.Dogger (Bathon.); 1a-c, opposite sides and edge view of holotype, $\times 54$ (*700).

Bronnimannia BERMÚDEZ, 1952, *127, p. 39 [*Discorbis palmerae* BERMÚDEZ, 1935, *117, p. 207; OD]. Test free, auriculate in outline, planispiral, evolute on both sides, plano-convex to nearly bi-concave, umbilical region open on apertural side, closed on opposite side with sharp, acute-angled peripheral ridge and truncate peripheral margin sloping sharply to marginal keel; umbilical flap near aperture of each chamber, those of earlier chambers of final whorl remaining visible; sutures arched on apertural side and curved backward at periphery, sigmoid on opposite side, curving backward from umbonal area, abruptly angled at sharp dorsal angle, and curving again to peripheral keel; wall coarsely perforate on umbonal, ridged side, finely perforate on apertural side; aperture opening beneath umbilical chamber flaps and connecting laterally along spiral suture to openings of earlier chambers of final whorl. [*Bronnimannia* differs from *Planulinoides* in having a slitlike aperture beneath the ventral umbilical chamber flaps, whereas in *Planulinoides* the aperture is peripheral and consists of an oblique ovate open-

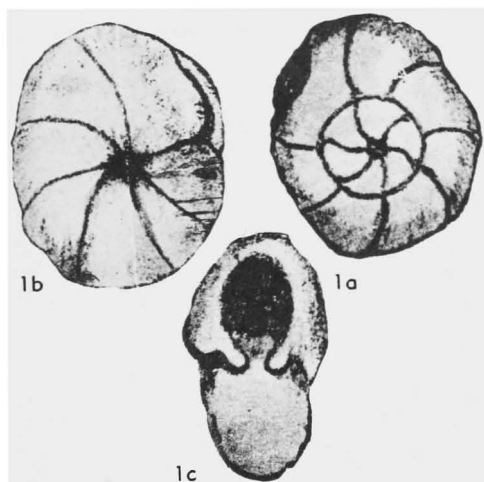


FIG. 452. Discorbidae (Discorbinae; 1, *Aboudaragina*) (p. C574).

ing surrounded by a lip, in addition to the ventral openings beneath rudimentary umbilical flaps.] *Rec.*, Gulf Mex.-Atl.-Pac.—FIG. 451,8. **B. palmerae* (BERMÚDEZ), Cuba (Bahia de Matanzas); lectotype, here designated (Coll. U.S.N.M.) from original syntypes of BERMÚDEZ; 8a-c, opposite sides and edge view, $\times 78$ (*2117).

Buccella ANDERSEN, 1952, *17, p. 143 [**Eponides hannah* PHLEGER & F. L. PARKER, 1951, *1455, p. 21; OD]. Test trochospiral, planoconvex to biconvex, periphery keeled; umbilical region and inner part of last whorl of chambers partially obscured by granular or pustulose coating on umbilical side; primary aperture interiomarginal, midway between umbilicus and periphery, supplementary sutural apertures at posterior margin of each chamber, near periphery on umbilical side. *Oligo.-Rec.*, N. Am.-Atl.-Pac.-Carib.-Japan-Eu.-S. Am.—FIG. 451, 9. **B. hannah* (PHLEGER & F. L. PARKER), *Rec.*, Gulf Mex.; 9a-c, opposite sides and edge view of holotype, $\times 80$ (*17).

Conorbina BROTZEN, 1936, *237, p. 141 [**C. marginata*; OD]. Test plano-convex, trochospiral; chambers crescentic, increasing in breadth as added, so that final whorl has relatively few; sutures oblique and curved on spiral side, nearly radial on opposite side; aperture a low slit at base of final chamber, in slight re-entrant of chamber margin, near periphery on umbilical side. [*Conorbina* differs from *Glabrattella* in lacking open umbilicus with surrounding radial ornamentation, and in having a suturally placed aperture.] *L.Cret.(Alb.)-U. Cret.(Senon.)*, Eu.-N. Am.—FIG. 453,1. **C. marginata*, L. Senon., Sweden; 1a-c, opposite sides and edge view, $\times 190$ (*2117).

Diplotremina KRISTAN-TOLLMAN, 1960, *1059, p. 64 [**D. astrofimbriata*; OD]. Test free, trochospiral, margin of large open umbilicus deeply lobed; chambers increasing gradually in size; wall calcar-

eous, perforate, microstructure and lamellar character unknown; primary aperture interiomarginal, about midway between umbilicus and periphery, umbilical chamber flap separating it from secondary umbilical opening, both apertures with crenulated margins. *M.Trias.*, Aus.—FIG. 454,1. **D. astrofimbriata*; 1a-c, opposite sides and edge view of holotype, $\times 125$ (*1059).

Discorbinella CUSHMAN & MARTIN, 1935, *512, p. 89 [**D. montereyensis*; OD] [= *Discopulvinulina* HOFKER, 1951, *936, p. 359 (type, *Rosalina bertheloti* D'ORBIGNY in BARKER-WEBB & BERTHELOT, 1839, *86, p. 135)]. Test free, plano-convex, compressed to scalelike, spiral side convex, nearly involute, only small portion of earlier whorls visible centrally, opposite side flattened to slightly concave, umbilicate, but nearly involute, with very little of previous coil visible at center, periphery carinate; aperture an interiomarginal arch, nearly peripheral on umbilical side, with supplementary opening at opposite margin of umbilical chamber flap; gametes biflagellate (in *D. bertheloti*). *Rec.*, Atl.-Pac.-Gulf Mex.—FIG. 453,2. **D. montereyensis*, USA (Calif., Monterey Bay); 2a-c, opposite sides and edge of holotype, $\times 115$ (*2117).—FIG. 453,3. *D. bertheloti* (D'ORBIGNY), Gulf Mex.; 3a-c, opposite sides and edge view, $\times 68$ (*2117).

[*Discorbinella* differs from *Discorbis* in its spiral side being only partially evolute, in having very simple umbilical chamber flaps, and in having a nearly peripheral primary aperture. HOFKER (1951, *936, p. 359; *928c, p. 448) proposed the name *Discopulvinulina* to include a variety of forms previously placed in *Discorbis*, *Discorbina*, *Pulvinulina*, *Rotalia*, *Cibicides*, and *Rosalina*. If species originally included by HOFKER under *Discopulvinulina* were in reality congeneric, his proposed name would be preoccupied by no less than six other valid generic names. However, on the basis of the type-species of these genera, *Discopulvinulina* is distinct from those, but a junior synonym of *Discorbinella*. D'ORBIGNY recorded *Rosalina bertheloti* (type-species of *Discopulvinulina*) from the Canary Islands, in marine sands at Tenerife. Our figured specimen from the Gulf of Mexico is one of the hypotypes originally figured by FLINT (1899, *723, pl. 72, fig. 4).]

Discorbitura BANDY, 1949, *70, p. 99 [**D. dignata*; OD]. Test free, trochospiral, concavo-convex, all chambers visible on convex spiral side; only last whorl visible on flat to concave umbilical side, periphery keeled; chambers with slight re-entrant at their irregular posterior margin on umbilical side, sufficiently pronounced as to nearly subdivide chamber into peripheral and umbilical lobe, and may have series of grooves branching out from sutures, umbilical region may be filled with nodes and pustules; sutures somewhat thickened on spiral side, depressed on opposite side; aperture peripheral, round areal opening at short distance above base of final chamber face, secondary openings which may be filled appear beneath posterior umbilical margin of chambers, rarely one or more of these remaining open after later chambers are added. *Oligo.*, N. Am.—FIG. 453,4. **D. dignata*, USA (Ala.); 4a-c, opposite sides and edge views, $\times 139$ (*2117).

[The secondary apertures on the umbilical side were not mentioned in the original description, nor was the in-

folding of the posterior chamber margins, although BANDY stated (*70, p. 99) that the sutures were "usually channeled with re-entrants." The holotype, paratypes, and metatypes have been examined by us and when examined at a sufficiently high magnification, all specimens show the features

described above. *Discorbitura* resembles *Discorbinella*, but differs in having an areal aperture, less distinct umbilical supplementary apertures, in being involute rather than partially evolute on the umbilical side, and in possessing umbilical nodes and branching sutural grooves.]

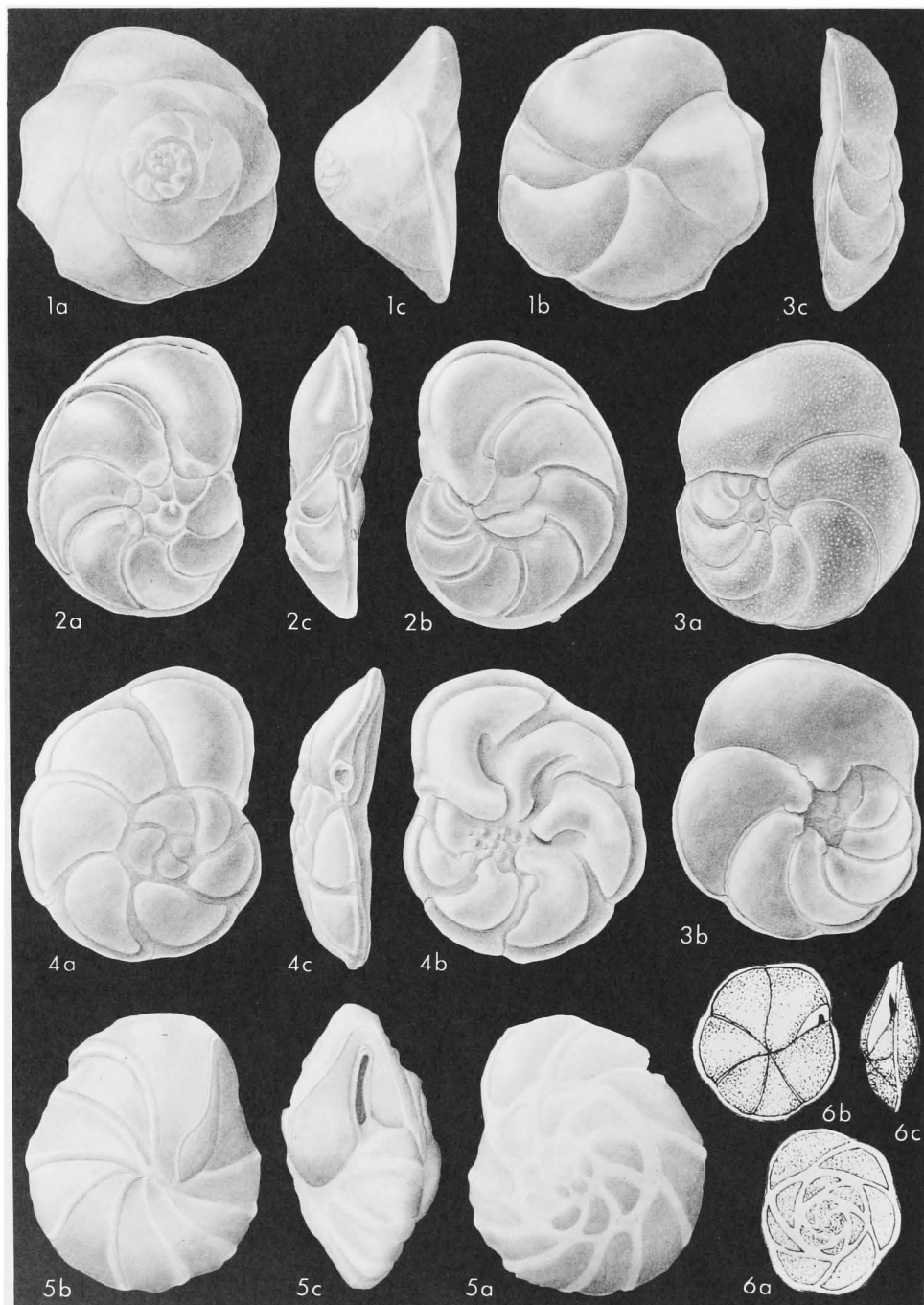


FIG. 453. Discorbidae (Discorbininae; 1, *Conorbina*; 2,3, *Discorbinella*; 4, *Discorbitura*; 5,6, *Epistominella*) (p. C575-C576, C578).

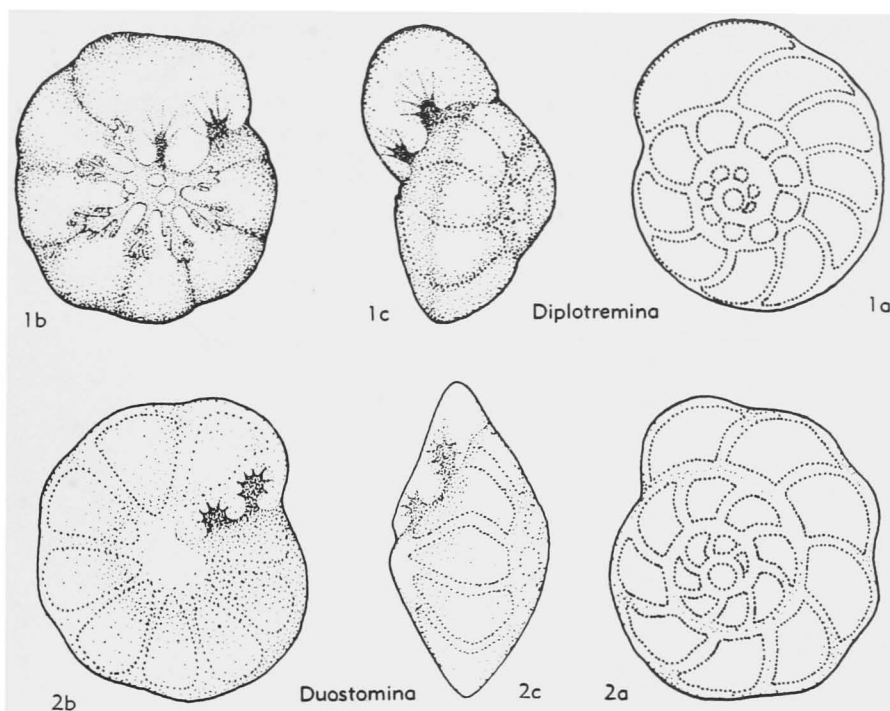


FIG. 454. Discorbidae (Discorbinae; 1, *Diplotremina*; 2, *Duostomina*) (p. C575, C577).

Duostomina KRISTAN-TOLLMANN, 1960, *1059, p. 68 [**D. biconvexa*; OD]. Test free, trochospiral, chambers enlarging gradually, wall calcareous, perforate, microstructure and lamellar character unknown; similar to *Diplotremina* but with closed umbilicus and both apertures and intervening flap at forward margin of final chamber, instead of one being umbilical in position. *M.Trias.*, Aus.—FIG. 454.2. **D. biconvexa*; 2a-c, opposite sides and edge view of holotype, $\times 125$ (*1059).

Earlmyersia RHUMBLER, 1938, *1576, p. 209 [*“*Pulvinulina punctulata* (D’ORBIGNY)”, HERON-ALLEN & EARLAND, 1913, *909, p. 134 (non *Rotalia punctulata* D’ORBIGNY, 1826) (= *Earlmyersia punctulata liliputana* RHUMBLER, 1938); OD]. Test trochospiral, plano-convex to concavo-convex, all whorls visible on spiral side and most of final 2 whorls visible on umbilical side, sutures thickened, strongly curved; wall calcareous, finely perforate, radial in structure, umbilical side with fine papillae; aperture obscure, an interiomarginal slit midway between periphery and umbilicus; growth or reproductive cysts may occur, during which agglutinated material temporarily covers protoplasm. *Rec.*, Ire.-Helgoland.—FIG. 455.1-3. **E. liliputana*, Helgoland (1), W.Ire. (Clare Is.) (2,3); 1a-c, opposite sides and edge view, $\times 200$ (*1576); 2,3, spiral and umbilical sides of different specimens, $\times 120$ (*909).

[The original definition of *Earlmyersia* stressed the flattened test, finely perforate wall, and the presence of pustulose ornamentation on the umbilical side. Both the descriptions by HERON-ALLEN & EARLAND and by RHUMBLER also mentioned specimens attached by the umbilical surface and surrounded by agglutinated material, comparable to the growth and reproductive cysts such as have been described for other Discorbinae. The type-species seems close to *Discorbinella* but as described, it differs in the apertural characters. *Discorbinella* has a primary peripheral interiomarginal aperture, a distinct umbilical chamber flap and a smaller opening behind this flap. A restudy of the type-species of *Earlmyersia* would show whether these features are also present therein, but meanwhile the genus is recognized tentatively as originally described. The type-species for *Earlmyersia* was originally designated by RHUMBLER (*1576, p. 209) as “*Pulvinulina punctulata* (d’Orb.) bei Heron-Allen und Earland in: Proc. roy. Irish Acad., V. 31, Pt. 64, 1913, p. 134, T 4, fig. 20, 21.” On the following page RHUMBLER (*1576, p. 210) described the specimens of HERON-ALLEN & EARLAND as “*Earlmyersia punctulata* (D’ORBIGNY) forma: *liliputana* nom. nov.1,” and the above reference, plate and figures again were cited. Taxa proposed as *forma* remain available if proposed before 1961 [ICZN Art. 17(9)], hence the type-species is “*P. punctulata* (D’ORBIGNY)” HERON-ALLEN & EARLAND, 1913 (non *Rotalia punctulata* D’ORBIGNY, 1826) = *Earlmyersia punctulata liliputana* RHUMBLER, 1938.]

Eoeponidella WICKENDEN, 1949, *2060, p. 81 [**E. linki*; OD (M)] [= *Heminwayina* BERMÚDEZ, 1951, *126, p. 325 (type, *Discorbis multisectus* GALLOWAY & HEMINWAY, 1941, *764, p. 384)]. Test free, plano-convex to nearly biconvex, umbilical side may be slightly depressed centrally, all chambers visible on convex spiral side, only final whorl visible on umbilical side where each chamber has supplementary chamber along its forward

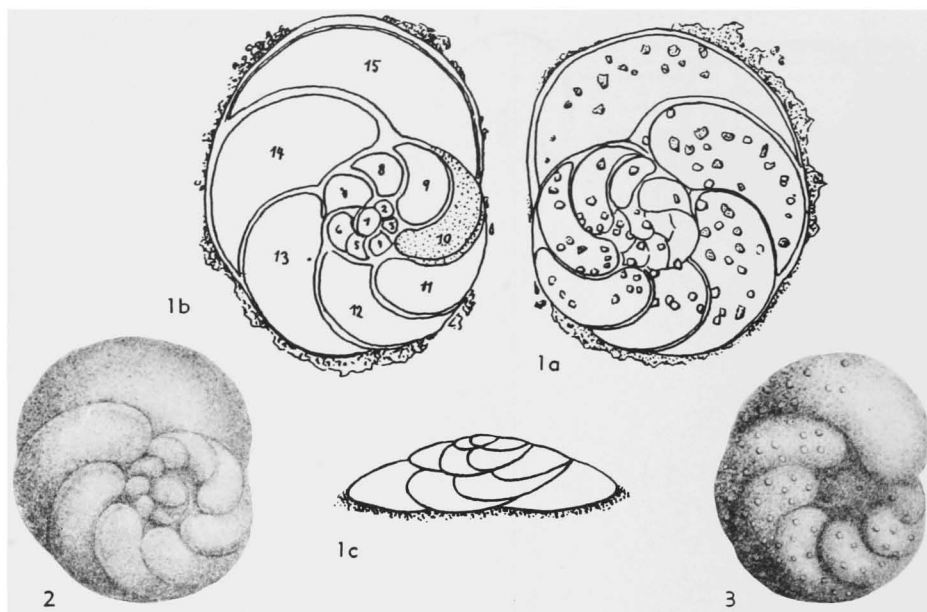


FIG. 455. Discorbidae (Discorbinae; 1-3, *Earlmyersia*) (p. C577).

margin near umbilical region, supplementary chambers apparently formed after main chamber; wall calcareous, rather coarsely perforate, microstructure not known; primary aperture a broad high interiomarginal umbilical arch, but in specimens possessing final supplementary chamber against final chamber, only smaller aperture remains near proximal chamber margin. [The large open-arched aperture leading into the umbilical area, coarsely perforate test, and simple radial chambers, place *Discorbis multisectus* GALLOWAY & HEMINWAY, the type-species of *Heminwayina*, in the genus *Eoeponidella*.] *U.Cret.-Oligo.*, N.Am.-Carib.

—FIG. 456,1. **E. linki*, *U.Cret.*, Can.(Sask.); 1a-c, opposite sides and edge view, $\times 242$ (*2117). —FIG. 456,2. *E. multisecta* (GALLOWAY & HEMINWAY), Mio., Puerto Rico; 2a-c, opposite sides and edge view of holotype, $\times 93$ (*764).

Epistominella HUSEZIMA & MARUHASI, 1944, *974, p. 397 [**E. pulchella*; OD] [= *Pulvinulinella* CUSHMAN, 1926, *426, p. 62 (type, *P. subperuviana*) (non *Pulvinulinella* EIMER & FICKERT, 1899); *Pseudoparrella* CUSHMAN & TEN DAM, 1948, *502, p. 49 (type, *Pulvinulinella subperuviana* CUSHMAN, 1926, *426, p. 63)]. Test trochospiral; all chambers visible on spiral side, only those of last whorl visible on umbilical side; sutures oblique on spiral side, nearly radial on umbilical side; wall calcareous, perforate, radial in structure and monolamellid; aperture an elongate vertical slit in face, near and parallel to peripheral keel. *U.Cret.-Rec.*, Japan-N. Am.-Pac. - Gulf Mex.-Eu. — FIG. 453,6. **E. pulchella*, Plio., Japan; 6a-c, opposite sides and edge views, $\times 70$ (*52b). — FIG. 453,

5. *E. subperuviana* (CUSHMAN), Mio., USA (Calif.); 5a-c, opposite sides and edge view of holotype, $\times 125$ (*2117).

Eurycheilostoma LOEBLICH & TAPPAN, 1957, *1172, p. 228 [**E. altispira*; OD]. Test free, trochospiral, high-spined, umbilical side excavated, earliest whorl with 4 to 6 chambers, which increase in breadth as added, so that in adults only 3 or 4 chambers occur in each whorl, final chamber occupying most of umbilical side, extending around both sides of open umbilicus, final whorl may abruptly attain greater diameter, resulting in flaring test; aperture a broad arch at inner margin of last chamber, opening into umbilicus, and partially covered by broad umbilical flap which may have serrate margin. [*Eurycheilostoma* differs from *Neonorbina* in being high-spined, rather than low, scalelike, and in having a rounded periphery. The apertural characters are similar, the broad umbilical flap with apertural re-entrants at the extremities occurring in both genera.] *L.Cret.*, N.Am. — FIG. 456,3. **E. altispira*, Alb., USA (Tex.); 3a-c, opposite sides and edge view of holotype, $\times 192$ (*1172).

Gavelinopsis HOFKER, 1951, *928c, p. 485 [**Discorbina praegeri* HERON-ALLEN & EARLAND, 1913, *909, p. 122; OD] [= *Gavelinopsis* HOFKER, 1951, *936, p. 359 (nom. nud.)]. Test free, planoconvex or biconvex, periphery keeled, all chambers visible on convex spiral side, only those of final whorl visible from flat to slightly convex umbilical side, which has prominent umbilical plug; sutures curving backward at periphery on spiral side, nearly radial on umbilical side; wall

calcareous, hyaline, finely perforate; aperture a low interiomarginal slit at short distance from periphery on umbilical side, with slight lip above.

Rec., Atl.-Pac.—FIG. 456,4. **G. praegeri* (HERON-ALLEN & EARLAND), Ire.; 4a-c, opposite sides and edge view, $\times 111$ (*2117).

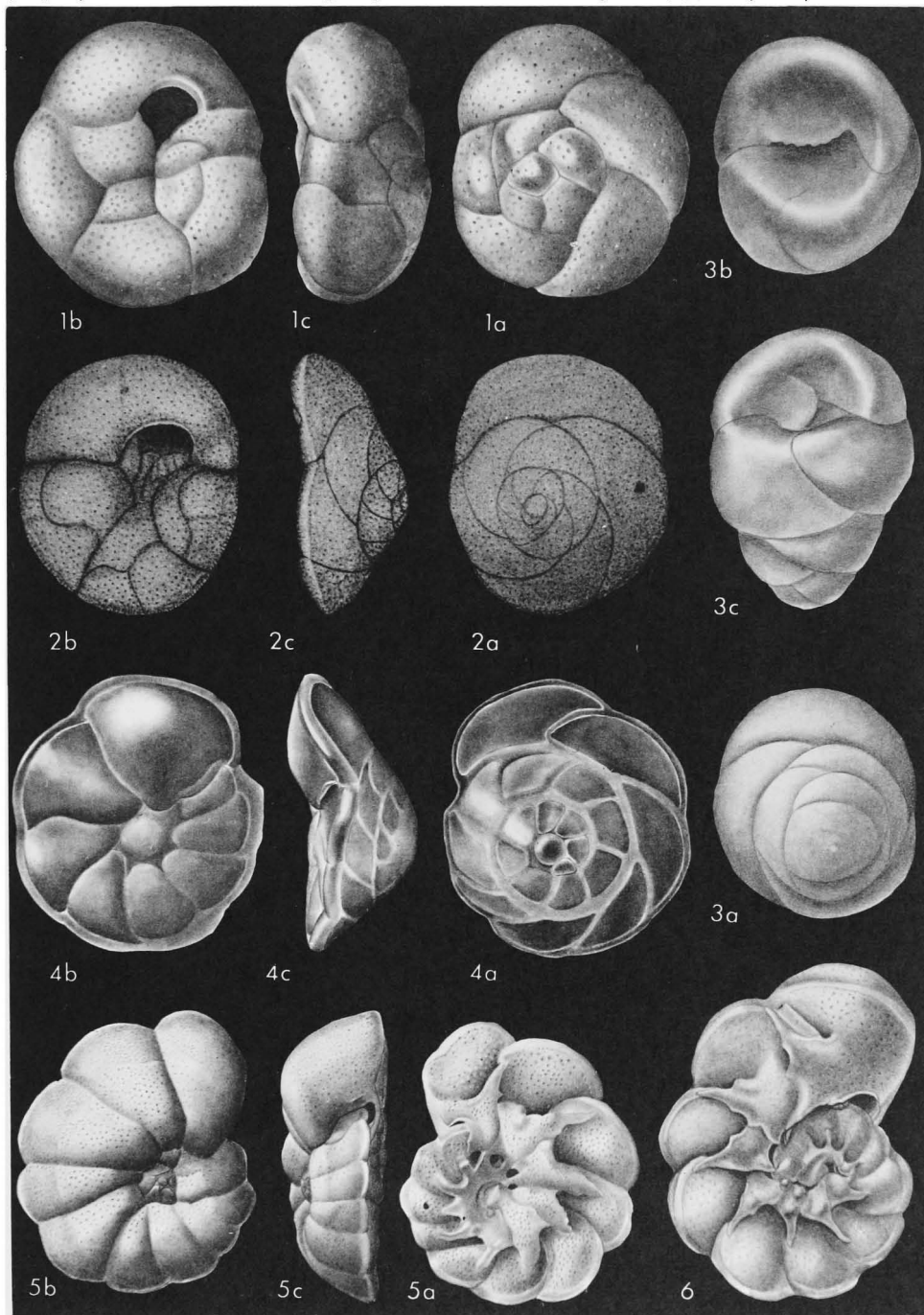


FIG. 456. Discorbidae (Discorbinae; 1,2, *Eoeponidella*; 3, *Eurycheilostoma*; 4, *Gavelinopsis*; 5,6, *Lamello-discorbis*) (p. C577-C580).

[*Gavelinopsis* differs from *Conorbina* in having a distinct umbilical plug and in having a more ovate aperture bordered by a distinct lip. It differs from *Discorbis* in having an umbilical plug, instead of an umbilicus covered only by the highly developed umbilical chamber flaps of *Discorbis*. HOFKER (*936, p. 359) introduced this generic name citing *Gavelinopsis atlantica* HOFKER as type, but no description was given and the species was a *nomen nudum*. Later (*928c, p. 485) the genus was described and *Gavelinopsis praegeri* (HERON-ALLEN & EARLAND) (= *Discorbina praegeri* HERON-ALLEN & EARLAND, 1913) was cited as type. In this paper HOFKER again referred to the undescribed *Gavelinopsis atlantica* as occurring in the West Indies. BERMÚDEZ (1952, *127, p. 150) considered that HOFKER referred to the same species by both names, but *G. atlantica* was described by HOFKER (1956, *946, p. 212) as a new species from off Frederiksted, Santa Cruz. It is probably not congeneric, having prominent umbilical flaps and should be placed in *Rosalina*. Neither genus is considered by us to be related to the gavelinellids or anomalinids.]

Helenina SAUNDERS, 1961, *1634, p. 148 [*Pseudoeponides anderseni* WARREN, 1957, *2039, p. 39; OD] [= *Helenia* SAUNDERS, 1957, *1632, p. 374 (obj.) (non WALCOTT, 1889)]. Test free, trochospiral, biconvex, periphery rounded; chambers numerous, all visible from spiral side, only those of final whorl visible on umbilical side, final chamber with umbilical flap; sutures depressed, radial on umbilical side, curved to sinuate on spiral side with sutural slits on both spiral and umbilical sides, opening into chambers; wall calcareous, finely perforate; aperture an interiomarginal slit, extending from umbilicus across peripheral margin onto spiral side where it follows suture line 0.5 to 0.7 of distance to periphery, additional sutural slit occurring on umbilical side, extending from umbilical flap of chamber toward periphery. *Rec.*, N.Am.-W.Indies (Trinidad).—FIG. 457, I. **H. anderseni* (WARREN), Trinidad; 1a-c, opposite sides and edge views, $\times 118$ (*1632).

[Differs from *Pseudoeponides* in having the supplementary slits sutural in position, whereas those of *Pseudoeponides* are nearly perpendicular to the sutures on the umbilical side and those of the spiral side are areal in position in the chamber walls. *Epistomaria* resembles *Helenina* in possessing sutural slits on both spiral and umbilical sides but differs in having supplementary chamberlets on the umbilical side, which also are bordered with slits, and an areal aperture in the face of the final chamber in addition to the interiomarginal aperture.]

Lamellogorbis BERMÚDEZ, 1952, *127, p. 39 [*Discorbina dimidiata* JONES & PARKER in CARPENTER, PARKER & JONES, 1862, *281, p. 201; OD]. Test free, plano-convex, periphery sharply angled and keeled, with inflated chambers around umbonal boss on spiral side, umbilical surface flattened, somewhat evolute, with alar projections on inner part of proximal margins of chambers, with opening on their umbilical side and leaving opening both in front of and behind flaps just before they attach to test at their outer ends, flaps usually coalescing at their inner margins so as to form continuous ring or spiral around open umbilicus; sutures depressed on both sides, somewhat limbate on umbilical side; wall calcareous, coarsely perforate, spiral side commonly with secondary coating that covers inner two-thirds of chambers and partially fills pores; aperture an arch at periphery, extending short distance past keel on spiral side and about one-third of distance to

umbilicus on opposite side, although it may merge with opening under chamber flaps so that a definite umbilical extent cannot be delineated, aperture bordered above by narrow lip. *Rec.*, Australia.—FIG. 456, 5, 6. **L. dimidiata* (JONES & PARKER); 5a-c, opposite sides and edge view of paratype; 6, umbilical side of larger paratype showing well-developed alar projections and apertures, $\times 26$ (*2117).

[Differs from *Discorbis* in its evolute umbilical side and relatively involute spiral side, in having a distinct open umbilicus, umbonal plug on the spiral side, and in extension of the aperture somewhat onto the spiral side. The type-species superficially resembles *Discorbis vesicularis* LAMARCK and, in fact, the description on the plate legend of PARKER & JONES (1865, *1418, p. 422) stated that it was "merely *D. vesicularis* modified by being sharp-edged, and flat, and even scooped on the under face (opposite to that which is flat in *Truncatulina*). All whorls are visible spirally in *D. vesicularis* and only the final whorl visible on the umbilical side, the opposite being true in *Lamellogorbis dimidiata*. The chamber flaps are also better developed and are perforate to a greater extent in the present species. The illustrations given by BERMÚDEZ (1952, *127, pl. 4, figs. 4a-c) are not of this species, or genus, but as noted by HORNIBROOK & VELLA (1954, *960, p. 27) are a copy of the figures of "*Discorbina vesicularis* (Lamarck)" given by BRADY (1884, *200, pl. 87, figs. 2a-c), whose figures show the convex evolute dorsal side and involute, somewhat flattened ventral side, typical of *Discorbis*, although it is not *D. vesicularis* LAMARCK. [In 1953, we studied the types of JONES & PARKER in the British Museum (Natural History). As no holotype had been selected for *D. dimidiata*, one of the original specimens is here designated as lectotype (BMNH-ZF 3651), the remainder of the syntypes becoming paratypes (BMNH-ZF 3650). All are from Recent sponge sands near Melbourne, Australia. The generic description and comparisons here given are based upon these original specimens of JONES & PARKER.]

Laticarinina GALLOWAY & WISSLER, 1927, *767, p. 193 [*pro Carinina* GALLOWAY & WISSLER, 1927, *766, p. 51 (non HUBRECHT, 1887)] [*Pulvinulina repanda* var. *menardii* subvar. *pauperata* PARKER & JONES, 1865, *1418, p. 395; OD] [= *Parvicarinina* FINLAY, 1940, *717d, p. 467 (type, *Truncatulina tenuimargo* var. *alto-camerata* HERON-ALLEN & EARLAND, 1922, *911, p. 209)]. Test free, planispiral, broad peripheral keel may show growth lines; chambers saddle-shaped, anterior margin of keel forming separation between 2 lobes of next-developed chamber, lobes larger on one side and closely appressed, final chambers may be irregular in outline and rarely small, irregularly placed, supplementary chambers may appear on side where lobes are larger, lobes small and less closely appressed on opposite side, interconnected by small tubular necks, final chamber commonly with broad attachment flange somewhat loosely attached at posterior umbilical margin, leaving opening beneath which connects to chamber interior, wide scarlike whitish area may occur around final 2 or 3 chambers on side with larger lobes; wall calcareous, finely perforate, keel apparently imperforate, although small irregularly spaced lines, "bubbles," and tubules may appear, possibly due to parasitic organisms; peripheral aperture at one side of keel, low slit perpendicular to periphery may be slightly produced in large specimens, this peripheral aperture being absent in some specimens and entire forward margin tightly

closed, with supplementary openings beneath posterior umbilical margin of smaller lobes of later chambers suggesting apertures beneath umbilical chamber flaps. *Paleoc.-Rec.*, Atl.-Pac.-Carib.-N.Z.

Afr.-Eu.—FIG. 457,2,3. **L. pauperata* (PARKER & JONES), *Rec.*, Carib.; 2, apert. or umbilical side; 3a,b, opposite sides of another specimen, $\times 19$ (*2117).—FIG. 457,4. *L. altocamerata* (HERON-

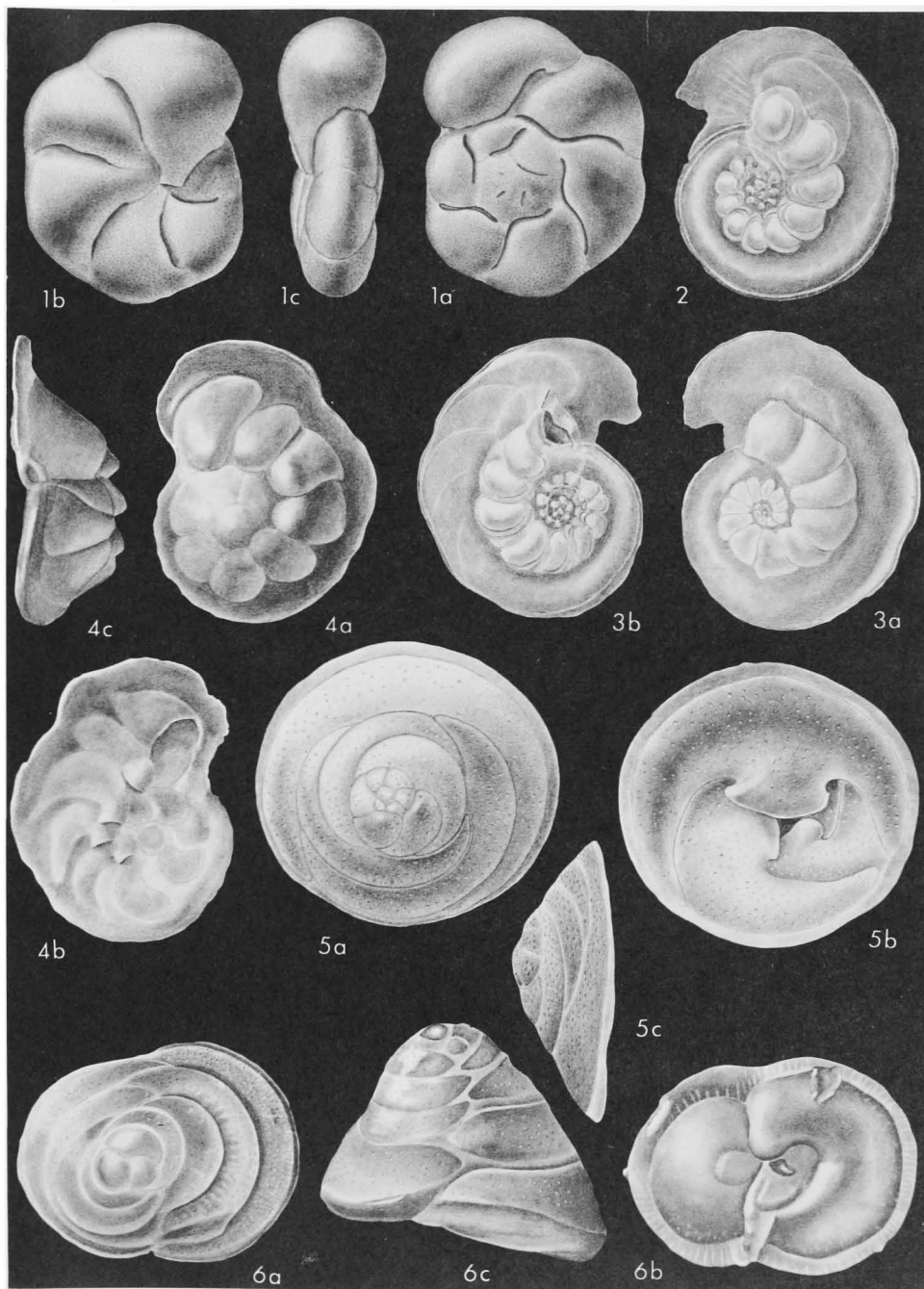


FIG. 457. Discorbidae (Discorbinae; 1, *Helenina*; 2-4, *Laticarinina*; 5, *Neoconorbina*; 6, *Patellinella*) (p. C580-C582).

ALLEN & EARLAND), L.Mio., N.Z.; 4a-c, opposite sides and edge view, showing peripheral and umbilical apertural openings, $\times 73$ (*2117).

[BERMÚDEZ (1952, *127, p. 40) cited the type-species of *Parvicarinina* as *P. alato-camerata* (HERON-ALLEN & EARLAND, = *Truncatulina tenuimargo* var. *alato-camerata* HERON-ALLEN & EARLAND). This species was described as *alto-camerata* and was so designated by FINLAY. The umbilical openings described above are found in the type-species of both *Laticarinina* and *Parvicarinina*, although not previously reported for *Laticarinina*. We have examined the original types of PARKER & JONES in the British Museum (Natural History) and isolated a lectotype that is here designated (BMNH-ZF 3574 ex 94.4.3.319) for *Pulvinulina repanda* var. *menardii* subvar. *pauperata* PARKER & JONES. FINLAY (1940, *717d, p. 467) had regarded *Laticarinina* as having only the peripheral aperture and *Parvicarinina* as having only the umbilical openings. However, the type-species of *Laticarinina* has both types of apertures well developed. Furthermore, the type-species of *Parvicarinina* also has the forward peripheral aperture; hence, *Parvicarinina* is regarded as a junior synonym. — [CUSHMAN & TODD (1941, *527, p. 105) regarded *Laticarinina* as closely related to *Cibicides*, stating that "the aperture in the adult is on the dorsal side on the inner margin of the last-formed chamber, low and elongate, similar to that in many species of *Cibicides*." The genus was placed in the Anomaliniidae by CUSHMAN (1948, *486, p. 334). The aperture is unlike that of *Cibicides*, however, and the test is not coarsely perforate, nor perforate granular in structure, as in the Anomaliniidae. GALLOWAY placed the genus in the Nonionidae, stating (1933, *762, p. 264), "*Laticarinina* evolved from *Nonion* by developing a peripheral flange. Free specimens are planispiral and symmetrical, but attached specimens are distorted and on that account bear some slight resemblance to the Rotaliidae." However, none of the Nonionidae show umbilical flaps with supplementary openings, and the Nonionidae have a perforate granular wall structure, whereas that of *Laticarinina* is perforate radial. — [BERMÚDEZ (1952, *127, p. 18) placed *Parvicarinina* in the subfamily Discorbininae [= Discorbininae], family Rotaliidae, and placed *Laticarinina* in the subfamily Planulininae (*127, p. 21), family Anomaliniidae. *Planulina* has radial perforate walls, as does *Laticarinina*, but the apertural characters are quite distinct. As *Parvicarinina* is a synonym of *Laticarinina*, "both" must be placed in the same family.]

Neoconorbina HOFKER, 1951, *936, p. 357 [*Rosalina orbicularis* TERQUEM, 1876, *1888, p. 75 (non *Rosalina orbicularis* D'ORBIGNY, 1850) (= *Discorbinina terquemi* RZEHAKE, 1888, *1602, p. 228); OD]. Test free, trochospiral, conical, concavo-convex, periphery acutely angled and carinate; early chambers subglobular, increasing very rapidly in breadth on spiral side and very little in height as added, so that final chamber occupies much of periphery and is much broader than high, chambers on umbilical side with distinct flap at mid-line and apertural re-entrant on either side; wall calcareous, of calcite, by X-ray powder diffraction film; aperture in forward re-entrant of chamber on umbilical side, covered by succeeding chambers to remain as intercameral opening, supplementary aperture occurring in other re-entrant of final chamber, those of earlier chambers of final whorl remaining open. *Rec.*, Atl.O.-Pac.O. — FIG. 457, 5. **N. terquemi* (RZEHAKE), Atl.; 5a-c, opposite sides and edge view, $\times 111$ (*2117).

[HOFKER described *Neoconorbina* with *N. orbicularis* (TERQUEM) (= *Rosalina orbicularis* TERQUEM, 1876) designated as type-species (*936, p. 357). The Siboga monograph (*928c) was mentioned (*936, p. 360) as being in press. *Neoconorbina* was described in detail in the Siboga paper (1951, *928c, p. 433) but in it HOFKER stated, "The type of the species [sic] is *Neoconorbina pacifica* HOFKER." Undoubtedly THALMANN (1952, *1897, p. 977) considered the Siboga paper as the original reference for the genus and therefore erroneously listed *Neoconorbina pacifica* HOFKER as the type-species. The genus was defined and the type-

species fixed by original designation and monotypy, however, in the earlier paper cited above. BERMÚDEZ (1952, *127, p. 34) regarded *Neoconorbina* as a synonym of *Rosalina* D'ORBIGNY. However, *Rosalina* differs from *Neoconorbina* in the presence of sutural slits, which are the remnants of earlier apertures. *Neoconorbina* also has a conical form, lunate chambers, and an overlapping final chamber on the umbilical side. It differs from *Conorboides* in having 2 distinct apertures, one at each side of the umbilical flap.]

Patellinella CUSHMAN, 1928, *436, p. 5 [**Textularia inconspicua* BRADY, 1884, *200, p. 357; OD]. Test free, conical, trochoid, plano-convex, earliest whorl may have more than 2 chambers, test later biserial, all whorls visible dorsally, only final pair visible ventrally; wall calcareous, finely perforate, radial in structure; aperture ventral, broad arch opening into umbilicus, not covered by next following chamber. *Rec.*, S.Pac.O. (Tasm.). — FIG. 457, 6. **P. inconspicua* (BRADY); 6a-c, opposite sides and edge view, $\times 183$ (*2117).

[Differs from *Patellinoides* in having more than 2 chambers in the early whorl, not a simple spiraling tube, and in having a less complex apertural region. WOOD (1949, *2073, p. 250) noted that the type of *Patellinella inconspicua* shows a perforate radial wall structure, whereas *Spirillina*, *Patellina*, and *Patellinoides* all have a test composed of a single crystal of calcite. This has been verified by us. Furthermore, the absence of an early undivided spire in the present genus, such as is found in the *Patellininae*, substantiates their separation shown by COLLINS (1958, *375, p. 400), who placed *Patellinella* in the "Discorbininae." HOFKER (1951, *936, p. 358) described *Discobolovina* as including the earlier genera "*Patellina*, *Patellinoides*, etc.," citing *Discobolovina corrugata* (WILLIAMSON) (= *Patellina corrugata* WILLIAMSON) as type-species. In the Siboga monograph (1951, *928c, p. 422) HOFKER also included *Patellinella* in *Discobolovina*, giving the generic description as an original description in this publication without citing a type-species. — [THALMANN (1952, *1897, p. 973) stated that HOFKER had not designated a type-species for *Discobolovina*, hence he selected *Patellinoides conica* HERON-ALLEN & EARLAND. As HOFKER's designation of *Patellina corrugata* WILLIAMSON as type was earlier, the designation by THALMANN was invalid and *Discobolovina* is a junior objective (isogenotypic) synonym of *Patellina*. HOFKER's discussion and figures of "*Discobolovina inconspicua* (Brady)" are of the species BRADY described as *Textularia jugosa*, and specimens belonging to BRADY's species *inconspicua* are included by HOFKER under *Discobolovina conica*. As BRADY well described and figured the 2 species, it is impossible to alter the names applied to them. — [The species *Textularia jugosa* does not belong to *Patellinella*; hence HOFKER's discussion of this form, although under the name *inconspicua*, has no bearing on the present genus. *Textularia jugosa* shows an open umbilical region into which open the apertures of final pair of chambers, and in *Patellinella* the apertures of the two final chambers are distinctly separated. Typical *Patellinella* is not characterized by a strongly ornamented test, as in *T. jugosa* BRADY.]

Pijpersia THALMANN, 1954, *1904, p. 153 [*pro Ruttenia* PIJPER, 1933, *1457, p. 30 (non RODHAIN, 1924)] [**Bonairea coroneaformis* PIJPER, 1933, *1456, p. 72; OD] [= *Bonairea* PIJPER, 1933, *1456, p. 72 (obj.) (non BURRINGTON BAKER, 1924); *Pseudoruttenia* Y. LE CALVEZ, 1959, *1115, p. 92 (type, *P. diadematoidea*)]. Test free, trochospiral, spiral side ornamented by tubercles and keels, umbilical side flat to concave and may show radial grooves; chambers inflated to angular, strongly overlapping on umbilical side; wall microstructure unknown; aperture umbilical, with broad umbilical flap. [Similar to *Glabratella* in the commonly ornamented spiral side and radially ornamented umbilical side, but differs in having a prominent umbilical flap, similar to *Conorboides*.] *Eoc.*, W.Indies (Bonaire-Trinidad)-

C.Am.(Panama)-Eu.—FIG. 458,1. **P. coronaeformis* (PIJPERS), Eoc.,Bonaire; 1a-c, opposite sides and back edge (not apert.) view of topotype, $\times 163$ (*2117).—FIG. 458,2. *P. diadema-*

toides (Y. LE CALVEZ), Cuis., Fr.; 2a-c, opposite sides and edge view of holotype, $\times 90$ (*1115). *Planodiscorbis* BERMÚDEZ, 1952, *127, p. 40 [**Discorbina rarens* BRADY, 1884, *200, p. 651, OD].

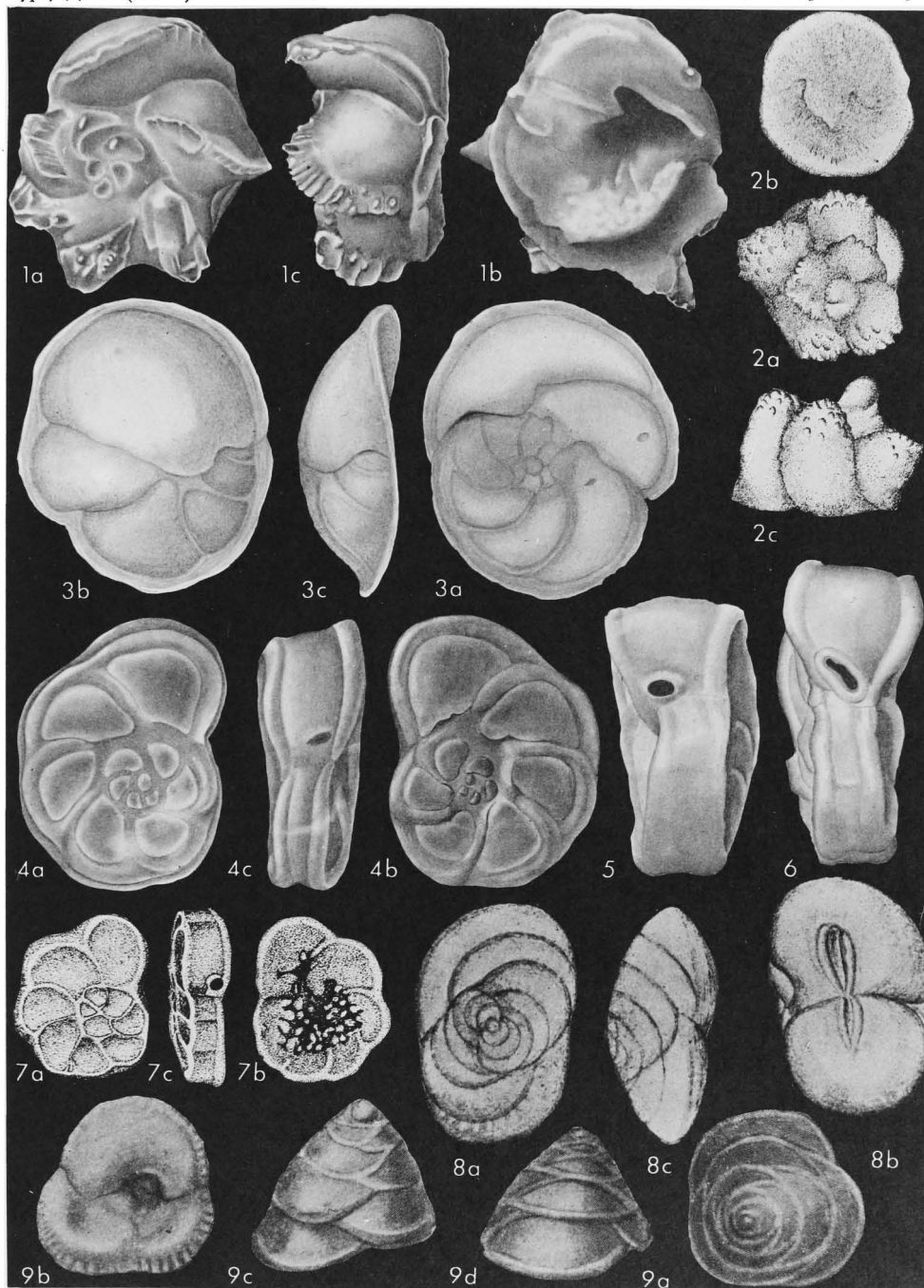


FIG. 458. Discorbidae (Discorbinæ; 1,2, *Pijpersia*; 3, *Planodiscorbis*; 4-7, *Planulinoides*; 8, *Pseudopatellina*; 9, *Pseudopatellinoides*) (p. C582-C584).

Test free or possibly attached during life, plano-convex or concavo-convex, with spiral side flattened or concave and all chambers visible, umbilical side convex with only chambers of final whorl visible around closed umbilicus, periphery angled with broad keel, chambers increasing rapidly in size, final chamber occupying much of umbilical side; aperture a small arch in slight re-entrant at basal margin of final chamber on flattened spiral side, about halfway between periphery and umbilical region. *Rec.*, Pac.O.—FIG. 458,3. **P. rarescens* (BRADY); 3*a-c*, opposite sides and edge view of lectotype, $\times 79$ (*2117).

[*Planodiscorbis* is very similar in character to *Discorbinella*, but is completely involute on the umbilical side, rather than partially evolute on both sides. It differs from *Discorbis* in having the spiral side flattened, possessing the aperture, with the umbilical side convex and involute. In *Discorbis* the umbilical side is flat and involute and contains the aperture, and the spiral side is evolute. *Planodiscorbis* also lacks the characteristic umbilical alar extensions of the chambers found in *Discorbis*.—[BRADY's types of *Discorbinella rarescens* in the British Museum (Natural History) were examined by us and we here designate as lectotype the specimen figured by BRADY (1884, *200, pl. 90, fig. 2) (BMNH-ZF3648, from *Challenger* station 185, off Raine Island, Torres Straits, at a depth of 155 fathoms). The remaining original syntypes are now designated as paratypes (BMNH-ZF1414).]

Planulinoides PARR, 1941, *1424, p. 305 [*Discorbinella biconcava* JONES & PARKER in CARPENTER, PARKER & JONES, 1862, *281, p. 201; OD] [= *Discotruncana* SHIRAI, 1960, *1734, p. 539 (type, *D. japonica*)]. Test free, biconcave, nearly planispiral, evolute, with broad truncate double-keeled periphery, evolute on spiral side, partially evolute on opposite side; primary areal aperture peripheral and somewhat oblique toward umbilical side and surrounded by lip, supplementary apertures on umbilical side at inner margin of chambers, under rudimentary umbilical flap. *Plio-Rec.*, Australia-Japan.—FIG. 458,4-6. **P. biconcava* (JONES & PARKER), *Rec.*, Victoria; 4*a-c*, opposite sides and edge view; 5,6, edge views of additional specimens showing variation in peripheral aperture, $\times 115$ (*2117).—FIG. 458,7. *P. japonica* (SHIRAI), *Plio.*, Japan; 7*a-c*, opposite sides and edge view, $\times 47$ (*1734).

[PARR originally stated that "the aperture is peripheral instead of being situated on the under surface, as in *Discorbis*." Apparently the openings on the umbilical side were not observed, although they are shown in the figures of PARKER & JONES (1865, *1418, pl. 19, fig. 10b) and BRADY (1884, *200, pl. 91, fig. 2b). *Planulinoides* was considered to be a synonym of *Discorbinella* CUSHMAN & MARTIN by CUSHMAN (1948, *486, p. 288) but it differs in being biconcave, bicarinate, and in having a truncate periphery, whereas *Discorbinella* is plano-convex, with a single keel, and more prominent umbilical flaps. *Planulinoides* differs from *Bronnimannia* BERMÚDEZ in having a peripheral aperture and a double keel. A lectotype for *Discorbinella biconcava* JONES & PARKER was isolated by us in 1953 and is here designated (BMNH-ZF3646, with paratype ZF3645), both from Recent shore sand, Melbourne, Australia.]

Pseudopatellinella TAKAYANAGI, 1960, *1863, p. 121 [**P. cretacea*; OD]. Test free, trochospiral, spiral side convex and evolute, umbilical side flattened; early chambers subglobular, rapidly increasing in breadth and becoming crescentic in spiral view, with only 2 chambers to whorl; wall

calcareous, perforate, microstructure and lamellar character unknown, inner surface of wall undulating, but without septula; aperture a narrow slit on umbilical side, extending up center of chamber face. [Although superficially resembling *Patellina*, this genus does not have the nonseptate coiled stage such as is characteristic of the Spirillinidae.] *U.Cret.*, Japan.—FIG. 458,8. **P. cretacea*; 8*a-c*, opposite sides and edge view of holotype, $\times 140$ (*1863).

Pseudopatellinoides KRASHENINNIKOV, 1958, *1051, p. 241 [**P. primus*; OD]. Test free, small, conical, trochospirally coiled with highly convex spiral side and flattened, centrally umbilicate opposite side, periphery angled and carinate; chambers few, commonly 3 to whorl, broad, low, semilunate, and all visible on spiral side, only 3 of last whorl visible on umbilical side where each occupies approximately one-third of test; sutures strongly oblique, thickened and flush on spiral side, radial, curved and depressed on umbilical side; wall calcareous, hyaline, finely perforate, radial in structure; aperture an interior-marginal, umbilical slit or slight arch, which does not extend to periphery. [*Pseudopatellinoides* differs from *Patellinella* in having 3 chambers to whorl throughout development.] *Mio.* (U.Torton.), USSR.—FIG. 458,9. **P. primus*; 9*a-d*, spiral, umbilical, and edge views, $\times 100$ (*1051).

Rosalina D'ORBIGNY, 1826, *1391, p. 271 [**R. globularis*; SD GALLOWAY & WISSLER, 1927, *766, p. 62] [= *Turbinolina* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 89 (type, *Rosalina globularis* D'ORBIGNY, 1826, *1391, p. 271; SD LOEBLICH & TAPPAN, herein); *Semirosalina* HORNIBROOK, 1961, *959, p. 103 (type, *S. inflata*)]. Test plano-convex, free or attached by flattened umbilical surface, all chambers visible from convex spiral side, only those of final whorl visible around open umbilicus on umbilical side; aperture a low interior-marginal arch at base of final chamber near periphery on umbilical side, with broad chamber flap just beneath aperture extending into open umbilicus, secondary sutural opening at opposite side of flap, those of previous chambers also remaining open. *Rec.*, Atl.O.-Pac.O.-Antarctic.—FIG. 459,1. **R. globularis*, Antarctic (Ross Sea); 1*a-c*, opposite sides and edge view, $\times 74$ (*2117).—FIG. 460,1. *R. inflata* (HORNIBROOK), L.Mio., N.Z.; 1*a-c*, opposite sides and edge view of holotype, $\times 100$ (*959).

[CUSHMAN (1948, *486, p. 286) & GALLOWAY (1933, *762, p. 286) considered *Rosalina* a synonym of *Discorbis*. BERMÚDEZ (1952, *127, p. 34) considered it a valid genus but placed *Neoconorbina* HORKER in the synonymy of *Rosalina*. All 3 are here considered to be distinct, *Rosalina* being intermediate, but lacking the pronounced ventral chamber flaps and closed umbilicus of *Discorbis* and differing from *Neoconorbina* in the presence of sutural slits which are remnants of earlier apertures. It differs from *Conorbina* in having an open umbilicus and a more extensive aperture nearer the umbilicus, with the proximal portions of earlier apertures remaining as sutural secondary openings. No definite locality was given in the original reference, the species being merely noted to occur on all ocean coasts. The specimen here figured was compared by us with

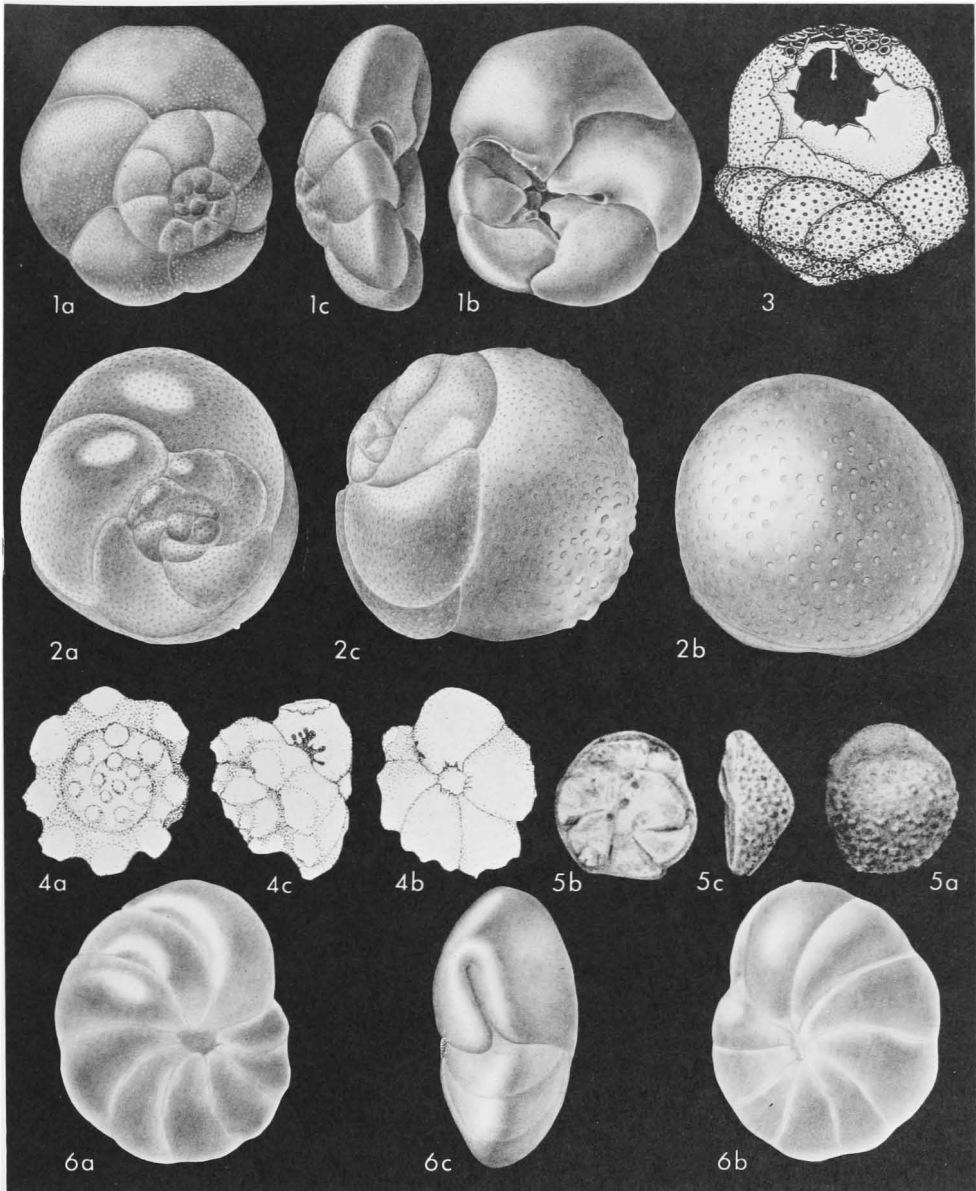


FIG. 459. Discorbidae (Discorbinae; 1, *Rosalina*; 2, 3, *Tretomphalus*; 4, *Variostoma*; 5, *Vernonina*; 6, *Stetsonia*) (p. C584-C586).

D'ORBIGNY's type-specimen in the Muséum National d'Histoire Naturelle, Paris, France.]

Stetsonia F. L. PARKER, 1954, *1414, p. 534 [**S. minuta*; OD]. Test small, lenticular, slightly trochospiral but involute on both sides, periphery narrowly rounded, chambers increasing gradually in size, low and broad; sutures radial, curved, slightly depressed; wall thin, calcareous, finely perforate, radial in structure, lamellar character not described; aperture an elongate slit ex-

tending from base of final chamber in equatorial position up face in slightly diagonal line on umbilical side, with narrow lip. *Rec.*, Gulf Mex. —FIG. 459,6. **S. minuta*; 6a-c, opposite sides and edge view, $\times 325$ (*2117).

Tretomphalus MÖBIUS, 1880, *1293, p. 67, 99 [**Rosalina bulloides* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 98; OD (M)]. Test with early benthonic stage similar to *Discorbis*, reproductive cycle with alternation of generations, asexually

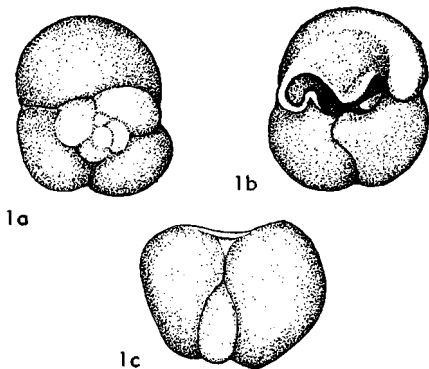


FIG. 460. Discorbidae (Discorbiniae; 1, *Rosalina*) (p. C584).

produced megalospheric individuals becoming encysted before development of gametes, developing large globular float chamber over umbilical region, small entosolenian tube extending inward from distal surface of float, through which ectoplasm may protrude, large gas bubble then developing within float chamber, added buoyancy allowing test to float to surface after breaking free from growth cyst, commonly 2 or more pelagic parent individuals then approaching closely by means of extended pseudopodia so as to insure fusion of maximum number of gametes, equally biflagellate gametes escaping through areal pores, those from different parent individuals fusing in pairs to form benthonic microspheric tests which in turn give rise asexually to megalospheric generation; test calcareous, with pseudo-chitinous inner membrane, wall microstructure unknown (if monolamellid, as in *Discorbis*, it is the only pelagic one); aperture umbilical, as in *Discorbis* in benthonic stage, and consisting of areal pores on pelagic float chamber. *Rec.*, Australia-Medit.-Gulf Mex.-tropical and sub-tropical Atl.O.-Pac.O.-Ind.O.-Medit. Sea-Red Sea. —FIG. 459,2; 461,1. **T. bulloides* (D'ORBIGNY), *Rec.*, USA (Fla.), (459,2), *Rec.*, USA (Calif.) (461,1); 459,2a-c, opposite sides and edge view of hypotype, $\times 135$ (*2117); 461,1a, sectioned decalcified specimen showing large central gas bubble, internal tube of float chamber, and gametes *in situ*, $\times 300$; 461,1b, biflagellate gametes below and left, fused gametes at right and zygote in center, $\times 2,000$ (*1341). —FIG. 459,3. *T. myersi* CUSHMAN, *Rec.*, USA (Calif.); side view of dissected specimen showing perforated float chamber exposing internal float with entosolenian tube, $\times 170$ (*1341).

Variostoma KRISTAN-TOLLMANN, 1960, *1059, p. 55 [**V. spinosum*; OD]. Test free, trochospiral, may be high-spined; all chambers visible on spiral side, opposite side involute, deeply umbilicate, with lobulate umbilical margin; wall calcareous-perforate, granular in structure, lamellar

character unknown; aperture interiomarginal, extraumbilical, with lobulate margin. *M.Trias.*, Eu. (Aus.). —FIG. 459,4. **V. spinosum*; 4a-c, opposite sides and edge view of paratype, $\times 25$ (*1059).

Vernonina PURI, 1957, *1488, p. 124 [**V. tuberculata*; OD]. Test trochospiral, hemispherical, with convex spiral side, covered with numerous rounded granules, flattened umbilical side with central plug or granules; sutures oblique but obscured by surface ornamentation on spiral side, radial and depressed on umbilical side; wall calcareous, perforate, microstructure and lamellar character not described; aperture interiomarginal, on umbilical side about half distance between umbilicus and periphery. *U.Eoc.*, USA (Fla.). —FIG. 459,5. **V. tuberculata*; 5a-c, opposite sides and edge view of paratype, $\times 40$ (*1488).

Subfamily BAGGININAE Cushman, 1927

[Baggininae CUSHMAN, 1927, p. 77] —[Dagger (†) indicates *paritum*] —[=Praerotalininae† HOFKER, 1933, p. 125 (*nom. nud.*); =Cancrisinae CHAPMAN, PARR & COLLINS, 1934, p. 567; =Valvulinierinae BROTZEN, 1942, p. 17; =Cancrisinae SIGAL in PIVETEAU, 1952, p. 228 (*nom. van.*)]

Test free, trochospiral, umbilical area closed, with clear thin imperforate area adjacent to umbilicus; aperture basal. *L. Cret.-Rec.*

Baggina CUSHMAN, 1926, *426, p. 63 [**B. californica*; OD]. Test free, subglobular, trochospiral, chambers few, rapidly enlarging and somewhat overlapping on spiral side, with closed umbilicus on opposite side; wall calcareous, perforate, radial in structure; aperture a broad umbilical opening below clear, nonperforate lunate area in face of final chamber. [*Baggina* differs from *Cancris* in having an open aperture without a lip, and in being somewhat involute on the spiral side.] *Cret.-Rec.*, cosmop. —FIG. 462,1. **B. californica*, Mio., USA (Calif.); 1a-c, opposite sides and edge view of paratype, $\times 56$ (*2117).

Cancris DE MONTFORT, 1808, *1305, p. 267 [**C. auriculatus* (=Nautilus auricularis FICHTEL & MOLL, 1798, *716, p. 108); OD] [=Cancris DE SHAYES, 1830, *590, p. 191 (*nom. null.*); *Pulvinulinella* EIMER & FICKERT, 1899, *692, p. 628 (obj.) (non CUSHMAN, 1926)]. Test free, trochospiral, bilconvex, commonly elongate and auriculate in shape, spiral side evolute, opposite side may have slightly open umbilicus; chambers rapidly enlarging, relatively low and broad; wall calcareous, perforate, radial in structure, may have peripheral keel; aperture on umbilical side, broad apertural lip extending over opening and projecting into umbilicus. [*Cancris* differs from *Baggina* in being more elongate, evolute on the spiral side, keeled, and in having an open umbilicus and an apertural lip. It resembles *Baggina* in having a broad nonperforate area above the aperture.] *Eoc.-Rec.*, cosmop. —FIG. 462,3. **C. auriculatus* (FICHTEL & MOLL), Plio., Italy; 3a-c, opposite sides and edge view, $\times 45$ (*2117).

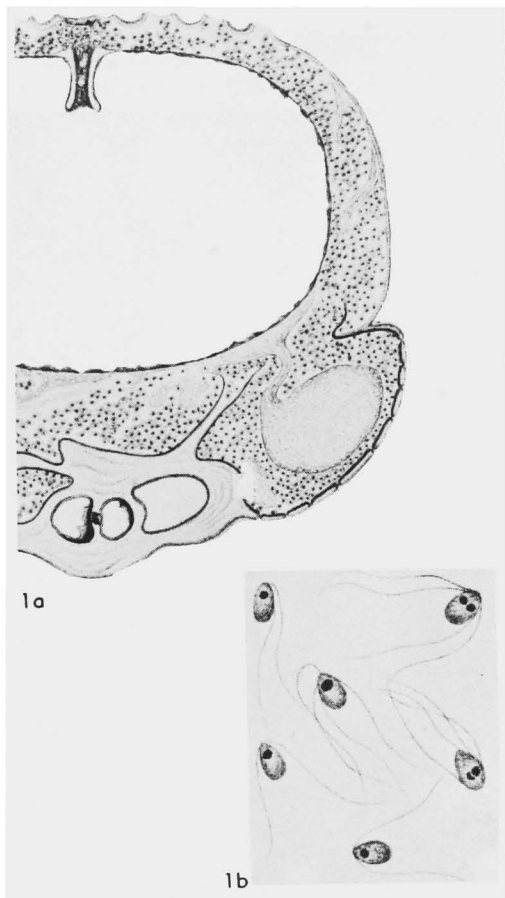


FIG. 461. Discorbidae (Discorbinae; 1, *Tretomphalus* (p. C585-C586).

Physalidia HERON-ALLEN & EARLAND, 1928, *913, p. 288 [**P. simplex*; SD GALLOWAY, 1933, *762, p. 337]. Test free, ovate or reniform in outline, composed of few (2 to 4) subglobular chambers arranged in apposition; wall calcareous, hyaline, radial in structure, very thin, coarsely perforate, with perforations produced into very thin tubules, lamellar character unknown; wall imperforate for short distance just beneath aperture on chamber opposite; aperture slitlike, at base of final chamber near its junction with earlier chambers, with slight lip on upper border. [Although previously placed with the Pegidiidae, the imperforate region near the aperture and lack of a distinct canal system and thickened lamellar wall suggest that *Physalidia* does not belong with the Rotaliacea. No specimens were available for sectioning, hence the present placement is tentative.] *Rec.*, Pac.O.—FIG. 462,2. **P. simplex*, S.Pac.O.(Cook Is.); 2a,b, side, edge views of holotype, $\times 79$ (*2117). **Rugidia** HERON-ALLEN & EARLAND, 1928, *913, p.

289 [**Sphaeroidina corticata* HERON-ALLEN & EARLAND, 1915, *910b, p. 681; OD]. Test free, small, consisting of 4 subglobular chambers arranged in apposed pairs, all visible externally, perhaps representing much reduced trochospiral coiling; wall calcareous; perforate, radial in structure, surface covered with numerous irregular knobs and ridges, presenting extremely rugose appearance, lamellar character unknown; aperture consisting of large pores between pairs of chambers on umbilical side, separated by pillar-like extensions from final chamber. *Rec.*, SE.Afr. (Moz.).—FIG. 462,4. **R. corticata* (HERON-ALLEN & EARLAND); 4a-c, opposite sides and edge view of lectotype, $\times 79$ (*2117).

[*Rugidia* differs from *Physalidia* in having a rugose exterior and multiple apertural openings between pillars along margins of the final chamber. A lectotype was selected by us at the British Museum (Natural History), and is here designated (BMNH-ZF3623, *910b, pl. 51, fig. 14) with paratypes (BMNH-ZF3621) from Kerimba Station 11, Manangoroshi to Lurio Points, Kerimba Archipelago, off Mozambique.]

Valvulineria CUSHMAN, 1926, *426, p. 59 [**V. californica*; OD] [= *Rotamorphina* FINLAY, 1939, *717c, p. 325 (type, *R. cushmani* FINLAY, 1939, *717c, p. 325 (non *Valvulineria cushmani* CORYELL & EMBICH, 1937) (= *Valvulineria teuriensis* LOEBLICH & TAPPAN, *nom. nov.*, herein)]. Test free, trochospiral, umbilicate, periphery rounded; chambers increasing gradually in size; sutures radial, thickened; wall calcareous, finely perforate, radial in structure, monolamellid, surface smooth; aperture interiomarginal, extraumbilical-umbilical, with broad thin apertural flap projecting over the umbilicus. *L.Cret. (Alb.)-Rec.*, cosmop.—FIG. 462,5-7; 463. **V. californica*, Mio., USA (Calif.); 462,5a-c, opposite sides and edge view; 462,6,7, umbilical sides showing more extensive umbilical flaps; all $\times 49$ (*2117); 463, horiz. sec. showing monolamellar radial structure, $\times 100$ (*1529).—FIG. 462,8. *V. teuriensis* LOEBLICH & TAPPAN, *nom. nov.*, U. Cret. (Teurian), N.Z.; 8a-c, opposite sides and edge view, $\times 44$ (*2117).

Family GLABRATELLIDAE Loeblich & Tappan, n.fam.

Test trochospiral, low to high-spined, umbilical side flattened; wall calcareous; hyaline, perforate, radial in structure; aperture umbilical in position; in Recent forms reproduction plastogamic, with specimens attaching in pairs by umbilical surfaces, gametes triflagellate; habitat commonly littoral. [The genera here included are distinct from the Discorbidae in having an umbilical aperture, flattened to concave and radially striate or grooved umbilical side and a plastogamic reproductive cycle with triflagellate rather than biflagellate gametes.] *Eoc.Rec.*

Glabratella DORREEN, 1948, *610, p. 294 [*G. crassa*; OD] [= *Conorbella* HOFKER, 1951, *928c, p. 448, 466 (type, *Discorbina pulvinata* BRADY,

1884, *200, p. 650); *Pileolina* BERMÚDEZ, 1952, *127, p. 38 (type, *Valvulina pileolus* D'ORBIGNY, 1839, *1393, p. 47)]. Test hemispherical, all



FIG. 462. Discorbidae (Baggininae; 1, *Baggina*; 2, *Physalidia*; 3, *Cancris*; 4, *Rugidia*; 5-8, *Valvulineria*) (p. C586-C587).

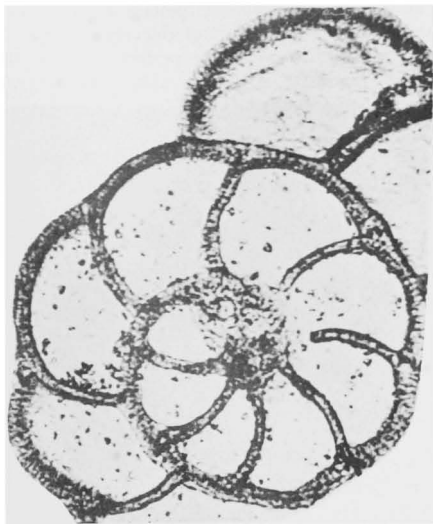


FIG. 463. Discorbidae (Baggininae; Valvulineria) (p. C587).

chambers visible from convex spiral side, only those of final whorl visible on flattened umbilical side, periphery rounded; schizont forms generally larger and flatter, gamont more high-spined; chambers relatively few, enlarging rapidly as added, sutures arcuate on spiral side, radial on opposite side; wall calcareous, hyaline, perforate, spiral surface generally ornamented with pustules, umbilical side with radial ornamentation, consisting of fine grooves or tiny, radially arranged pustules; aperture a small rounded opening restricted to open umbilicus; sexual reproduction plastogamic, with 2 specimens attaching by their umbilical surfaces, gametes triffagellate, habitat of plastogamic forms always littoral. *U.Eoc.-Rec.*, N.Z.-Pac.O.-Atl.-Australia-E.Afr. (Kerimba Arch.)-Medit. Sea-Eu.—FIG. 464,1. **G. crassa*, *U.Eoc.*, N.Z.; 1a-c, opposite sides and edge view of paratype, $\times 119$ (*2117).—FIG. 464,2. *G. pulvinata* (BRADY), *Rec.*, S.Australia; 2a-c, opposite sides and edge view, $\times 188$ (*2117).—FIG. 464,3. **G. pileolus* (D'ORBIGNY), *Rec.*, S.Am.(Chile); 3a-c, opposite sides and edge view, enlarged (*127).—FIG. 465. *G. mediterraneensis* (D'ORBIGNY), *Rec.*, *Medit.*; living triffagellate gamete, $\times 1500$ (*1109).

[*Glauertella* resembles *Discorbis* in having a flat, involute umbilical side and convex, evolute spiral side, but differs in lacking the umbilical alar extensions of the chambers, in having the typical umbilical radial ornamentation, and in having as an aperture only the open umbilical area. It differs from *Angulodiscorbis* in being low-spined, and in having relatively few chambers in each whorl, and in having the open umbilical aperture, instead of a sutural aperture at the base of the final chamber. *Glauertella* was defined by DORREEN with *G. crassa* as type, but also included in the genus was *Discorbina pulvinata* BRADY, which HOFKER later (1951, *928c) selected as type-species of *Conorbella* without reference to the prior *Glauertella*.—BERMÚDEZ (1952, *127, p. 36, 37) recognized both genera, consider-

ing *Glauertella* to have a central umbilical aperture and *Conorbella* to have a slitlike interiomarginal aperture. However, the sutural aperture described by HOFKER and cited by BERMÚDEZ for *Conorbella* is lacking in the type-species, hence species showing this feature should be separated, possibly placed in *Angulodiscorbis* which HOFKER and BERMÚDEZ had considered to be a synonym of *Conorbella*. *Discorbina pulvinata* is very similar to *G. crassa* except in minor features of ornamentation and degree of convexity, which we regard as only of specific importance, hence *Conorbella*, as based on the type-species, is classed as a synonym of *Glauertella*, as it had been by HORNIBROOK & VELLA (1954, *960, p. 25). *Pileolina* is also regarded as a synonym.—J. LE CALVEZ (1952, *1110) studied some plastogamic species of "*Discorbis*" (= *Glauertella*) and noted that they have triffagellate gametes, and that the schizont generation is commonly larger and flatter than the gamont, the 2 generations commonly having been given distinct specific names. Synonymies of many of these were noted by LE CALVEZ. *Discorbina pulvinata* BRADY (type-species of *Conorbella* and also originally included in *Glauertella*), *Valvulina pileolus* D'ORBIGNY (type-species of *Pileolina*) and *Discorbis patelliformis* and *D. opercularis* (included later in *Conorbella* by BERMÚDEZ and HOFKER) all were among the plastogamic species studied by LE CALVEZ. These similarities in reproductive habits substantiate the congeneric status of *Glauertella*, *Conorbella* and *Pileolina* and their separation from *Discorbis*.]

Angulodiscorbis UCHIO, 1953, *1960, p. 156 [**A. quadrangularis*; OD]. Test free, spiral side extremely high-spined, with all chambers visible, and may be somewhat angular in section, opposite side flat to convex, umbilicate, with only chambers of final whorl visible; chambers numerous, crescentic, broad, low, with considerable overlap; spiral surface commonly with vertical ornamentation, resulting in angular test, or with vertical ribs or very fine striae, with pores of wall aligned in fine striae, ornamentation of umbilical side also with many fine radial striae; aperture a low slit at base of final chamber. *Rec.*, Pac.O.—FIG. 466,1. **A. quadrangularis*, Ifaluk Atoll; 1a-c, spiral, umbilical, and edge views, $\times 148$ (*2117).

[As had been noted for nearly all similar conical, high-spined species, pairs of specimens are frequently found attached by their umbilical surfaces, which are resorbed by these plastogamic species during the reproductive process. Other specimens may later become detached, and with much of the ventral surface dissolved, appear to have an oversized umbilicus. HOFKER (1951, 928c, p. 466) considered some of the high-spined species to belong to *Conorbella* and BERMÚDEZ (1952, *127, p. 37) considered *Angulodiscorbis* a synonym of *Conorbella*. On the basis of their type-species, *Conorbella* is here regarded as a synonym of *Glauertella*, and *Angulodiscorbis* is available for the high-spined rotaliiform species with a slitlike aperture at base of the final chamber.]

Bueningia FINLAY, 1939, *717b, p. 122 [**B. creeki*; OD] [= *Ruttenella* KEYZER, 1953, *1031, p. 279 (type, *R. butonensis*) (non *Ruttenella* VAN DEN BOLD, 1946); *Lamarckinita* KEYZER, 1955, *1032, p. 119 (nom. subst. pro *Ruttenella* KEYZER, 1953 non VAN DEN BOLD, 1946)]. Test small, inflated, both sides involute, umbilical side flattened, with distinct peripheral keel and deep umbilicus, opposite side convex; wall calcareous, finely perforate except for keel, microstructure and lamellar character unknown; aperture umbilical, with small apertural lip. *L.Mio.-Plio.*, N.Z.-W.Indies (Indon.).—FIG. 464,5. *B. butonensis* (KEYZER), *Mio.-Plio.*, Indon.; 5a,b, opposite sides, $\times 111$ (*2117).—FIG. 464,6. **B. creeki*, *L.Mio.*, N.Z.; 6a-c, opposite sides and edge view. $\times 115$ (*2117).

Heronallenia CHAPMAN & PARR, 1931, *324, p. 236

[**Discorbina wilsoni* HERON-ALLEN & EARLAND, 1922, *911, p. 206; OD]. Test trochospiral, compressed, plano-convex, periphery carinate but rounded; chambers increasing rapidly in breadth

as added, in few whorls, umbilical side with broad open umbilicus; sutures thickened on spiral side; wall calcareous; finely perforate, radial in structure, lamellar character unknown, surface

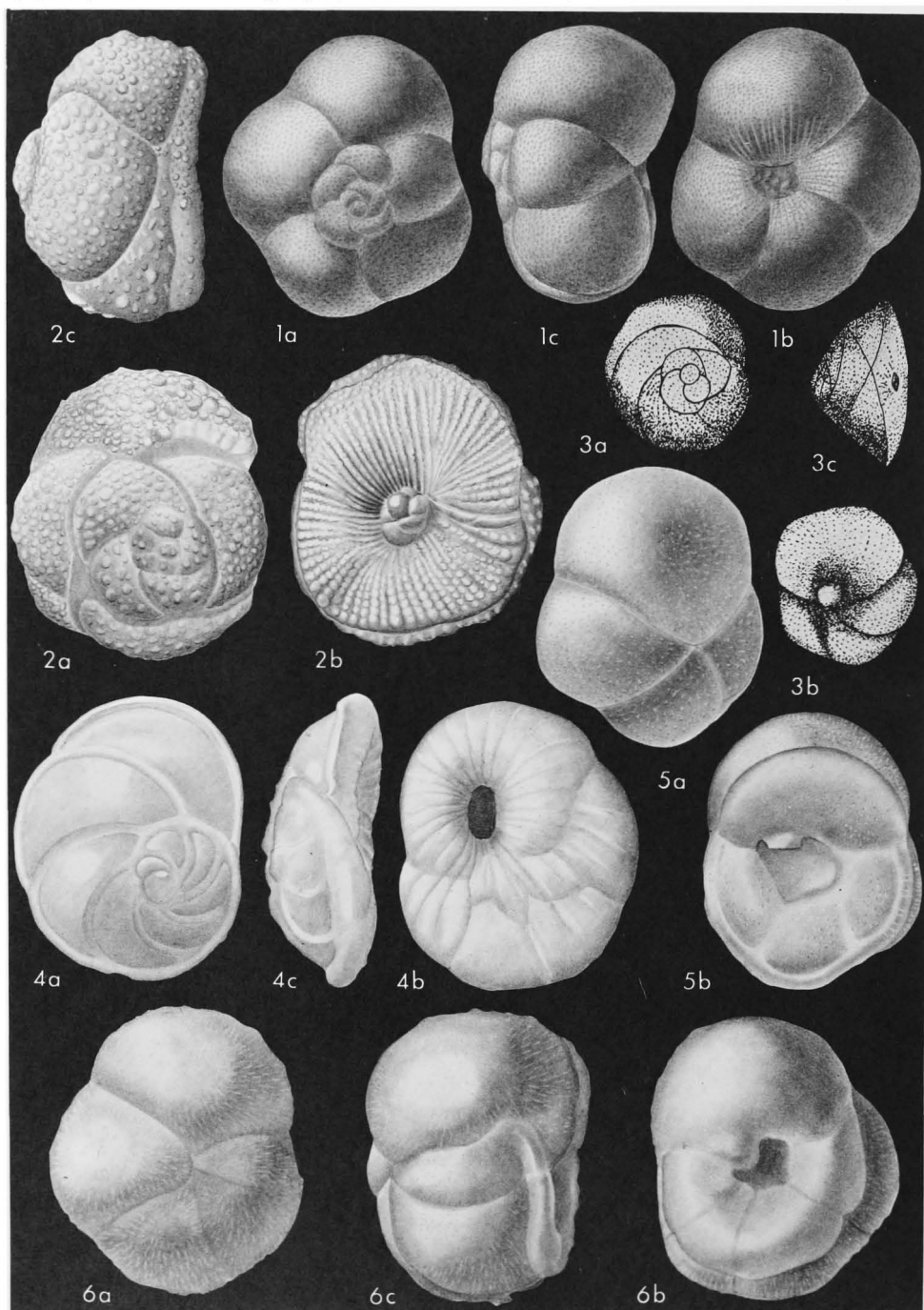


FIG. 464. Glabratellidae; 1-3, *Glabratella*; 4, *Heronallenia*; 5-6, *Bueningia* (p. C588-C591).

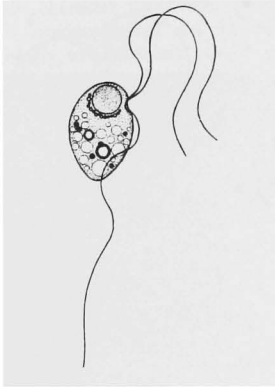


FIG. 465. Glabratellidae; *Glabratella* (p. C588-C589).

radially grooved; aperture a large ovate opening into umbilicus. *Eoc.-Rec.*, Antarctic-Australia-N. Am.-Carib.—FIG. 464,4. **H. wilsoni* (HERON-ALLEN & EARLAND), *Rec.*, Antarctic; 4a-c, opposite sides and edge view, $\times 93$ (*2117).

Schackoinella WEINHANDL, 1958, *2043, p. 141 [**S. sarmatica*; OD]. Test trochospiral, with inflated chambers, open umbilicus and single thick spine projecting from each chamber on spiral side; wall finely perforate, microstructure and lamellar character not described; aperture apparently basal and umbilical in position. [*Schackoinella* was defined as belonging to the Hantkeninidae, but it differs from that group in having a trochospiral coil. No information is available as to the lamellar character of the type-species, but the general appearance strongly suggests its placement with the Glabratellidae. Additional study is needed of its internal characters.] *Mio. (Sarmat.)*, Eu.(Aus.).—FIG. 467,1. **S. sarmatica*; 1a-c, opposite sides and edge view, $\times 68$ (*2043).

Family SIPHONINIDAE Cushman, 1927

[non. transl. N. K. BYKOVA, VASELENKO, VOLOSHINOVA, MYATLYUK & SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 270 (ex subfamily Siphonininae CUSHMAN, 1927, p. 77)]

Test trochospiral or may become uncoiled or biserial, periphery commonly with fimbriate keel; aperture oval, bordered by distinct lip and projecting on neck. *Eoc.-Rec.*

Siphonina REUSS, 1850, *1540, p. 372 [**S. fimbriata*, = *Rotalina reticulata* CZJZEK, 1848, *545, p. 145; OD (M)]. Test free, biconvex, trochospiral, lenticular, periphery with fimbriate keel, umbilicus closed; wall calcareous, coarsely perforate, radial in structure, monolamellar, surface may be ornamented with radial striae or pustules; sutures oblique on spiral side, radial on umbilical side; aperture areal, elliptical, nearly equatorial, with short neck and phialine lip. *Eoc.-Rec.*, Eu.-N.Am.-Carib.-Australia-Pac.O.-Atl.O.-S.Am.-Afr.—FIG. 468,1. **S. reticulata* (CZJZEK), *Mio.*, Eu.(Aus.); 1a-c, opposite sides and edge view of holotype of *S. fimbriata* REUSS, approx. $\times 47$ (*1540).

Siphonides FERAY, 1941, *714, p. 174 [**S. biserialis*; OD]. Test free, tiny, early stage as in *Siphonina*, later chambers uncoiled and biserially arranged, periphery with fimbriate keel; aperture subterminal, with neck and phialine lip. *M.Eoc.*, USA (Tex.).—FIG. 468,7. **S. biserialis*; 7a-c, opposite sides and edge view of topotype, $\times 218$ (*2117).

Siphoninella CUSHMAN, 1927, *431, p. 77 [**Truncatulina soluta* BRADY, 1884, *200, p. 670; OD]. Test similar to *Siphonina* in early stage, later chambers uncoiling and rectilinear; aperture terminal with neck and phialine lip. *M.Eoc.-Rec.*, Carib.-N.Am.—FIG. 468,2. **S. soluta* (BRADY), *Rec.*, W.Indies; 2a-c, opposite sides and edge view, $\times 100$ (*200).

Siphoninoides CUSHMAN, 1927, *431, p. 77 [**Planorbulina echinata* BRADY, 1879, *196b, p. 283; OD]. Test subglobular, irregularly trochospiral, few chambers to whorl, involute; wall calcareous, coarsely perforate, surface commonly spinose or tuberculate; aperture circular, with neck and phialine lip. *Mio.-Rec.*, Australia-Pac.O.-Ind.O.—FIG. 468,3-6. **S. echinata* (BRADY), *Rec.*, W.Pac.O.(Admiralty Is.) (3,4), Hawaii (5,6); 3,4, side and edge views of different speci-

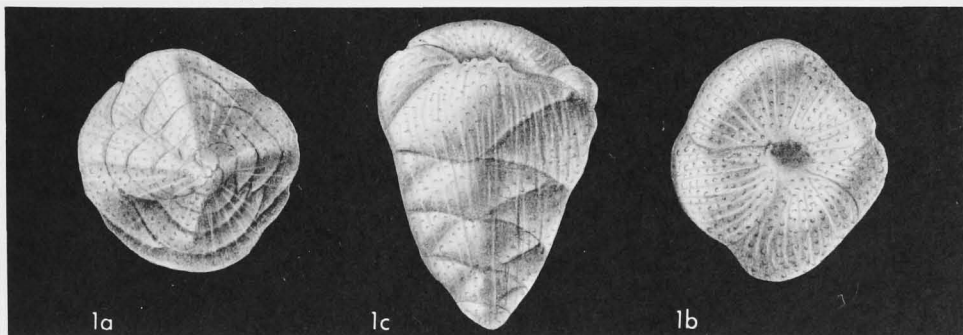
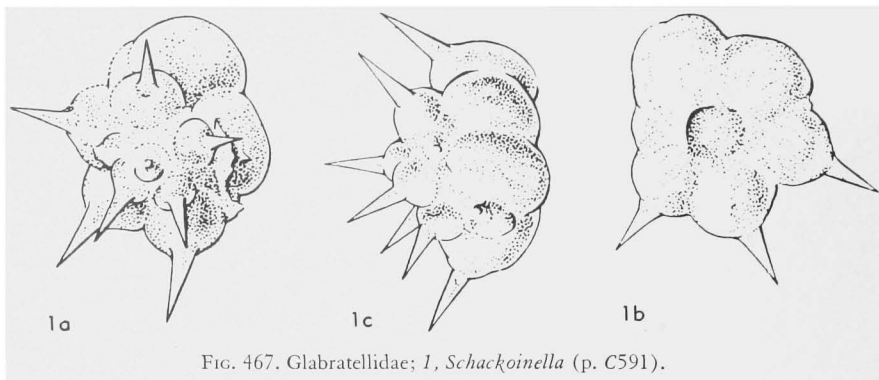


FIG. 466. Glabratellidae; 1, *Angulodiscorbis* (p. C589).

FIG. 467. Glabratellidae; 1, *Schackoinella* (p. C591).

mens, $\times 100$; 5, 6, apert. view and optical sec. showing chamber arrangement, $\times 100$ (*200).

ASTERIGERINIDAE

By R. W. BARKER

[Shell Development Company, Houston, Texas]

Family ASTERIGERINIDAE d'Orbigny, 1839

[*Asterigerinidae* D'ORBIGNY in DE LA SAGRA, 1839, p. xxxix, 116] [= *Helicotrochina* AGASSIZ, 1844, p. 2 (*nom. nud.*) (*partim*); *Asterigerinida* COPELAND, 1956, p. 187 (*nom. van.*)]

Test free, simple, calcareous, unequally biconvex, dorsal side usually more elevated; numerous chambers arranged in flat turbinoid spiral, with oblique sutures; dorsal chambers all visible in simple spiral, those on ventral side with less oblique sutures and alternating with small secondary chambers arranged in rosette form around umbilical plug; surface smooth; primary chambers showing slit aperture on inner side of ventral face of last chamber, secondary chambers with loop-shaped aperture leading into primaries, growth of these two series thus alternating; no canal system (*241, *553, *762, *1392). [Warm, shallow water; probably linked to *Discorbis* and perhaps to the *Ceratobuliminidae*, according to BROTZEN.] *Cret.-Rec.*

Asterigerina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 117 [**A. carinata*; SD CUSHMAN, 1927, *433, p. 190]. Test simple, 3 to 5 whorls visible dorsally; ventrally secondary chamberlets form star-shaped rosette around umbilical plug. *Cret.-Rec.*, cosmop.—FIG. 469, 2. **A. carinata*, Rec., W. Indies (Barbados); 2a-c, dorsal, lat., vent. sides, $\times 60$ (*2110).

Asterigerinata BERMÚDEZ, 1949, *124, p. 266 [**A. dominicana*; OD]. Differs from *Asterigerina* in having more convex dorsal side and ventral side almost flat; aperture shorter and more elliptical; test approaching *Discorbis* in general form, vitre-

ous, compressed, secondary chambers smaller and more globular than in *Asterigerina* (*124). *Oligo.-Rec.*, cosmop.—FIG. 469, 1. **A. dominicana*, U. Oligo., W. Indies (Santo Domingo); 1a-c, dorsal, lat., vent. sides of topotype, $\times 55$ (*2110).

Asterigerinella BANDY, 1949, *70, p. 118 [**A. gallowayi*; OD]. Similar to *Asterigerina* but planispiral, tending to become evolute; spire visible on both sides; periphery lobulate or carinate; chambers numerous, closely appressed and enlarging gradually; surface smooth or papillate (*70). *Eoc.*, N. Am.—FIG. 470, 1. **A. gallowayi*, U. Eoc., USA (Miss.); 1a-c, dorsal, lat., vent. sides, $\times 30$ (*2110).

Asterigerinoides BERMÚDEZ, 1952, *127, p. 61 [**Discorbina gürichi* FRANKE, 1912, *739, p. 29; OD]. Many-chambered trochoidal test similar to *Asterigerina* but possessing prominent spheroidal umbo on ventral side; differs from *Asterigerinata* in having more numerous chambers and long, narrow, slitlike aperture on inner edge of last chamber (*127). *Oligo.*, Eu. (Fr.-Belg.-Ger.-Neth.)-N. Am. (USA).—FIG. 471, 1. **A. gürichi* (FRANKE), Neth.; 1a-c, vent., lat., dorsal sides, enlarged (*557, *127).

Family EPISTOMARIIDAE Hofker, 1954

[*Epistomariidae* HOFKER, 1954, p. 166]

Test trochospiral, supplementary chamberlets on umbilical side; interiomarginal primary aperture, and supplementary sutural and areal apertures. *U. Cret.-Rec.*

Epistomaria GALLOWAY, 1933, *762, p. 286 [*pro Epistomella* CUSHMAN, 1928, *436, p. 6 (*non* ZITTEL, 1878)] [**Discorbina rimosa* PARKER & JONES in CARPENTER, PARKER & JONES, 1862, *281, p. 205; OD]. Test free, trochospiral, biconvex, early whorls visible on spiral side, chambers enlarging rapidly as added, with complex system of internal partitions junction of which with outer wall give appearance of supplementary chamberlets around umbilicus and occupy much of umbilical side; sutures depressed; radial, curved; wall calcareous, perforate, but wall microstructure

and lamellar character unknown; primary aperture a low interiomarginal slit, extending from periphery nearly to umbilicus, second aperture in

face of final chamber, and series of slitlike accessory apertures paralleling peripheral margin, one at suture formed by attachment of internal plate

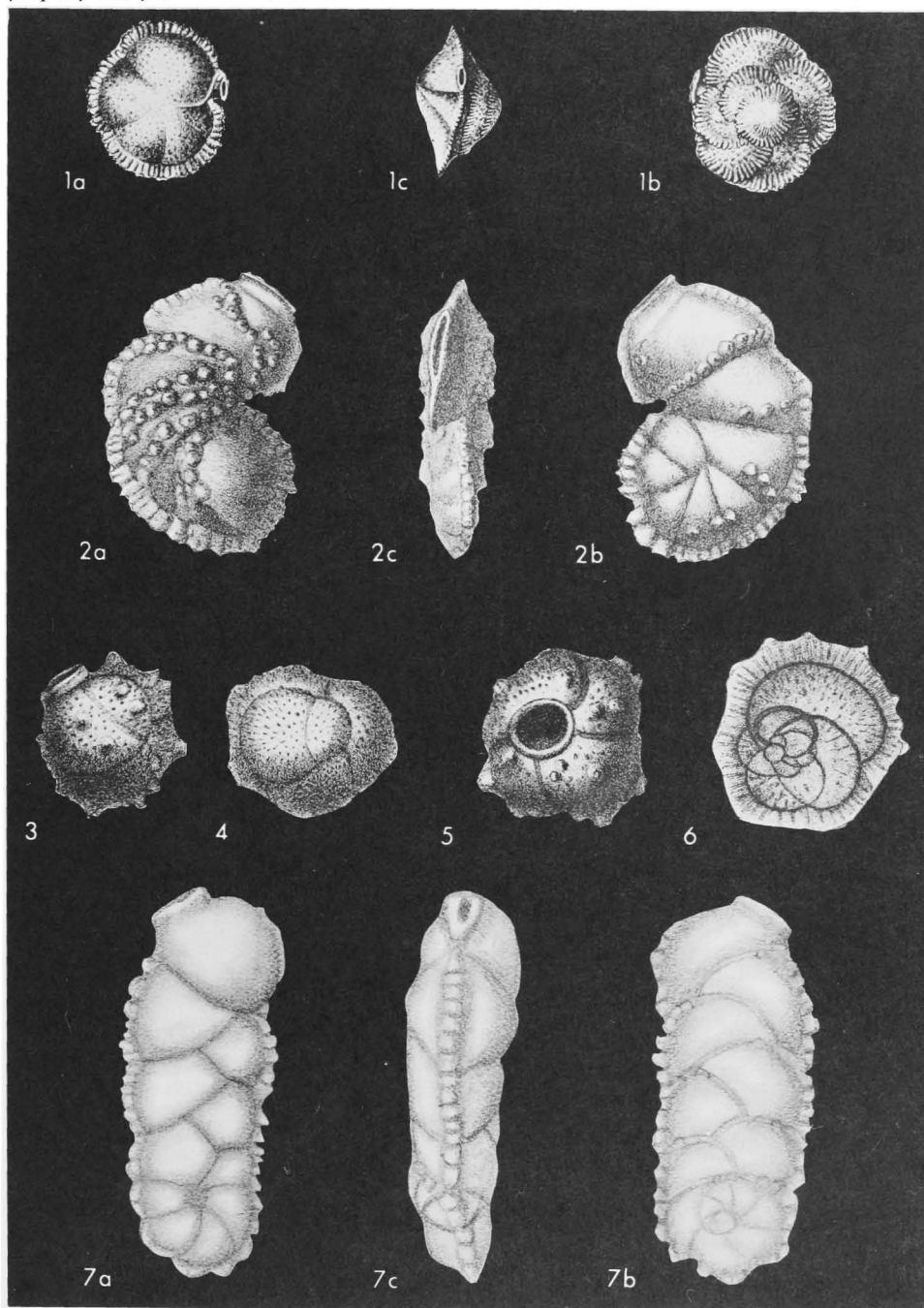


FIG. 468. Siphoninidae; 1, *Siphonina*; 2, *Siphoninella*; 3-6, *Siphoninoides*; 7, *Siphonides* (p. C591-C592).

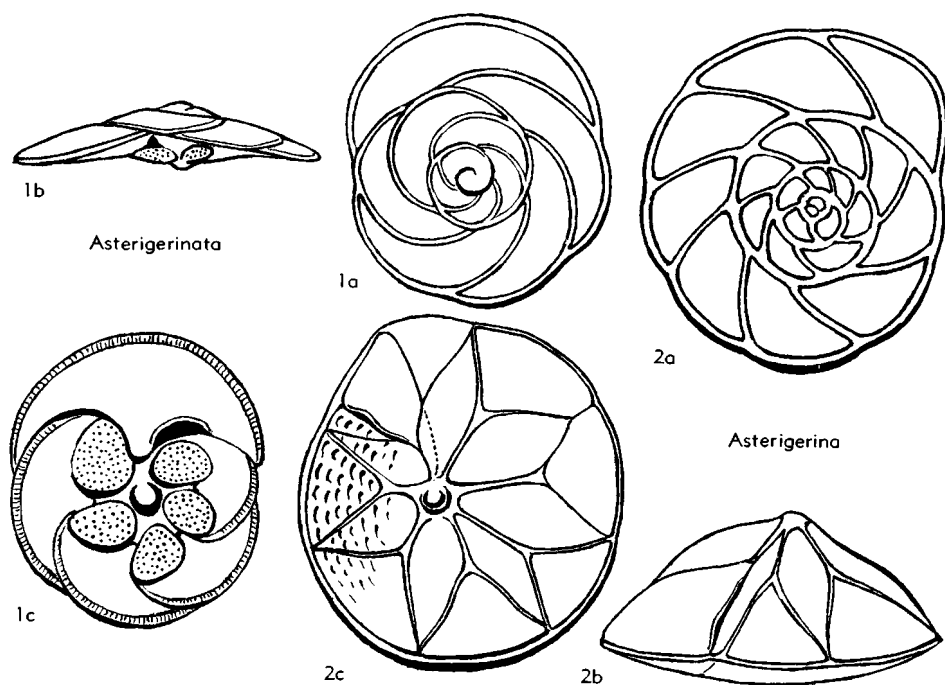


FIG. 469. Asterigerinidae; 1, *Asterigerinata*; 2, *Asterigerina* (p. C592).

on each chamber on umbilical side, and additional supplementary apertures along sutures on both spiral and umbilical sides. [A lectotype for *Discorbina rimosa* PARKER & JONES was selected and isolated in the British Museum (Natural History) by us and is here designated (BMNH-P41670), also paratypes (BMNH-P41669), from the Eocene, Hauteville, France.] *Eoc.*, Eu.—FIG. 472, 1-3. **E. rimosa* (PARKER & JONES); M. Eoc. (Lutet.), Fr. (1,2), USSR (Ukraine) (3); 1a-c, opposite sides and edge view of paratype, $\times 40$; 2, edge view of another paratype, $\times 40$ (*2117); 3, sec. showing internal partitions, $\times 33$ (*1509).

Elphidioides CUSHMAN, 1945, *482, p. 7 [**E. americanus*; OD]. Test free, trochospiral, biconvex, all whorls visible from spiral side, umbilical side involute with umbilicus covered by extension of final chamber, periphery rounded; chambers numerous, gradually increasing in size; sutures radial, nearly straight, slightly depressed, with sutural pores and retral processes; wall calcareous, coarsely perforate, microstructure and lamellar character unknown; aperture an interiomarginal slit, midway between periphery and umbilicus on umbilical side, with supplementary, curved, slitlike, oblique areal opening. *U.Eoc.* (Jackson.), USA (Ga.).—FIG. 472, 4, 5. **E. americanus*; 4a-c, opposite sides and edge view of paratype; 5, edge view of additional paratype; all $\times 111$ (*2117).

Epistomarioides UCHIO, 1952, *1959, p. 158 [**Dis-*

corbina polystomelloides PARKER & JONES, 1865, *1418, p. 421; OD] [= *Epistomarioides* THALMANN, 1953, *1897k, p. 866 (*nom. null. pro Epistomarioides* UCHIO, 1952)]. Test free, trochospiral but nearly equally biconvex, all whorls visible on spiral side, umbilical side with supplementary chambers formed by transverse internal partition as in *Eponidella* and *Epistomaria*; sutures deeply incised with shell material bridging them as in Elphidiidae; wall calcareous, thin, coarsely perforate, surface with granulose ornamentation which forms network of ridges in very large specimens and extending over sutures as sutural bars; microstructure and lamellar character unknown; primary aperture a low interiomarginal arch extending from peripheral margin to umbilicus, opening into supplementary chambers present at edge of sutural incision, internal extension from secondary chamberlets opening into areal aperture on final chamber. [A lectotype for *Discorbina polystomelloides* PARKER & JONES was chosen by us and is here designated (BMNH-ZF3603) with paratypes (BMNH-ZF3602) all from "Juke's No. 2, at 14 fathoms, north of Sir C. Hardy's inside reefs, northeast coast of Australia."] *Rec.*, Australia-N. Guinea-Japan-E. Afr. (Kerimba Arch.).—FIG. 473, 1-3. **E. polystomelloides* (PARKER & JONES); Australia (Lord Howe Is.) (1,2), Kerimba Arch (3); 1a-c, opposite sides showing incised sutures and bars, and edge view showing basal and areal apertures,

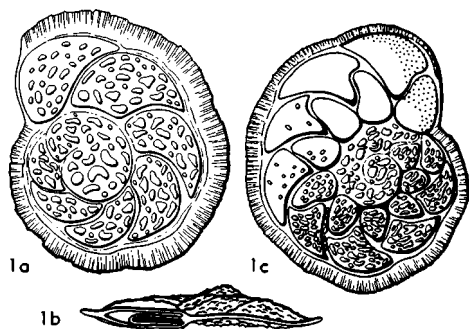


FIG. 470. Asterigerinidae; 1, *Asterigerinella* (p. C592).

×23 (*2117); 2a-c, opposite sides and edge view of larger specimen with more prominent network of ornamentation and sutural bridges, ×26 (*2117); 3a, optical sec. of specimen in balsam, spiral side with primary chambers shown in outline, secondary chambers shaded; 3b, same from umbilical side, showing extensions to apert. openings, ×23 (*910a).

Eponidella CUSHMAN & HEDBERG, 1935, *506, p. 13 [*E. libertadensis*; OD] [= *Paranonion* LOGUE & HAAS, 1943, *1189, p. 177 (type, *P. venezuelanum*)]. Test free, trochospiral but nearly biconvex, supplementary umbilical series of chambers appearing to be result of transverse chamber partition that extends from aperture across umbilical side of chambers and attaches to previous septum, but not reaching inner wall of spiral side of test; wall calcareous, coarsely perforate, with pseudochitinous inner layer, that of supplementary portion being thinner walled; lamellar character and microstructure unknown; aperture interiomarginal, extending in loop up peripheral apertural face, lower portion closed secondarily so that intercameral foramina consist only of areal openings. *Mio.-Rec.*, S. Am. (Venez.)-USA-Carib.—FIG. 472,6,7. **E. libertadensis*, Mio., Venez.; 6a-c, opposite sides and edge view, ×168 (*2117); 7a-d, edge views of holotype and paratypes showing septal foramen and fragments of internal partition, ×100 (*506).—FIG. 472,8,9. *E. venezuelana* (LOGUE & HAAS), U.Mio., Venez.; 8a-d, edge views showing apertural development for comparison with *E. libertadensis*, ×100 (*1189); 9a-c, opposite sides and edge view of holotype, ×122 (*2117).

[*Eponidella* appears closely related to *Palmerinella* but has less complex apertural and septal foramina. Details of the wall structure and internal features of the secondary partitions need additional study. *Paranonion* is a synonym of *Eponidella*, but its type-species does not show the suture of the internal partition as well as *E. libertadensis*. This may be a result of a difference in preservation, however.]

Nuttallides FINLAY, 1939, *717a, p. 520 [*Eponides trumpyi* NUTTALL, 1930, *1371, p. 287; OD]. Test trochospiral, lenticular, with poreless peripheral keel; chambers broad, low; sutures oblique

on spiral side, radial and gently curved on umbilical side; umbilicus closed by poreless umbonal boss; internal plate extending diagonally from septal foramen toward peripheral apertural notch but not connecting to opposite wall so as to form supplementary chamberlets; wall calcareous, perforate, radial in structure, septa monolamellid, imperforate; aperture interiomarginal, extending from umbilical boss nearly to peripheral keel, with small notch parallel to plane of coiling. *Eoc.*, Mex.-N.Z.—FIG. 473,7,8. **N. trumpyi* (NUTTALL), Mex.; 7a-c, opposite sides and edge view of lectotype, here designated (USNM CUSHMAN Coll. 59492), ×65 (*2117); 8, interior of final chamber showing internal plate and marginal notch, enlarged (*108).

[The internal partitions in *Nuttallides* were described by BELFORD (1958, *108, p. 93, who regarded the genus as belonging to the Epistominidae, but possibly intermediate between *Alabamina* and *Epistomina*. As *Alabamina* has a granular, rather than radiate, wall structure, and *Epistomina* has an aragonite, rather than calcite, test, *Nuttallides* is not regarded as close to either of these genera.]

Nuttallinella BELFORD, 1959, *109, p. 20 [*pro Nuttallina* BELFORD, 1958, *108, p. 96 (non DALL,

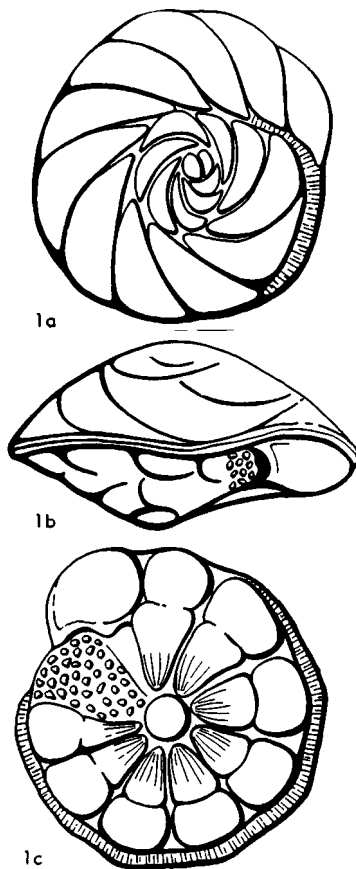


FIG. 471. Asterigerinidae; 1, *Asterigerinoides* (p. C592).

1871)] [*Nuttallina coronula* BELFORD, 1958, *108, p. 97; OD]. Test trochospiral, plano-convex, with flattened spiral side, periphery with broad

flangelike imperforate keel; all chambers visible from spiral side; umbilical side with small open umbilicus; sutures radial, straight to sinuate; wall

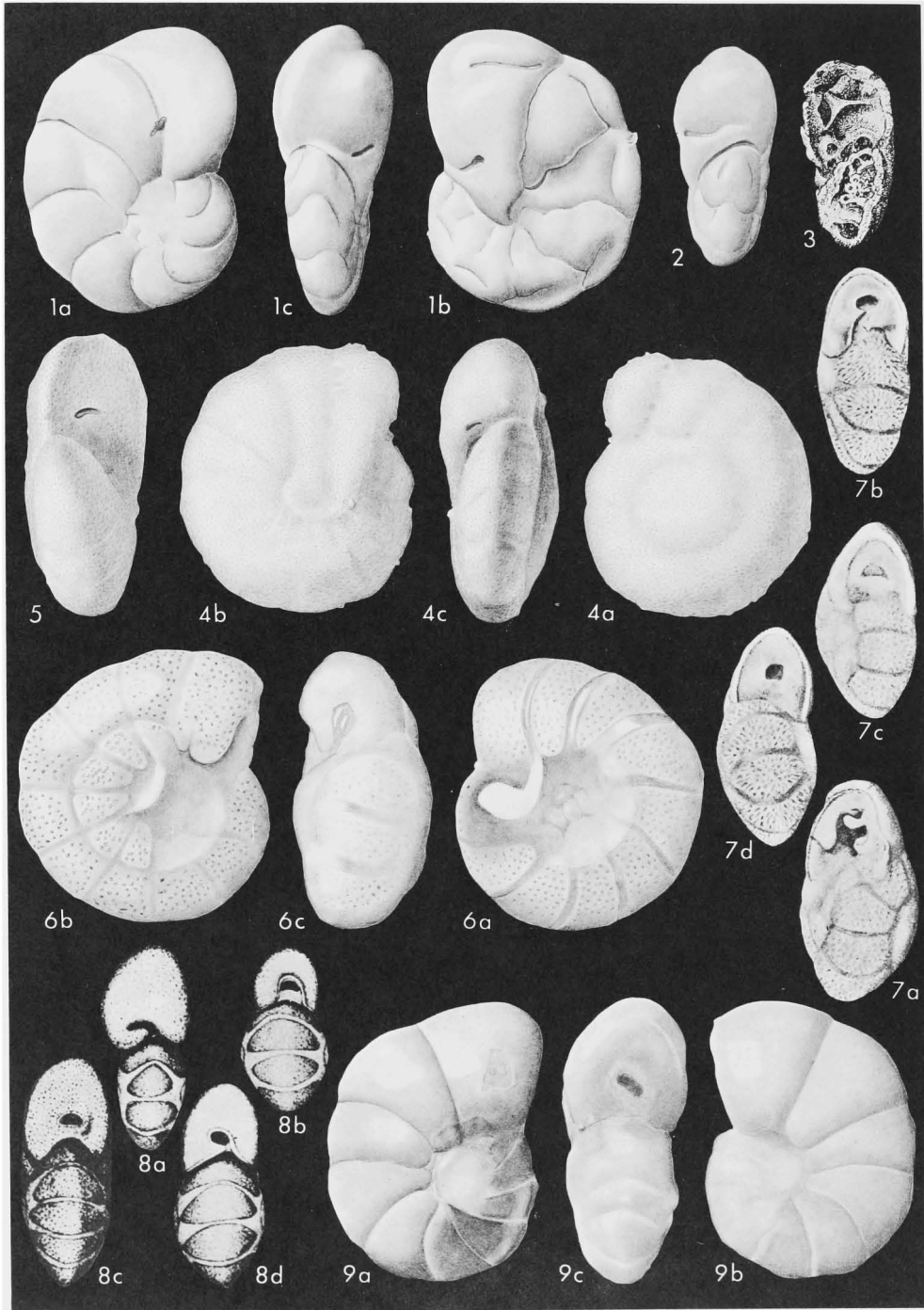


FIG. 472. Epistomariidae; 1-3, *Epistomaria*; 4,5, *Elphidioides*; 6-9, *Eponidella* (p. C592-C595).

calcareous, perforate, radial in structure, septal walls single, monolamellid, imperforate; aperture elongate, interiomarginal on umbilical side, with

narrow lip, and may have small flap over umbilicus, internal tooth plate extending diagonally across chamber from near periphery back to pre-

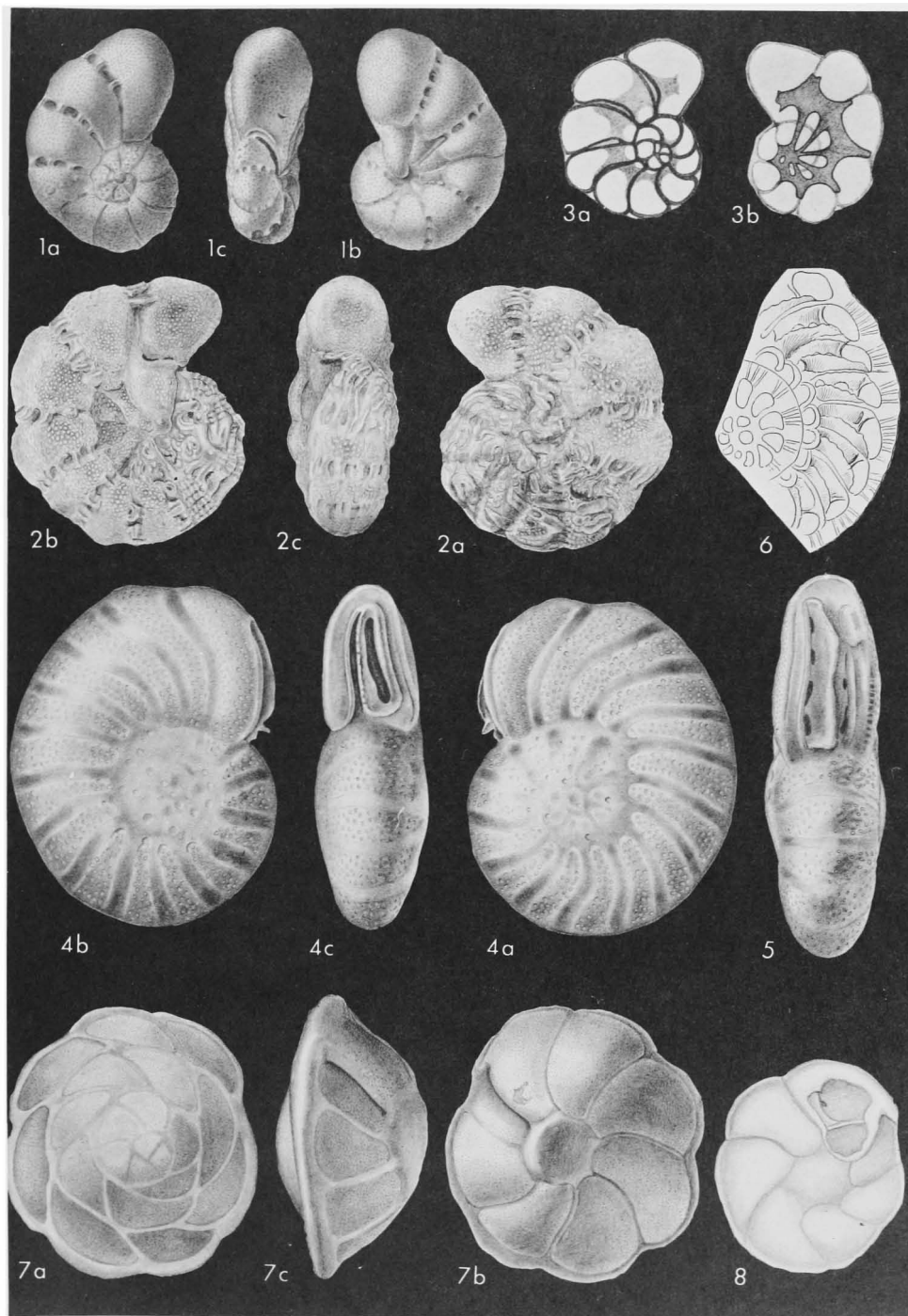


FIG. 473. Epistomariidae; 1-3, *Epistomaroides*; 4-6, *Palmerinella*; 7,8, *Nuttallides* (p. C594-C595, C598).

vious septal foramen, as in *Nuttallides*, but tooth plate of *Nuttallinella* has strongly folded upper edge. [Differs from *Nuttallides* in having an open umbilicus, a more extensive aperture, which extends to the umbilicus, and folded upper margin of the tooth plate.] *U.Cret.*(*U.Santon.-U. Campan.*), Australia.—FIG. 474,2-4. **N. coronula* (BELFORD), Santon., W.Australia; 2a-c, opposite sides and edge view of holotype, $\times 66$; 3, axial section showing tooth plate in final chamber at right, $\times 72$ (*108); 4, paratype with dissected penultimate chamber showing tooth plate, enlarged (*108).

Palmerinella BERMÚDEZ, 1934, *116, p. 83 [**P. palmerae*; OD]. Test free, discoidal, adult nearly planispiral and evolute, with low, broad chambers and small secondary chambers at umbilical margin of primary chambers on umbilical side, central portion of both sides of test with clear secondary shell material which may also obscure secondary chamberlets; secondary shell material pierced by few large pores; sutures gently curved; wall calcareous, coarsely perforate; microstructure and lamellar character unknown; aperture a broad open arch in terminal face with narrow raised bordering lip that extends somewhat to umbilical side in final chamber, this portion of earlier apertures being covered by secondary chamberlets; vertical internal partition subdividing aperture, curving at lower border to form continuous S-shaped ridge and leaving 2 elongate slits open in final chamber, these being closed by secondary plate in earlier chambers, plate containing vertical row of large perforations. [The asymmetrical aperture suggests that the nearly planispiral development is modified from a trochospiral ancestry.] *Rec.*, Carib.-N.Am.(USA).—FIG. 473, 4-6. **P. palmerae*, Cuba; 4a-c, opposite sides and edge view of lectotype showing aperture; 5, edge view of paratype with broken final chamber showing septal partition and pores, $\times 90$ (*1632); 6, equat. sec. showing internal partitions and chamberlets, $\times 80$ (*949).

Pseudoeponides UCHIO in KAWAI *et al.*, 1950, *1027, p. 190 and UCHIO, 1951, *1957, p. 38 [**P. japonica*; OD] [= *Epistomaria* (*Epistomariella*) KUWANO, 1950, *1071, p. 315 (type, *E. (E.) miurensis*, = *P. japonicus* UCHIO, 1950)]. Test free, lenticular, trochospiral, chambers numerous, broad, semilunar in outline, with strongly oblique sutures on spiral side but nearly radial on umbilical side; wall calcareous, very finely perforate, wall microstructure and lamellar character not described; aperture a low interiomarginal opening midway between umbilicus and periphery, supplementary slitlike openings parallel to spiral suture near mid-point of each chamber on spiral side at junction of spiral and septal sutures, surrounded by poreless area of chamber wall, additional hook-shaped supplementary slits at posterior margin of each chamber on umbilical side

extending perpendicularly from near mid-point of previous suture and curving toward the anterior margin, thus suggesting presence of internal tooth plate, which extends vertically through chamber to attach at supplementary opening on spiral side. *Plio.-Rec.*, Japan-Neth.-Carib.—FIG. 474,5,6. **P. japonicus*, Plio., Japan; 5a-c, opposite sides and edge view of paratype, $\times 148$ (*2117); 6a, axial sec. showing tooth plates extending from aperture on umbilical side through test to attach to wall of spiral side proximal to supplementary openings; 6b, partial sec. showing tooth plates, ground from umbilical side through center of test so as to cut final whorl of chambers; both $\times 107$ (*950).

[*Pseudoeponides* was stated by UCHIO (1951, *1957) to be related to *Mississippina* or *Epistomina*, because of the supplementary apertures. KUWANO (1950, *1071) considered it to be a subgenus of *Epistomaria*. Later UCHIO (1953, *1960) included *Rotalina umbonata* REUSS in *Pseudoeponides*, regarded the genus as related to *Eponides*, and placed it in the "Rotaliinae." HOFKER (1958, *950) and REISS (1960, *1533) regarded *Pseudoeponides* as a true rotaliid genus (double septa), related to *Ammonia*. HOFKER (1956, *945) considered *P. japonica* to have a "very highly developed toothplate and toothplate foramina at the dorsal side of each chamber." *Epistomina* has an aragonitic wall, the Rotaliinae are characterized by double septa and a canal system, *Eponides*, including *Rotalina umbonata* (= *Eponides*) is bilamellid, without supplementary openings and tooth plate.]

Torresina PARR, 1947, *1427, p. 129 [**T. haddoni*; OD]. Test free, trochospiral, compressed, chambers increasing gradually in size, few to whorl, chamber interior divided by secondary partitions projecting inward from peripheral margin; wall calcareous, perforate, microstructure and lamellar character unknown; aperture peripheral, short slit in plane of coiling and inclined toward umbilical side, second opening interiomarginal on umbilical side, and may have an umbilical chamber flap, as in *Discorbinella*. *U.Tert.-Rec.*, Australia.—FIG. 474,1. **T. haddoni*, Rec., Torres Straits; 1a-c, opposite sides and edge view of topotype, $\times 133$ (*2117).

Superfamily SPIRILLINACEA Reuss, 1862

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 317 (*pro* superfamily Spirillinoidea CHAPMAN, PARR & COLLINS, 1934, p. 554, and superfamily Spirillinoidea POKORNÝ, 1958, p. 311)] [= family group Archi-Monothalamidia RHUMBLER in KÜKENTHAL & KRUMBACH, 1923, p. 85 (*partim*)]

Test planispiral to conical, simple forms with proloculus followed by enrolled tubular second chamber, nonseptate or with septa in later stages, advanced forms with septa throughout, becoming biserial, later may develop annular chambers; wall perforate, calcareous, may consist optically of single crystal of calcite; amoeboid gametes in plastogamic reproductive cycle; quadrinucleate. ?*Trias.*, *Jur.-Rec.*

Family SPIRILLINIDAE Reuss, 1862

[*nom. correct.* RHUMBLER, 1895, p. 85 (*pro* family Spirillinoidea REUSS, 1862, p. 364)]—[All names cited of family

rank]—[=Spirillinina LANKESTER, 1885, p. 847; =Spirillinida HAECKEL, 1894, p. 185; =Spirillinac DELAGE & HÉROUARD, 1896, p. 144]

Proloculus followed by nonseptate en-

rolled tubular second chamber which may be septate in later stages, becoming biserial and may develop annular chambers; wall

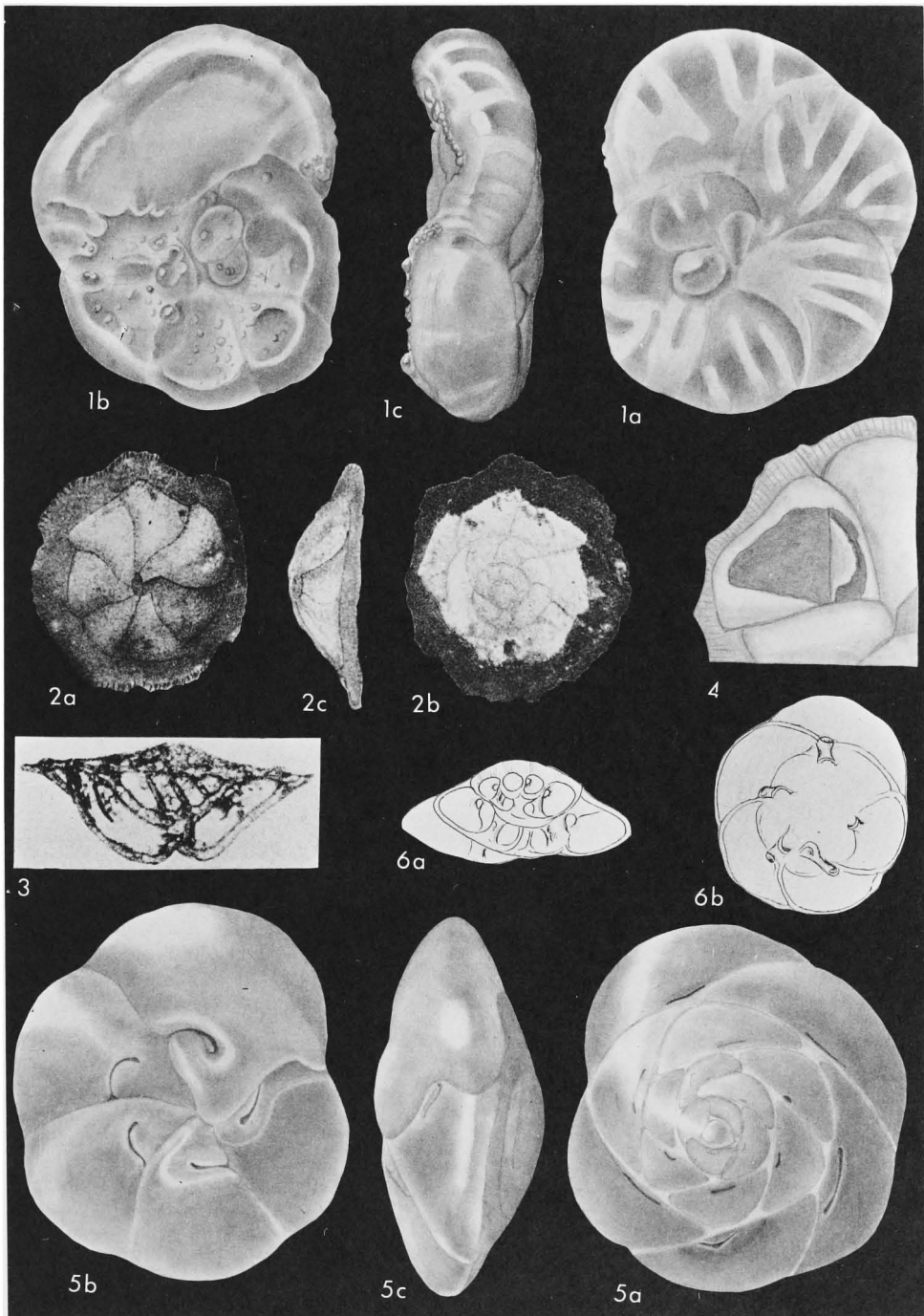


FIG. 474. Epistomariidae; 1, *Torresina*; 2-4, *Nuttallinella*; 5, 6, *Pseudoeponides* (p. C595-C598).

consisting optically of single crystal of calcite. ?*Trias.*, *Jur.-Rec.*

Subfamily SPIRILLININAE Reuss, 1862

[*nom. transl.* BRADY, 1884, p. 72 (ex family Spirillinidea REUSS, 1862)]—[All names cited of subfamily rank]—[=Arspirillina RHUMBLER, 1913, p. 388 (*nom. van.*); =Turrispirillininae CUSHMAN, 1927, p. 73; =Terebralininae CUSHMAN, 1927, p. 65]

Test with proloculus and enrolled tubular, nonseptate second chamber only; aperture simple, single, at open end of tube. ?*Trias.*, *Jur.-Rec.*

Spirillina EHRENBURG, 1843, *672, p. 402 [**S. vivipara*; OD (M)] [=Mychostomina BERTHELIN, 1881, *134, p. 557 (type, *Spirillina vivipara revertens* RHUMBLER, 1906, *1571, p. 32, SD GALLOWAY, 1933, *762, p. 88); *Arspirillum* RHUMBLER, 1913, *1572b, p. 388 (*nom. van.*)]. Test free, planispiral, or with one side slightly concave, proloculus followed by closely appressed, spirally wound, undivided tubular second chamber, proloculus of "megalospheric" generation (agamont) smaller than that of "microspheric" generation; wall calcareous, hyaline, composed of single crystal of calcite (more rarely 2 or 3), deposited over pseudochitinous membrane, finely to coarsely perforate, although, according to SOLLAS (*1811, p. 207), the wall has "pseudopores" rather than true perforations, commonly with one side more coarsely perforate than the opposite; aperture terminal, peripheral, somewhat crescentic where final whorl lies against previous whorl, or final portion of tubular chamber may be somewhat turned inward to one side of periphery and directed toward umbilicus. ?*Trias.*, *Jur.-Rec.*, cosmop.—FIG. 475, 1, 2. **S. vivipara*, Rec., soft muddy white sand at 10 fathoms, Dry Tortugas, Fla. (Station 23), between Middle Ground and White Shoal (1), Gulf Mex. (2); 1a-c, opposite sides and edge view of neotype (Cushman Coll. 10186, U.S. Natl. Mus.), here designated, $\times 150$; 2, hypotype showing mychostomine appearance of agamont form, $\times 150$ (*2117).—FIG. 475, 3, 4. *S. revertens* RHUMBLER, Rec., W.Pac.O. (Caroline Is.); 3a-c, opposite sides and edge view of hypotype with incurved chamber (agamont); 4a, b, opposite sides of typical spirilline form (gamont); all $\times 148$ (*2117).

[EHRENBURG's types, originally in Berlin, were reportedly destroyed during the last war. As was noted by WOOD (1949, p. 245) the type-species of *Spirillina*, as generally understood, has a test composed of a single crystal of calcite, but EHRENBURG's original description stated that acid had no effect on the shell. CUSHMAN (1931, *451, p. 4) stated: "Ehrenberg originally described this species from off the Coast of Mexico, near Vera Cruz. I examined the type in the Ehrenberg collection in Berlin and the drawing given by Ehrenberg . . . is an excellent one of the type specimen. The species is a fairly common one in the West Indian region . . ." CUSHMAN stated of his own illustrated specimens: "The figures given show the typical form and appearance of this species in the West Indian region from which it was described." As EHRENBURG stated that the test was insoluble in acid, this would imply that he was concerned with a siliceous or agglutinated form, such as *Ammodiscus*. However, no noncalcareous species of similar appearance is known from the

type area. As CUSHMAN's types were from the same general area, Gulf of Mexico, as the original of EHRENBURG and as he had seen the original types (now lost) and stated that his specimens were typical, we are here designating as neotype the specimen illustrated by CUSHMAN (1931, *451, pl. 1, figs. 4a-c), here refigured. The original description was probably in error in stating that the test is not soluble in acid and by designating a neotype upon which to base the emended generic definition, the nomenclature can be stabilized.—[Mychostomina BERTHELIN, 1881, was defined without citation of species, and *Spirillina vivipara* var. *revertens* RHUMBLER, 1906, was designated as type-species by GALLOWAY, 1933 (subsequent monotypy). CUSHMAN in his various classifications of the foraminifers (1933, 1940, 1948) considered *Mychostomina* as a synonym of *Spirillina*, whereas GALLOWAY (1933, *762, p. 88) stated that *Turrispirillina* CUSHMAN may be a synonym of *Mychostomina*. BERMÚDEZ (1952, *127, p. 18) recognized all three genera. We have examined specimens of *Spirillina revertens* from the Caroline Islands. In this species only slight overlap of the umbilical region by the distal end of the tubular chamber is seen and even this is difficult to determine in some specimens. In addition, very similar specimens of a typical planispiral *Spirillina* are associated with *S. revertens*.—[MYERS (1936, *1337, p. 123), in his study of living cultures of *Spirillina vivipara* and their ontogenetic development and reproduction, stated, "In the final stage of the agamont test the distal end of the spiral chamber is usually turned inward, so that the aperture is directed toward the umbilicus." Thus, the agamont (sexually produced) generation may show the "generic" character of *Mychostomina*, with a recurved distal end of the spiral chamber, and the gamont test would show the typical *Spirillina*-like planispiral coil. PHLEGER & PARKER (1951, pl. 13, figs. 3a, b) also figured a specimen of *Spirillina vivipara* from the Gulf of Mexico which shows the recurved distal end of the spiral chamber. We have here refigured it for comparison with the 2 forms of the type-species of *Mychostomina*. The genus *Gyrammina* EIMER & FICKERT, 1899, with its type-species, *Trochammina annularis* BRADY, 1876, was placed in the synonymy of *Spirillina* by GALLOWAY (1933, *762, p. 85).—[The types of this species in the BRADY collection in the British Museum (Natural History) in London were examined by us and the species found to be unrecognizable on the basis of the type material. *S. vivipara* is one of the best-known species of all foraminifers and many details have been published as to its morphological characters (MYERS, 1936, *1337, p. 123), shell composition (WOOD, 1949, *2073, p. 245), ontogenetic development, reproductive process (MYERS, 1936, *1337, p. 125), cytology (MYERS, 1936, *1337, p. 126), and ecology (MYERS, 1936, *1337, p. 122). It has been widely recorded from Recent oceans.]

Alanwoodia LOEBLICH & TAPPAN, 1955, *1166, p. 26 [**Patellina campanaeformis* BRADY, 1884, *200, p. 634; OD]. Test free, conical, high-spined, ventrally flattened or slightly excavated, consisting of proloculus and long, undivided, broad and low tubular chamber in high, open conical spire, central area being filled with clear or laminated calcite, tiny pores around exterior spiral suture, wall calcareous, test composed of single calcite crystal; aperture ventral, at open end of spiraling tube. Rec., Pac.O.—FIG. 476, 1, 2. **A. campanaeformis* (BRADY); 1, long. sec. of holotype showing clear central filling; 2a-c, opposite sides and edge of paratype; all $\times 146$ (*1166).

Conicospirillina CUSHMAN, 1927, *431, p. 73 [**Spirillina trochoides* BERTHELIN, 1879, *132, p. 37; OD]. Test free, conical, consisting of proloculus and undivided tubular spiraling second chamber, spiral side convex and evolute, umbilical side concave and nearly completely involute, final whorl nearly or completely overlapping all previous whorls, rarely leaving small open umbilicus; aperture at open end of tube on umbilical side. [Differs from *Spirillina* in being ventrally involute and in being conical in form. It differs

from *Turrispirillina* in its involute ventral side with the final whorl occupying the entire ventral side.] *Jur.-Rec.*, Eu.-Atl.O.-Pac.O.—FIG. 475,5.

**C. trochoides* (BERTHELIN), L.Jur.(L.Pliensbach.), Eu.(Fr.); 5a-c, opposite sides and edge view of topotype, $\times 257$ (*2117).

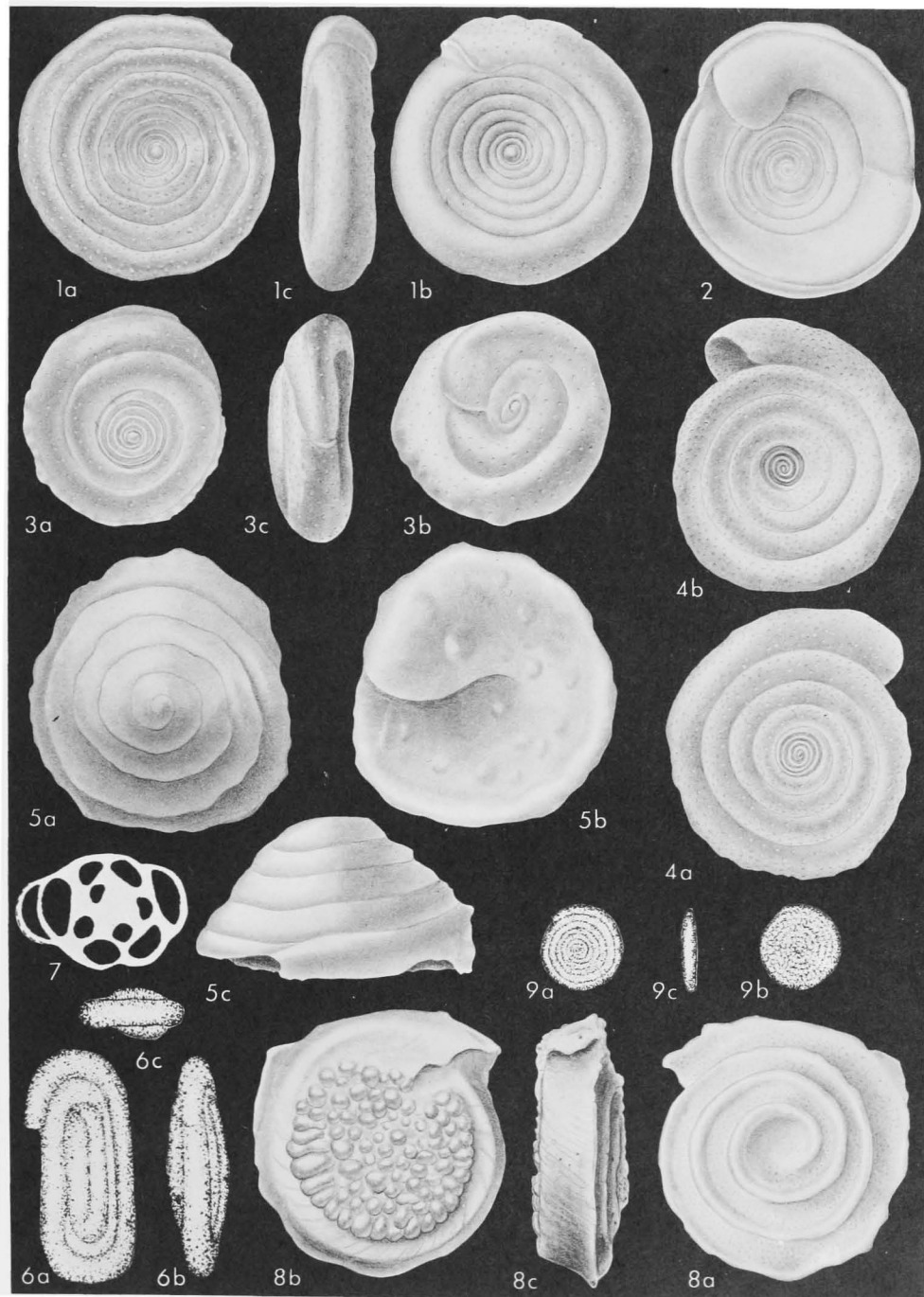


FIG. 475. Spirillinidae (Spirillininae; 1-4, *Spirillina*; 5, *Conicospirillina*; 6,7, *Miliospirella*; 8,9, *Planispirillina*) (p. C600-C602).

Miliospirella GRIGELIS in N. K. BYKOVA *et al.*, 1958, *265, p. 75 [*M. lithuanica*; OD]. Test with proloculus followed by enrolled nonseptate tubular second chamber with plane of coiling changing regularly, so that successive whorls are approximately 120° apart, giving pseudotriloculine appearance; wall calcareous, coarsely perforate; aperture simple, at open end of tube. [Differs from *Spirillina* in its pseudotriloculine coiling, from *Triloculina* in its nonseptate tube, simple aperture, and perforate wall, and from *Agathammina* in its perforate wall.] *M.Jur.*(U.Callov.), Eu. (Lith.).—FIG. 475,6,7. **M. lithuanica*; 6a-c, side, edge, and top views of holotype, $\times 120$; 7, sec. showing arrangement of successive whorls of nonsegmented tube, $\times 240$ (*265).

Planispirillina BERMÚDEZ, 1952, *127, p. 26 [*Spirillina limbata* BRADY var. *papillosa* CUSHMAN, 1915, *404e, p. 6; OD] [= *Trochospirillina* MITYANINA, 1957, *1290, p. 230 (type, *T. granulosa*)]. Test free, planispiral, periphery rounded to truncate, all whorls visible on spiral side, all whorls except last obscured on ventral side by secondary accumulation of nodes and pustules of clear calcite which completely fill central region; wall calcareous, hyaline, coarsely perforate dorsally, finely perforate ventrally; aperture at open end of tube. *Jur.-Rec.*, Pac.O.-Eu.-Medit. Sea-Australia.—FIG. 475,8. **P. papillosa* (CUSHMAN), Rec., Pac.; 8a-c, opposite sides and edge view of holotype, $\times 75$ (*2117).—FIG. 475,9. *P. granulosa* (MITYANINA), U.Jur.(L.Oxford.), Belorussian SSR; 9a-c, spiral, umbilical, and edge views of type-specimen(s), $\times 44$ (*1290).

[*Planispirillina* differs from *Spirillina* in the presence of secondary granules on its umbilical side. The original figures of *Trochospirillina granulosa* (*1290) seem to refer to a single specimen but either they represent different specimens or one figure is reversed, as the aperture is shown to the left in both figures.]

Sejunctella LOEBLICH & TAPPAN, 1957, *1172, p. 228 [*S. earlandi*; OD]. Test free, planispiral, discoidal, may have peripheral keel; globular to ovate proloculus followed by loosely wound, spiral, undivided, tubular second chamber that does not lie in contact with previous whorl but is separated from it by solid platelike area; wall calcareous, finely perforate, chamber wall and peripheral keel, when present, formed of single calcite crystal but intercalary plate between coils of tubular chamber not composed of single crystal but of secondary granular calcite; aperture a rounded opening at end of tubular chamber. *Rec.*, Atl.O.—FIG. 477,4. **S. earlandi*; side view of holotype, showing fimbriate peripheral keel and intercalary plate between whorls, composed of keels of earlier whorls with addition of secondary granular calcite, $\times 253$ (*1172).

[Differs from *Spirillina* in the presence of its platelike intercalation between the planispiral whorls, a condition considered to be generically important, not only on external appearance but also because it differs in structure, being composed of granular calcite instead of a single crystal, as is the remainder of the test. The type-species has a peripheral keel on the final whorl, but this may be lacking in other species.]

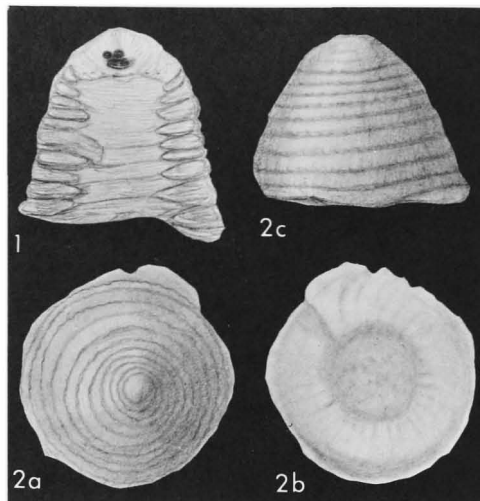


FIG. 476. Spirillinae (Spirillinae; 1,2, *Alanwoodia*) (p. C600).

Terebralina TERQUEM, 1866, *1887, p. 471, 473 [*pro Spirigerina* TERQUEM, 1866, *1886, p. 454 (non D'ORBIGNY, 1847)] [*Spirigerina antiqua* TERQUEM, 1866, *1886, p. 353, 454, = *Terebralina regularis* TERQUEM, 1866, *1887, p. 473; OD (M)]. Test consisting of proloculus and undivided tubular second chamber in high trochospiral coil; wall calcareous, perforate; aperture at open end of tubular chamber. [Although previously placed in the Buliminidae, *Terebralina* is here placed in the Spirillinae because of its nonseptate coil, simple aperture, and absence of tooth plate. It differs from *Turrispirillina* in being extremely high-spired.] *L.Jur.*(Lias.), Eu.(Fr.).—FIG. 477, 5. **T. antiqua* (TERQUEM); side view, $\times 66$ (*519).

Turrispirillina CUSHMAN, 1927, *431, p. 73 [*Spirillina conoidea* PAALZOW, 1917, *1403, p. 217; OD] [= *Turrispirillina* NEAVE, 1940, *1348d, p. 594 (nom. null.)]. Test free, conical, consisting of proloculus and spirally wound tubular second chamber, which forms hollow cone, all coils visible dorsally and ventrally; wall calcareous, finely perforate, dorsal surface somewhat roughened; aperture at open end of tube on ventral side of test. [Differs from *Spirillina* in its hollow conical spire rather than being planispiral.] *Jur.-Rec.*, Eu.-N.Am.-Australia-Antarctic.—FIG. 477,1. **T. conoidea* (PAALZOW), U.Jur., Eu.(Ger.); 1a-c, opposite sides and edge view of topotype, $\times 90$ (*2117).

Subfamily PATELLININAE Rumbler, 1906

[Patellinae RHUMBLER, 1906, p. 35] [= Arpatellina RHUMBLER, 1913, p. 390 (nom. van.)]

Proloculus and trochospirally coiled nonseptate chamber in early stage, followed by septate stage with 2 chambers to whorl, or chambers annular; aperture umbilical. *L. Cret.-Rec.*

Patellina WILLIAMSON, 1858, *2065, p. 46 [**P. corrugata*; OD (M)] [= *Arpatellum* RHUMBLER, 1913, *1572b, p. 391 (*nom. van.*); *Discobolivina*

HOFKER, 1951, *936, p. 358 (obj.)]. Test free, conical, spiral side elevated and evolute, umbilical side flat and involute, elliptical proloculus fol-

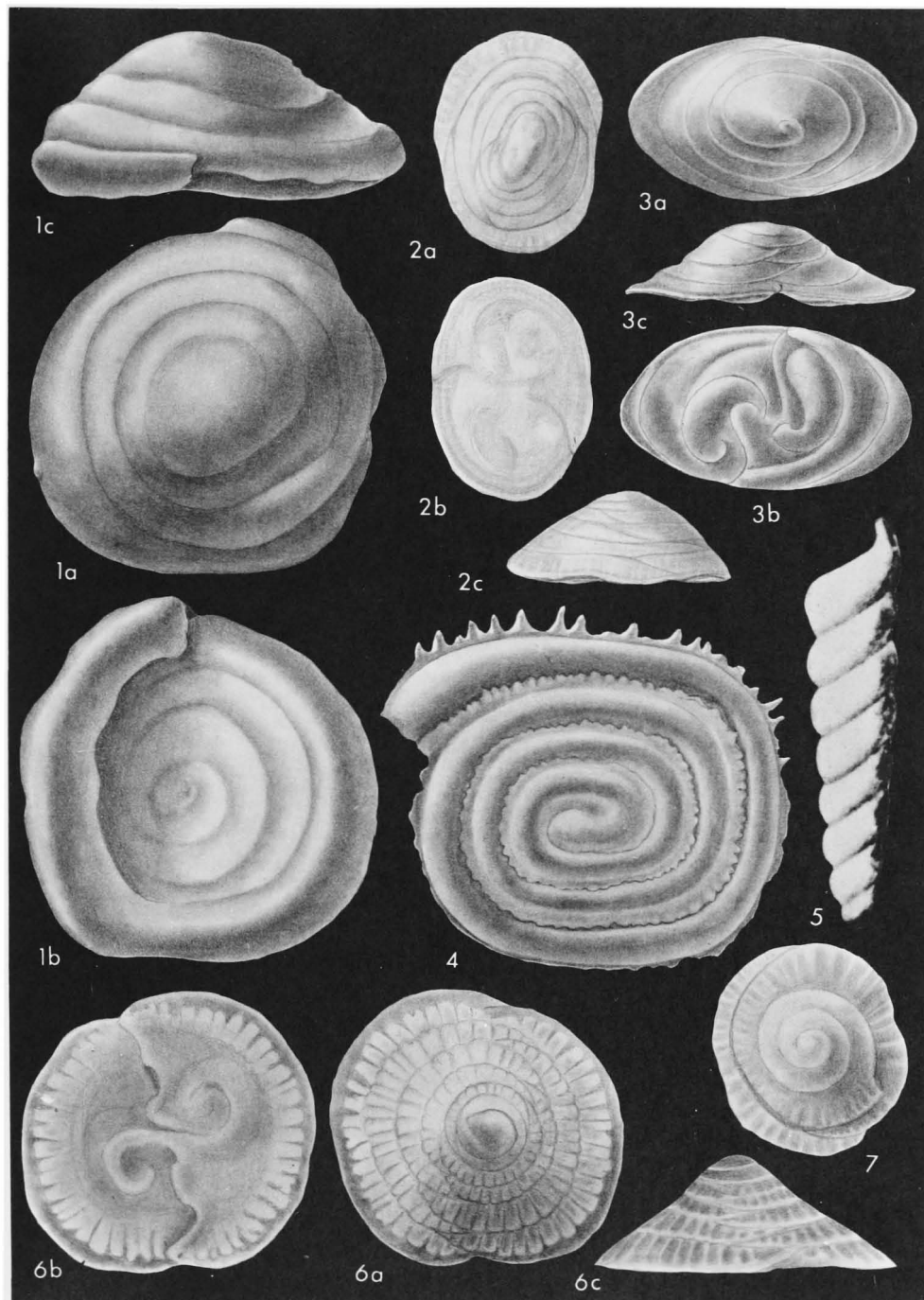


FIG. 477. Spirillinidae (Spirillininae; 1, *Turrispirillina*; 4, *Sejunctella*; 5, *Terebralina*; Patellininae; 2,3, *Patellinoides*; 6,7, *Patellina*) (p. C602-C604).

lowed by spirally wound tubular undivided second chamber of 1 to 3 whorls in microspheric form, proloculus continuous with spiral tube in megalospheric test, smaller in size than that of microspheric generation, later stage with 2 broad, low chambers to each whorl, primary chambers divided by numerous incomplete secondary transverse septa and commonly with intercalated shorter third series, these transverse septa giving typical cancellated appearance to test but extending only approximately width of chambers, as seen from the spiral side, not reaching across umbilical portion of chambers; wall calcareous, built as single calcite crystal, finely perforate; aperture a low arch under exterior margin of scroll-like median septum of final chamber at center of test, median septa of entire test arranged above each other to form columella. *L.Cret.-Rec.*, cosmop.—FIG. 477,6,7, **P. corrugata*, *Rec.*, Can. (6), Greenl. (7); 6a-c, opposite sides and edge view of microspheric hypotype; 7, megalospheric hypotype; all $\times 100$ (*1162).

[HOFKER (1951, *936, p. 358) stated "that all species known as *Patellina* and *Patellinoides* do not show in the initial part a spiral without septa, but that in contrary all genera and species observed show a more or less highly developed conorbine initial part, with fine, only in a clarifier visible, septa." He also added (*928c, p. 422) "that those records which mention an undivided first part of the test, are erroneous ones, or that this character is due to the insufficient state of fossilization."—However, the exacting and detailed work on Recent living specimens of *Patellina corrugata* by MYERS (1935, *1336, pl. 13, fig. 18), definitely showed the presence of an undivided spire, and nuclear characters in camera lucida drawings of decalcified cytological preparations. MYERS also noted that the microspheric tests had a distinct proloculus, followed by an undivided spiral, whereas the megalospheric test showed no separation of the proloculus from the spirally wound tubular chamber. The proloculus of the microspheric generation of *Patellina* was also shown by MYERS (1935, *1335, p. 399) to be larger than that of the megalospheric generation, so that "the terms megalospheric and microspheric, when applied to the dimorphic tests of this species, are not descriptive of the relative diameters of the initial chambers of these two stages The diameter of a megalospheric test having a given number of semilunar chambers is larger than that of a microspheric test having a similar number of chambers because of the larger diameter of the spiral stage of the megalospheric test . . . [p. 402]. The diameter of the initial chamber of a megalospheric test is influenced by the diameter of the nucleus involved, and may or may not depend on the amount of cytoplasm that surrounds the nucleus." MYERS also studied the internal features of the test (*1335, p. 395, fig. 7, and p. 397) and the columella which forms the S-shaped ventral structure considered as a tooth plate by HOFKER (probably this is the "previously unmentioned" feature HOFKER considered a basis for his genus *Discobolovina*) and discussed the morphology of the secondary septa (not mentioned by HOFKER).—HOFKER (1951, *928c, p. 422) stated that the wall was without pores, but MYERS (1935, *1335, p. 396) had shown the presence of a row of pores even in the microspheric proloculus of *P. corrugata* and several rows of pores in the dorsal wall of the chamberlets in later chambers. The conorbine initial stage in *Patellina*, reported by HOFKER (1951, *936, p. 358) does not occur in *P. corrugata*, as MYERS showed in cytological preparations. We have also examined this species in reflected light at magnifications higher than $\times 200$, by transmitted light with anise oil as a clarifier, and in oil immersion at $\times 400$, and no conorbine early portions were found, only a spiral nonseptate coil. Only the genus *Patellinella* has this early conorbine stage, and it lacks the secondary septa of *Patellina*. WILLIAMSON originally described *Patellina corrugata* from Arran, Skye, Shetland, Brixham, and Fowey, all from the British Isles, and from Hunde Island, in Davis Straits, Arctic Canada. He did not cite a holotype, and since all localities are represented on a single slide preserved in the British Museum (Natural

History), London, England, it is impossible to state which is the type locality.]

Patellinoides CUSHMAN, 1933, *461, p. 236 [**P. conica* HERON-ALLEN & EARLAND, 1932, *916, p. 408; OD] [= *Patellinoides* HERON-ALLEN & EARLAND, 1932, *916, p. 407 (*nom. nud.*)]. Test free, tiny, conical, plano-convex, somewhat ovate in outline, trochoid, all chambers visible dorsally, only final pair visible ventrally; proloculus followed by simple undivided spiral tubular chamber of 1 or 2 volutions, then followed by chambers arranged biserially around internal S-shaped columella, as in *Patellina*, but lacking radial secondary septa which form partial chamberlets in *Patellina*; wall calcareous, perforate, composed of single calcite crystal, light reflections from fine pores sometimes giving radial pattern to exterior of test but no true internal secondary partitions present; aperture ventral, small arch near umbilicus. *Rec.*, N.Atl.O.-S.Atl.O.—FIG. 477,2,3, **P. conica* (HERON-ALLEN & EARLAND), S.Atl.; 2a-c, opposite sides and edge view of lectotype (here designated) (BMNH-ZF3568 from R.R.S. *William Scoresby* station WS 408, lat. $53^{\circ}50'00''$ S., long. $62^{\circ}10'00''$ W., Falk. Is., at 454 m.), $\times 200$; 3a-c, opposite sides and edge view of hypotype, $\times 187$ (*2117).

[*Patellinoides* was named by HERON-ALLEN & EARLAND (1932, *916, p. 407) as a new genus including *P. conica*, n. sp., and *P. depressa*, n. sp., neither of which was designated as type-species for the genus. Thus, it was a *nomen nudum*, with no status of availability or validity (Zool. Code, 1961, Art. 13(b)). The genus was validated when the type-species was designated by CUSHMAN (1933, *461, p. 236), who also gave a description and figure for this genus; CUSHMAN must be considered the author of the genus, therefore. The species names *conica* and *depressa* published by HERON-ALLEN & EARLAND in 1932 comply with the Rules in being accompanied by adequate "indications," and they are not *nomina nuda* because given in combination with an invalid generic name; their availability for designation of the specific taxa described is not affected by the status of *Patellinoides* as a *nomen nudum* in the original publication (Zool. Code, 1961, Art. 11(g)(ii), Art. 17(3)). In assigning these species to *Patellinoides* CUSHMAN, the names of the authors HERON-ALLEN & EARLAND need to be enclosed by parentheses, just as if they had used the generic name *Patellina* with *conica* and *depressa*.]

Family ROTALIELLIDAE Loeblich & Tappan, n.fam.

Test trochospiral, consisting of few crescentic to subglobular chambers; wall calcareous, finely perforate, radial in structure, monolamellar; aperture central on umbilical side; quadrinucleate, sexual reproduction with amoeboid gametes. [Because of the similarity in the reproductive cycle, with the amoeboid gametes and the quadrinucleate agamont form, this family is placed in the Spirillinacea.] *Rec.*

Rotaliella GRELL, 1954, *818, p. 269 [**R. heterocaryotica*; OD]. Test tiny, to 60μ diam., free, trochospiral, chambers inflated, subglobular to crescentic, 3 to whorl, increasing rapidly in size, proloculus followed by small hourglass-shaped

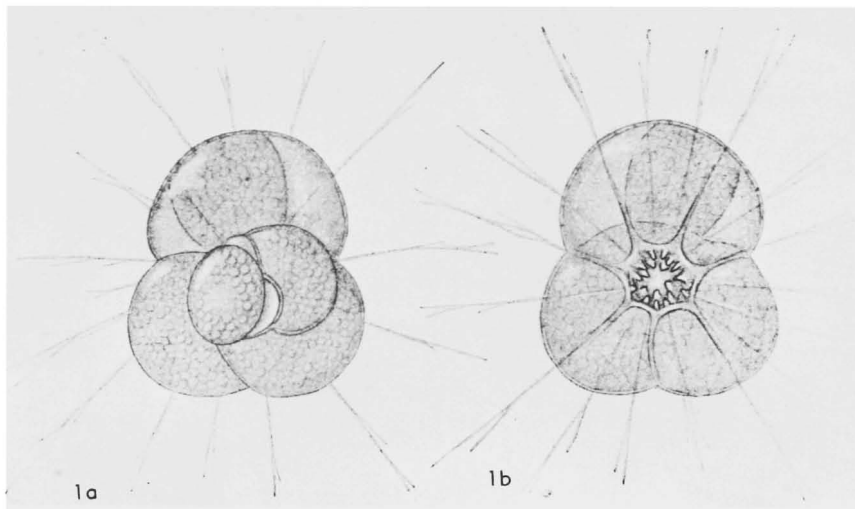


FIG. 478. Rotaliellidae; 1, *Rotaliella* (p. C604-C605).

"intermediate" chamber preceding second normal chamber, adult gamont (megalospheric) with 5 chambers, microspheric test commonly with 6 or rarely 7 chambers; wall calcareous, very thin, transparent, finely perforate, radial in structure and monolamellar; aperture umbilical in position, apertural border with numerous small teeth projecting inward; pseudopodia few, relatively thin, with granular streaming; cytoplasm with 1 or 2 large yellow oil globules, that of agamont (microspheric) form greenish due to presence of large numbers of small *Chlamydomonas* cells, probably ingested as food, agamont heterokaryotic, with single vegetative or somatic nucleus and 3 generative nuclei, dividing in asexual reproduction to form 12 embryonic gamonts, adult mononucleate gamonts each producing 10 to 24 amoeboid gametes which form and may fuse with others within individual parent test (autogamy), zygote developing proloculus and reniform "intermediate" chamber of test before release from parent test. *Rec.*, Eu. (Yugosl.-W.Fr.).—FIG. 478, 1. **R. heterocaryotica*, Yugosl.; 1a, spiral side showing few globular chambers, with proloculus followed by narrow reniform "intermediate" chamber; 1b, umbilical side with thin elongate pseudopodia radiating from umbilicus and umbilical margin with inward-pointing teeth, $\times 680$ (*818).

Superfamily ROTALIACEA Ehrenberg, 1839

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 303 (*pro* superfamily Rotaliacea GLAESSNER, 1945, p. 143)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹superfamily, ²family group); dagger(†) indicates *partim*]—[=¹Orthoklinostegiat EIMER & FICKERT, 1899, p. 685 (*nom. nud.*); =²Rotaliaria RHUMBLER in KÜENTHAL & KRUMBACH, 1923, p. 88; =²Rotaliformes BROTZEN, 1942, p. 9 (*nom. neg.*); =²Rotaliidea SMOUT, 1954, p. 40; =¹Rotaliaceae BRÖNNIMANN, 1958, p. 175]

Canaliculate, double walls and septa of radial laminated calcite secondarily formed; without primary aperture or large pores, or with pores on apertural face or elsewhere, and may have interiomarginal intercameral foramina. *U.Cret.-Rec.*

Family ROTALIIDAE Ehrenberg, 1839

[*nom. correct.* CHAPMAN, 1900, p. 10 (*pro* family Rotalina EHRENBURG, 1839, table opposite p. 120)]—[All names cited of family rank; dagger(†) indicates *partim*]—[=¹Polythalamat LATREILLE, 1825, p. 161 (*nom. nud.*); =¹Turbinaceat and Turbinacés DE BLAINVILLE, 1825, p. 390 (*nom. nud.*); =¹Hélicostégues d'ORBIGNY, 1826, p. 268 (*nom. nud.*, *nom. neg.*); =¹Radiolatat CROUCH, 1827, p. 41 (*nom. nud.*); =¹Radiolididae BRODERIP, 1839, p. 321; =¹Turbinoidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =¹Turbinoidat SCHULTZE, 1854, p. 52 (*nom. nud.*)]—[=¹Rotaliidae REUSS, 1860, p. 221; =¹Rotalida SCHMARDT, 1871, p. 164; =¹Rotaliidae HANTKEN, 1875, p. 80; =¹Rotaliidae SCHWAGER, 1876, p. 479; =¹Rotaliidae BRADY, 1881, p. 44; =¹Rotaliidae DELAGE & HÉROUARD, 1896, p. 145; =¹Rotaliariae RHUMBLER, 1913, p. 339; =¹Arrotalaridia RHUMBLER, 1913, p. 342 (*nom. van.*); =¹Rotaliformes THALMANN, 1945, p. 403 (*nom. neg.*); =¹Rotalidos GADEA BUISÁN, 1947, p. 19 (*nom. neg.*)]—[=¹Pegidiidae HERON-ALLEN & EARLAND, 1928, p. 283; =¹Pegidiida COPELAND, 1956, p. 188 (*nom. van.*)]—[=¹Chapmaniidae GALLOWAY, 1933, p. 316; =¹Chapmaninidae THALMANN, 1938, p. 207; =¹Chapmaniida COPELAND, 1956, p. 187 (*nom. van.*)]

Test trochospiral throughout; with radial canals or fissures and intraseptal and subsutural canals. *U.Cret.-Rec.*

Subfamily ROTALIINAE Ehrenberg, 1839

[*nom. correct.* CHAPMAN, 1900, p. 11 (*pro* subfamily Rotalina SCHULTZE, 1854, p. 52)]—[All names cited of subfamily rank]—[=¹Rotalinae CARPENTER, PARKER & JONES, 1862, p. 198; =¹Rotalina JONES in GRIFFITH & HENFREY, 1875, p. 320; =¹Rotalidae SCHWAGER, 1877, p. 20; =¹Rotalininae HOFKER, 1933, p. 125]

Test trochospiral, all external openings, except perforations, on umbilical side; with radial canals or fissures or umbilical cavities, and commonly with intraseptal and subsutural canals. *U.Cret.-Rec.*

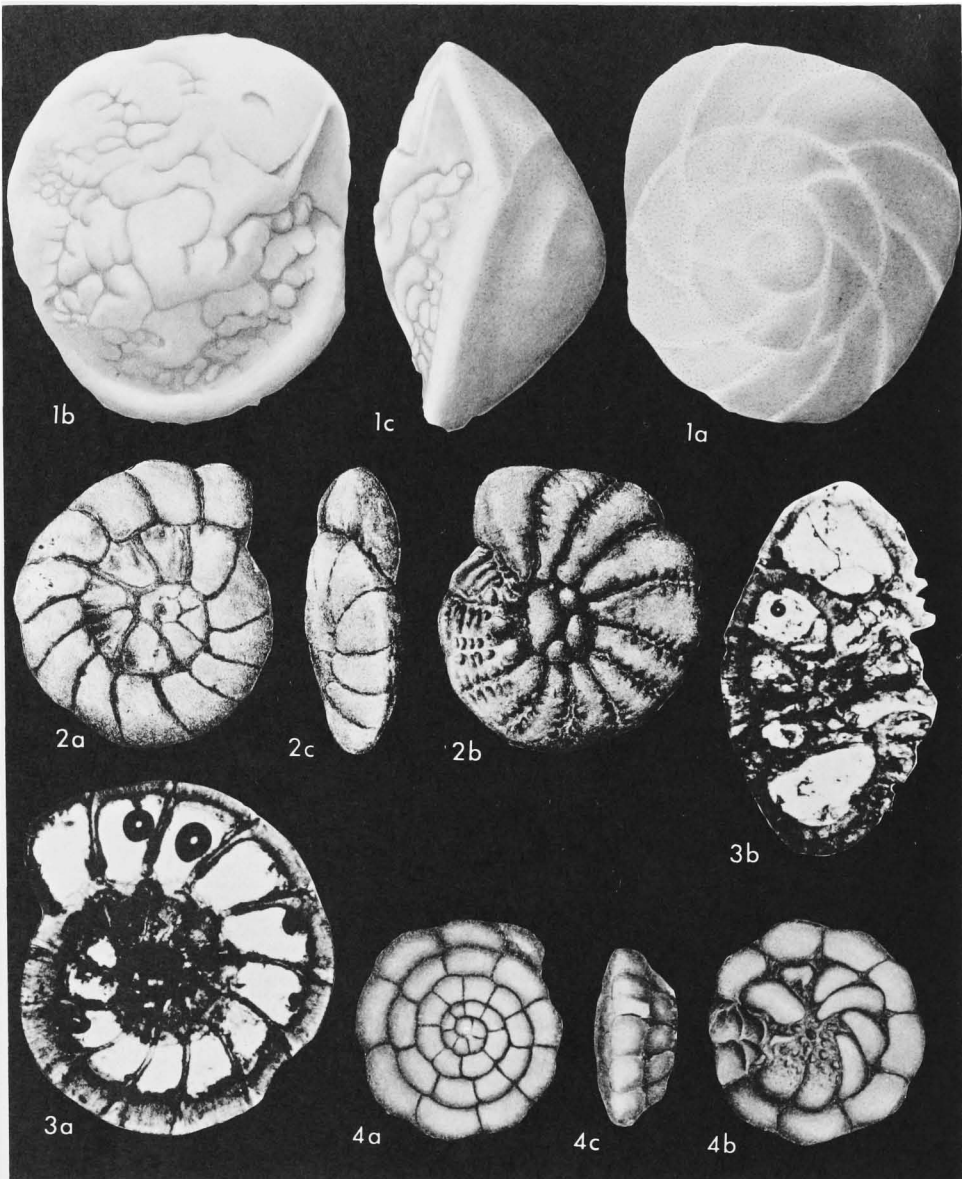
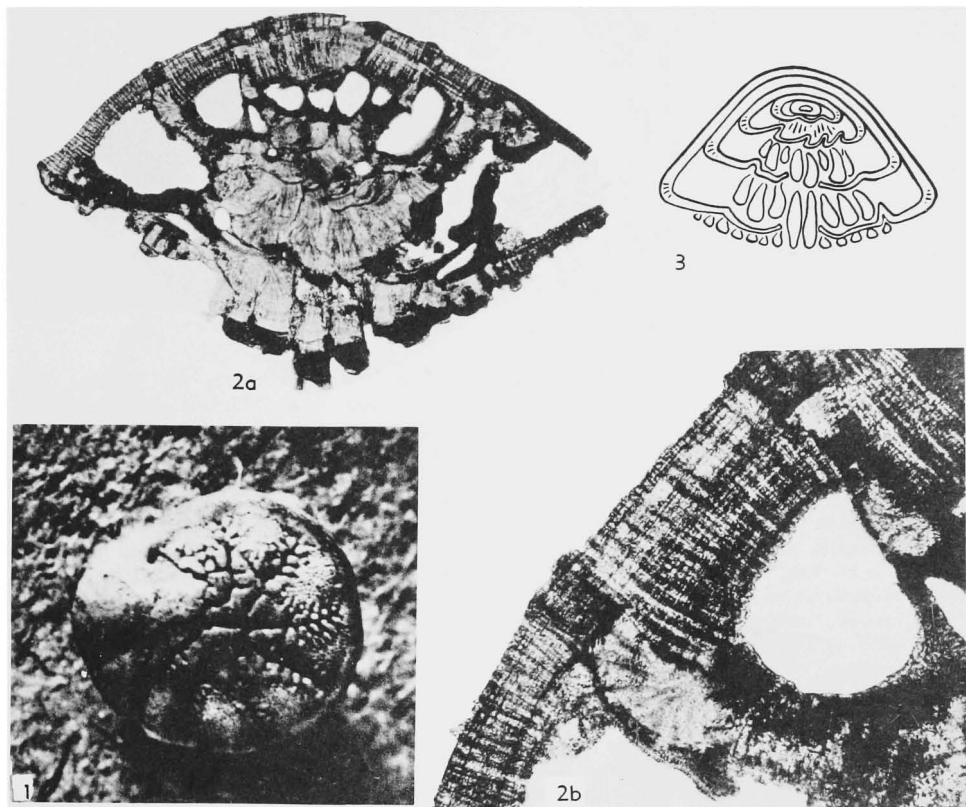


FIG. 479. Rotaliidae (Rotaliinae; 1, *Rotalia*; 2-4, *Ammonia*) (p. C606-C607).

Rotalia LAMARCK, 1804, *1085a, p. 183 [**Rotalites trochidiformis* LAMARCK, 1804, *1085a; SD GALLOWAY & WISSLER, 1927, *766, p. 59] [= *Rotalina* DE BLAINVILLE, 1828, *143, p. 66 (*nom. van. pro Rotalia* LAMARCK, 1804)]. Test free, trochospiral, lenticular to plano-convex, 1-4 mm. diam., all whorls visible from spiral side, spire multilocular and single, direction of coiling random; chambers simple, 8 to 17 to whorl; septa primarily double, formed by upward bending of chamber floor; wall calcareous, coarsely perforate, of radially fibrous calcite; spiral side smooth, umbilical side with

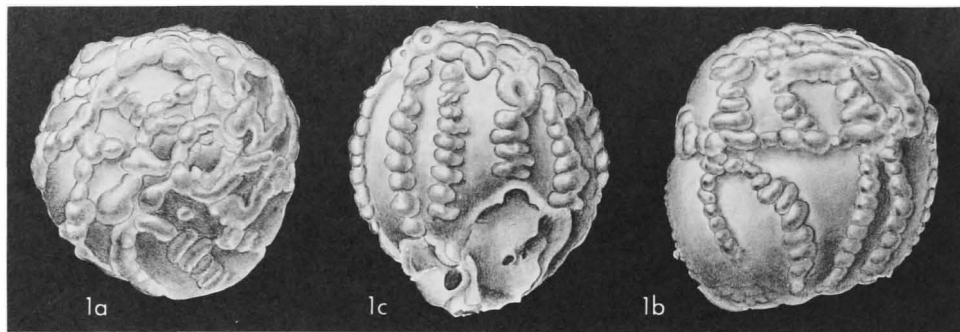
plug split by anastomosing fissures into numerous tubercles and pillars that crowd central portion of test, pillars not continuous from one whorl to next, as in *Dictyoconoides* and *Lockhartia*, but limited to each whorl, although they may fuse laterally to close fissures and form solid central mass, with umbilical canal beneath cortical chamber layer receiving tributary canals from umbilical slitlike apertures at inner side of chambers; in some species fissures or canals also present in septa. [The double septa have long been noted in *Rotalia* (CARPENTER, PARKER & JONES, 1862,

FIG. 480. Rotaliidae (Rotaliinae; 1-3, *Rotalia*) (p. C606-C607).

*281, p. 214; ANDREAE, 1884, *19, p. 215) although only recently has use been made of this character in classification (SMOUT, 1954, *1803, p. 9).] *U.Cret.(Senon.)-Rec.*, cosmop.—FIG. 479, 1; 480, 1-3. **R. trochidiformis* LAMARCK, M.Eoc. (Lutet.), Eu.(Fr.); 479, 1a-c, opposite sides and edge view, $\times 31$ (*2117); 480, 1, lectotype, $\times 20$; 480, 2a, axial sec. showing radially built lamellar walls and umbilical pillars, which are not continuous from one whorl to next, $\times 25$; 480, 2b, portion of preceding sec., $\times 85$; 480, 3, diagram. sec. showing character of umbilical plugs (*561). **Ammonia** BRÜNNICH, 1772, *248, p. 232 [**Nautilus beccarii* LINNÉ, 1758, *1140, p. 710; SD FRIZZELL & KEEN, 1949, *752, p. 106] [= *Hammonium* FICHEL & MOLL, 1798, *716, p. 13, 15 (obj.); *Discorbula* LAMARCK, 1816, *1089, p. 14 (type, *D. ariminsensis*); *Streblus* FISCHER DE WALDHEIM, 1817, *720, p. 449 (obj.); *Les Turbinulines* D'ORBIGNY, 1826, *1391, p. 275 (nom. neg.); *Turbinulina* RISSO, 1826, *1579a, p. 18 (obj.); *Rolshausenia* BERMÚDEZ, 1952, *127, p. 63 (type, *Rotalia rolshauseni* CUSHMAN & BERMÚDEZ, 1946, *493, p. 119); *Rotalidium* ASANO, 1936, *48, p. 350 (type, *R. pacificum*)]. Test free, biconvex, low trochospiral coil of 3 or 4 volutions, sutures

slightly curved, thickened, depressed on umbilical side, septa primarily double; wall calcareous, finely perforate, radial in structure; umbilical surface with irregular granules along suture and over umbilical region; umbilicus with open umbilical fissures and plug in young forms, which is broken up into numerous fused pillars and bosses in adult specimens, umbilical plugs extending inward to proloculus, no umbilical canal; aperture interiomarginal. [*Rotalidium* is regarded as a synonym of *Ammonia*, the "supplementary chamberlets" being the characteristic umbilical extensions, and the very rare type-species as a possible synonym of *Rotalia japonica* HADA, 1931, also described from Recent deposits along the Japanese coast.] *Mio.-Rec.*, cosmop.—FIG. 479, 2, 3. **A. beccarii* (LINNÉ), Rec., Italy (2), S.Fr. (3); 2a-c, opposite sides and edge view of topotype, $\times 27$ (*437); 3a, b, axial and equat. secs., $\times 50$ (*358).—FIG. 479, 4. *A. pacifica* (ASANO), Rec., Japan; 4a-c, opposite sides and edge view of holotype, $\times 33$ (*48).

Asanoina FINLAY, 1939, *717a, p. 541 [**Rotaliatina globosa* YABE & ASANO, 1937, *2087, p. 124; OD]. Test large, to 2 mm. diam., globose, relatively high trochospiral coil of 2 or more whorls,

FIG. 481. Rotaliidae (Rotaliinae; 1, *Asanoia*) (p. C607-C608).

with strongly convex spiral and umbilical sides, nonumbilicate; sutures raised and granulate; internal structure not described; aperture slitlike interiomarginal opening. *Plio.-Rec.*, Malay Arch. (Java).—FIG. 481, 1. **A. globosa* (YABE & ASANO); 1a-c, spiral and 2 edge views, intercameral foramen visible as rounded opening near umbilical region, $\times 33$ (*2117).

Asterorotalia HOFKER, 1950, *932, p. 73, 76 [**Calcarina pulchella* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 80, =*Rotalia trispinosa* THALMANN, 1933, *1895, p. 248; OD (M)]. Test free, trochospiral, biconvex, with 3 prominent slender spines radiating from test and continuous through all whorls from earliest, margin carinate; septa with intraseptal passages, opening as series of pores or fissures in and along sutures of umbilical side, partly covered by thin plates with distal openings; wall calcareous, perforate radial in structure, elongate spines formed by outer, main chamber lamellae, around stream of protoplasm emerging from intraseptal space, each spine containing tubular radial canal, surface of spiral side with irregular raised knobs and elevated sutures; interiomarginal aperture nearly equatorial in position, with strongly developed lips, which are fused in sutural region, posterior end of lip extended toward periphery, partly covering previous chamber and intraseptal fissure, leaving labial aperture in sutural position between lip and chamber, interior with strongly twisted tooth plate, intercameral foramina broadly elliptical in outline. [The type-species was originally described as *Calcarina pulchella* D'ORBIGNY, 1839, and transferred to *Rotalia* by BRADY (1884, *200, p. 710), an apparent synonym of *Rotalia pulchella* D'ORBIGNY (1826, *1391, p. 274). It was later transferred to *Pulvinulina* (= *Eponides*) by JONES, PARKER & BRADY (1866, *1002, pl. 2, fig. 25-27), and *Calcarina pulchella* was renamed *Rotalia trispinosa* by THALMANN (1933, *1895, p. 248). However, as the 2 species were originally described in distinct genera and are not now regarded as congeneric, the specific name *pulchella* is valid for the present type-species.] *Pleist.-Rec.*, Carib. (Cuba)-E.Indies (Indon.)-Pac.O.—FIG. 482, 1-4.

**A. pulchella* (D'ORBIGNY); Rec., Indon.; 1a,b, opposite sides, $\times 50$ (*200); 2, umbilical side of young specimen showing aperture, sutural plates, and their distal openings; 3a, portion of umbilical side of larger specimen; 3b, final chamber, showing poreless but tuberculate apertural face, and aperture; all $\times 168$ (*928c); 4, horiz. sec. showing spines with central canal, septal flaps, and intraseptal passages, $\times 55$ (*1534).

Dictyoconoides NUTTALL, 1925, *1367, p. 384 [*nom. subst. pro Conulites* CARTER, 1861, *287b, p. 53 (*non* FISCHER DE WALDHEIM, 1832; *nec* COZZENS, 1846) [**Conulites cooki* CARTER, 1861, *287b, p. 53; OD]]. Test conical, with proloculus at apex, spiral side with thin imperforate lamina beneath which is layer of rectangular, spirally arranged chambers, in multiple spire, umbilical side with radiating pillars of shell matter extending out from apex and 0.1-0.15 mm. diam. at surface, with intervening spaces of nearly same size, spaces being divided by horizontal partitions; septa double, with median intraseptal canal and sub-sutural canal system; wall calcareous, umbilical side with granules, cavities in umbilical region separated by perforate plates and buttressing pillars; aperture multiple, umbilical, consisting of pores between pillars. *M.Eoc.*, Asia (India-Qatar Penin.)-Afr. (Somali).—FIG. 483, 1-5. **D. cooki* (CARTER), Somali. (1), India (2-5); 1a-c, opposite sides and edge view, $\times 6$ (*1788c); 2, axial sec., $\times 8$; 3, tang. sec. through rectangular chambers, $\times 16$; 4, horiz. sec. through pillars, $\times 8$ (*1367); 5, axial sec. of lectotype, showing chambers near outer margin of conical test and prominent vertical pillars, $\times 10$ (*561).

Dictyokathina SMOUT, 1954, *1803, p. 64 [**D. simplex*; OD]. Test trochospiral, with umbilical mass containing strong vertical radial canals, as in *Kathina*, but with spire repeatedly doubling in plane of coiling to form multiple spire, as in *Dictyoconoides*; wall calcareous, radially fibrous, finely perforate and laminated; intercameral foramen an interiomarginal slit, probably representing earlier aperture. *Paleoc.*, ?*L.Eoc.*, Arabia (Qatar Penin.)-Iraq.—FIG. 484, 1-4. **D. simplex*, *Paleoc.*, Qatar (1,3,4), Iraq (2); 1,2, horiz. secs.

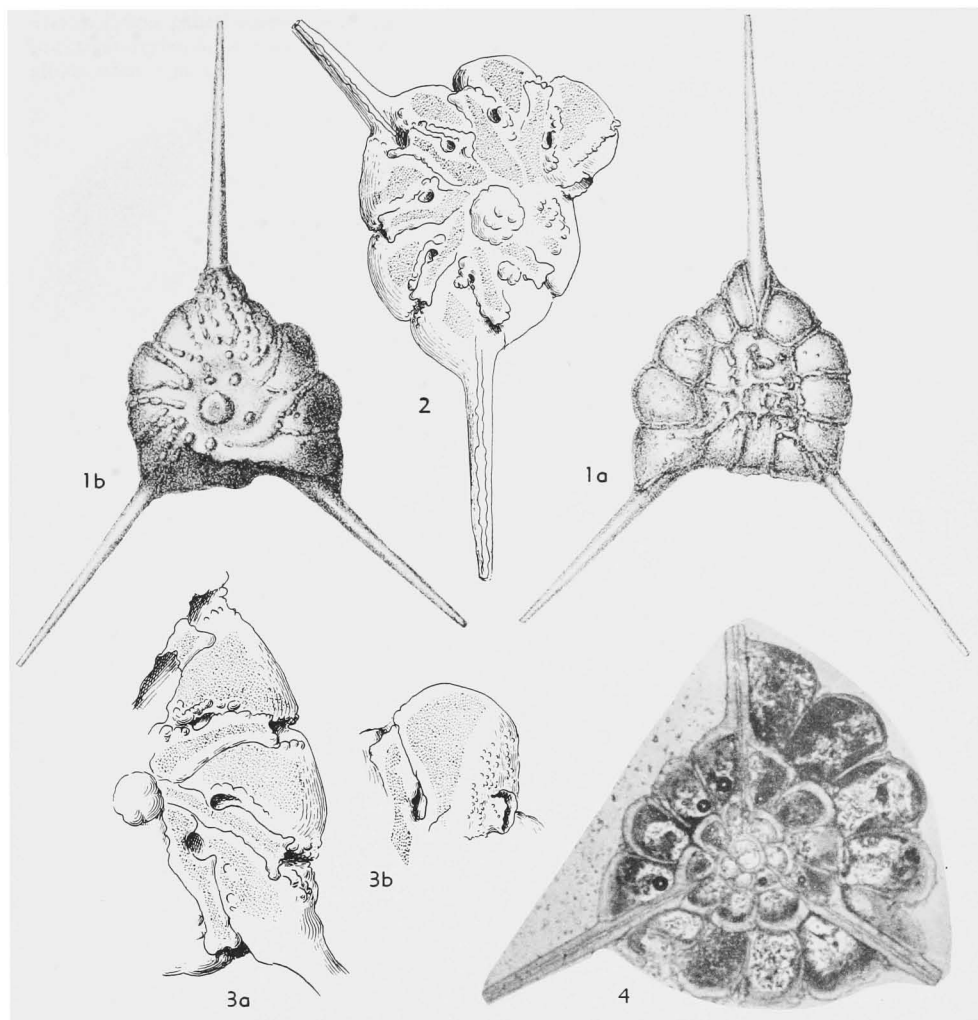


FIG. 482. Rotaliidae (Rotaliinae; 1-4, *Asterorotalia*) (p. C608).

of megalospheric and microspheric forms, $\times 12$, $\times 10$; 3a-c, opposite sides and edge view of paratype, $\times 16$; 4, nearly axial vert. sec. of megalospheric form, $\times 25$ (*1803).

Kathina Smout, 1954, *1803, p. 61 [*K. delseata*; OD]. Test trochospiral, differing from *Dictyoconoides* in having chambers arranged in simple spire, umbilical side may have central plug with strong vertical canals; chambers simple, without supplementary chamberlets or umbilical extensions found in *Lockhartia* and *Sakesaria*; septa double, with intraseptal and subsutural canals but no definite sutural openings or retral processes, strong vertical canals opening as pores or slits on umbilical side; wall very finely perforate, of radially fibrous calcite, lamellar thickening pronounced, but no pustules or ornamentation; aper-

ture an interiomarginal slit. *U.Cret.-Paleoc.*, Arabia (Qatar Penin.) - Carib.(Cuba).—FIG. 484,5-8. **K. delseata*, Paleoc., Qatar; 5a,b, spiral and umbilical sides of paratype; 6, decorticated holotype showing simple spire; 7, paratype, umbilical view showing apertures at end of vertical canals; all $\times 12$; 8, axial sec. of paratype, $\times 25$ (*1803).

Lockhartia DAVIES, 1932, *561, p. 406 [*Dictyoconoides haimeii* DAVIES, 1927, *559, p. 280; OD]. Test conical to lenticular, trochospiral; chambers forming outer layer of cone, leaving wide umbilical area, chamber walls curving inward toward umbilicus leaving open only marginal slit which opens into cavity between outer wall laminae; local thickening and bending of umbilical laminae may result in irregular buttresses or pillars, which fill umbilical area, appearing as granules at um-

bilical surface, may be labyrinthic; wall calcareous, of laminated radially fibrous calcite, coarsely perforate, aperture an interiomarginal slit. [*Lockhartia*

has numerous intercommunicating umbilical cavities into which the cortical chambers open, and which open to the exterior as large pores on the

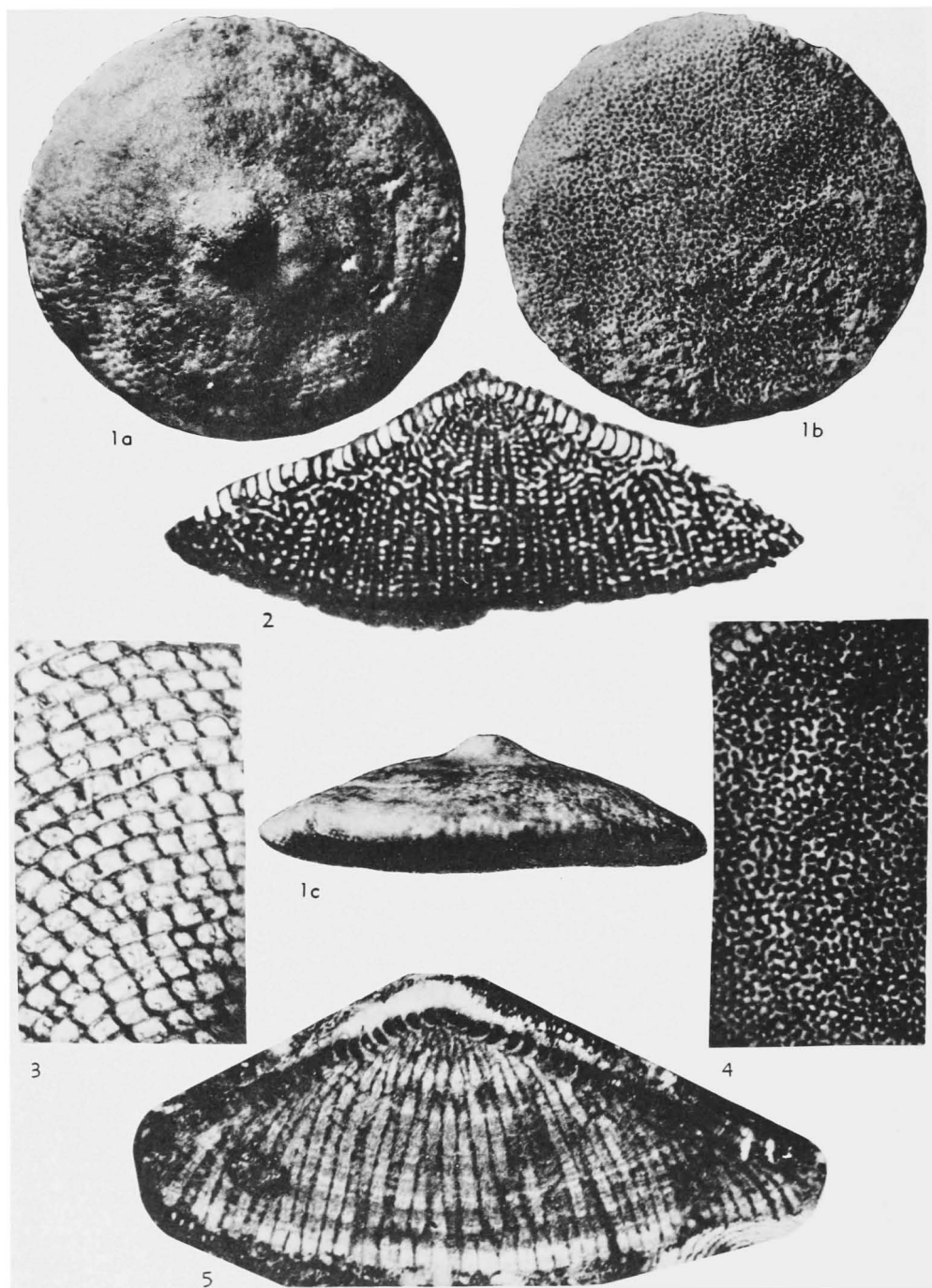


FIG. 483. Rotaliidae (Rotaliinae; 1-5, *Dictyoconoides*) (p. C608).

umbilical side. *Rotalia* differs in having a solid umbilical plug or fissured one with a spiral canal beneath the chambers and tributary canals con-

necting to them. *Dictyoconoides* is similar to *Lockhartia*, but has intercalary whorls into the spire.] *Paleoc.-M.Eoc.*, Asia (India-Arabia-Iraq)-

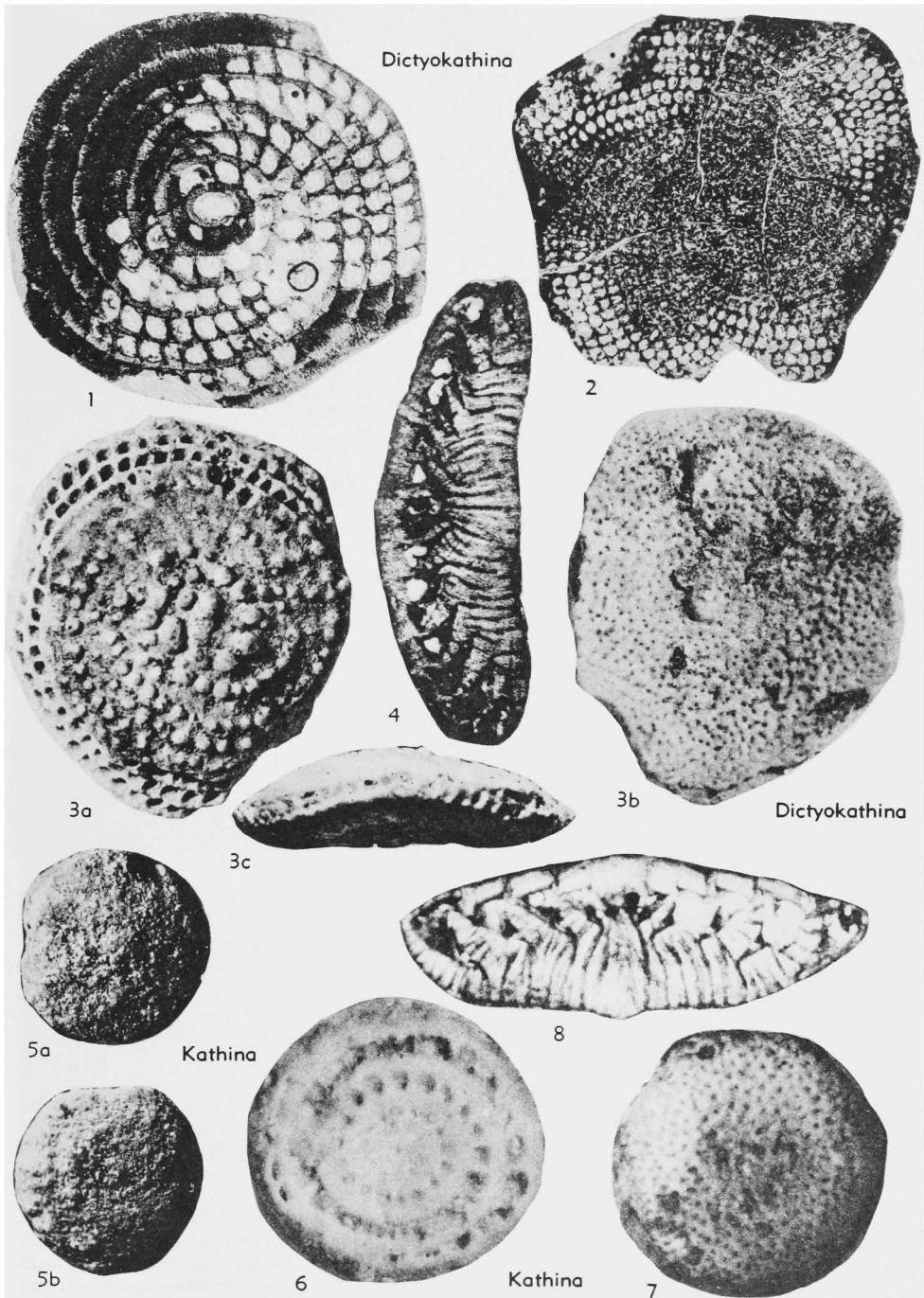


FIG. 484. Rotaliidae (Rotaliinae; 1-4, *Dictyokathina*; 5-8, *Kathina*) (p. C608-C609).

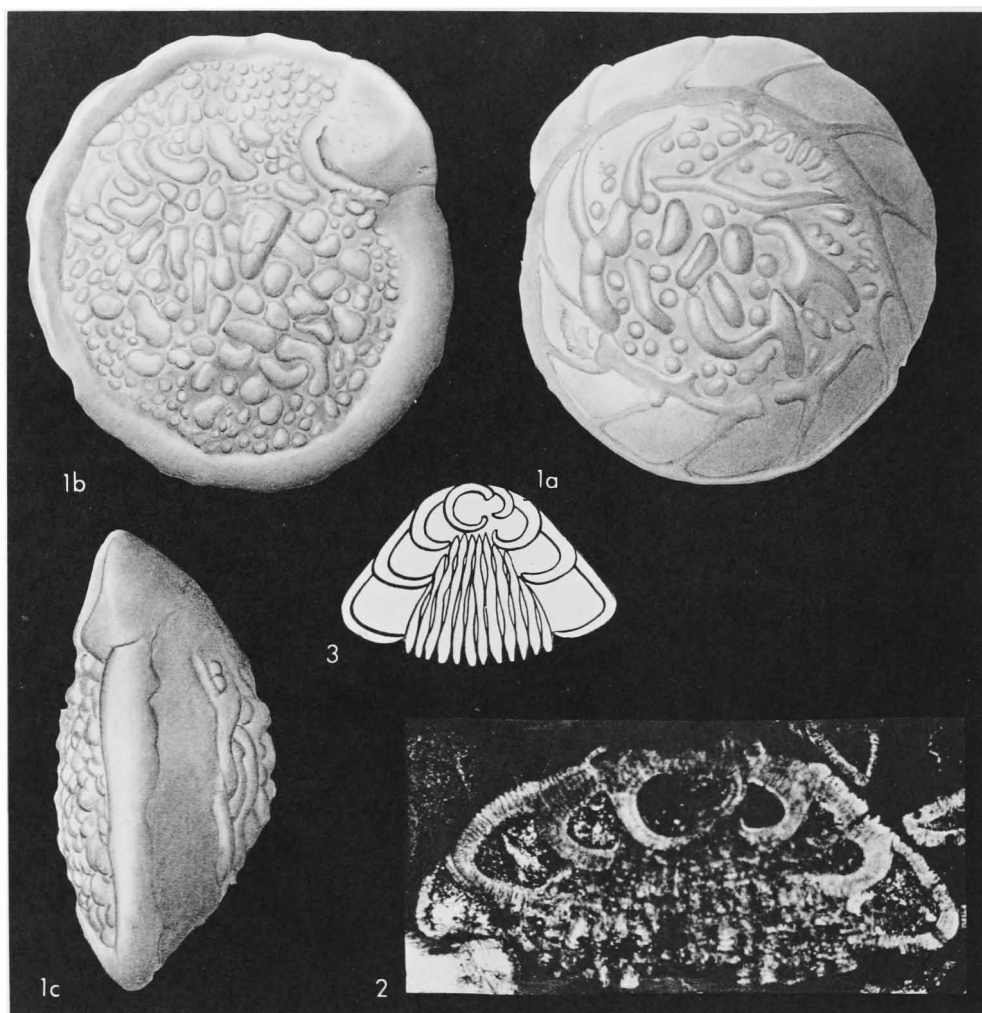


FIG. 485. Rotaliidae (Rotaliinae; 1-3, *Lockhartia*) (p. C609-C612).

E. Afr.-S. Am. — FIG. 485, 1-3. **L. haimeii* (DAVIES), Paleoc., India; 1a-c, opposite sides and edge view of topotype, $\times 26$ (*2117); 2, axial sec. showing umbilical pillars, $\times 30$; 3, diagram. sec. (*561).

Pararotalia Y. LE CALVEZ, 1949, *1112, p. 32 [**Rotalia inermis* TERQUEM, 1882, *1890, p. 68; OD] [= *Neorotalia* BERMÚDEZ, 1952, *127, p. 75 (type, *Rotalia mexicana* NUTTALL, 1928, *1370, p. 374); *Woodella* HAQUE, 1956, *876, p. 194 (type, *W. granosa*)]. Test free, trochospiral, plano-convex to biconvex, umbilicus filled by plug which may be broken out in preservation, chambers rounded to ovate in plan, may have smoothly rounded periphery or develop short, blunt peripheral spine on each chamber, umbilical region of each chamber partially covered by umbilical flap; wall calcareous, perforate, radially built, rotaliid in structure, smooth or variously ornamented with

large solid spines or fine scattered spines or nodes; apertures on umbilical side, interiomarginal and extraumbilical-umbilical, with lip; internal "tooth plate" near umbilical and axial chamber wall, intercameral foramen narrow, elongate, comma-shaped or slitlike areal opening, consisting of portion of former aperture, roughly paralleling base of apertural face and restricted by tooth plate of following chamber. [*Woodella* is apparently synonymous with *Pararotalia* and the type-species *W. granosa* appears to be conspecific with *Rotalia capdevilensis* CUSHMAN & BERMÚDEZ.] *U.Cret.(Coniac.)-Rec.*, cosmop. — FIG. 486, 1-3. **P. inermis* (TERQUEM), M.Eoc.(Lutet.), Eu.(Fr.); 1a-c, opposite sides and edge view, $\times 73$; 2, apert. region of dissected specimen showing tooth plate of final chamber attached to intercameral foramen of penultimate chamber, $\times 128$ (*1171); 3, equat. sec. showing double septa and intra-

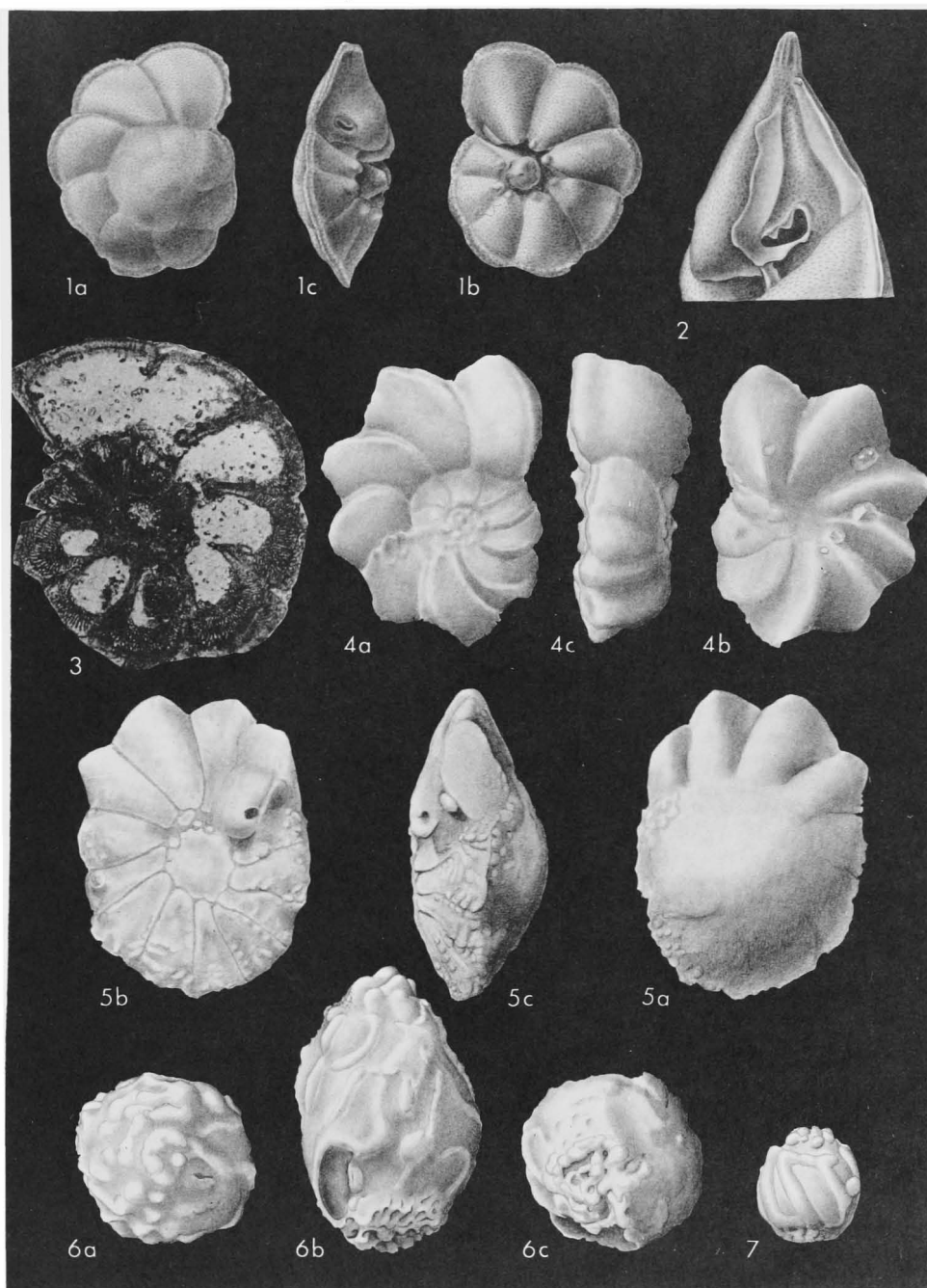


FIG. 486. Rotaliidae (Rotaliinae; 1-5, *Pararotalia*; 6, 7, *Sakesaria*) (p. C612-C614).

septal passages, $\times 65$ (*1534).—FIG. 486.4. *P. nammalensis* (HAQUE), Paleoc., Asia(Pak.); 4a-c, opposite sides and edge view of specimen originally described as *Woodella*, $\times 98$ (*2117).—FIG. 486.5. *P. mexicana* (NUTTALL), U.Eoc., Mex.; 5a-c, opposite sides and edge view of lectotype,

here designated (*1370, pl. 50, fig. 7), $\times 29$ (*2117).

Pseudorotalia REISS & MERLING, 1958, *1534, p. 13 [**Rotalia schroeteriana* CARPENTER, PARKER & JONES, 1862, *281, p. 212: OD]. Test trochospiral, periphery acute, with imperforate keel;

chambers with imperforate umbilical lips confined to radial sector and with imperforate plate-like extensions formed by each succeeding chamber lamella covering umbilical area, those added by successive chambers with intervening cavities, imperforate plates may be pierced by few scattered large rounded openings, surrounded by thickened rims but without pillars or buttresses, opening of successive plates not aligned; septa secondarily doubled by septal flaps, which leave intraseptal passages that open to outside by means of double row of canals in alternating arrangement and sutural position, on both sides of test; wall lamellar, of radially fibrous calcite, coarsely perforate; cameral aperture interiomarginal on umbilical side, partly covered by narrow extension of apertural face, which is resorbed when new chambers are added and aperture becomes intercameral foramen, strongly developed and twisted tooth plate attached at angle, extending backward to close lower part of preceding intercameral foramen, apertural lip forming interiomarginal labial aperture at inner umbilical side of chamber, those of successive chambers remaining open. [*Pseudorotalia* differs from *Rotalia*, *Ammonia*, and *Lockhartia* in having sutural canals on both spiral and umbilical sides and in lacking umbilical labial apertures.] *Plio.-Rec.*, E. Indies (Indon.-Borneo). —FIG. 487, 1-5. **P. schroeteriana* (CARPENTER, PARKER & JONES), *Rec.*, Borneo (1-3,5), ?loc. (4); 1, horiz. sec. showing bifurcating sutural canals, $\times 55$; 2, vert. sec. showing tooth plates, umbilical lips and cavities, and sutural canals, $\times 55$; 3, horiz. sec. showing tooth plates and relationship to septal flap, $\times 55$; 4, oblique ext. view, enlarged; 5, diagram of dissected chamber showing intercameral foramen in septal face, tooth plate attaching below it and labial aperture at umbilical end of chamber (1-3,5, *1534; 4, *281).

Sakesaria DAVIES in DAVIES & PINFOLD, 1937, *563, p. 49 [**S. cotteri*; OD (M)]. Test similar in structure to *Lockhartia*, but differing in having elongate axis of coiling, more numerous whorls, and convex rather than flattened umbilical side; wall calcareous, coarsely perforate, surface commonly ornamented with raised and limbate sutures, pustules and bars. *Paleoc.-L.Eoc.*, Asia (India-Arabia, Qatar Penin.)-Afr. (Somali.). —FIG. 486, 6,7; 487, 6,7. **S. cotteri*, L.Eoc., Qatar Penin. (486,6,7), India (487,6,7); 486, 6a-c, opposite sides and edge view showing high spire and characteristic ornament, $\times 22$ (*2117); 486,7, edge view of young specimen, $\times 22$ (*2117); 487,6, axial sec., $\times 25$ (*563); 487,7, axial sec., $\times 20$ (*1803).

Smoutina DROOGER, 1960, *631b, p. 306 [**S. cruysi*; OD]. Test trochospiral, biconvex, simple spire visible on spiral side, opposite side with central umbilical filling occupying about half of test diameter; chambers communicating with spiral

canals at their umbilical end; septa double, with fissures on umbilical side that connect with branching spiral canal system in umbilical mass, which contains vertical canals opening as pores at surface; wall lamellar, of radially built calcite, finely perforate; aperture of final chamber not described, intercameral foramen elongate. [*Smoutina* differs from *Rotalia* in having a less completely fissured umbilical mass, and from *Kathina* in having a spiral canal system.] *U.Cret.-M.Eoc.*, S. Am. (Fr. Guiana)-W. Indies (Cuba)-USA (Fla.). —FIG. 487, 8-11. **S. cruysi*, Paleoc., Fr. Guiana; 8a-c, opposite sides and edge view of holotype; 9, axial half sec. showing vert. canals of umbilical mass; 10a,b, horiz. half secs. near umbilical and spiral sides showing canal systems, double septa, and radial walls; 11, peripheral view of broken specimen showing intraseptal and vert. canals and nearly basal intercameral foramina; all $\times 27$ (*631b).

Subfamily CUVILLIERININAE

Loeblich & Tappan, n.subfam.

Test trochospiral to nearly planispiral, spiral and umbilical sides not differentiated in structure; canal system with subsutural and intraseptal canals and vertical canals or fissures, without differentiated marginal cord, spines or retral processes. *U.Cret. (Campan.)-Mio.*

Cuvillierina DEBOURLE, 1955, *567b, p. 55 [**C. eocenica*, = *Laffitteina vallisensis* RUIZ DE GAONA, 1948, *1595, p. 87, = *L. vanbelleni* GRIMSDALE, 1952, *826, p. 232; OD] [= *Cuvillierina* DEBOURLE, 1955, *567a, p. 19 (nom. nud.)]. Test free, planispiral, but slightly asymmetrical, exterior with reticulate ornamentation related to canal system, commonly with chevron pattern over sutures, open umbilical region with numerous pillars, and spongy with vertical and lateral canals present, as in *Notorotalia* and *Elphidium*, on both sides of test; septa double, rows of sutural canals connecting vertical grooves with intraseptal passages; septal flap "tooth plate" nearly equatorial but longitudinally folded, bending forward to coalesce with distal face of chambers and forming "spiral canal," which is not a true canal; wall calcareous, perforate, radially built; intercameral foramina comma-shaped, similar to those of *Pararotalia* and *Laffitteina*. [*Cuvillierina* was originally placed in the Nonionidae, but has a radially built rotalid wall structure rather than granular wall structure. Because of the absence of retral processes and the planispiral coiling it was placed in the Miscellaneousidae by REISS, 1957, *1528b.] *Eoc. (Ypres.)*, Eu. (Spain-Fr.)-Asia (Iraq-Syria-Israel). —FIG. 488, 1-4. **C. vallisensis* (RUIZ DE GAONA), Fr. (1-3), Syria (4); 1a,b, side and apert. views, $\times 82$ (*2117); 2, equat. sec. showing double septa with intraseptal passages; 3, axial

sec., $\times 87$ (*1534); 4, portion of tang. sec. showing vert. canals in umbilical region and divergent canals over chambers of outer whorl, $\times 27$ (*826).

Arnaudiella DOUVILLÉ, 1907, *618, p. 599 [*A. grossouvrei*; OD]. Test thin, lenticular, 5 to 7 mm. diam., planispiral, with approximately 4

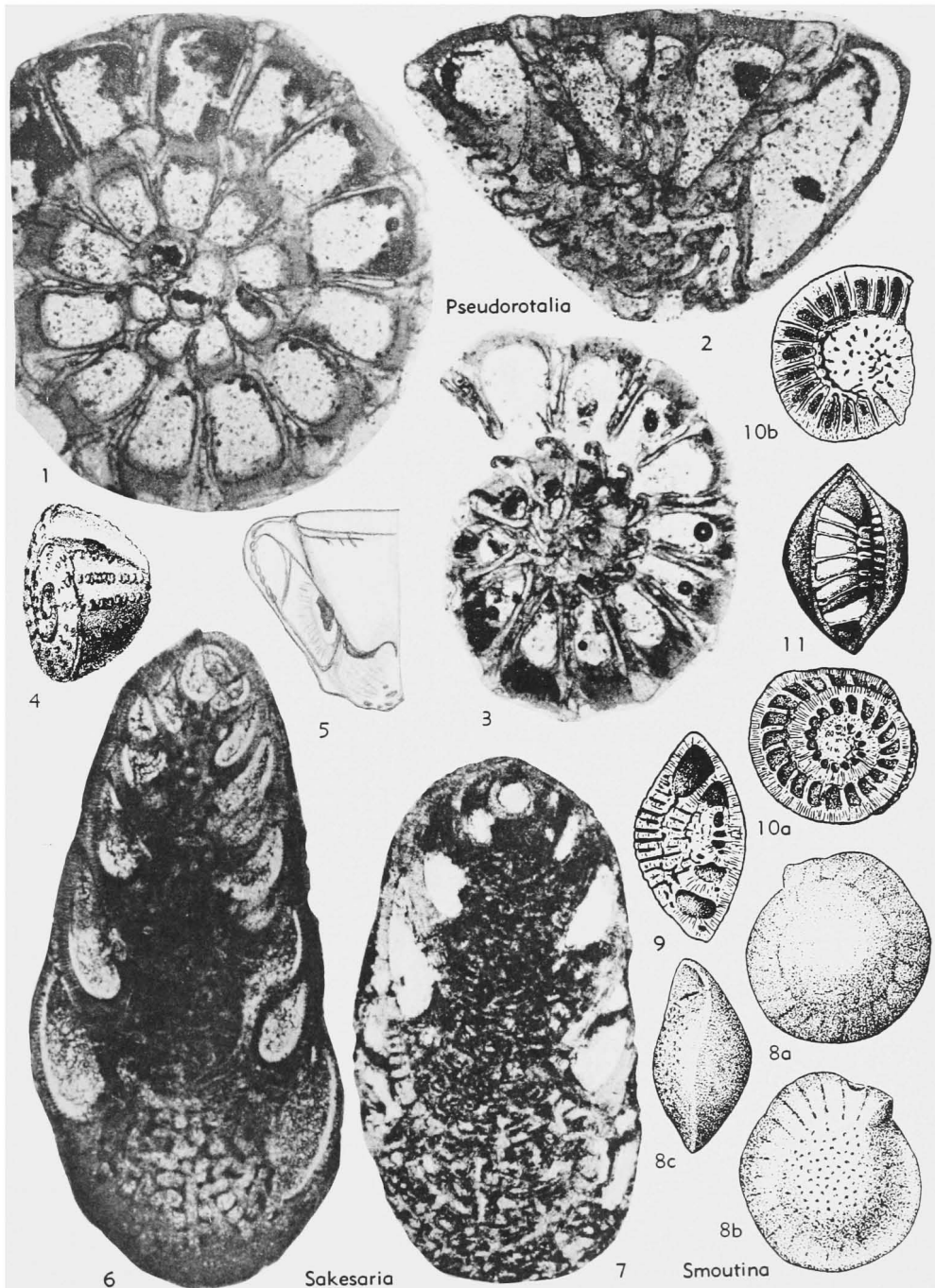


FIG. 487. Rotaliidae (Rotaliinae; 1-5, *Pseudorotalia*; 6,7, *Sakesaria*; 8-11, *Smoutina*) (p. C613-C614).

whorls; chambers numerous, involute, with layers of vacuoles resembling lateral chamberlets; wall calcareous, lamellar, spiral septum strongly thickened, umbilical pillars appearing as nodes at sur-

face. *U.Cret.(Campan.)*, Eu.(Fr.).—FIG. 489, 1-3. **A. grossouvrei*; 1, holotype, $\times 8$ (*2118); 2, oblique tang. sec. cutting chambers near center and showing thickened spiral septum containing

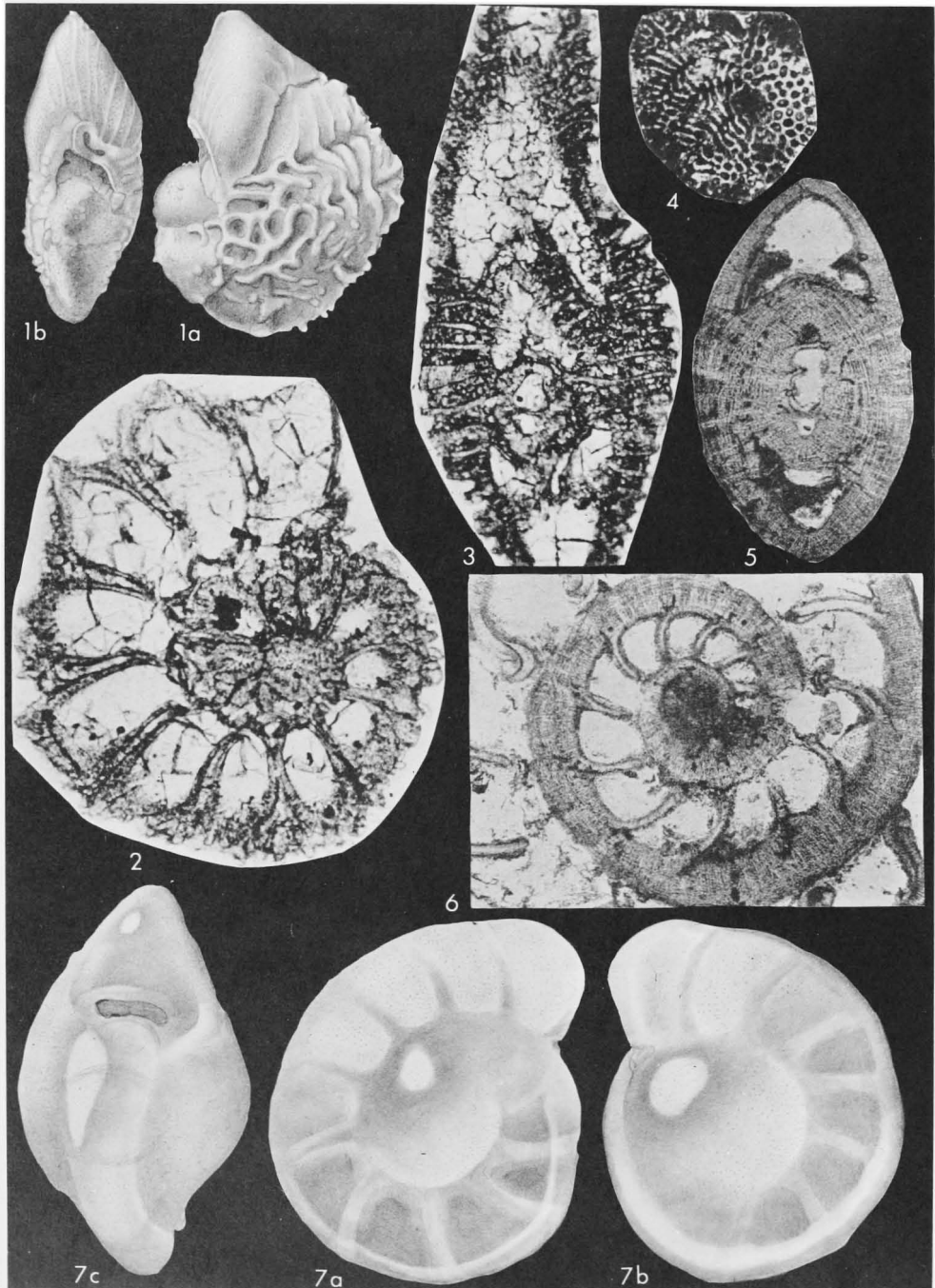


FIG. 488. Rotaliidae (Cuvillierininae; 1-4, *Cuvillierina*; 5-7, *Crespinella*) (p. C614-C615, C617).

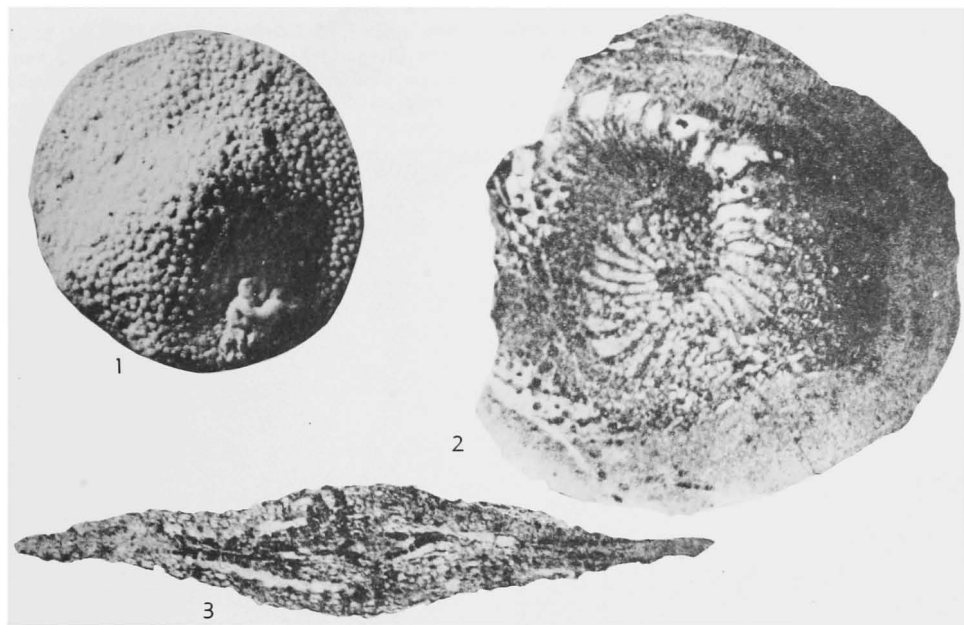


FIG. 489. Rotaliidae (Cuvillierininae; 1-3, *Arnaudiella*) (p. C615-C616).

small vacuoles, $\times 13$; 3, axial sec. showing involute whorls and vacuolated spiral septum, $\times 13$ (*618).

Crespinella PARR, 1942, *1426, p. 361 [**Operculina? umbonifera* HOWCHIN & PARR, 1938, *968, p. 309; OD]. Test free, early stage trochospiral, in adult biinvolute and nearly planispirally enrolled, biconvex and biumbonate, periphery subacute to rounded, chambers increasing gradually in size, numerous; sutures indistinct, radial and slightly curved; wall calcareous, thick, lamellar, microstructure unknown, distinctly perforate, apparently with interseptal canals and tubular passages in plane of coiling; aperture an interiomarginal equatorial or somewhat asymmetrical slit with projecting upper lip. *Mio.*, S. Australia.—FIG. 488, 5-7. **C. umbonifera* (HOWCHIN & PARR); 5, axial sec., $\times 35$; 6, central portion of equat. sec., $\times 47$ (*1426); 7a-c, opposite sides and edge view, $\times 40$ (*2117).

Daviesina SMOUT, 1954, *1803, p. 66 [**D. khatiyahi*; OD] [= *Miscellanoides* SANDER, 1962, *1625A, p. 13 (type, *M. bramkampii*)]. Test operculine, biconvex to concavoconvex, but slightly asymmetrical, umbilical region with pillars, fissures, and vertical canals on both sides of test; septa double, with intraseptal canals; wall calcareous, lamellar, perforate, radially built; aperture not observed, intercameral foramen a basal slit. [*Miscellanoides* was described in 1962, but in a footnote the author stated that the genus had been described previously by SMOUT, 1954, as *Daviesina*.] *Paleoc.*, Arabia (Qatar Penin.).—FIG. 490, 1-4. **D. khatiyahi*, M. Paleoc.; 1a-c, opposite sides and edge of microspheric form; 2a-c,

megalospheric form; all $\times 17$ (*2117); 3, nearly axial sec. of microspheric form, $\times 28$; 4, equat. sec. of megalospheric form, $\times 17$ (*1803).

Fissoelphidium SMOUT, 1955, *1804, p. 208 [**F. operculiferum*; OD]. Test planispiral, bilaterally symmetrical, chambers numerous; septa double and sutures fissured in dendritic pattern; umbilical region with fissured umbilical mass similar to that of *Rotalia* but occurring on both sides of test; wall calcareous, lamellar and radially fibrous, perforate; aperture a series of pores in somewhat protruding apertural plate in interiomarginal position, plate being resorbed when next chamber forms, leaving equatorial interiomarginal slitlike foramen. *U. Cret.* (Maastricht.), Asia (Arabia-Iraq).—FIG. 490, 5; 491, 1-3. **F. operculiferum*, Qatar Penin; 490, 5a, b, side and edge views showing fissured umbilical mass, dendritic fissured sutures, and perforated apertural plate, $\times 28$ (*2117); 491, 1, edge view showing intercameral slitlike foramen; 491, 2, axial sec. showing umbilical thickening; 491, 3, equat. sec. showing double septa; all $\times 30$ (*1804).

Penoperculoides COLE & GRAVELL, 1952, *372, p. 714 [**P. cubensis*; OD] [= *Penoperculinoides* HANZAWA, 1962, *875, p. 140 (*nom. van.*)]. Test slightly asymmetrical, trochoid in early stages, adult nearly planispiral, involute; wall calcareous, laminated and finely tubulated; aperture an arched slit at base of last-formed chamber so arranged that it extends more on one side of median line than other. *M. Eoc.*, Carib.—FIG. 492, 1. **P. cubensis*, Cuba; 1a-d, ext. views, $\times 10$; 1e, axial sec., $\times 20$; 1f, g, equat. secs., $\times 20$ (*372).

Pokornyyellina LOEBLICH & TAPPAN, *nom. nov.* [*pro* *Pokornyyella* LOEBLICH & TAPPAN, 1961, *1181, p. 220 (*nom. subst. pro* *Siderina* ABRARD, 1926) (*non* *Pokornyyella* OERTLI, 1956)] [**Siderina douvillei* ABRARD, 1926, *2, p. 31, here designated as

type-species] [= *Siderina* ABRARD, 1926, *2, p. 31 (*non* DANA, 1848) (*obj.*)]. Test large, to 7 mm. diam., discoidal, slightly asymmetrical, laterally compressed but with prominent umbilical thickening on both sides, consisting of pillars which appear

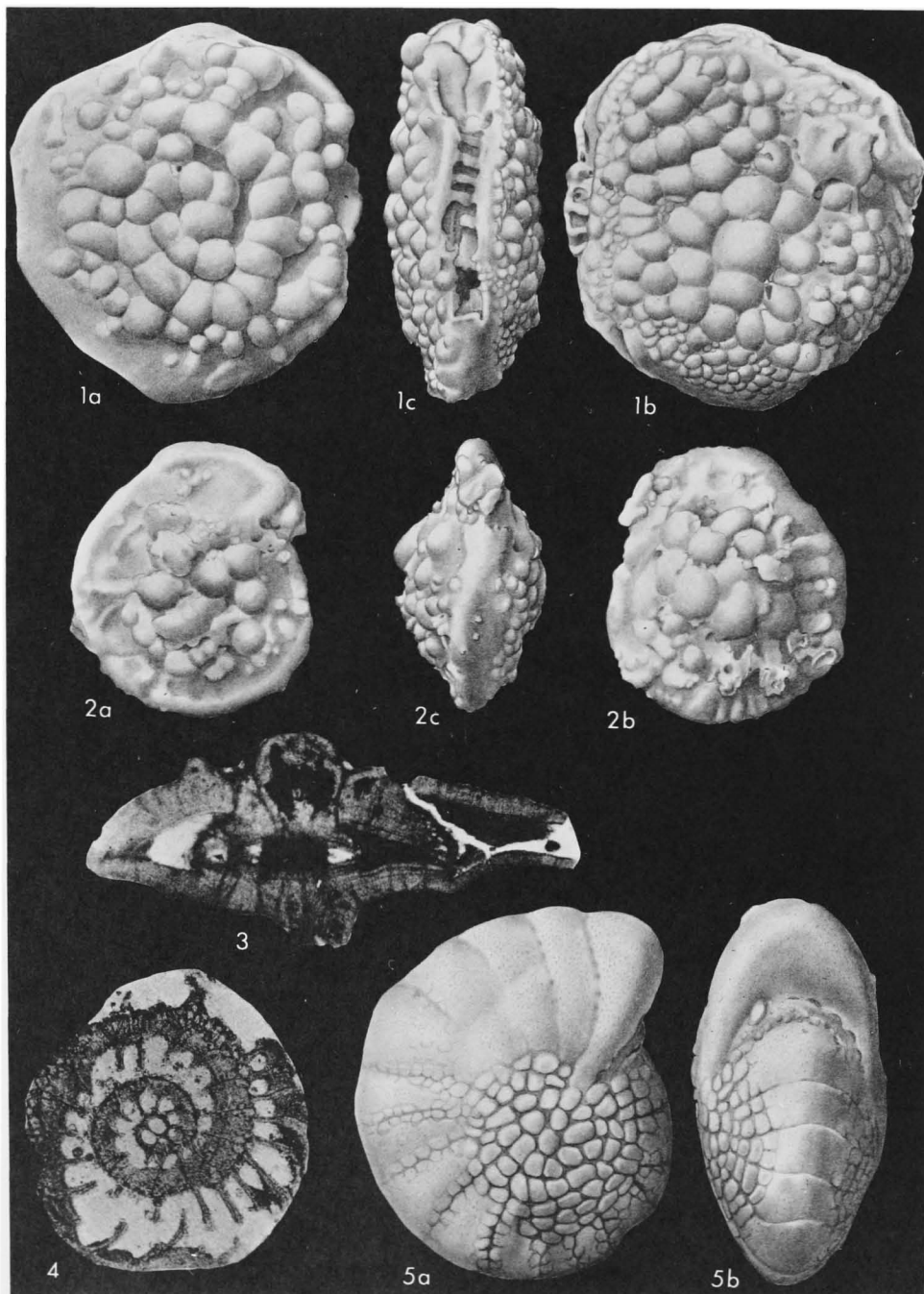


FIG. 490. Rotaliidae (Cuvillierininae; 1-4, *Daviesina*; 5, *Fissoelphidium*) (p. C617).

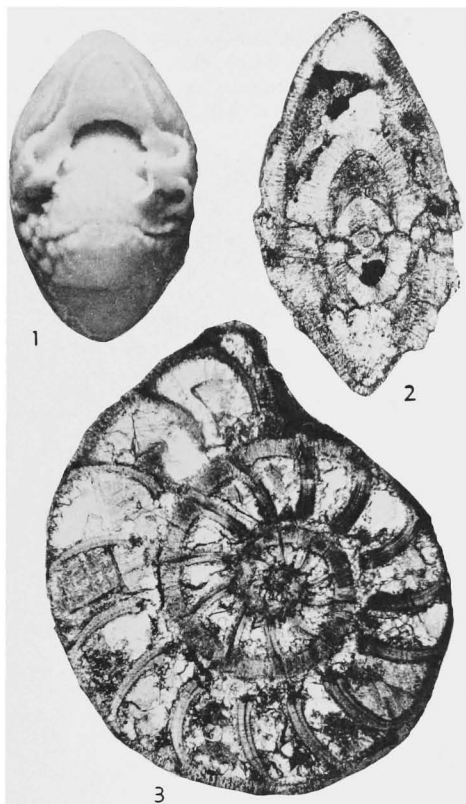


FIG. 491. Rotaliidae (Cuvillierininae; 1-3, *Fissolophidium*) (p. C617).

at umbilical surface as small nodes; chambers broad, low and numerous, planispirally coiled; aperture not described. *U.Cret.(Campan.)*, Eu. (Fr.).—FIG. 493,1,2. **P. douvillei* (ABRARD); 1, ext., $\times 4.5$; 2, equat. sec., $\times 6$ (*2).

[The original illustrations and description of *Siderina* ABRARD suggest that it may be congeneric with *Arnaudiella* or *Pseudosiderolites*. Until type material of all three type-species can be re-examined, the present genus is tentatively recognized, and is renamed, inasmuch as *Siderina* ABRARD, 1926, and *Pokornyella* LOEBLICH & TAPPAN, 1961, are both homonyms.]

Pseudosiderolites SMOUT, 1955, *1804, p. 206 [**Siderolites vidali* DOUVILLÉ, 1907, *618, p. 599; OD]. Test lenticular, bilaterally symmetrical, planispirally coiled, with numerous radial canals, umbilical region with pillars, showing as nodes at surface; septa double, with intraseptal canals; walls perforate, of radially built calcite, lamellar and thickened particularly in marginal area; aperture not described. [*Pseudosiderolites* differs from *Arnaudiella* in having prominent radial canals and in lacking intralamellar vacuoles.] *U.Cret.*, Eu. (Spain-Fr.).—FIG. 493,3-5. **P. vidali* (DOUVILLÉ), Maastricht, Spain; 3, ext., holotype, $\times 4$ (*618); 4, axial sec.; 5, equat. sec. showing thickened marginal region, radial canals, and double septa; $\times 15$ (*1450).

Pseudowoodella HAQUE, 1956, *876, p. 202 [**P. mamilligera*; OD]. Test free, trochospiral, biconvex, periphery broadly rounded; spiral side evolute but flat to slightly excavated centrally, umbilical side involute, nonumbilicate, sutures radial; wall calcareous, hyaline perforate, radial in structure, lamellar character unknown, surface with single short spine at center of each chamber on spiral side; aperture equatorial, interiomarginal. [The genus was originally placed in the Anomalinidae, but the spiny ornamentation is not characteristic of that group, which also differs in having a granular wall. The type-species needs restudy as to possible lamellar character of the wall and presence of a canal system.] *Paleoc.-L. Eoc.*, Asia (Pak.).—FIG. 493,6. **P. mamilligera*, Paleoc.; 6a-c, opposite sides and edge view of holotype, $\times 115$ (*876).

Storrsella DROOGER, 1960, *631a, p. 295 [**Cibicides haasteri* VAN DEN BOLD, 1946; *155, p. 125; OD]. Test trochospiral, similar to *Fissoelphidium*, fissured sutures on both sides of test, but with umbilical thickened mass only on umbilical side, as

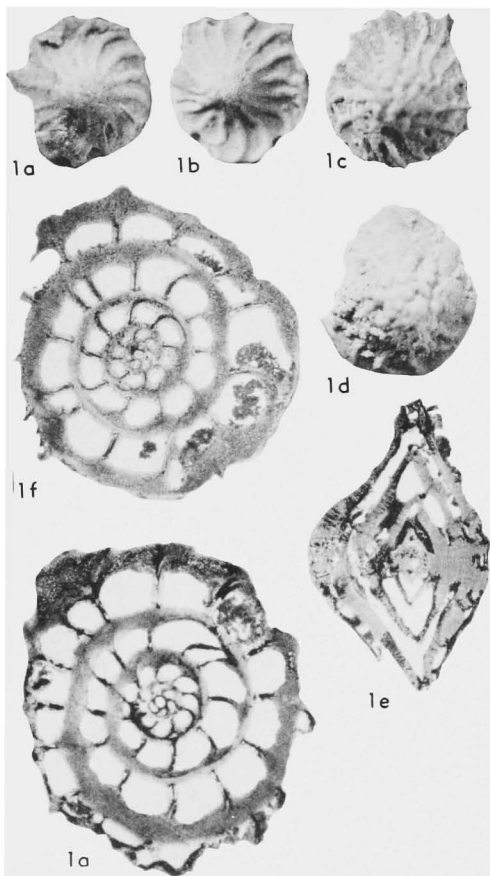


FIG. 492. Rotaliidae (Cuvillierininae; 1, *Penoperculoides*) (p. C617).

in *Rotalia*; aperture of final chamber not described, intercameral foramen interiomarginal, subequatorial, somewhat toward umbilical side. *Paleoc.-L.Eoc.*, C. Am. (Guat.-Br.Hond.)-W. Indies

(Cuba)-S.Am. (Fr. Guiana).—FIG. 493,7-9. **S. haasteri* (VAN DEN BOLD), Guat. (7), Fr. Guiana (8,9); 7a-c, opposite sides and edge view, showing fissures; 8, equat. half sec. showing double

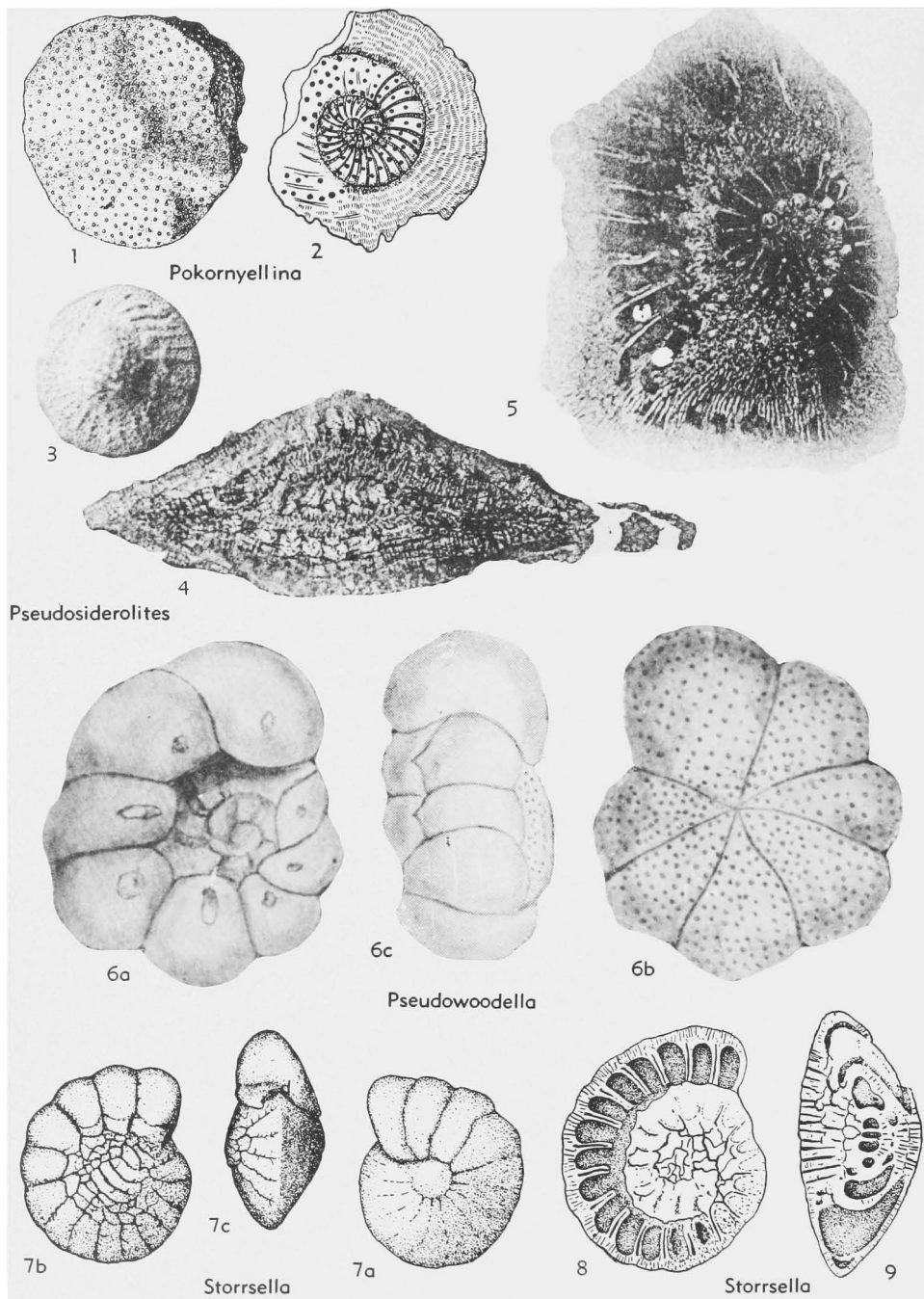


FIG. 493. Rotaliidae (Cuvillierininae): 1,2, *Pokornyyellina*; 3-5, *Pseudosiderolites*; 6, *Pseudowoodella*; 7-9, *Storrrella* (p. C618-C620).

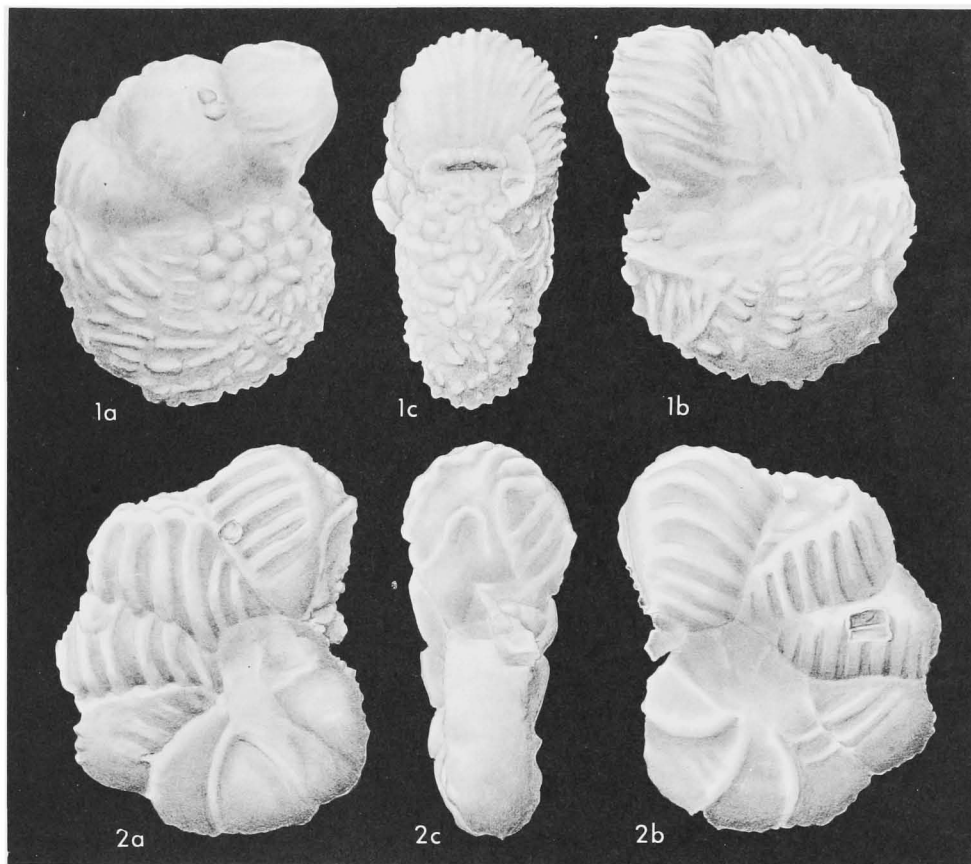


FIG. 494. Rotaliidae (Cuvillierininae; 1,2, *Thalmannita*) (p. C621).

septa and fissured umbilical mass; 9, axial half sec. showing fissured umbilical plugs on both sides of test; all $\times 45$ (*631a).

Thalmannita BERMÚDEZ, 1952, *127, p. 76 [*Rotalia madrugensis* CUSHMAN & BERMÚDEZ, 1947, *494, p. 24; OD] [= *Ornatanomalina* HAQUE, 1956, *876, p. 196 (type, *O. geei*)]. Test free, small, slightly trochoid in early stage, later planispiral, peripheral outline lobulate to angular, peripheral margin rounded, about 8 to 10 chambers to whorl; sutures radial to slightly curved; wall calcareous, perforate-radial in structure, surface ornamented with strong spiraling costae interrupted at sutures and may be interrupted by median ridges on chamber or broken into smaller nodes and ridges, similar nodes and pustules may occur in umbilical region; aperture a low equatorial, interiomarginal slit. [*Thalmannita* was originally referred to the Rotaliinae and *Ornatanomalina* to the Anomalinidae.] *Paleoc.-Oligo.*; W. Indies (Cuba-Puerto Rico)-Asia (Pak.).—FIG. 494, 1. **T. madrugensis* (CUSHMAN & BERMÚDEZ), *Paleoc.*, Cuba; 1a-c, opposite sides and edge view of holotype, $\times 86$ (*2117).—FIG. 494, 2. *T. hafeezi* (HAQUE), *Paleoc.*, Pak.; 2a-c, opposite

sides and edge view of topotype, originally referred to *Ornatanomalina*, $\times 95$ (*2117).

Subfamily CHAPMANININAE Thalmann, 1938

[*nom. transl.* FRIZZELL, 1949, p. 482 (ex family Chapmaninidae THALMANN, 1938)]

Test conical, early portion trochospiral, later uniserial; double walls and septa, with intraseptal spaces; septa invaginated into tubes or chamberlets; aperture consisting of tube openings. *M.Eoc.-Mio.*

Chapmanina A. SILVESTRI, 1931, *1784, p. 74 [*nom. subst. pro Chapmania* A. SILVESTRI & PREVER in SILVESTRI, 1904, *1759, p. 117 (non MONTICELLI, 1893; nec SPULER, 1910; nec de MIRANDA RIBEIRO, 1920; nec BERNHAUER, 1933)] [= *Chapmania gassinensis* A. SILVESTRI, 1905, *1762, p. 130 = *Chapmania aegyptiensis* (CHAPMAN) A. SILVESTRI, 1904, (sic) *1759, p. 117 (non *Patellina aegyptiensis* CHAPMAN, 1900) = *Archapmanoum gassinicoum* RHUMBLER, 1913, *1572b, p. 392 (*nom. van.*); OD (M), ICZN pending] [= *Archapmanoum* RHUMBLER, 1913, *1572b, p. 392 (obj.) (*nom. van.*); *Preverina* FRIZZELL, 1949, *751, p. 489 (type, *Chapmania galea* A. SILVESTRI, 1923, *1776,

p. 90]. Test conical, with early stage of few chambers trochospirally coiled, later whorls with small rectangular cortical chambers in widely

flaring arrangement, possibly in multiple spire, umbilical region perforated with horizontal laminae and interlamellar pillars, similar to *Dictyo-*

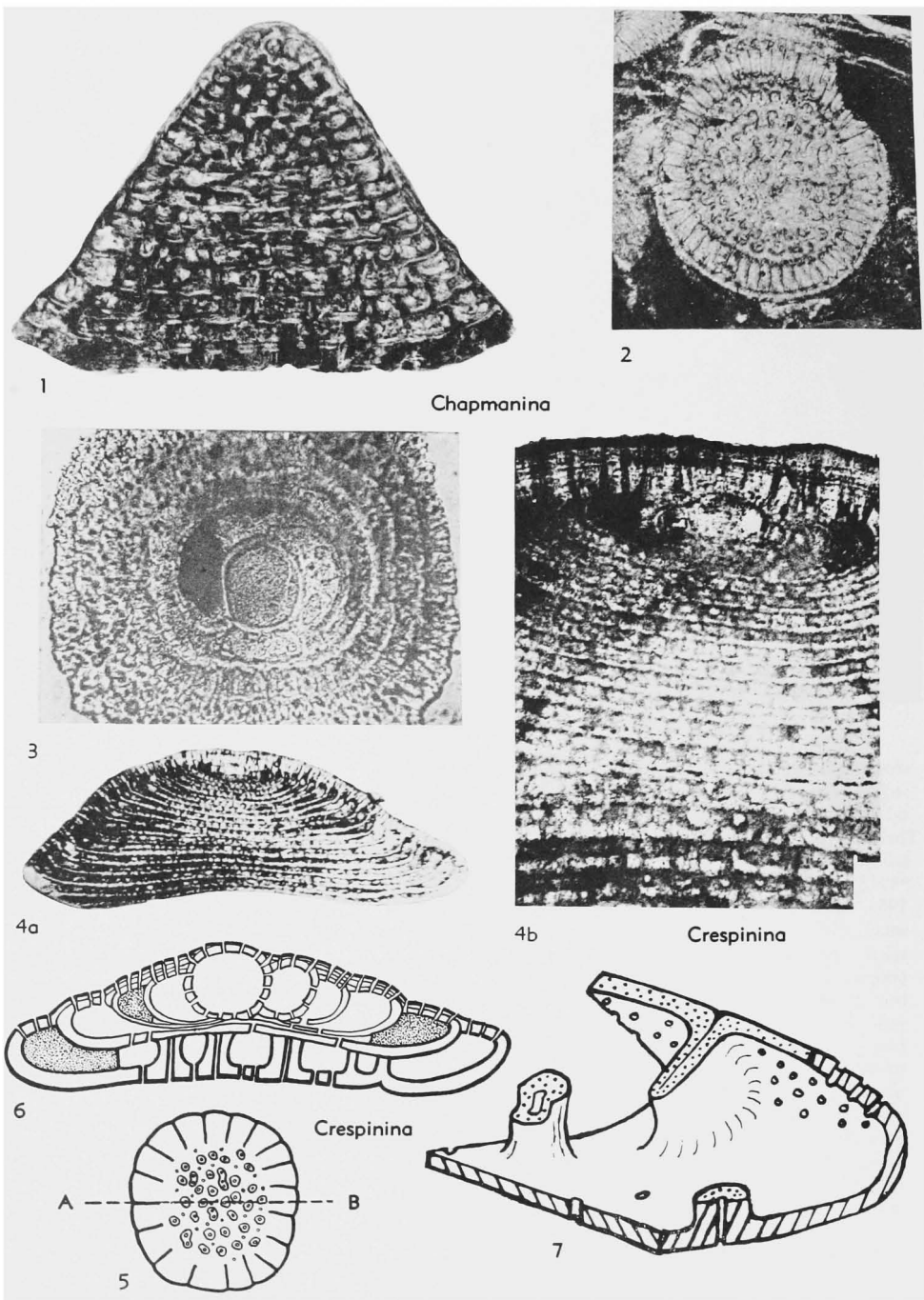


FIG. 495. Rotaliidae (Chapmanininae; 1,2, *Chapmanina*; 3-7, *Crespina*) (p. C621-C624).

conoides, sutures fissured on umbilical side; septal walls invaginated from lower margin, resulting in double septa with intraseptal spaces; wall cal-

careous, perforate; aperture consisting of large pores in umbilical area, surrounded by tubelike pillars that extend from one umbilical lamina to

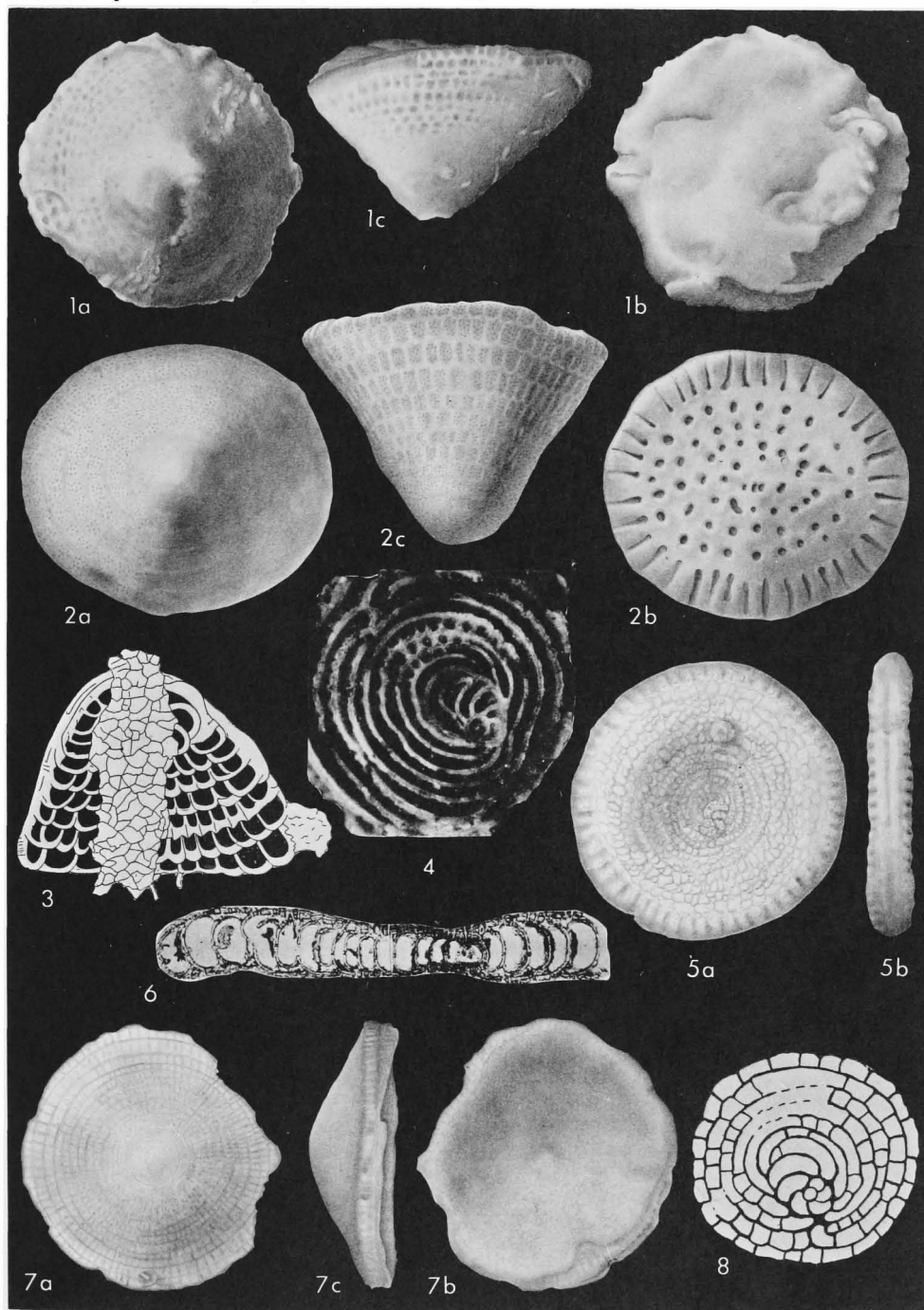


FIG. 496. Rotaliidae (Chapmanininae; 1-3, *Chapmanina*; 4-6, *Sherbornina*; 7,8, *Crespina*) (p. C621-C625).

the next, chambers connecting to interlamellar spaces by means of pores. *M.Eoc.-M.Mio.*, Eu.—FIG. 495,1,2; 496,1,2. **C. gassinensis* (SILVESTRI), Eoc., Italy (495,1,2; 496,1), Fr. (496,2); 495,1, axial sec. showing outer cortical layer of chambers and umbilical series of plates and pillars, $\times 37$ (*1784); 495,2, sagittal sec., $\times 34$ (*1780); 496,1a-c, spiral, umbilical, and edge views of toptype, $\times 28$ (*2117); 496, 2a-c, spiral, umbilical, and edge views showing fissured and perforated base and small rectangular cortical chambers, $\times 35$ (*2117).—FIG. 496,3. *C. galea* (SILVESTRI), Mio., Italy; original figure of holotype and only specimen, $\times 40$ (*1776).

[*Chapmania* 1904 was based on Italian specimens which were referred to the species *Patellina egyptiensis* CHAPMAN, 1900 (type-species of *Dictyoconus* BLANCKENHORN, 1900). In 1905 SILVESTRI noted that his specimens were neither conspecific nor congeneric and proposed the specific name *Chapmania gassinensis*. *C. gassinensis* has since then been regarded as the type-species of *Chapmania* SILVESTRI & PREVER. The generic name *Chapmanina* SILVESTRI, 1931, was proposed as a *nom. subst.* for *Chapmania* SILVESTRI & PREVER, 1904, a homonym of *Chapmania* MONTICELLI, 1893, and *C. gassinensis* has generally been regarded as its type-species. FRIZZELL, 1949, *751, noted that the type-species of *Chapmania*, by monotypy, was *Patellina egyptiensis* CHAPMAN and stated that a petition was being prepared for recognition of *C. gassinensis* as type-species, by use of the plenary powers of the ICZN. However, no petition was submitted (personal communication) and the generic status remained doubtful, hence the writers prepared such a petition in early 1963. *Chapmanina* was interpreted by FRIZZELL (*751) as having an early coil and later stage with low uniserial chambers, with secondary septa. It is here regarded as closely related to *Dictyoconoides* in structure, but has more widely spaced pillars and a longer axis. It differs from *Dictyokathina* in having a fissured base. *Preverina* was described by FRIZZELL from the figure and description of the type-species, *Chapmania galea* SILVESTRI. The type-species is known only from a drawing of a single vertical section, whose central part was replaced with crystalline calcite; the type-specimen is lost and no additional material referable to this species has been found at the type locality (*344A). According to FRIZZELL (*751, p. 489), "*Preverina* differs from *Chapmanina* in the single wall and absence of intraseptal spaces. It is distinguished as well by the relatively larger initial spiral, and by the greater number of rows of chamberlets." The initial spire of the holotype is obscured by recrystallization and the monolamellar character is questionable, as the original figure (here reproduced) shows apparent single septa in part, but also shows apparent double septa in other parts of the section. No features are shown in the original figure that would preclude its assignment to *Chapmanina*, and *Preverina* is therefore regarded as a synonym.]

Crespinina WADE, 1955, *2026, p. 45 [**C. kingscotensis*; OD]. Test free, low and conical, megalospheric form with globular proloculus followed by embracing second chamber and annular undivided third chamber, microspheric form with planispiral stage with chambers increasing rapidly in length to become embracing, later annular chambers being subdivided by imperforate radial partitions, resulting in numerous rectangular chamberlets, all chambers visible from convex perforate spiral side, umbilical side partly imperforate, with perforate pillars extending from one horizontal lamina to next, but not continuous through test; wall calcareous, lamellar, septa double, formed by invagination of outer wall; intercameral connection by means of fine pores which open into chambers directly or may run through pillars, external large pores serving as apertures. [*Crespinina* is similar to *Dictyoconoides*, but dif-

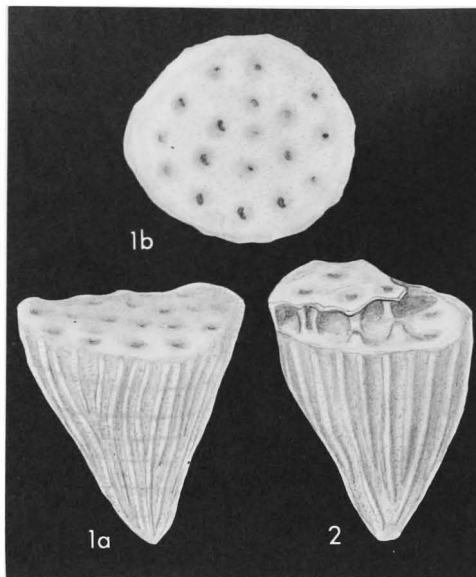


FIG. 497. Rotaliidae (Chapmanininae; 1,2, *Ferayina*) (p. C624-C625).

fers in its pillars not being continuous throughout the test, and thus differs in much the way that *Rotalia* differs from *Lockhartia*. The multiple spiral chamber development is also not evident in *Crespinina*.] *U.Eoc.-L.Oligo.*, S.Australia.—FIG. 495,3-7; 496,7,8. **C. kingscotensis*, Eoc.; 495,3, horiz. sec. through early chambers of megalospheric form, $\times 140$; 495,4a,b, vert. sec. through apex, $\times 40$, $\times 140$ (*2026); 495,5, diagram. view of umbilical side of small specimen showing marginal partitions, perforate pillars, and pores, $\times 60$ (*2026); 495,6, axial sec. along line AB of 495,5, showing perforate protoconch and deuteroconch and later chambers with imperforate marginal partitions and central perforate pillars, $\times 175$ (*2026); 495,7, diagram showing perforated pillars and pores in largely imperforate lower surface, perforate upper surface, and in-folded double septa (*2026); 496,7a-c, opposite sides and edge view, $\times 30$ (*2117); 496,8, diagram. figure of early whorls of microspheric test, $\times 300$ (*2026).

Ferayina FRIZZELL, 1949, *751, p. 483, 492 [**F. coralliformis*; OD]. Test free, conical, proloculus followed by 3 or 4 tiny low chambers of undetermined arrangement, later with rapidly enlarging, low, uniserially arranged chambers; septa horizontal, flat, imperforate except for large rounded intercameral foramina, sutures indistinct at surface; wall of calcite (by X-ray analysis), finely perforate, radial in microstructure, surface with low longitudinal costae which increase by bifurcation and are thus equidistant throughout; aperture multiple, consisting of numerous rounded openings on terminal face, each provided in-

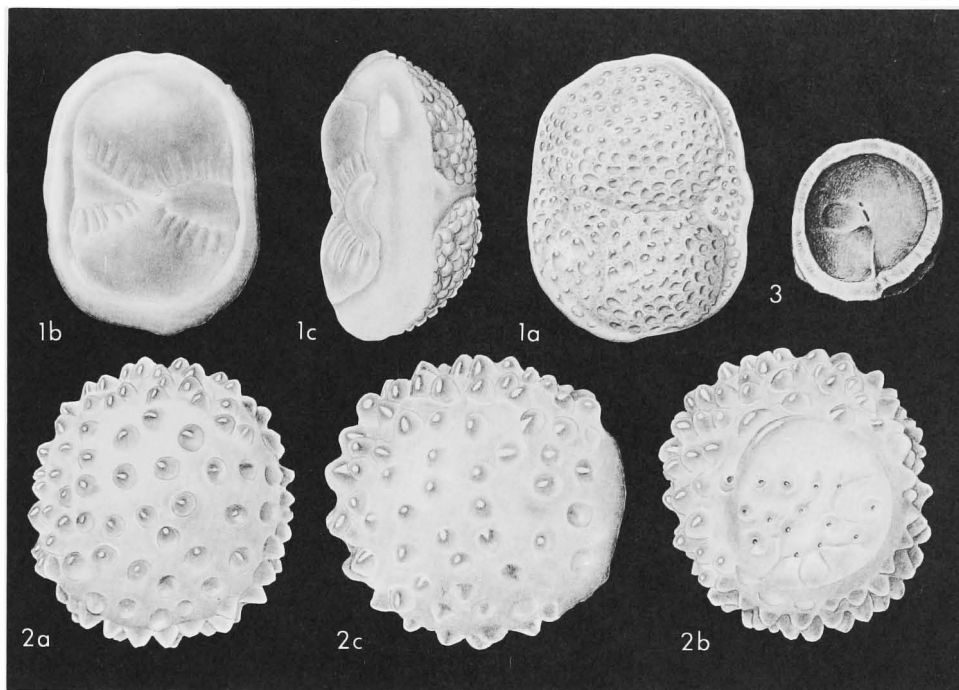


FIG. 498. Rotaliidae (Pegidiinae; 1, *Pegidia*; 2,3, *Sphaeridia*) (p. C625-C627).

ternally with hollow pillar-like process, extending to previous septum. *M.Eoc.*, USA (Tex.-Calif.)-S.Am. (Ecuad.-Peru).—FIG. 497, 1, 2. **F. coralliformis*, Claiborne F., Tex.; 1a, b, side, apertural views of topotype; 2, side view of partially dissected specimen showing hollow pillar-like processes connecting adjacent septa; all $\times 105$ (*2117).

[*Ferayina* was originally placed with the Chapmaniidae by FRIZZELL, HOFKER (1956, *945, p. 897) stated that the wall has an imperforate outer layer and contains embedded mineral particles; thus he considered the genus related to *Dictyoconus* and the valvulinids. The wall of topotypes of *Ferayina* was investigated by us and proved by X-ray and petrographic analysis to consist of radially built calcite; hence the genus is not regarded as related to the valvulinids.]

Sherbornina CHAPMAN, 1922, *322, p. 501 [**S. atkinsoni*; OD]. Test discoidal, thin, up to 2 mm. diam., early stage with nearly planispirally arranged chambers, megalospheric form with 4 to 10 enrolled chambers, microspheric form with 14 enrolled chambers, later with 3 or 4 more embracing chambers followed by cyclical chambers, all later chambers with corrugated margins near sutures, projections of successive chambers alternating in position; wall calcareous, coarsely perforate, radial in structure, lamellar, with well-developed canal system of septal canals in young stage and septal and radial canals in adult, with branches forming radial canals that open at surface as coarse pores, test perforations smaller than canal-system pores, surface may be pustulose; no visible aperture. *U.Eoc.-Mio.*, S.Pac.O. (Tasm.).—FIG. 496, 4-6. **S. atkinsoni*, Oligo.; 5a, b, side, edge views, $\times 33$ (*2117); 4, specimen split

in median plane showing corrugated septa and early embryonic coil, $\times 35$ (*2028); 6, vert. sec. showing lamellar walls, canals, and pores, $\times 100$ (*2028).

Subfamily PEGIDIINAE Heron-Allen & Earland, 1928

[*nom. transl.* CHAPMAN & PARR, 1936, p. 144 (ex family Pegidiidae HERON-ALLEN & EARLAND, 1928)]

Trochospirally derived test, with chambers few and inflated, each successive chamber opposed to or partially enveloping that preceding, early chambers resorbed during growth; aperture a series of tubes which may pierce umbilical shell material. *Mio.-Rec.*

Pegidia HERON-ALLEN & EARLAND, 1928, *913, p. 290 [**Rotalia dubia* D'ORBIGNY, 1826, *1391, p. 274, = *Pegidia papillata* HERON-ALLEN & EARLAND in HERON-ALLEN & BARNARD, 1918, *905, p. 90; OD] [*Pegidia* HERON-ALLEN & EARLAND in HERON-ALLEN & BARNARD, 1918, *905, p. 90 (*nom. nud.*)]. Test free, sublenticular, unequally biconvex, with 3 or 4 chambers arranged in apposition, early chambers may be resorbed as new ones form; calcareous wall and septa thick, perforate, radially built, lamellar character not described, surface of spiral side may be closely tuberculate, peripheral margin with broad, smooth keel, grooves radiating from umbilicus and tubular vertical canals piercing solid umbilical plug, opening at surface; no aperture other than open-

ings of tubular canals. *Mio.-Rec.*, Eu.(Île de France) - Indian O. (Mauritius Is.) - Afr. (Kerimba Arch.)-E.Indies (Java-Philip. Is)-W.Indies-W.Pac.O. (Caroline Is., Ifaluk Atoll)-Eu.—FIG. 498,1. **P. dubia* (p'ORBIGNY), *Rec.*, Mauritius; 1a-c, oppo-

site sides and edge view of topotype, $\times 33$ (*2117).

Sphaeridia HERON-ALLEN & EARLAND, 1928, *913, p. 294 [**S. papillata*; OD]. Test free, 0.7-0.85 mm. diam., globular, chambers 3 or 4, increasing

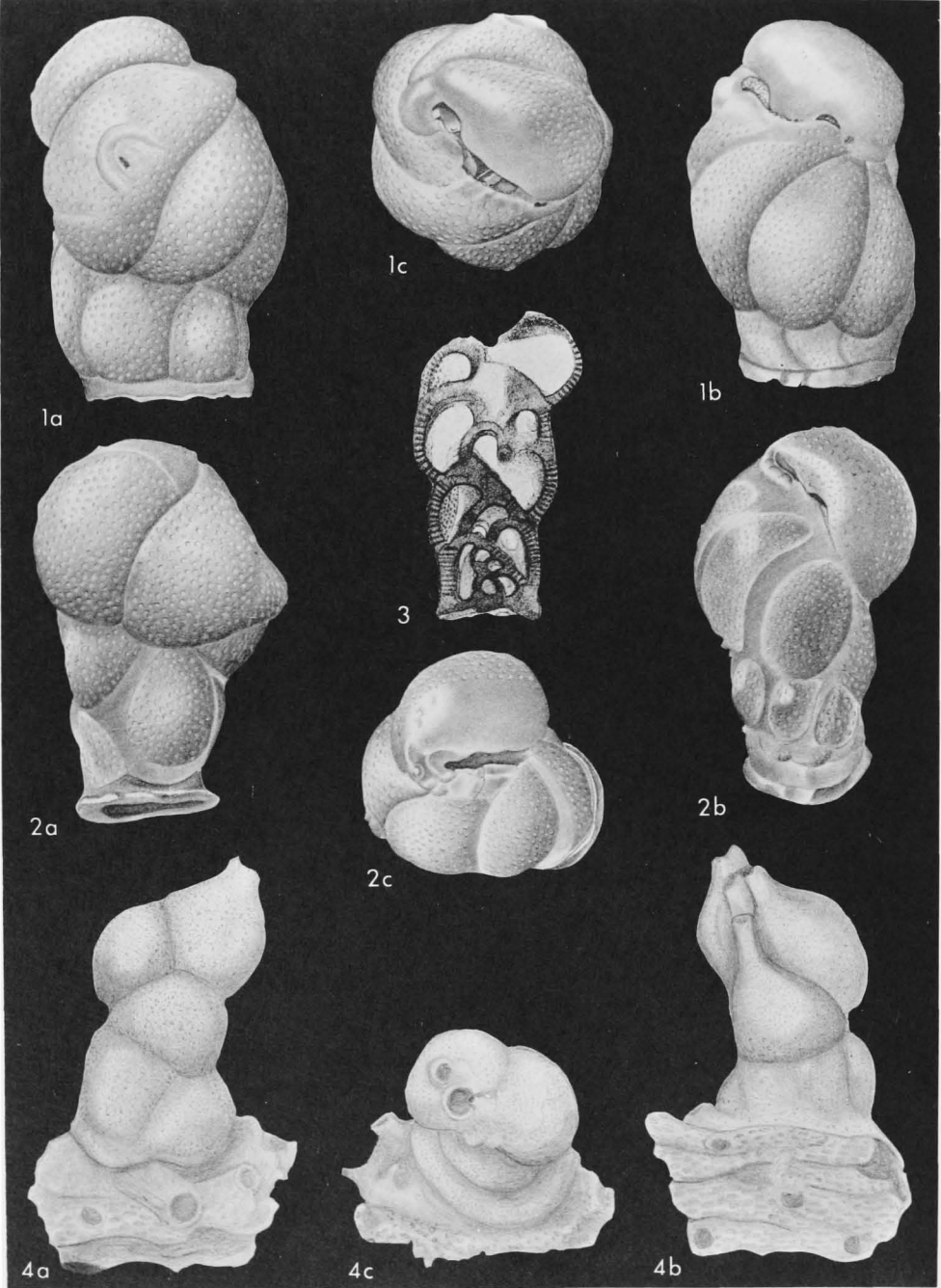
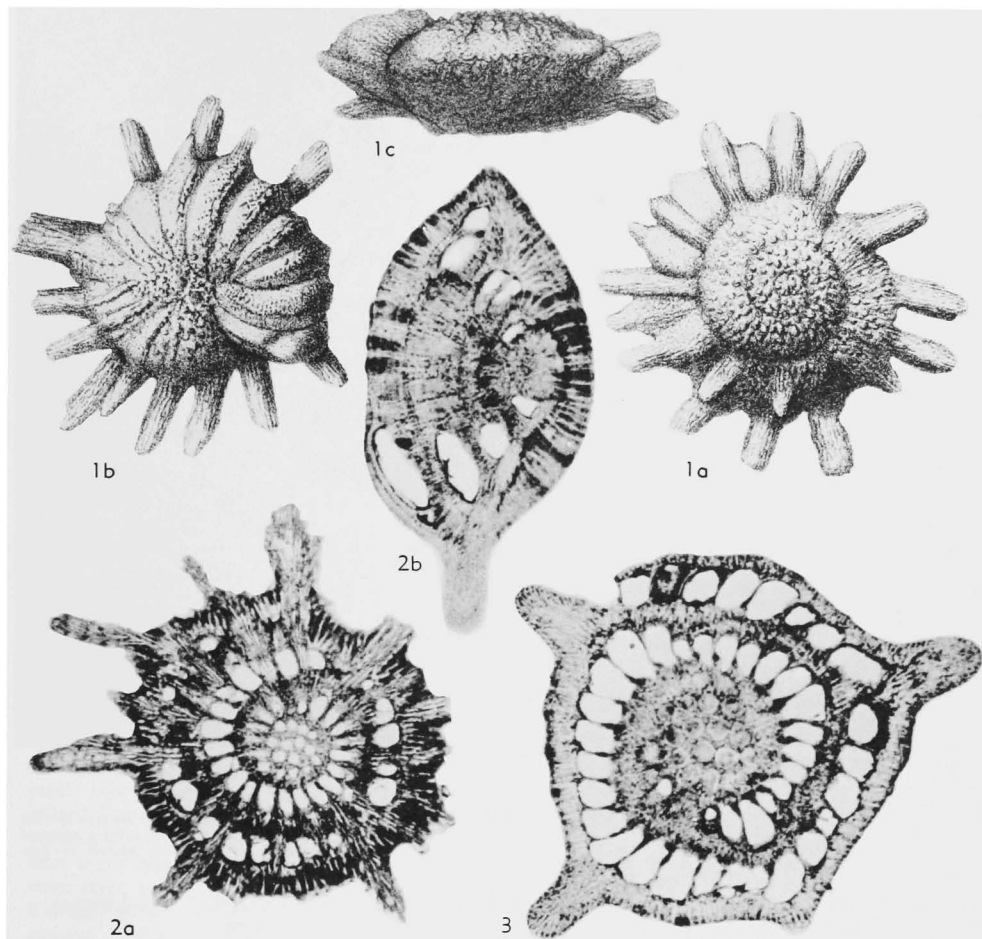


FIG. 499. Rotaliidae (Rupertininae: 1-3, *Rupertina*; 4, *Biarritzina*) (p. C627-C628).

FIG. 500. Calcarinidae; 1-3, *Calcarina* (p. C628-C629).

rapidly in size, arranged in apposition and strongly enveloping, probably resorbed as new chambers are formed, umbilical region filled by large solid plug that occupies about one-fourth surface of test and is perforated by series of bifurcating vertical tubular canals; wall thick, calcareous, perforate radial in structure, lamellar character not described, surface ornamented with beads or pustules of clear shell material; aperture consisting of pores at surface marking outlets of tubular canals. *Rec.*, Afr. (Kerimba Arch.)-Ind.O. (Mauritius Is.).—FIG. 498, 2, 3. **S. papillata*; 2a-c, specimen from Ind.O. showing globular form, clear calcite pustules, umbilical plug, and bifurcating tubular canals, $\times 64$ (*2117); 3, broken specimen from Mauritius Is. showing thick wall, main septum, traces of resorbed earlier septa, and inner opening of tubular canals in center, $\times 33$ (*913).

Subfamily RUPERTININAE

Loeblich & Tappan, 1961

[Rupertininae LOEBLICH & TAPPAN, 1961, p. 312 (*nom. subst. pro* Rupertinae GALLOWAY, 1933, p. 302)] [=Rupertinae SILVESTRI, 1937, p. 143 (*nom. van.*)]

Test attached by basal disc, early chambers trochospiral, later extending upward from base in loose spiral; wall calcareous, coarsely perforate, radiate in structure, septa doubled as in Rotaliidae; aperture narrow, interiomarginal. ?*Eoc.*, *Mio.-Rec.*

Rupertina LOEBLICH & TAPPAN, 1961, *1177, p. 312 [*nom. subst. pro* Rupertia WALLICH, 1877, *2036, p. 502 (*non* Rupertia GRAY, 1865)] [**Rupertia stabilis* WALLICH, 1877, *2036, p. 502; OD]. Test attached by large prominent basal disc; chambers numerous, early ones in close coil, later vertically elongated and coiling in tall spire; wall calcareous, radiate in structure, coarsely

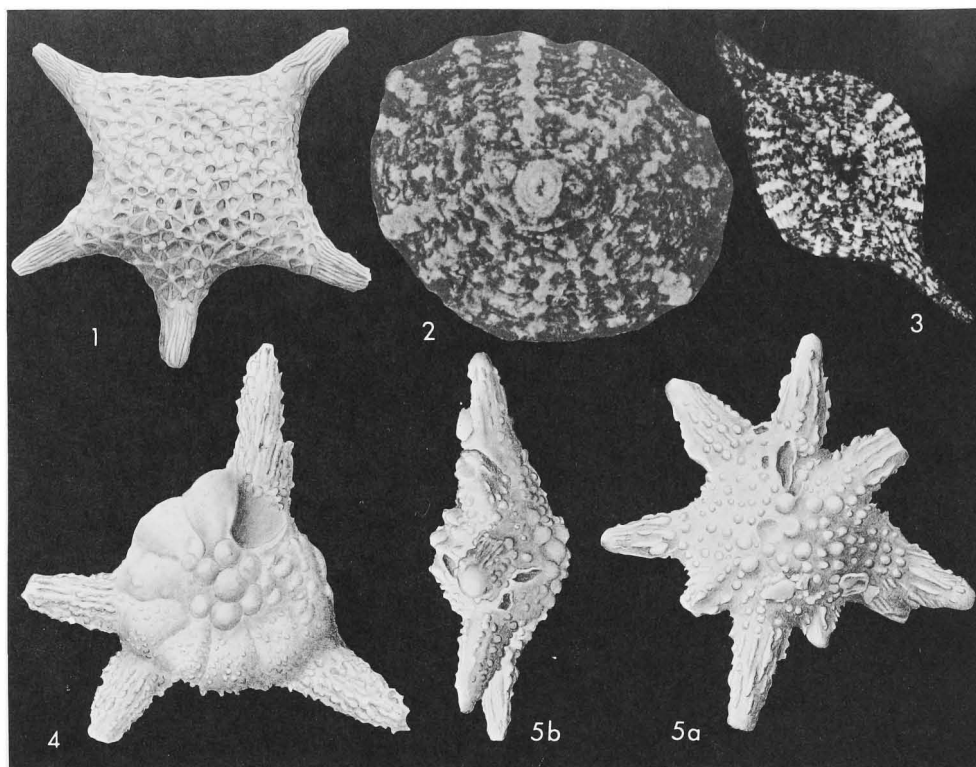


FIG. 501. Calcarinidae; 1-3, *Baculogypsina*; 4, *Baculogypsinoidea*; 5, *Siderolites* (p. C629-C631).

perforate, with rotaliid wall structure; aperture commonly narrow, slitlike, bordered above by prominent lip. ?*Eoc.*, *Mio.-Rec.*, *Atl.O.-S.Pac.O.-W.Pac.O.* (Bismarck Arch.)-*Ind.O.-USA-W.Indies* (Carib.)-*Eu.*—FIG. 499, 1-3. **R. stabilis* (WALLICH), *Rec.*, *Atl.O.*; 1a-c, 2a-c, opposite sides and apert views, $\times 40$ (*2117); 3, long. sec., $\times 27$ (*200).

Biarritzina LOEBLICH & TAPPAN, *nom. subst.* herein [*pro Columella* HALKYARD, 1918, *861, p. 28 (*non* WESTERLUND, 1878)] [**Columella carpenteriaeformis* HALKYARD, 1918, *861, p. 28, here designated as type-species]. Test attached by flaring base, then growing upright; chambers few, inflated, early chambers trochospirally coiled, later chambers in loose, elevated spire, tending to become uniserial; sutures depressed; wall calcareous, with coarse perforations scattered between fine pores; aperture rounded, terminal, with distinct bordering lip or neck of nonperforate calcite. *Tert.-Rec.*, *Eu.-Australia-Pac.O.* (Philip. Is.)-*W. Indies* (Carib.)-*Atl.O.*—FIG. 499, 4. **B. carpenteriaeformis* (HALKYARD), *Eoc.*, *Fr.*; 4a-c, opposite sides and apert. view of topotype attached to bryozoan, $\times 22$ (*2117).

[The original type-specimens of the type-species, from the Auvergnian of Biarritz, France, deposited in the collection of Victoria University, Manchester, England, were destroyed during the war. *Columella* was regarded as a synonym of *Carpenteria* by GALLOWAY (1933, *762) but *Carpenteria* is

here restricted to the low conical forms like its type-species. As *Columella* HALKYARD is a homonym, it is here renamed and the subcylindrical species previously placed in *Carpenteria* should be referred to *Biarritzina*.]

Family CALCARINIDAE Schwager, 1876

[*nom. correct.* EIMER & FICKERT, 1899, p. 703 (*pro* family Calcarine SCHWAGER, 1876, p. 481)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹family, ²subfamily)]—[=¹Tinoporidea SCHWAGER, 1877, p. 21; =²Tinoporinae BRADY, 1884, p. 74; =¹Tinoporina LANKESTER, 1885, p. 847; =¹Tinoporinae DELAGE & HÉROUARD, 1896, p. 147; =¹Tinoporidae LISTER in LANKESTER, 1903, p. 146; =²Tinoporinae HOFKER, 1933, p. 125 (*nom. van.*)]—[=²Calcarininae HOFKER, 1927, p. 42; =¹Siderolitidae FINLAY, 1939, p. 525; =²Siderolitinae SIGAL in PIVETEAU, 1952, p. 250; =¹Baculogypsinae SMOUT, 1955, p. 205]

Test coiled, without differentiation into spiral and umbilical surfaces, advanced genera may become globular, large spines formed by thickenings, and not marginal projections of chambers; canal system diffuse and confused with perforations. *U.Cret.-Rec.*

Calcarina D'ORBIGNY, 1826, *1391, p. 276 [**Nautilus spengleri* GMELIN, 1788, *798, p. 3371; SD PARKER & JONES, 1859, *1417a, p. 482]. Test large, 1 or 2 mm. diam., lenticular, biconvex, trochospiral throughout, chambers numerous, no later acervuline chambers present; sutures radial, depressed, but largely obscured by supplementary

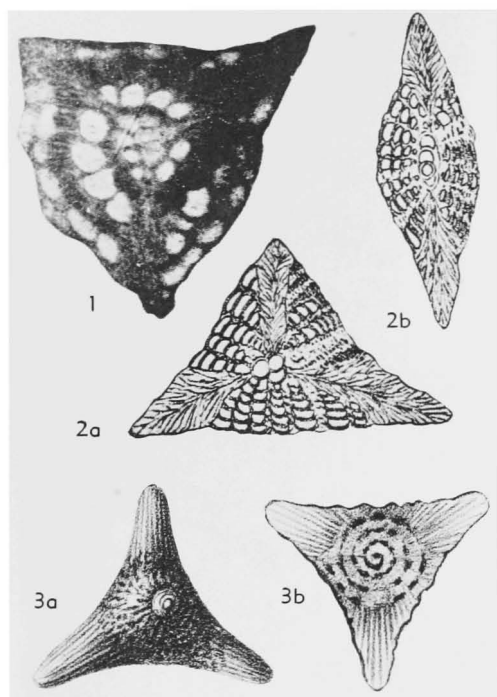


FIG. 502. Calcarinidae; 1-3, *Baculogypsinoidea* (p. C629).

lamellar calcite on umbilical side; intraseptal passages present, umbilical cavities interrupted by pillars and radial and lateral canals; wall calcareous, chamber roofs and floors with 2 layers, thin inner layer and coarsely perforate, thicker outer layer, surface thickly covered with tubercles; 6 to 30 thick, elongate, longitudinally striated, peripheral spines may bifurcate terminally, probably serving for anchorage on reef algae; aperture narrow and strongly indented, interiomarginal, intercameral foramina identical in form. [The type-species, discussed by LOEBLICH & TAPPAN (1962, *1186, p. 33, 34) is *Nautilus spengleri* Gmelin, by subsequent designation of PARKER & JONES, 1859. The type cannot be *Calcarina calcar*, either by tautonymy or subsequent designation, as that species was a *nomen nudum* in the original publication.] ?*U.Cret.*, Rec., Pac.O.—FIG. 500, 1-3. **C. spengleri* (Gmelin), Rec., Admiralty Is. (1), Okinawa (2), Marshall Is. (3); 1a-c, opposite sides and edge view, $\times 30$ (*200); 2a,b, horiz. and axial secs., $\times 20$ (*531); 3, horiz. sec., $\times 20$ (*531).

Baculogypsina SACCO, 1893, *1607, p. 206 [*Orbitolina sphaerulata* PARKER & JONES, 1860, *1417d, p. 34; OD (M)] [= *Taurogypsina* SACCO, 1893, *1607, p. 205 (type, *T. taurobaculata*)]. Test free, periphery lobulated, with few coarse radial spines, early stage trochospiral, juvenarium or embryonic apparatus distinct, consisting of spherical proloculus followed by 1.5 whorls of planispirally

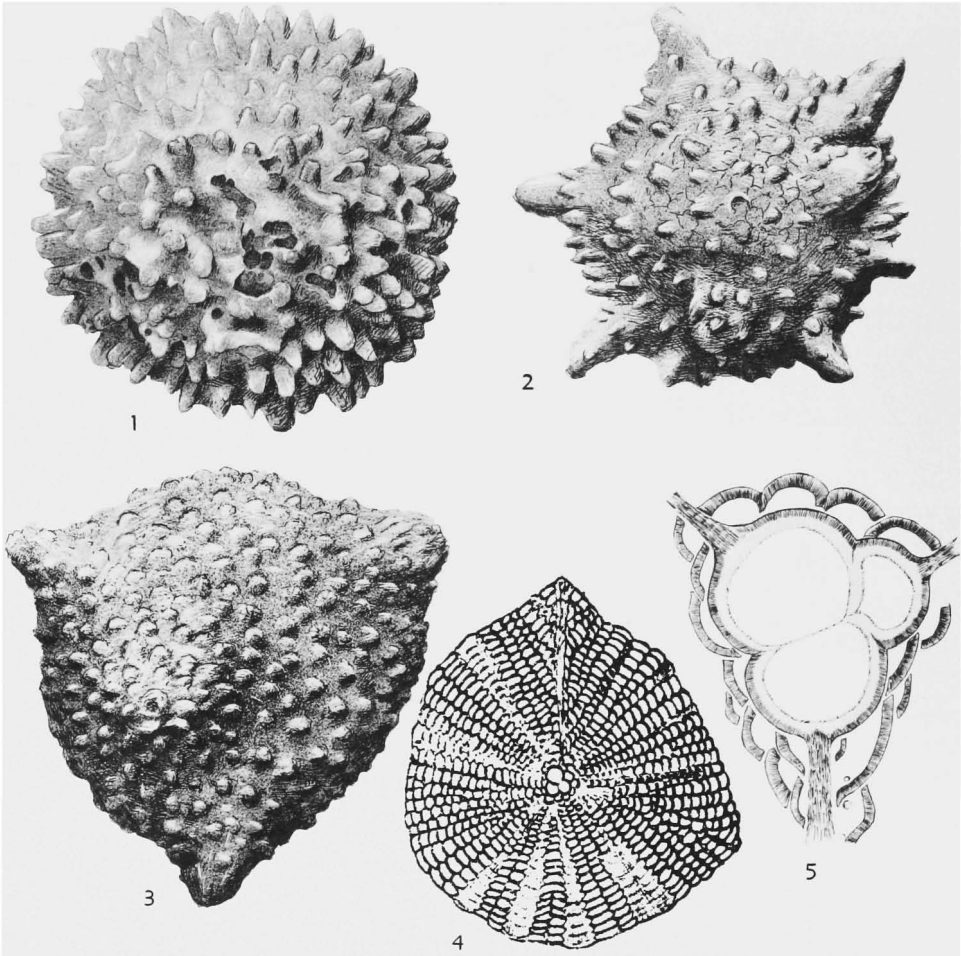
arranged chambers, without canal system but with umbilical plugs on one side, later chambers arranged in radially disposed layers with numerous thin, conical pillars interspersed, ends of the pillars projecting at surface as tubercles; wall of chamber roofs and floors finely perforate, radial spines arising from juvenarium in its plane of coiling, of solid supplementary shell material, pierced by anastomosing canals and covered with several layers of chambers except at tip. *Mio.-Rec.*, Eu.-Pac.O.—FIG. 501, 1-3. **B. sphaerulata* (PARKER & JONES), Rec., Fiji Is. (1), Pleist., Saipan (2,3); 1, side view of paratype, $\times 20$ (*2117); 2, equat. sec., $\times 53$ (*364); 3, axial sec., $\times 27$ (*364).

[A lectotype for *Orbitolina sphaerulata* PARKER & JONES was chosen by us in the British Museum (Natural History) and is here designated (BMNH-ZF3599) and paratypes (BMNH-ZF3598) (all ex 94.4.3.1822) all from Recent deposits at Rewa Reef, Fiji. *Baculogypsina* was placed in the Cibicidinae by HANZAWA (1952, *872), in the Calcarinidae by CUSHMAN (1948, *486), and in the Baculogypsinae by SMOUT (1955, *1804).]

Baculogypsinoidea YABE & HANZAWA, 1930, *2093, p. 43 [**B. spinosus*; OD (M)] [= *Silvestriella* HANZAWA, 1952, *872, p. 17 (type, *Calcarina tetraedra* GÜMBEL, 1870, *840, p. 656)]. Early stage trochospiral, as in *Calcarina*, later chambers acervuline, lateral walls compact, peripheral wall coarsely perforate; wall calcareous, with coarse tubuli, commonly with 3 or 4 thick blunt spines, with anastomosing canal system, arising near proloculus and extending outward in plane of coiling, interior with numerous thin conical vertical pillars, which project at surface as tubercles. *Eoc.-Rec.*, Philip. Is.-Eu.-China Sea (Ryukyu Is.). —FIG. 501, 4; 502, 1. **B. spinosus*, Rec., Philip. (501, 4), Pleist., Ryukyu Is. (502, 1); 501, 4, lecto-type, $\times 33$ (*2117); 502, 1, equat. sec., $\times 40$ (*872). —FIG. 502, 2, 3. *S. tetraedra* (GÜMBEL), U.Eoc., Italy (2), Eoc., Aus. (3); 2a,b, equat. and axial secs., $\times 7.5$ (*872); 3a,b, ext. and equat. sec., $\times 10$ (*840).

[The type-specimens of *B. spinosus* were stated to be those figured by CUSHMAN (1919, *412, pl. 45) as *Siderolites? tetraedra* (GÜMBEL), which are not conspecific with GÜMBEL's form. A lectotype is here designated and redrawn (USNM 15364b, *412, pl. 45, figs. 2a,b, from *Albatross* Station D5179, Philippines). *Silvestriella* was shown by KÜPPER (1954, *1069) to be a synonym of *Baculogypsina* oides.]

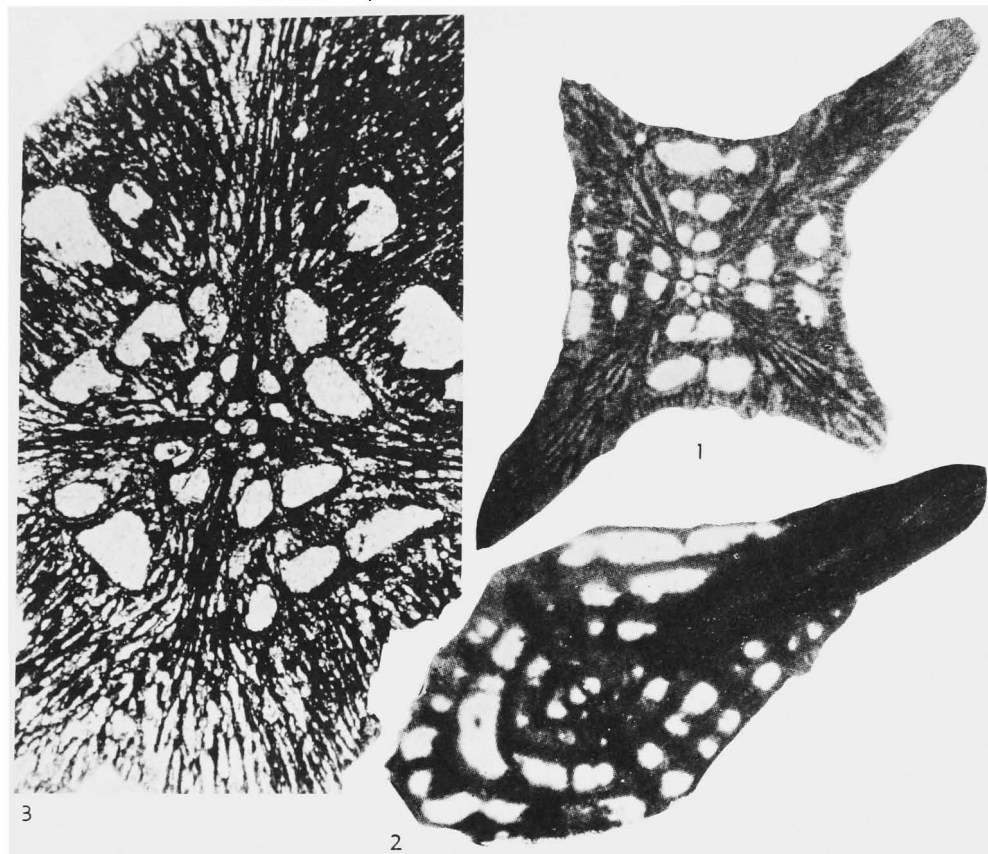
Schlumbergerella HANZAWA, 1952, *872, p. 19 [**Baculogypsina floresiana* SCHLUMBERGER, 1896, *1657, p. 88; OD]. Test large, globular, to 3.5 mm. diam., with spines projecting slightly or forming tubercles; juvenarium of megalospheric form consisting of 3 chambers (of raspberry form, not coiled), microspheric form with early coil, later chambers undifferentiated acervuline, forming angle of about 60° to axis of spine, spines arising from juvenarium, containing radial and ramifying canals; pillars also present, similar to spines but smaller and with fewer canals, and different in structure from chamber walls, perhaps representing radial rows of calcified lateral chambers; wall calcareous, perforate; apertures consisting of rows of rounded openings in cham-

FIG. 503. Calcarinidae; 1-5, *Schlumbergerella* (p. C629-C630).

ber roofs, with 2 to 4 apertures in row, smaller openings or perforations also connecting adjacent chambers through wall of roof, these openings being widest at outer surface, stolons also connecting acervuline chambers, one stolon opening into preceding chamber and 2 stolons opening into different later chambers, possibly with additional stolons. *Pleist.-Rec.*, E.Indies(Indon.).—FIG. 503,1-5. **S. floresiana* (SCHLUMBERGER), *Rec.*; 1,2, microspheric specimens, $\times 16.5$, $\times 20$ (*928a); 3, megalospheric specimen, $\times 20$ (*928a); 4, transv. sec. showing early juvenarium, $\times 21$ (*872); 5, central part of equat. sec. showing juvenarium, spines, and acervuline chambers, $\times 56$ (*1069).

Siderolites LAMARCK, 1801, *1084, p. 376 [*S. calcitrapoides*; OD (M)] [= *Siderolithes* DE MONTFORT, 1808, *1305, p. 151 (obj.); *Siderolina* DEFRANCE, 1824, *579e, p. 180 (obj.); *Sideroporus* BRONN, 1825, *209, p. 30, 31 (type, *S. calcitrapa*,

= *Sidérolite calcitrapoïde* FAUJAS, 1799, *712, p. 188); *Siderolithus* BRONN, 1838, *210, p. 711 (obj.)]. Test large, planispirally coiled throughout from globular proloculus, without raspberry type of embryonic apparatus and without supplementary acervuline chambers; wall of chamber roofs and floors of 2 layers, inner layer thin and finely perforate, outer layer thick and coarsely perforate, few large coarse spines originating near proloculus and radiating in plane of coiling, spines with ramifying canal system and commonly protruding somewhat at periphery, numerous conical pillars piercing successive spiral lamellae and appearing as tubercles at test surface. [Differs from *Calcarina* in being planispiral rather than trochospiral throughout.] *U.Cret.-L.Eoc.*, Eu.-Asia(India).—FIG. 501,5; 504,1-3. **S. calcitrapoides*, *U.Cret.*(Maastricht.), Neth.: 501,5a,b, side and edge views, $\times 11$ (*2117); 504,1,2, equat. and axial secs., $\times 20$ (*872); 504,3, de-

FIG. 504. Calcarinidae; 1-3, *Siderolites* (p. C630-C631).

calcified equat. sec. in canada balsam preparation, $\times 20$ (*1998).

Family ELPHIDIIDAE Galloway, 1933

[*nom. transl.* SIGAL in PIVETEAU, 1952, p. 240 (ex subfamily Elphidiinae GALLOWAY, 1933, p. 265)]—[In synonymic citations dagger (†) indicates *partim*]—[=Polythalamat LATREILLE, 1825, p. 161 (*nom. nud.*); =Hélicostéguest D'ORBIGNY, 1826, p. 268 (*nom. nud.*; *nom. neg.*); =Helicotrochinat EHRENBURG, 1839, table opp. p. 120 (*nom. nud.*); =Nautiloidat SCHULTZE, 1854, p. 53 (*nom. nud.*); =Polystomellidea REUSS, 1862, p. 308, 388; =Polystomellida SCHMARDT, 1871, p. 165; =Polystomellina LANKESTER, 1885, p. 848; =Polystomellinae DELAGE & HÉROUARD, 1896, p. 150; =Polystomellidae EIMER & FICKERT, 1899, p. 698; =Canaliferidae KRASHENINNIKOV, 1953, p. 89 (*non* Canaliferidae BRODERIP, 1839)]

Test planispiral, trochospiral, or uncoiling; sutural canal system opening into single or double row of sutural pores; wall calcareous, perforate, radial in structure; aperture interiomarginal, single or multiple, or areal. *Paleoc.-Rec.*

Subfamily ELPHIDIINAE Galloway, 1933

[Elphidiinae GALLOWAY, 1933, p. 265] [=Orbientina MARRIOTT, 1878, p. 30 (*nom. nud.*); =Polystomellida SCHULTZE, 1854, p. 53; =Polystomellina JONES in GRIFFITH & HENFREY, 1875, p. 320; =Polystomellinae BRADY, 1881, p. 44; =Cribroelphidiinae VOLOSHINOVA, 1958, p. 167]

Test free, planispiral and symmetrical, at least in adult, may uncoil in later stages, with sutural pores and sutural canal system, and retral processes projecting across sutures; aperture consisting of interiomarginal or areal pores or both. *Paleoc.-Rec.*

Elphidium DE MONTFORT, 1808, *1305, p. 14 [**Nautilus macellus* FICHTEL & MOLL var. β FICHTEL & MOLL, 1798, *716, p. 66; OD] [=Pelorus DE MONTFORT, 1808, *1305, p. 22 (type, *Nautilus ambiguus* FICHTEL & MOLL, 1798, *716, p. 62); *Andromedes* DE MONTFORT, 1808, *1305, p. 38 (type, *Nautilus strigillatus* FICHTEL & MOLL var. α FICHTEL & MOLL, 1798, *716, p. 49); *Sporilus* DE MONTFORT, 1808, *1305, p. 42 (type, *Nautilus strigillatus* FICHTEL & MOLL, var. β FICHTEL & MOLL, 1798, *716, p. 49); *Themeon* DE MONTFORT, 1808, *1305, p. 202 (type, *Nautilus crispus* LINNÉ, 1758, *1140, p. 709; =*Themeon rigatus* DE MONTFORT, 1808); *Geophonus* DE MONTFORT, 1808, *1305, p. 18 (type, *Nautilus macellus* FICHTEL & MOLL var. α FICHTEL & MOLL, 1798, *716, p. 66); *Ceophonus* Bosc, 1816, *176, p. 491 (*nom. null. pro Geophonus* DE MONTFORT,

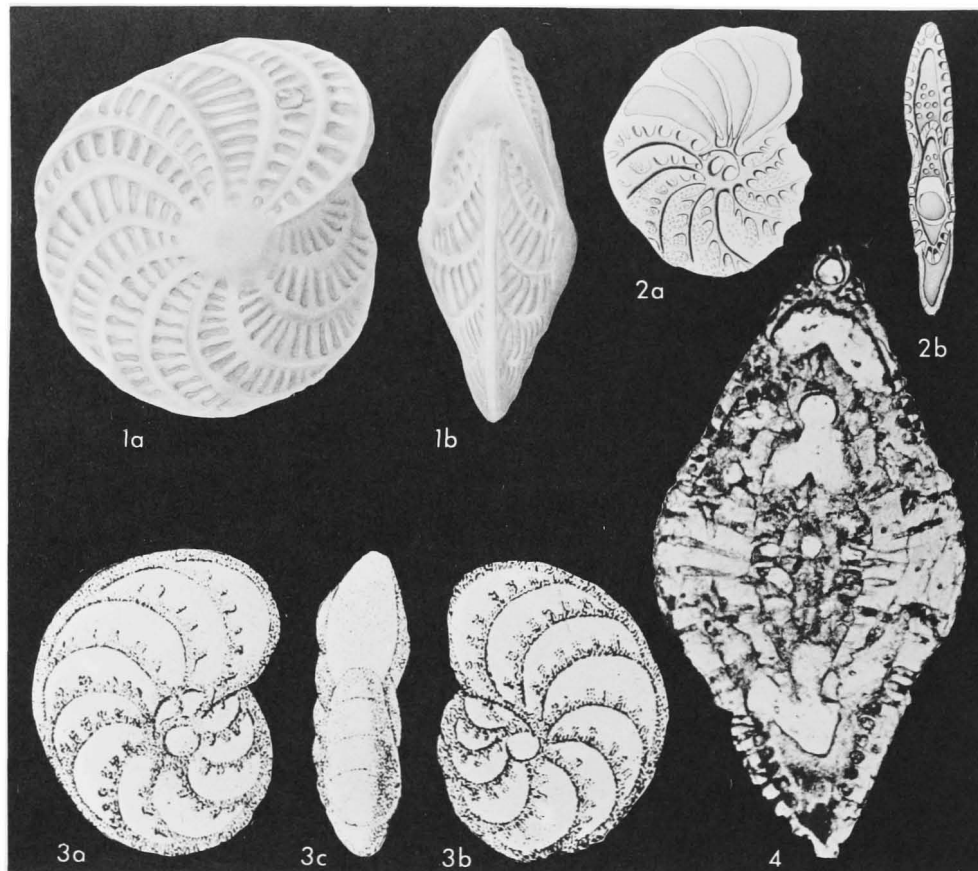


FIG. 505. Elphidiidae (Elphidiinae; 1-4, *Elphidium*) (p. C631-C635).

1808); *Polystomella* LAMARCK, 1822, *1090, p. 624 (type, *Nautilus crispus* LINNÉ, 1758, *1140, p. 709); *Thamoeone* BERTHOLD in LATREILLE, 1827, *1097A, p. 161 (*nom. van.*); *Polystomatium* EHRENBERG, 1839, *667, table opp. p. 120 (type, *Nautilus strigillatus* FICHTEL & MOLL, 1798, *716, p. 49); *Geoponus* EHRENBERG, 1839, *667, p. 132 (*nom. van. pro Geophonus* DE MONTFORT, 1808); *Planoelphidium* VOLOSHINOVA, 1958, *2019, p. 165 (type, *Polystomella laminata* TERQUEM, 1878, *1889, p. 16); *Faujasinella* VOLOSHINOVA, 1958, *2019, p. 162 (type, *Elphidium semiinvoluta* MYATLYUK in DABAGYAN, MYATLYUK & PISHVAN-OVA, 1956, *547, p. 228); *Discorotalia* HORNIBROOK, 1961, *959, p. 141 (type, *Polystomella tenuissima* KARRER, 1865, *1020, p. 83)]. Test planispiral, bilaterally symmetrical, involute, chambers numerous, with numerous retral processes or internal chamber projections along septal borders, ending blindly against septal face in final chamber, but pierced by tiny pore formed by resorption of septum at base of retral process in earlier chambers, resulting in numerous tubular perforations connecting chambers; septa secondarily doubled, incomplete septal flap being formed

against apertural face as succeeding chamber forms, leaving septum single-layered near center and base and double near outer edges where it encloses canal system, with prominent lamellar thickening of outer wall; canal system complex, spiral canal present along umbilical chamber margins leading to vertical umbilical canals through umbilical plug, and also giving rise to subsutural septal canals at each septum in intraseptal space between septal face and septal flap formed by succeeding chamber and lying below retral processes, communicating with surface by means of diverging canals; wall calcareous, finely perforate, radial in structure, surface commonly with grooves (fossettes) or ridges paralleling periphery (striped crenulation) and commonly coinciding with internal retral processes, or surface may be smooth or finely pustulose; aperture consisting of row of pores at base of septal face, earlier septa may also have areal foramina due to resorption; pseudopodia extremely numerous, long, and attenuated; alternation of asexual (producing up to 200 embryos) and sexual reproduction with development of inequally biflagellate gametes. [Habitat shallow water or tide pools on sandy or shelly bottoms, with

algae, radiating pseudopodia binding together a mass of sand to prevent dislodging during moderate turbulence.] *L.Eoc.-Rec.*, cosmop.—FIG. 505,1,2. **E. macellum* (FICHTEL & MOLL), *Rec.*, Eu.(Italy); 1*a,b*, side, apert. views, $\times 68$ (*2117);

2*a*, horiz. sec. in canada balsam, showing canal system; 2*b*, transv. sec. showing canal system and septal foramina, $\times 70$ (*928a).—FIG. 505,3. *E. semiinvolutum* MYATLYUK, U.Eoc., Carpathians; 3*a-c*, opposite sides and edge view showing faintly

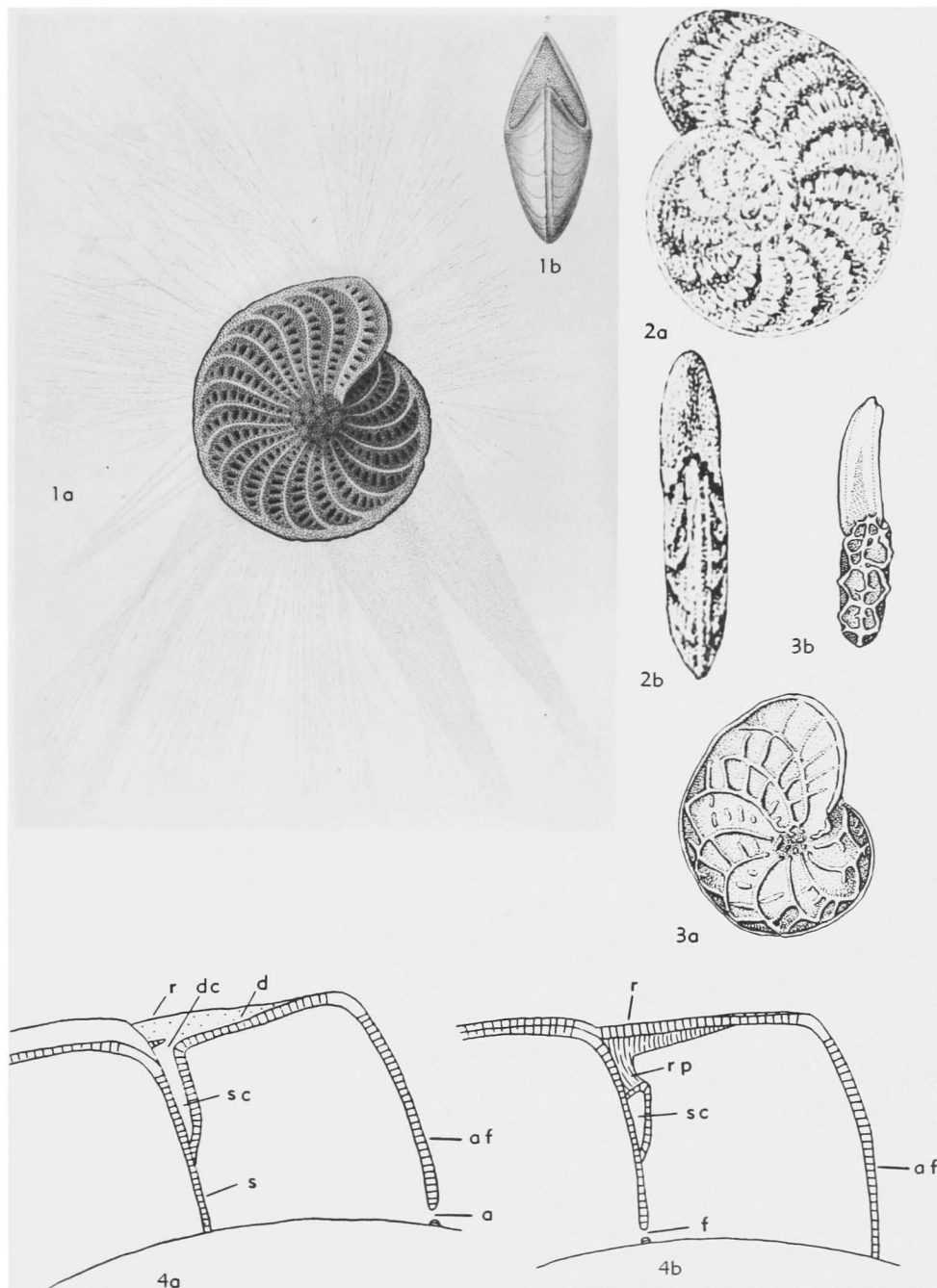


FIG. 506. Elphidiidae (Elphidiinae; 1-4, *Elphidium*) (p. C631-C635).

asymmetrical form, $\times 100$ (*2019).—FIG. 505, 4; 506, 4. *E. crispum* (LINNÉ), Mio., Asia (Israel); 505, 4, vert. sec., $\times 87$ (*1534); 506, 4a, diagram.

sec. through surface depression or fossette; 506, 4b, sec. through ridge between surface depressions showing aperture (a), apertural face (af), sur-

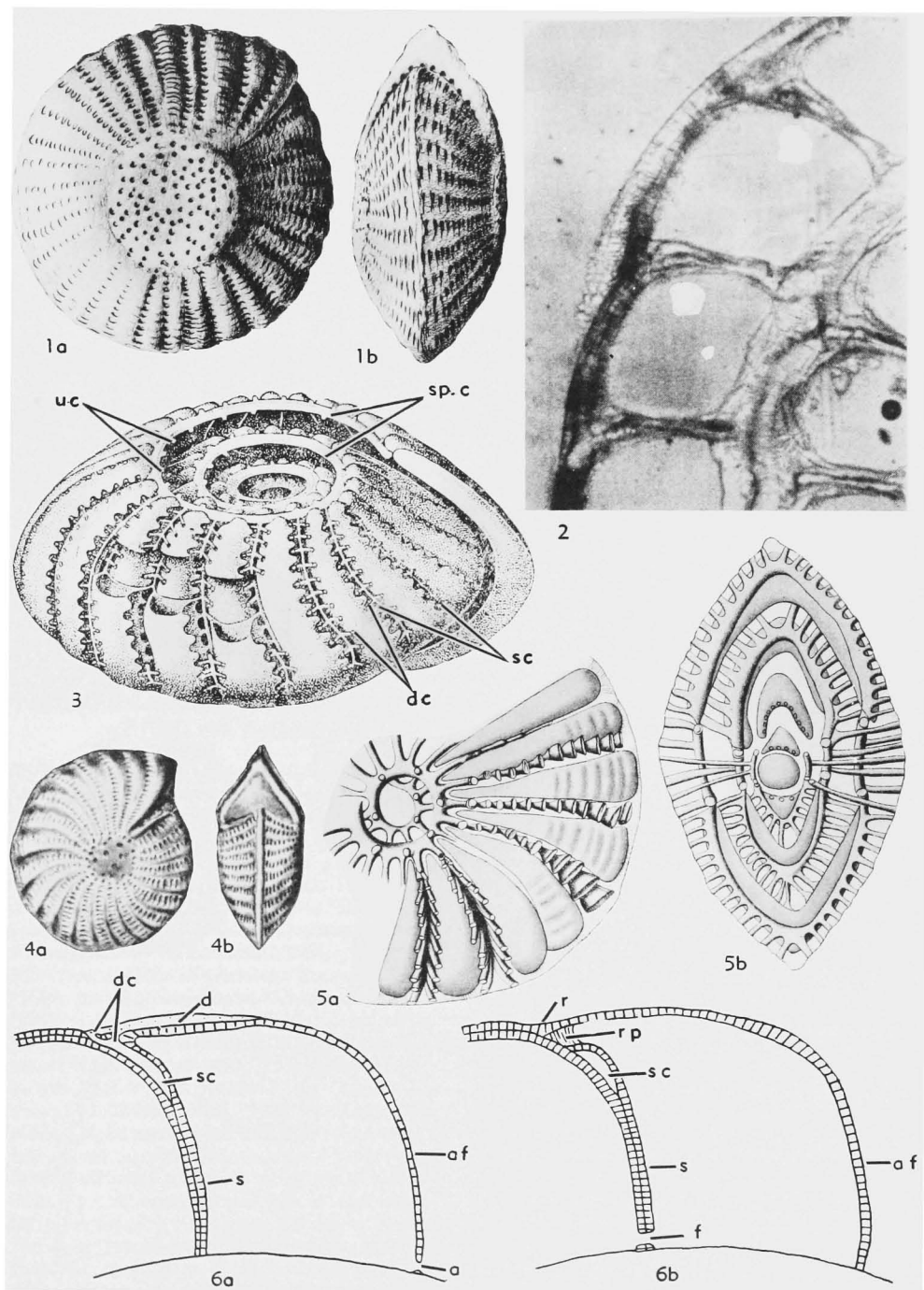


FIG. 507. Elphidiidae (Elphidiinae; 1-6, *Cellanthus*) (p. C635).

face depression (*d*), diverging canal (*dc*), foramen (*f*), surface ridge (*r*), retral process (*rp*), septum (*s*), and septal canal (*sc*), locality of specimens not given, $\times 300$ (*2027).—FIG. 506, 1. *E. strigillatum* (FICHEL & MOLL), Rec., Eu. (Italy); 1*a*, living specimen showing granular pseudopodia, which actually extend to a length 4 to 6 times diam. of test; 1*b*, edge view, $\times 72$ (*1695).—FIG. 506, 2. *E. laminatum* (TERQUEM), Plio., Eu. (Albania); 2*a*, side and apert. views, side view suggesting an evolute condition but arched chamber seen in edge view suggesting that this is a normally involute form, $\times 100$ (*2019).—FIG. 506, 3. *E. tenuissimum* (KARRER), Oligo-Mio., N.Z.; 3*a*, side, edge views, $\times 120$ (*959).

[Numerous recent revisions of *Elphidium* have been undertaken, varying from the inclusive usage of CUSHMAN (1939, *473) to finer divisions variously based on apertural form and position, type of internal canals, and other characters. The present somewhat restricted usage of *Elphidium* is based on revisions of the genus by HOFKER (1956, *946), UJTIÉ (1956, *1964), WADE (1957, *2027), VOLOSHINOVA (1958, *2019), and KRASHENINNIKOV (1960, *1054). The previously synonymized *Elphidium*, *Cellanthus*, *Cribrorophidium*, and *Elphidiella* are recognized as distinct genera. *Planorophidium* was described as being partially evolute, although this was not indicated in the original description of the type-species from the Pliocene of Rhodes, nor was this apparent except by dampening specimens (e.g., from Albania). TERQUEM reported *E. macellus* from the Middle Eocene (Lutetian) of the Paris Basin, but the form from these deposits was not conspecific with the type-species and was later named *Elphidium terquemianum* LE CALVEZ (1950, *1113). It appears that compressed tests result from very narrow highly arched chambers, and that the very thin lateral shell layers become transparent on dampening, erroneously suggesting an evolute condition. The Recent evolute species *E. subevolutum* CUSHMAN, mentioned by VOLOSHINOVA (*2019) as a probable *Planorophidium* may be an incompletely developed *Ozawaia*, as both occur at Rotonga. *Planorophidium* is therefore regarded as a synonym of *Elphidium*. *Faujasinella* was defined as differing from *Elphidium* in being slightly asymmetrical, although the aperture and canal system are as in *Elphidium*. It was separated from *Faujasina* because it is biconvex. As many species of *Elphidium* may have slightly asymmetrical specimens, this is not regarded as a generic character and *Faujasinella* is considered a synonym of *Elphidium*. *Discorotalia* was stated to differ from *Notorotalia* in being discoidal, with a cluster of areal pores as an aperture and having sporadic sutural pores. The tests of the 2 species included are only slightly evolute on one side; otherwise they seem referable to *Elphidium*, which also may have areal pores and narrow interseptal surface costae. *Discorotalia* is therefore also regarded as a synonym of *Elphidium*.]

Cellanthus DE MONTFORT, 1808, *1305, p. 206 [**Nautilus craticulatus* FICHEL & MOLL, 1798, *716, p. 51; OD] [= *Vorticialis* LAMARCK, 1812, *1087, p. 122 (obj.); *Cellulia* AGASSIZ, 1844, *5, p. 6 (nom. van. pro *Cellanthus* DE MONTFORT, 1808); *Helicoza* MÖBIUS, 1880, *1293, p. 103 (obj.); *Carpenterella* KRASHENINNIKOV, 1953, *1050, p. 88 (non COLLENETTE, 1933; nec. BERMÚDEZ, 1949) (obj.)]. Test large, planispiral, chambers numerous, with large umbilical plug on each side which may occupy over half diameter of test, chambers gradually enlarging but not involute, if umbilical plug is discounted; septa completely double and may enclose additional intraseptal canals; canal system similar to *Elphidium*, but more highly developed, spiral canal at umbilical chamber margin giving rise to straight unbranched canals that lead to surface of umbilical

plugs and also to subsutural intraseptal canals which may branch into divergent canals near surface; wall calcareous, finely perforate, radial in structure, surface not highly ornamented as in *Elphidium*, but only with perforations of canal system; aperture single row of pores at base of apertural face. Plio.-Rec., Indo-Pac. reg.—FIG. 507, 1-6. **C. craticulatus* (FICHEL & MOLL), Rec., Tonga Is. (4), Indon. (5); 1*a*, side and apert. views of microspheric adult, $\times 30$; 2, portion of equat. sec., showing septal canals between septal face and septal flap, and retral processes at peripheral margin, locality not given, $\times 200$; 3, schematic figure of internal cast of chambers and canals, with umbilical plug removed to show spiral canal (*spc*), umbilical canal (*uc*), septal or meridional canals (*sc*), diverging canals (*dc*), $\times 20$ (*2019); 4*a*, side, apert. views of megalospheric specimen, $\times 64$ (*473); 5*a*, schematic equat. sec. combining parts of both megalospheric and microspheric canal systems, 3 septal rows showing megalospheric canal system character, and 2 showing the forking canals of microspheric test, $\times 52.5$; 5*b*, axial sec., $\times 52.5$ (*928*a*); 6*a*, diagram. view of last chamber cut through surface depression; 6*b*, same cut through ridge between depressions, showing aperture (*a*), apertural face (*af*), surface depression (*d*), diverging canal (*dc*), foramen (*f*), surface ridge (*r*), retral process (*rp*), septum (*s*), and septal canal (*sc*), $\times 300$ (*2027).

Cribrorophidium CUSHMAN & BRÖNNIMANN, 1948, *498, p. 18 [**C. vadesens*; OD] [= *Elphidiononion* HOFKER, 1951, *936, p. 356 (type, *Polystomella poeyana* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 55); *Cribrorophyidium* TINOCO, 1955, *1935, p. 30 (nom. van.) (obj.); *Cribrorophidium* (*Rimelphidium*) VOLOSHINOVA, 1958, *2019, p. 173 (type, *Elphidium vulgare* var. *vulgare* VOLOSHINOVA in VOLOSHINOVA & DAIN, 1952, *2022, p. 53)]. Test free, planispiral and involute, commonly robust with rounded periphery and few chambers to whorl; sutures distinct, depressed and may be crossed by solid pillars or septal bars but without retral processes at chamber margins, large sutural pores may be present between septal bars leading to simplified sutural canal system; wall calcareous, coarsely perforate, radiate in microstructure; aperture multiple, with one or more pores at base of septal face and with one or more areal pores in addition. Mio.-Rec., cosmop.—FIG. 508, 1. **C. vadesens*, Rec., W. Indies (Trinidad); 1*a*, side, edge views, $\times 167$ (*1940).—FIG. 508, 2. *C. kugleri* CUSHMAN & BRÖNNIMANN, Rec., W. Indies (Trinidad); 2*a*, side, edge views of holotype, $\times 174$ (*2117).—FIG. 508, 3, 4. *C. poeyanum* (D'ORBIGNY), Rec., W. Indies (Cuba); 3*a*, side, edge views of lectotype, here designated (MNHN, Paris), $\times 64$ (*2117); 4*a*, septum showing areal pores and simple canal, and septal canal from interior of chamber showing relation to incised suture, and solid nonperforate septal

bridges, enlarged (*946).—FIG. 508,5. *C. vulgare* (VOLOSHINOVA), U.Mio., E.USSR(Sakhalin Is.); 5*a,b*, side, edge views, $\times 66$ (*2019).

[Previously considered a synonym of *Elphidium* by us (*1162, p. 105), *Criboelphidium* is here recognized as

differing from *Elphidium* in the absence of hollow retrol processes, the presence of solid, nonperforate septal bridges, coarser pores in the wall, and a simpler canal system, which does not connect to the chamber interior through retrol processes. It resembles *Cribronion* in having solid septal bridges and simple canal system but differs in the presence of an areal aperture in addition to the pore or

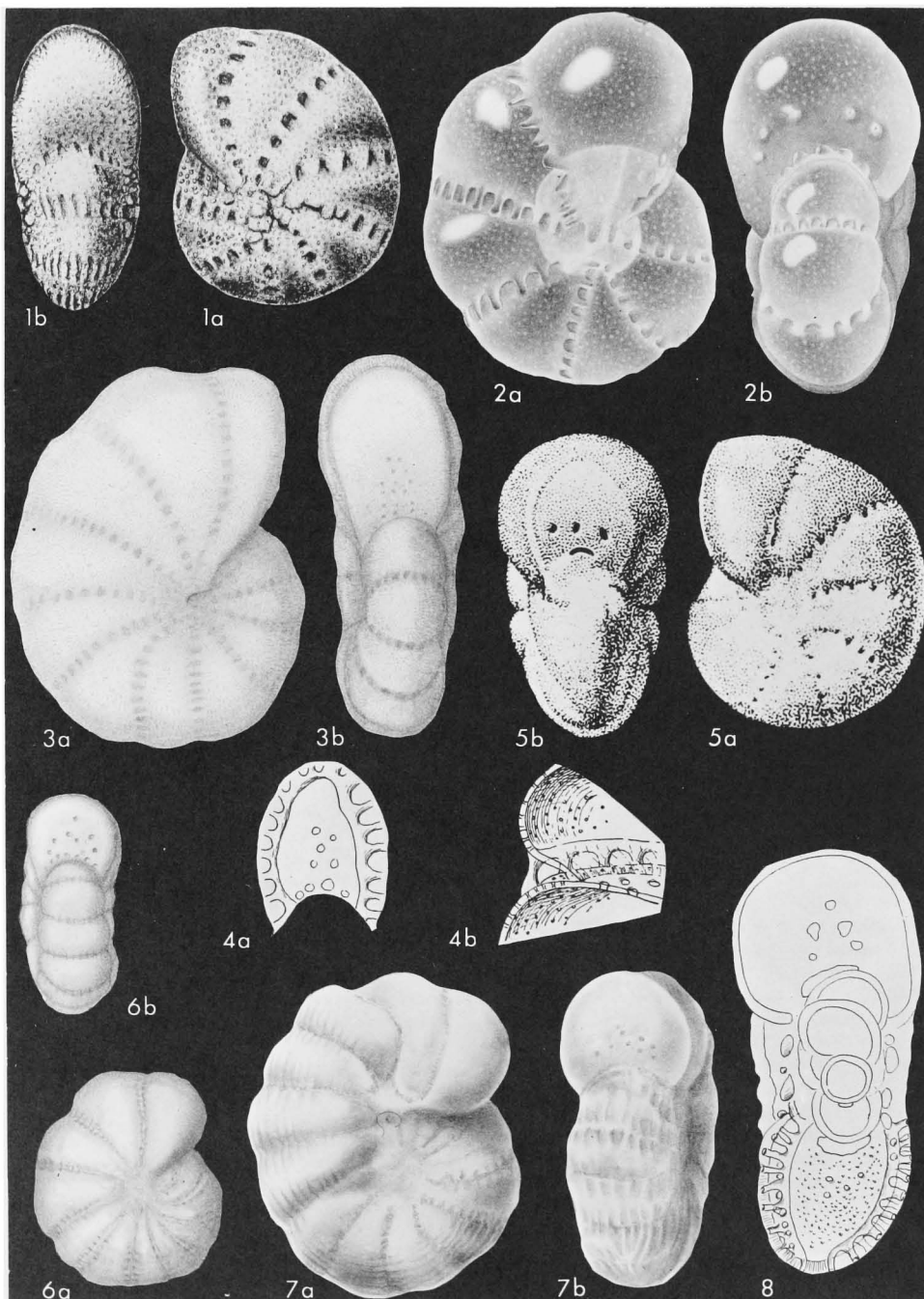


FIG. 508. Elphidiidae (Elphidiinae; 1-5, *Criboelphidium*; 6-8, *Elphidiella*) (p. C635-C639).

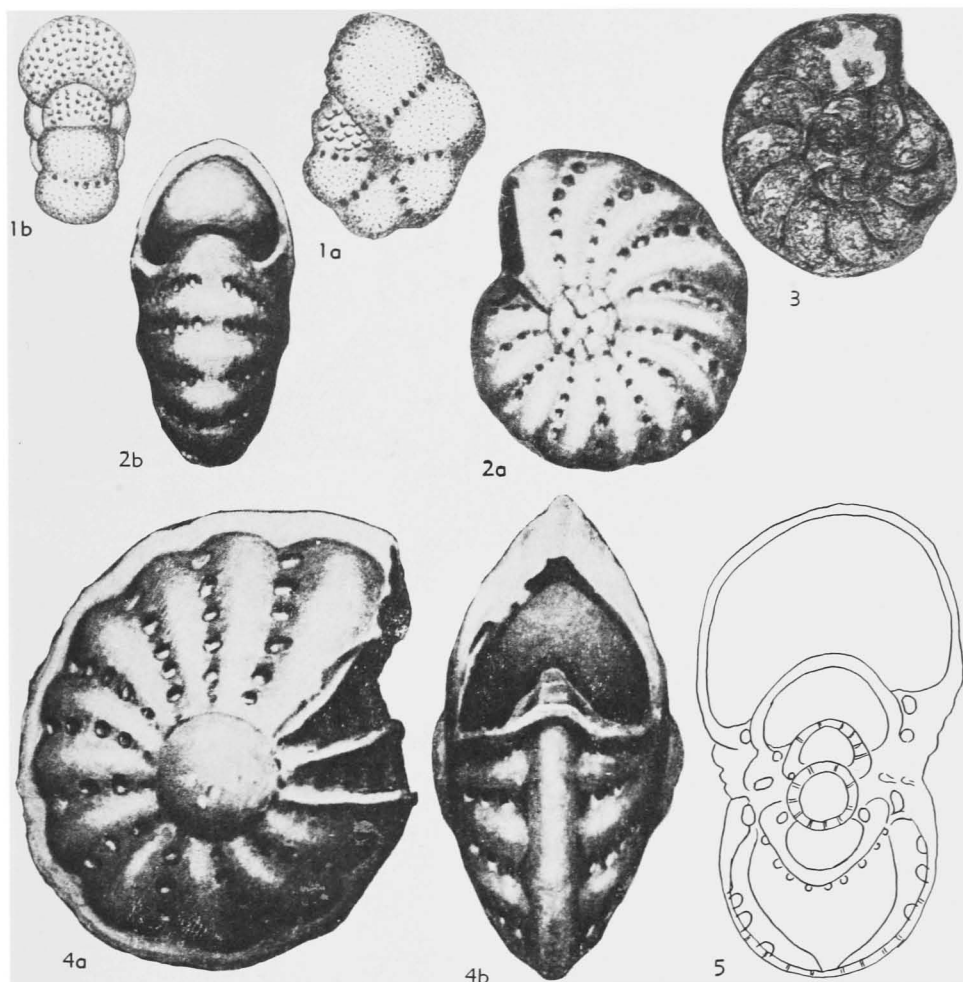


FIG. 509. Elphidiidae (Elphidiinae; 1-5, *Cribrononion*) (p. C637-C638).

row of pores at base of the septal face. Some species previously placed in *Cribrorhynchium* by reason of the presence of a multiple areal aperture belong to *Elphidium*, as shown by the presence of retrai processes and a complex canal system, or to *Elphidiella*. It is regarded as belonging to the Elphidiidae, because of the canal system and radially built wall. A lectotype is here designated for *Polystomella poeyana* d'ORBIGNY, type-species of *Elphidiononion*. The lectotype (here redrawn) and paratypes (Recent, off Cuba) are in the d'ORBIGNY collection, Muséum Natl. Histoire Nat., Paris.]

Cribrononion THALMANN, 1947, *1899c, p. 312 [**Nonionina heteropora* EGGER, 1857, *657, p. 300; OD] [=Nonion (*Cribrononion*) THALMANN, 1947, *1899c, p. 312 (obj.); *Canalifera* KRASHENINNIKOV, 1953, *1050, p. 88 (type, *Elphidium eichwaldi*) (nom. nud.); *Canalifera* (*Canalifera*) KRASHENINNIKOV, 1960, *1054, p. 59 (type, *Elphidium eichwaldi* BOGDANOVICH in SEROVA, 1955, *1719, p. 354); *Canalifera* (*Criptocanalifera*) KRASHENINNIKOV, 1960, *1054, p. 60 (type, *C. (C.) clara*)]. Test planispiral, bilaterally symmetrical, involute, chambers simple; sutures ex-

cavated to open into intraseptal canal, connecting to spiral canal at each side in umbilical region, no retrai processes, but solid and imperforate septal bridges may occur; wall calcareous, coarsely perforate, radial in structure; aperture a single opening or row of pores at base of apertural face, single slitlike foramen in earlier septa possibly due to later resorption. *Mio.-Rec.*, cosmop.—FIG. 509,1. **C. heteroporum* (EGGER), Mio., Eu. (Bav.); 1a,b, side, edge views, showing pustulose apertural face, not an areal aperture, $\times 60$ (*700).—FIG. 509,2,3. *C. clarum* (KRASHENINNIKOV), M. Mio. (U. Torton.), Eu. (Ukraine); 2a,b, side and edge views of holotype showing arched slitlike foramen; 3, sec., $\times 80$ (*105+).—FIG. 509,4. *C. eichwaldi* (BOGDANOVICH), M. Mio. (U. Torton.), Eu. (Ukraine); 4a,b, side, edge views, $\times 80$ (*105+).—FIG. 509,5. *C. incertum* (WILLIAMSON), Rec., Arctic (Iceland); axial sec. showing

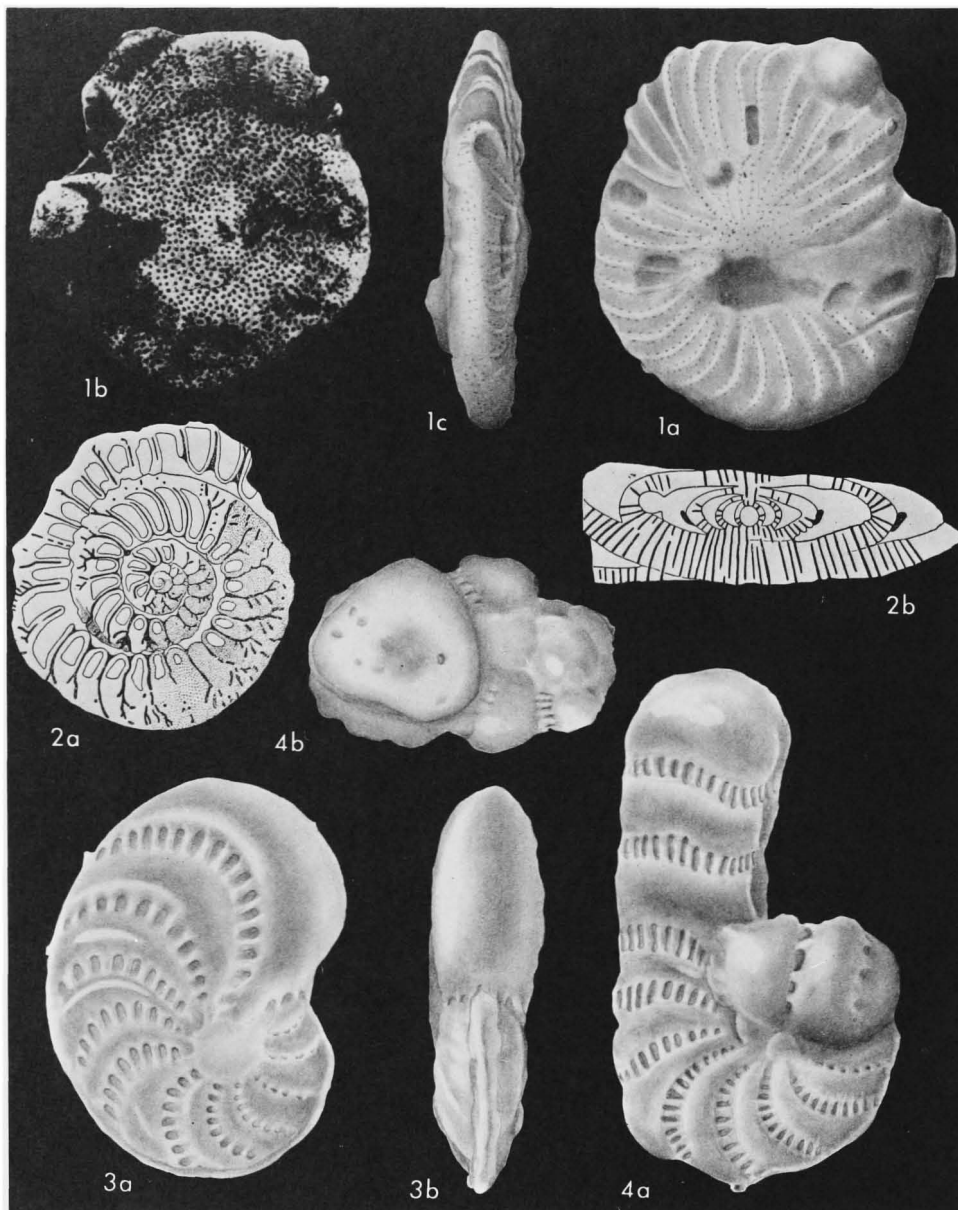


FIG. 510. Elphidiidae (Elphidiinae; 1,2, *Laffitteina*; 3,4, *Ozawaia*) (p. C639-C640).

basal multiple foramen and canal system, enlarged (*946).

[Originally placed in the Nonionidae, this genus is here regarded as related to the Elphidiidae because of its canal system, radially built wall, and septal pores. These features are not characteristic of the Nonionidae. Although specimens of the type were not available for examination, other species here included (e.g., *Polystomella umbilicatulula* var. *incerta* WILLIAMSON, 1858) have been found to be radially built, as are the Elphidiidae, and not granular, as in the Nonionidae. *Canalifera* was defined as having an aperture with a single row of pores and the subgenus *Criptocanalifera* as having a single arched basal slit. The single slit described in the type-species of the monotypic

subgenus represented a foramen of an earlier septum, not a terminal aperture, and is probably due to resorption. *Cribrononion* also includes some species that have been placed in *Elphidiononion* (= *Cribroelphidium*). As here redefined, *Cribrononion* includes species with the shell morphology of *Cribroelphidium* but with basal aperture of one or more openings and without the multiple areal aperture of *Cribroelphidium*.]

Elphidiella CUSHMAN, 1936, *469, p. 89 [**Polystomella arctica* PARKER & JONES in BRADY, 1864, *186, p. 471; OD]. Test free, planispiral and involute, bilaterally symmetrical with equitant chambers commonly leaving axial umbilical plug

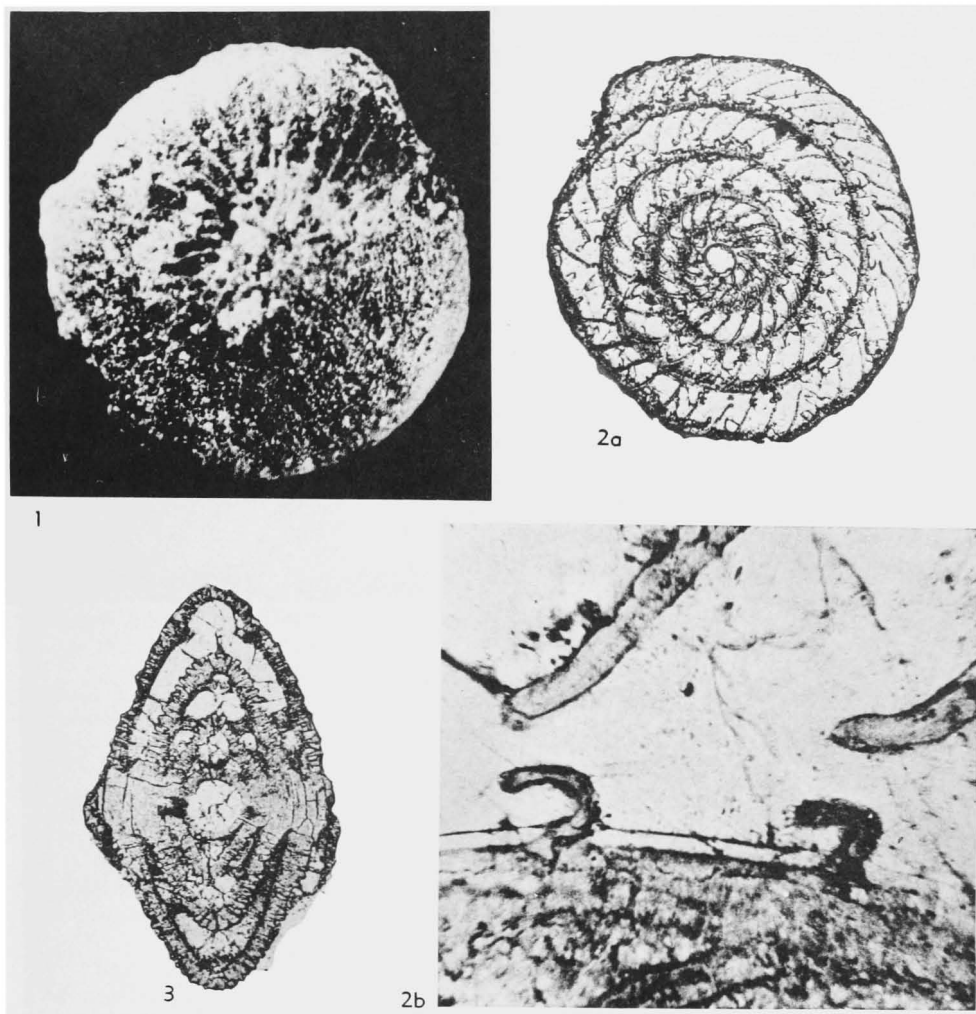


FIG. 511. Elphidiidae (Elphidiinae; 1-3, *Pellatispirella*) (p. C640).

which lacks radial canals; sutures with openings to subsutural and vertical canals, generally forming double row of alternating pores along each radial suture, without retral processes, although striate surface ornamentation may be present, consisting of grooves originating at sutural pores and extending onto chamber walls; wall calcareous, radial and laminated in structure; aperture multiple, interiorareal, consisting of scattered pores in apertural face. *Paleoc.*(*Dan.*)-*Rec.*, cosmop.—FIG. 508,6-8. **E. arctica* (PARKER & JONES), *Rec.*, Arctic (6), Alaska (7), N.Atl. (8); 6*a,b*, side, apert. views, $\times 23$ (*2117); 7*a,b*, side, apert. views, $\times 26$ (*1162); 8, axial sec. showing septal canal, simple sutural septal foramen, and areal openings due to resorption, approx. $\times 50$ (*946). [*Elphidiella* differs from *Elphidium* in lacking retral processes. It differs from *Laffitteina* in being bilaterally sym-

metrical. WADE (1957, *2027) regarded the retral processes as unimportant and *Elphidiella* as a synonym of *Elphidium*. SMOUT (1955, *1804) considered these processes of family importance, and removed *Elphidiella* from the Elphidiidae. UJRIÉ (1956, *1964) regarded the double row of pores as a main criterion and included *Nautilus craticulatus* (the type-species of *Cellanthus*) in *Elphidiella*. If congeneric, the valid name for this group would then necessarily be *Cellanthus*. The 3 genera are here recognized on a similar basis to that used for grouping their type-species by PARKER & JONES (1865, *1418, p. 400), *Polystomella arctica* (= *Elphidiella*) has a well-developed canal system, septal bridges, and apertural bars, but no retral processes; *P. craticulata* (= *Cellanthus*) was stated by PARKER & JONES, 1865, to be characterized by a highly developed canal system, retral processes, septal bridges, and apertural bars, whereas *P. macella*, *P. strigillata* and *P. crispa* (= *Elphidium*) have retral processes, septal bridges, and apertural bars, but only a feebly developed canal system.]

Laffitteina MARIE, 1946, *1217, p. 430 [*L. bibensis*; OD]. Test free, lenticular; chamber numerous, planispirally arranged, internally asymmetrical, with spiral lamella tending to adhere somewhat

to one side of test; wall calcareous, septal walls double, with interseptal space enclosing part of canal system, which opens as double row of sutural pores and with vertical umbilical canals; aperture a basal peripheral slit. *Paleoc.*(*Montian*), Eu.(Fr.)-W.Afr.(Mauritania).—FIG. 510,1,2. **L. bibensis*, Fr.; 1*a,c*, spiral side and edge of holotype showing double row of septal pores, $\times 21$ (*2117); 1*b*, opposite side of holotype, showing numerous scattered pores in umbilical thickening, $\times 20$ (*1217); 2*a*, equat. sec. showing chambers, interseptal canals and canals in supplementary shell material, $\times 26$ (*1217); 2*b*, axial sec. of decorticated specimen showing asymmetrical chamber cavities and adherence of spiral lamella to lower side, canal system and apertures of chamber, $\times 22$ (*1217).

[*Laffiteina* resembles *Elphidiella* in its double row of sutural pores, differing in internal asymmetry, and from asymmetrical *Faujasina* in its double row of sutural pores. Regarded as a synonym of *Lockhartia* by BERMÚDEZ (1952, *127), it differs from that genus in being planispiral and in having a sutural canal system and pores.]

Ozawaia CUSHMAN, 1931, *449, p. 80 [**O. tongaensis*; OD]. Test similar to *Elphidium* in early stage, later uncoiling, with chambers becoming rounded in section, retral processes in both coiled and uncoiled stages; aperture in early stage series of pores at base of apertural face, as in *Elphidium*, cribrate in terminal face of adult. *Rec.*, S.Pac.O.—FIG. 510,3,4. **O. tongaensis*, Tonga Is.; 3*a,b*, side and edge views of young megalospheric specimen, $\times 95$ (*2117); 4*a,b*, side and apert. views of microspheric holotype, $\times 95$ (*2117).

Pellatispirella HANZAWA, 1937, *867, p. 114 [**Camerina matleyi* VAUGHAN, 1929, *1991, p. 376; OD]. Test lenticular to compressed, 1-2.4 mm. diam., periphery rounded to subcarinate, biumbonate, with umbilical plugs, proloculus followed by numerous gradually enlarging planispiral and involute chambers, 20 to 40 in final whorl, no multilocular embryonic apparatus; septa may be slightly elevated and may bifurcate toward periphery; wall calcareous, finely perforate, surface smooth, septa double, walls solid, no marginal cord, umbilical plug perforated by vertical canals; primary aperture siphonate, equatorial and areal in position, with secondary smaller apertures at each side along base of septal face. *M.Eoc.*, W. Indies-C.Am.—FIG. 511,1-3. **P. matleyi* (VAUGHAN), W.Indies(Jamaica); 1, side view, $\times 20$; 2*a,b*, equat. secs. showing character of siphonate primary aperture, $\times 20$, $\times 230$; 3, axial sec. of megalospheric specimen showing pectinate character of spiral lamella, $\times 40$ (*362).

Protelphidium HAYNES, 1956, *887, p. 86 [**P. hofkeri*; OD] [= *Porosonion* PUTRYA in VOLOSHINOVA, 1958, *2019, p. 135 (type, *Nonionina subgranosa* EGGER, 1857, *657, p. 299, = *Nonionina tuberculata* D'ORBIGNY, 1846, *1395, p. 108)]. Test planispiral and involute, similar to *Nonion*, but with perforate, radial wall structure, no sutural pores or retral processes but vertical canals pierce-

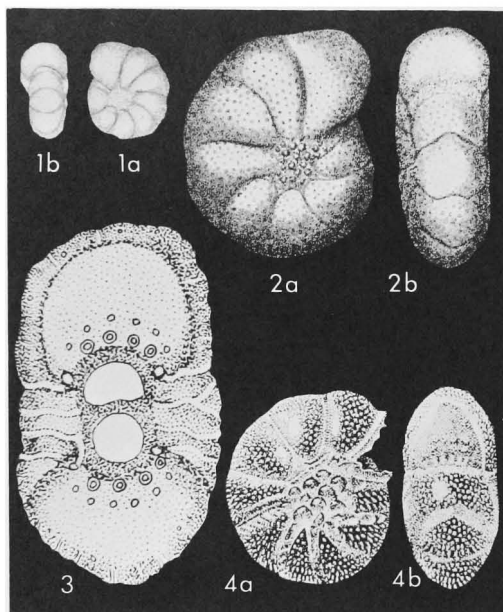


FIG. 512. Elphidiidae (Elphidiinae; 1-4, *Protelphidium*) (p. C640).

ing umbilical plug of secondary shell material; primary aperture not seen, possibly interiomatic, secondary areal foramina and umbilical pores. *Paleoc.-Plio.*, Eu.—FIG. 512,1. **P. hofkeri*, Paleoc., Eng.; 1*a,b*, side, apert. views of holotype, $\times 50$ (*887).—FIG. 512,2-4. *P. tuberculatum* (D'ORBIGNY), Mio., Aus. (2), Caucasus (3,4); 2*a,b*, side, edge views of topotype, $\times 90$ (*473); 3, axial sec. showing cribrate foramina, spiral and vertical canals, $\times 150$ (*2019); 4*a,b*, side, edge views, $\times 100$ (*2019).

[Originally placed in the Nonionidae, it differs from these in its radially built, rather than granular perforate, wall. *Porosonion* was said to differ from *Protelphidium* in having a multiple aperture, but this is not present on the terminal face, only appearing in earlier septa by resorption. The type-species of *Porosonion* was also placed in *Cribronion* by THALMANN (1947, *1899c) but that genus has sutural pores and canals.]

Subfamily FAUJASININAE Bermúdez, 1952

[*Faujasininae* BERMÚDEZ, 1952, p. 192] [= *Notorotaliinae* HORNIBROOK, 1961, p. 129]

Test trochospiral to planispiral, may have umbilical plug with anastomosing canals; sutural pores associated with well-developed sutural canal system; wall calcareous, surface with coalescing granules or narrow ribs connecting sutures; aperture of 1 or 2 rows or cluster of pores, near base of apertural face. *M.Eoc.-Rec.*

Faujasina D'ORBIGNY IN DE LA SAGRA, 1839, *1611, p. 109 [**F. carinata*; OD (M)] [= *Faujasina* TERQUEM, 1882, *1890, p. 48 (*nom. van.*)]. Test free, plano-convex, chambers numerous, low and broad, all visible on flat spiral side, only those of

final whorl visible on convex umbilical side; spiral canal system well developed on umbilical side, rudimentary on spiral side, interseptal canals joining 2 spiral canals; sutures curved backward

at periphery; wall calcareous, with regular, closely spaced, interseptal bars and grooves extending forward from sutures; aperture an interiomarginal row of pores. *Plio.*, Eu.-Japan.—FIG. 513, 1, 2;

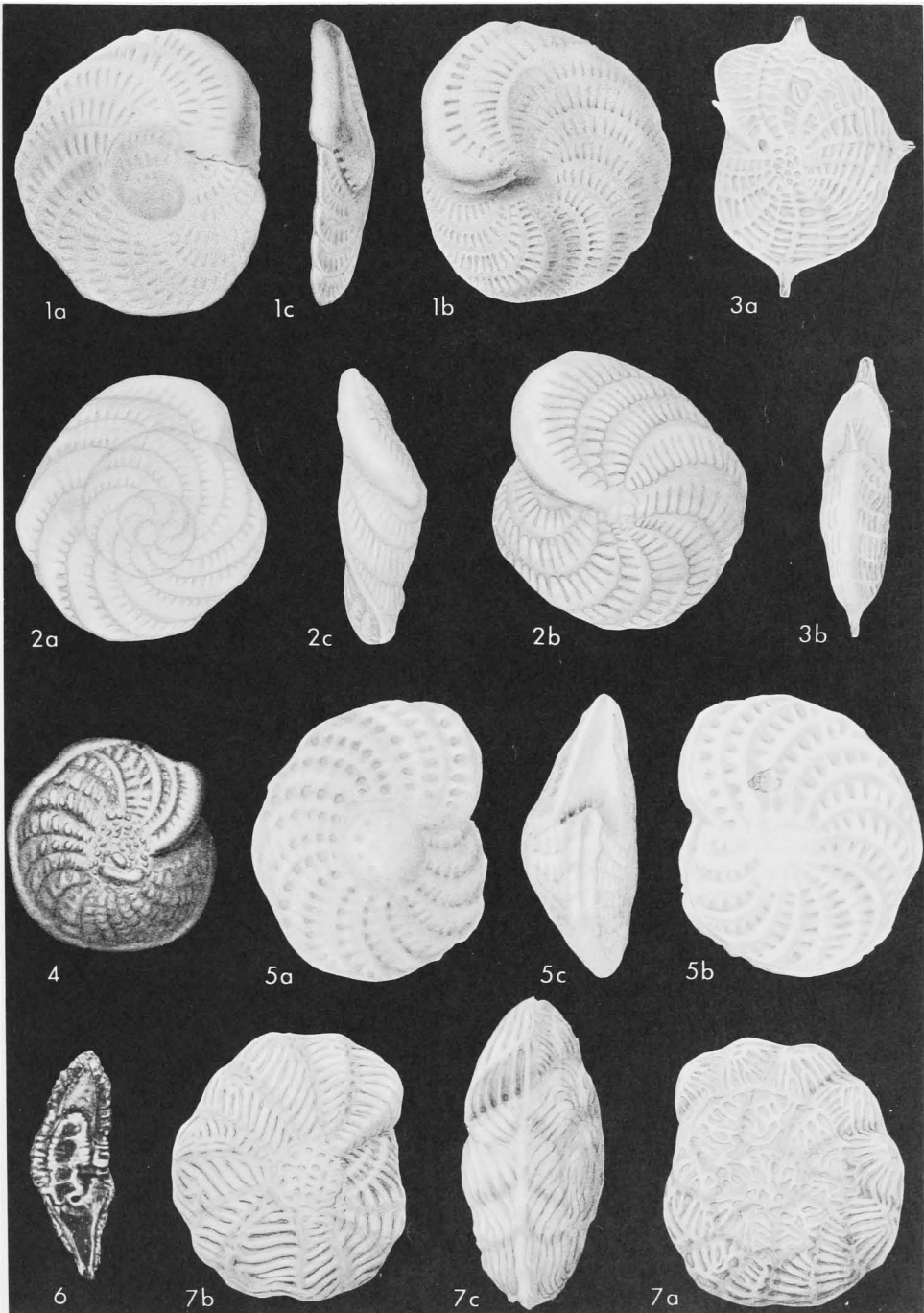


FIG. 513. Elphidiidae (Faujasininae; 1, 2, *Faujasina*; 3, *Parrellina*; 4-7, *Polystomellina*) (p. C640-C643).

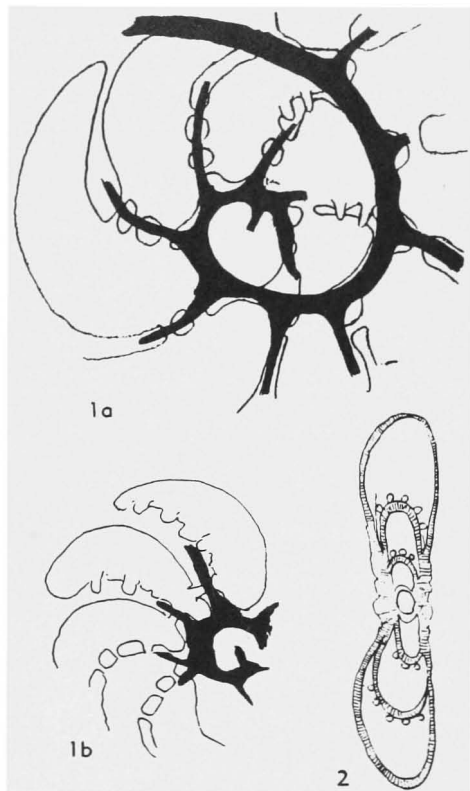


FIG. 514. Elphidiidae (Faujasininae; 1,2, *Faujasina*) (p. C640-C642).

514,1,2. **F. carinata*, Plio., St. Erth, Eng.; 513, 1a-c, opposite sides and edge view of hypotype, showing apert. pores, $\times 45$ (*2117); 513,2a-c, opposite sides and edge view of lectotype (MNHN, Paris), here designated, stated (probably erroneously) to be from the Maastrichtian of Holland (Netherlands), $\times 48$ (*2117); 514,1a, canal system of central portion of umbilical side, $\times 150$; 514,1b, canal system of spiral side, $\times 350$; 514,2, axial sec. showing foraminal pores, $\times 150$ (*929).

[Originally reported to be from the Maastrichtian, this genus is undoubtedly solely a late Cenozoic one. Specimens identical to the original types occur in the Pliocene of St. Erth, as noted by CUSHMAN (1939, *473) and it is very probable that mislabeling or contamination of material resulted in the original "Maastrichtian" record of this genus. It was regarded as a post-Miocene genus by SMOUT (1955, *1804, p. 203). A lectotype is here designated and refigured; it and 4 paratypes are in the d'ORBIGNY collection, Muséum National d'Histoire Naturelle, Paris, labeled as from the Maastrichtian at Maastricht, Holland. It has not been reported since from this area or age. The figured hypotype is from the Pliocene of St. Erth and shows the apertural row of pores which are somewhat obscure in the original type-specimens.]

Parrellina THALMANN, 1951, *1899d, p. 224 [*nom. subst. pro Elphidioides* PARR, 1950, *1429, p. 373 (non CUSHMAN, 1945)] [**Polystomella imperatrix* BRADY, 1881, *196c, p. 66; OD]. Test free, bilaterally symmetrical, planispiral and involute; chambers numerous; sutures distinct, raised, with

spiraling, irregular anastomosing ridges across chambers between sutures, costae roughly coinciding with retral processes; apertural face with vertical ridges extending up from its base; wall calcareous, perforate-radiate in structure, may be ornamented with few thick blunt peripheral spines, well-developed canal system with dendroid septal canals and diverging canals, septal pores small; aperture consisting of fine pores near base of apertural face, but may be obscured by ornamentation. [*Parrellina* is similar to *Polystomellina* in surface ornamentation, and to *Elphidium* in its symmetrical test, differing from both in the anastomosing canal system.] *Oligo-Rec.*, Tasm.-Australia (New S. Wales-Vict.).—FIG. 513,3. **P. imperatrix* (BRADY), Rec., Australia; 3a,b, side, apert. views, $\times 37$ (*2117).—FIG. 515,1,2. *P. craticulatiformis* WADE, L.Mio., S.Australia; 1, nearly equat. sec. showing dendroid canal system; 2, axial sec. showing radial and anastomosing umbilical canals, $\times 40$ (*2027).

Polystomellina YABE & HANZAWA, 1923, *2089, p. 99 [**Polystomella* (*Polystomellina*) *discorbinoides*; OD (M)] [= *Polystomella* (*Polystomellina*) YABE & HANZAWA, 1923, *2089, p. 99 (obj.)]; *Notoralia* FINLAY, 1939, *717a, p. 517 (type, *N. zealandica*). Test trochospiral, lenticular to planoconvex, periphery subangular to keeled, umbonal region of umbilical side with overlapping septal flaps or extensions of chambers, chambers with retral processes, intraseptal canal system, canals

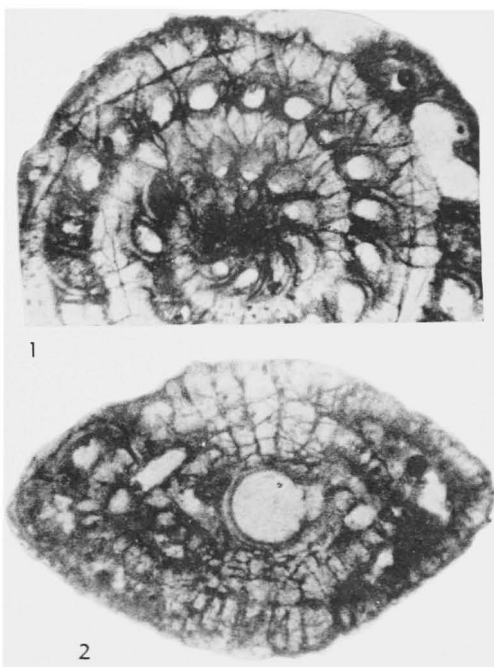


FIG. 515. Elphidiidae (Faujasininae; 1,2, *Parrellina*) (p. C642).

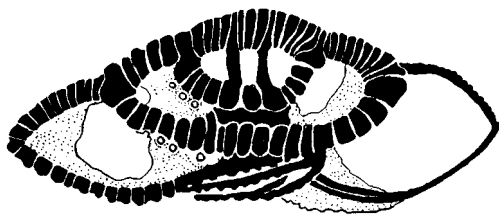


FIG. 516. Elphidiidae (Faujasininae; *Polystomellina*) (p. C642-C643).

narrowing near surface to lead into diverging canals and tiny irregularly developed sutural pores which may occur on both sides of sutures, vertical umbilical canals also present; wall calcareous, perforate, surface typically ornamented with prominent spiraling or discontinuous ribs connecting elevated sutures; aperture 1 or 2 rows of pores near base of apertural face. *M.Eoc.-Rec.*, Japan-N.Z.-Australia-S.Am.-Antarctic. — FIG. 513,4-6. **P. discorbinoides*, Plio., Japan; 4, umbilical side, showing somewhat anastomosing ridges, and canalliculate umbonal plug, $\times 40$ (*473); 5a-c, opposite sides and edge view showing apert. pores, $\times 62$ (*2117); 6, axial sec. showing septal foramina and vertical umbilical and septal canals and pores, $\times 60$ (*2089). — FIG. 513,7; 516. *P. zelandica* (FINLAY), M.Pleist., N.Z.; 513,7a-c, opposite sides and edge view of paratype showing characteristic ornamentation, $\times 33$ (*2117); 516, axial sec. of topotype showing umbilical septal flaps, vertical canals, and apert. pores, $\times 60$ (*959).

[*Polystomellina* was originally described as similar to *Faujasina* but with the umbilical side flattened and spiral side convex, and the original figures somewhat misleadingly suggested a conical test with septal pores but otherwise smooth surface. The type-species is from a limestone and preservation somewhat obscures the features, but when colored with a slight amount of dye a highly ornate surface is apparent, with ridges extending from suture to suture between septal pores on the spiral side and discontinuous and anastomosing ridges on the more flattened umbilical side, canal openings also appearing in the umbonal plug. The true characters of the species are better shown by CUSHMAN (*473, pl. 19, fig. 12a-c). CUSHMAN (1936, *469) also described 2 additional species of *Polystomellina*. FINLAY, 1939, defined *Notorotalia* for certain species previously placed in *Rotalia*, but also included CUSHMAN's 2 Australian species of *Polystomellina* (*469), stating that *Polystomellina* differed in being flat on the umbilical side rather than biconvex, and in having only porous radial sutures as ornament, lacking the characteristic reticulation of "*Notorotalia*." He did not comment on CUSHMAN's figures of the type-species of *Polystomellina* that correctly show the surface ornamentation. According to FINLAY, no visible aperture is present in *Notorotalia*, but HORNIBROOK (*959) showed that all species do have a row of small pores at the base of the apertural face, although these commonly are difficult to see. *Polystomellina* was stated to have a single low opening, but the type-species also shows a number of pores between slight ridges at the base of the apertural face, these also being more evident as foramina in earlier septa. Later workers have placed numerous species in *Notorotalia* but have left *Polystomellina* with only the type-species. As *Notorotalia* is identical in surface, apertural, and internal features, it is here suppressed as a junior synonym of *Polystomellina*. A lectotype for the previously unfigured *Notorotalia zelandica* was selected and illustrated by VELLA (1957, *2001).]

Porosorotalia VOLOSHINOVA, 1958, *2019, p. 167
[**Notorotalia clarki* VOLOSHINOVA in VOLOSHINOVA

& DAIN, 1952, *2022, p. 56; OD] [= *Cribrorotalia* HORNIBROOK, 1961, *959, p. 138 (type, *Notorotalia tainuia* DORREEN, 1948, *610, p. 290)]. Test trochospiral, strongly biconvex, may have peripheral keel; 10 to 13 chambers in final whorl, retrol processes present, prominent umbilical plug with labyrinthic canal system, internal spiral canal occurring on umbilical side and opening into sutural pores; wall calcareous, thick, lamellar, radially built, sculpture consisting of numerous granules especially well developed on umbilical side, where they may coalesce to form ribs or bars joining sutures; external aperture generally not visible, but may consist of row of very tiny pores, septal foramina of distinct row of openings at base of septum, enlarged by resorption. *Eoc.-Pleist.*, USSR (Sakhalin Is.)-N.Z.-N.Am. — FIG. 517,1. **P. clarki* (VOLOSHINOVA), Mio., Sakhalin Is.; 1a-c, opposite sides and edge view of holotype showing septal foramina visible through broken final chamber, $\times 80$ (*2019). — FIG. 517,2,3. *P. tainuia* (DORREEN), U.Eoc., N.Z.; 2a-c, opposite sides and edge views of holotype lacking external aperture; 3, edge view of paratype, final chamber broken, showing septal foramina; all $\times 93$ (*610). — FIG. 517,4. *P. obesa* (HORNIBROOK), L.Mio., N.Z.; axial sec. showing canal system and foramina, $\times 40$ (*959).

[*Porosorotalia* was originally placed by VOLOSHINOVA in the *Cribrorotaliinae* with *Cribrorotalia*, *Elphidiella*, and *Cellanthus*. *Cribrorotalia* was classed by HORNIBROOK in the new subfamily *Notorotaliinae* [= *Faujasininae*] with *Notorotalia* [= *Polystomellina*], *Discorotalia* [= *Elphidium*], *Polystomellina*, *Faujasina*, and *Parrellina*. Both *Porosorotalia* and *Cribrorotalia* were independently separated from "*Notorotalia*" on the basis of their granular, rather than costate, ornamentation, differences in the canal system, and well-developed umbilical plug in *Porosorotalia*. Both authors included DORREEN's (*610) species in their new genera.]

NUMMULITIDAE

By W. STORRS COLE

[Cornell University]

Family NUMMULITIDAE de Blainville, 1825

[*nom. correct.* EIMER & FICKERT, 1899, p. 706 (*pro* family Nummulacea DE BLAINVILLE, 1825, p. 372).] — [All cited names are of family rank; dagger(†) indicates *parim*] — [= Nummulacés DE BLAINVILLE, 1825, p. 372 (*nom. neg.*); = Nummulitiidae REUSS, 1862, p. 308; = Nummulitida CARPENTER, PARKER & JONES, 1862, p. 238; = Nummulitidae GÜMBEL, 1870, p. 84; = Nummuliti SCHWAGER, 1876, p. 477; = Nummulitidae SCHULZE, 1877, p. 29; = Nummulitina LANKESTER, 1885, p. 848; = Nummulinetta HAECKEL, 1894, p. 164; = Nummulitinae DELAGE & HÉROUARD, 1896, p. 152; = Nummulariidae WEDEKIND, 1937, p. 111; = Nummulitidos GADEA BUISÁN, 1947, p. 18 (*nom. neg.*); = Nummulitida HAECKEL, 1894, p. 185 (*nom. van.*)] — [= Polythalamat LATREILLE, 1825, p. 161 (*nom. nud.*); = Enthomostegest D'ORBIGNY, 1826, p. 304 (*nom. nud.*; *nom. neg.*); = Helicosorinat EHRENBURG, 1839, table opp. p. 120 (*nom. nud.*); = Velledidae AGASSIZ, 1844, p. 5 (*nom. nud.*); = Cameriniidae MEER & HAYDEN, 1865, p. 11] — [= Cycloclypeina LANKESTER, 1885, p. 848; = Cycloclypeida HAECKEL, 1894, p. 185; = Cycloclypeinae DELAGE & HÉROUARD, 1896, p. 152; = Cycloclypeidae GALLOWAY, 1933, p. 441] [Editor's Note—The author of this section has agreed here to use Nummulitidae and Nummulites in order to conform with editorial policy of the *Treatise* in accepting names legally fixed by ICZN.]

Test normally planispiral, but one terminal genus with annular ephebic cham-

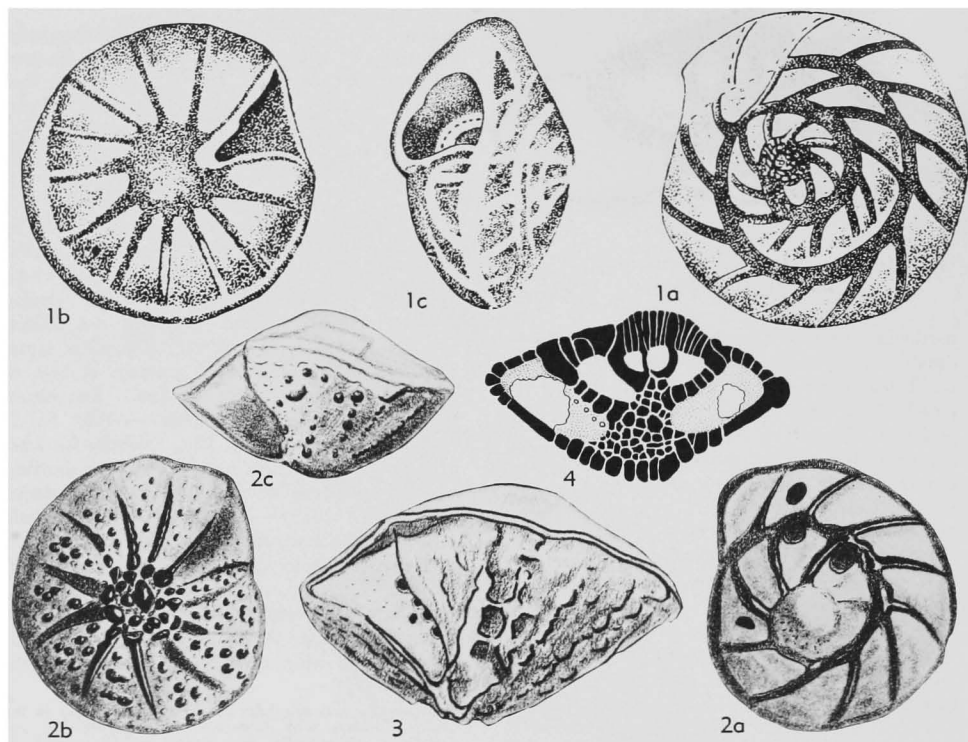


FIG. 517. Elphidiidae (Faujasininae; 1-4, *Porosorotalia*) (p. C643).

bers; slightly asymmetrical to bilaterally symmetrical; involute or evolute; median chambers numerous, simple, or subdivided into chamberlets; with or without lateral chambers; complex canal system consisting of septal, marginal, and vertical canals; aperture typically an arched slit at the base of the septa. *U.Cret.-Rec.*

The nummulitids can be divided into 4 kinds on the development of the median layer: (1) those with planispirally coiled, simple chambers (*Nummulites*, Fig. 518,1); (2) those with planispirally coiled chambers subdivided into chamberlets (*Heterostegina*, Fig. 518,4); (3) those with planispirally coiled initial chambers associated with annular lateral chambers subdivided into chamberlets (*Cyclocypeus*, Fig. 518,2); and (4) those with a double median layer in the peripheral part of the test (*Biplanispira*, Fig. 518,3).

Transverse sections show additional features useful in generic and specific classification. In involute tests (Fig. 518,1) the chamber cavities extend to the axis of the test, producing elongate, V-shaped cavities

(alar prolongations), whereas in evolute tests these prolongations do not appear (see Fig. 520,3). Lateral chambers may be present (*Spiroclypeus*, Fig. 518,6) or absent (*Heterostegina*, Fig. 518,4) in genera which have similar median sections. One genus (*Cyclocypeus*, Fig. 518,2) has the median layer covered on each side by walls made of laminellae, but others (*Pellatispira*, Fig. 518,5) have walls composed of coarse pillars between which numerous large vertical canals occur.

In the past, many generic names have been erected for nummulitids with undivided median chambers, based on the assumption that the type of coiling (involute or evolute), number of the coils, height of the coils, shape of the chambers, character of the spiral wall, and strength of the marginal cord are structures of constant nature within groups of species and accordingly usable for defining genera. These structures can be used to distinguish species from one another, even though they vary within limits between specimens of the same species. Thus, the structures mentioned are char-

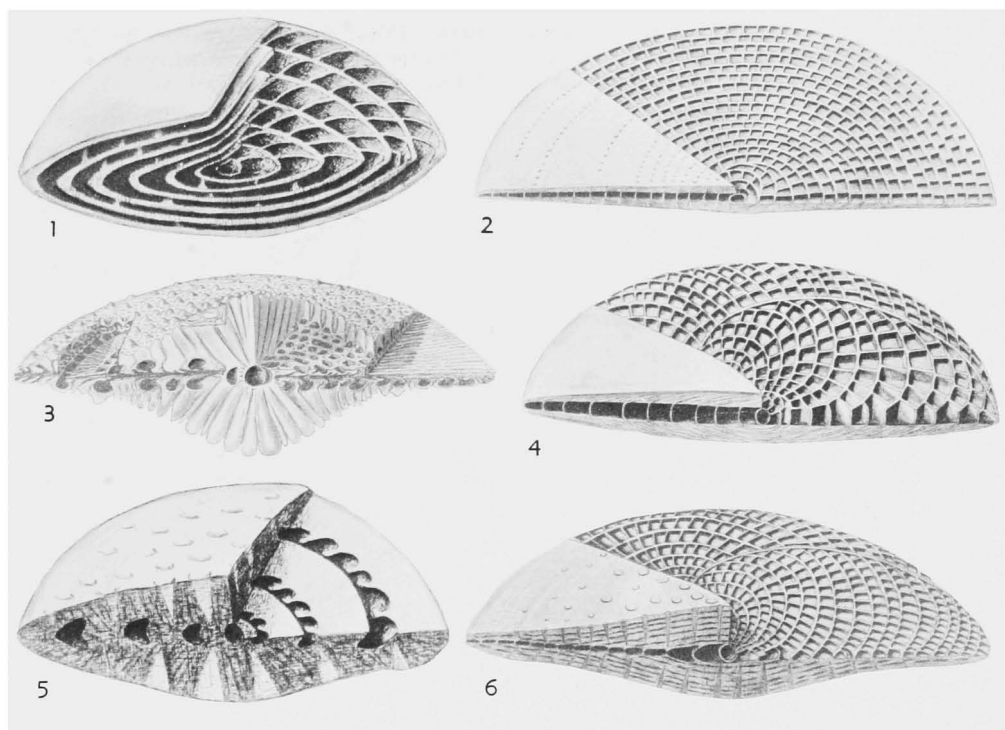


FIG. 518. Nummulitidae. Oblique views of representative genera showing internal structures revealed by transverse and equatorial sections (diagrammatic, not to scale).—1. *Nummulites*.—2. *Cycloclypeus*.—3. *Biplanispira*.—4. *Heterostegina*.—5. *Pellatispira*.—6. *Spiroclypeus* (3, *1969; others, *2121).

acteristic of species, not genera.

Sulcoperculina (U.Cret.) presumably was derived from a rotaliid ancestor, and, in turn it generated *Miscellanea* and *Nummulites*. The heterostegine kind of test was developed by subdivision of the median chambers into chamberlets. The more advanced *Spiroclypeus* has lateral chambers, although in median section it is identical with *Heterostegina*. The most advanced genus, *Cycloclypeus*, has an initial heterostegine stage and undoubtedly had a heterostegine ancestor.

In most species great size differentiation is observed between relatively small specimens of the megalospheric generation and specimens many times larger which represent the microspheric generation.

Subfamily NUMMULITINAE de Blainville, 1825

[*nom. transl.* BRADY, 1881, p. 44 (ex family Nummulacea DE BLAINVILLE, 1825)] [All cited names are of subfamily rank] [=Nummulinina JONES in GRIFFITH & HENFREY, 1875, p. 320; =Nummulitidae SCHWAGER, 1877, p. 19; =Camerininae CUSHMAN, 1928, p. 209; =Assilinininae PURI, 1957, p. 97]

Median chambers numerous, simple, but in one genus occurring in double peripheral

layer; without distinct lateral chambers, but vacuoles may develop in wall of spiral sheet. *U.Cret.-Rec.*

Nummulites LAMARCK, 1801, *1084, p. 101 [validated by ICZN under plenary powers (Opinion 192, 1945, p. 154)] [**Camerina laevigata* BRUGUIÈRE, 1792, *247, p. 399; SD ICZN, 1945] [=*Helicites* GESNER, 1758 (non-Linnean); *Camerina* BRUGUIÈRE, 1792, *247, p. 395 (type, *C. laevigata*); *Phacites* BLUMENBACH, 1799, *150a, pl. 40 (type, *P. fossilis*); *Lycophris* DE MONTFORT, 1808, *1305, p. 159 (type, *Lycophris lenticularis*); *Egeon* DE MONTFORT, 1808, *1305, p. 167 (type, *E. perforatus*); *Helicites* DE BLAINVILLE, 1824, *141a, p. 179 (type, not designated); *Nummulina* D'ORBIGNY, 1826, *1391, p. 295-296 (obj.); *Nummularia* SOWERBY & SOWERBY, 1826, *1820, p. 73 (obj.); *Operculina* D'ORBIGNY, 1826, *1391, p. 281 (type, *Lenticulites complanatus* DEFRANCE, 1822, *579c, p. 453); *Nummulita* FLEMING, 1828, *722, p. 233 (obj.); *Assilina* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 48 (type, *Nummulites spira* DE ROISSY, 1805, *1584, p. 57; *Discospira* MORRIS in MANTELL, 1850, *1213, p. 142 (type, *Discospira* sp., =*Nummulites complanatus* LAMARCK, 1804, *1085b, p. 242); *Monetutiles* EHRENBERG, 1855, *681, p. 289 (type, not designated); *Cumerina*

SCUDDER, 1882, *1709a, p. 93 (*nom. null. pro Camerina* BRUGUIÈRE, 1792); *Discospora* SHERBORN, 1893, *1731a, p. 102 (*nom. null. pro Discospira*

MORRIS, 1850); *Frilla* DE GREGORIO, 1894, *816A, p. 10 (type, *Operculina ammonica* LEYMERIE, 1846, *1132A, p. 359); *Gümbelia* PREVER, 1902, *1481,

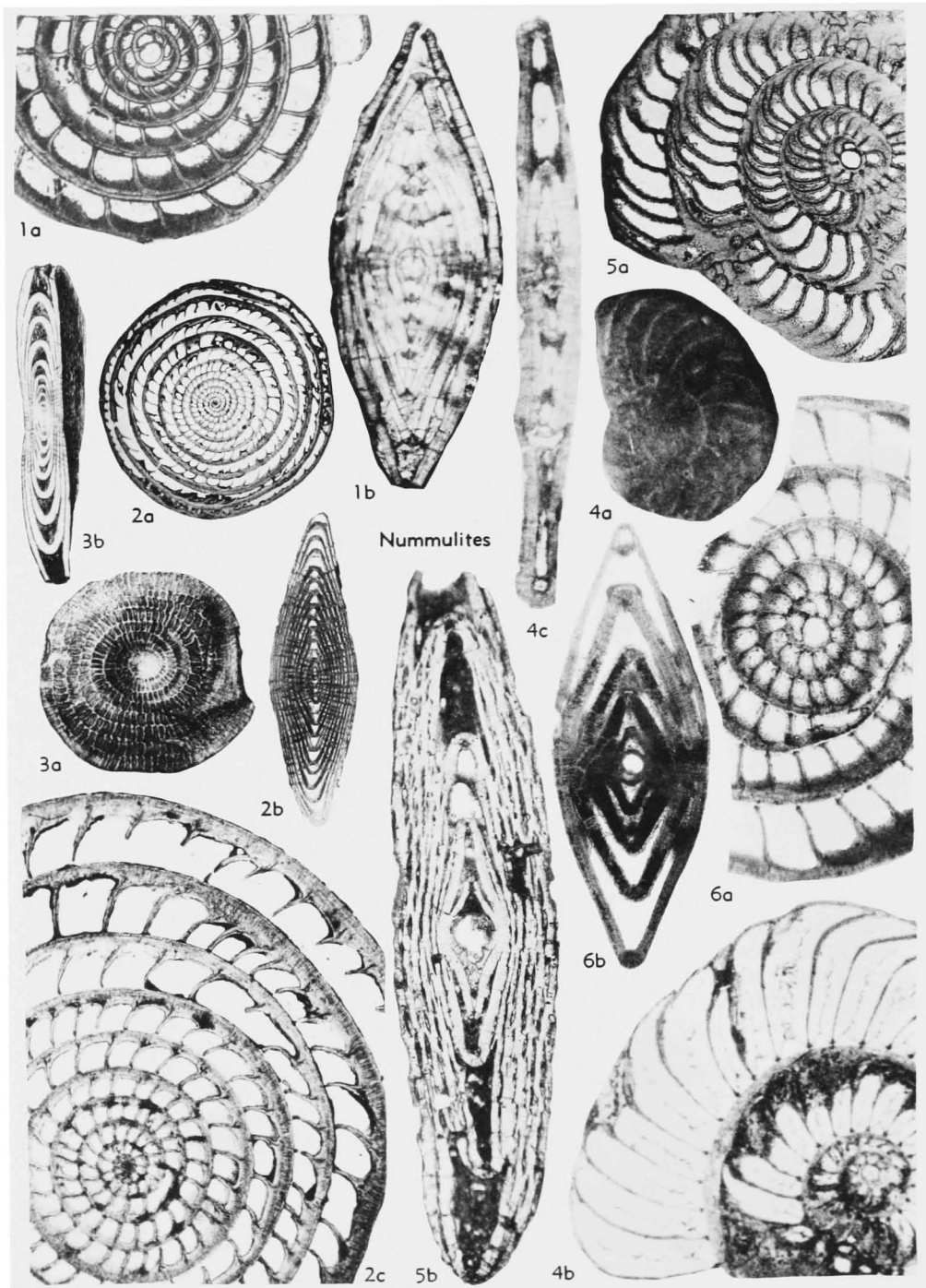


FIG. 519. Nummulitidae (Nummulitinae; 1-6, *Nummulites*) (p. C645-C647).

p. 11 (type, *Nautilus lenticularis* FICHEL & MOLL, 1798); *Bruguiera* PREVER, 1902, *1481, p. 11 (obj.); *Hantkenia* PREVER, 1902, *1481, p. 11 (non MUNIER-CHALMAS in FISCHER, 1885) (type, *Nummulites tchihatcheffi* D'ARCHIAC & HAIME, 1853, *38, p. 98; OD) (non *Nummulites complanata* LAMARCK, 1804, *1085b, p. 242, invalidly designated by GALLOWAY, *762, p. 416, because species not in originally included list assigned to genus and because type-species was otherwise fixed by OD); *Laharpia* PREVER, 1902, *1481, p. 11 (type, *Camerina tuberculata* BRUGUIÈRE, 1792, *247, p. 400); *Paronaea* PREVER, 1903, *1481A, p. 461 (type, *Nummulites tchihatcheffi* D'ARCHIAC & HAIME, 1853); *Paronia* PREVER in CHELUSSI, 1903, *330A, p. 74, = *Hantkenia* PREVER, 1902, obj. (non *Paronia* DIAMARE, 1900); *Verbeekia* A. SILVESTRI, 1908, *1770, p. 137 (type, *Amphistegina cumingii* CARPENTER, 1860, *271b, p. 32) (non *Verbeekia* FRITSCH, 1877, p. 90); *Palaeonummulites* SCHUBERT, 1908, *1686, p. 378 (type, *Nummulina pristina* BRADY, 1874, *191, p. 225); *Operculinella* YABE, 1908, *2084, p. 126 (type, *Amphistegina cumingii* CARPENTER, 1860, *271b, p. 32); *Operculinoides* HANZAWA, 1935, *866, p. 18 (type, *Nummulites willcoxi* HEILPRIN, 1883, *893, p. 191); *Pseudonummulites* A. SILVESTRI, 1937, *1787, p. 149 (type, *Amphistegina cumingii* CARPENTER, 1860, *271b, p. 32); *Paraspiroclypeus* HANZAWA, 1937, *867, p. 116 (type, *Camerina chawneri* PALMER, 1934, *1408, p. 261); *Ranikothalia* CAUDRI, 1944, *304, p. 367 (type, *Nummulites nuttalli* DAVIES, 1927, *559, p. 266); *Nummulitoides* ABRARD, 1956, *2A, p. 489 (type, *Operculina* (N.) *tessieri*); *Planocamerinoides* COLE, 1957, *365, p. 262 (type, *Nummularia exponens* J. DE SOWERBY in SYKES, 1840, *1860, p. 719); *Euassilina* SINGH, 1957, *1793A, p. 210 (type, *E. elliptica*); *Neoperculinoides* GOLEV, 1961, *807, p. 114 (type, *Nautilus ammonoides* GRONOVIVUS, 1781, *828, p. 282). Test involute to evolute, spiral sheet with or without vacuoles. *Paleoc.-Rec.*, cosmop., trop.—FIG. 519.2. **N. laevigata* (BRUGUIÈRE), Eoc., Eu.(Fr.); 2a,b, med. and transv. secs., of microspheric specimens, $\times 3$; 2c, part of med. sec., $\times 12.5$ (*2113c).—FIG. 519.1. *N. striatoreticulata* (RUTTEN), U.Eoc., C.Am.(Panama); 1a,b, med. and transv. secs., $\times 12.5$ (*2113c).—FIG. 519.3. *N. exponens* (SOWERBY), Eoc., Asia(India); 3a, ext. view, $\times 1$; 3b, transv. sec., $\times 1.5$ (*1860).—FIG. 519.4. *N. complanatus* (DEFRANCE), Mio., Japan; 4a, ext. view, $\times 10$; 4b,c, med. and transv. secs., $\times 20$ (*367).—FIG. 519.6. *N. willcoxi* (HEILPRIN), Eoc., N.Am.(Fla.); 6a,b, med. and transv. secs., $\times 20$ (*2113c).—FIG. 519.5. *N. chawneri* (D. K. PALMER), Mio., W.Indies(Cuba); 5a,b, med. and transv. secs., $\times 20$ (*365).

Biplanispira UMBROGROVE, 1937, *1970, p. 309 [nom. subst. pro *Heterospira* UMBROGROVE, 1936, *1969, p. 156 (non KOKEN, 1896)] [**Heterospira mirabilis* UMBROGROVE, 1936, *1969, p. 157; OD]. Median

layer single except in the wide peripheral flange where a double row of chambers occurs; covering layers thick, perforate. *Eoc.*, Indo-Pac.Reg.—FIG. 520.1. **B. mirabilis* (UMBROGROVE), U.Eoc., Saipan Is.; 1a,b, med. and transv. secs., $\times 20$ (*2113c).

Miscellanea PFENDER, 1935, *1451, p. 230 [**Nummulites miscella* D'ARCHIAC & HAIME, 1854, *38, p. 345; OD] [= *Miscellanea* PFENDER, 1934, *1450, p. 80 (nom. nud.)]. Like *Nummulites* but with a coarsely perforate spiral sheet composed of closely spaced pillars. *Paleoc.*, Eu.-Asia (India).—FIG. 520.3. **M. miscella* (D'ARCHIAC & HAIME), India; 3a, ext. view, $\times 10$; 3b, med. sec., $\times 12.5$; 3c, transv. sec., $\times 20$ (*362).

Pellatispira BOUSSAC, 1906, *178, p. 91 [**P. douvillei* (= *Nummulites madaraszi* HANTKEN, 1876, *863, p. 75; OD) [= *Vacuolispira* TAN, 1936, *1869, p. 177 (type, *Pellatispira inflata* UMBROGROVE, 1928, *1967, p. 63)]. Median layer single, composed of a loose coil of chambers separated by canaliferous shell material; covering walls thick, coarsely perforate. *Eoc.*, Eu.-Indo-Pac.Reg.—FIG. 520.2. **P. madaraszi* (HANTKEN), Italy; 2a, ext. view, $\times 7$; 2b,c, med., transv. secs., $\times 11$ (*178).

Sulcoperculina THALMANN, 1939, *1899b, p. 330 [**Camerina* (?) *dickersoni* PALMER, 1934, *1408, p. 243; OD]. Test involute, slightly asymmetrical, peripheral margin with radial plates forming a peripheral sulcus. *U.Cret.*, trop. Am.—FIG. 520.4. **S. dickersoni* (PALMER), Cuba; 4a, ext. view, $\times 40$ (*1408); 4b,c, med., transv. secs., $\times 40$ (*2113a); 4d, schematic internal structure (*2111).

Subfamily CYCLOCYPEINAE Bütschli, 1880

[nom. correct. BRADY, 1884, p. 76 (pro subfam. Cyclocypidae BÜTSCHLI in BRONN, 1880, p. 215)] [=Cyclocypeina CALKINS, 1901, p. 109; Heterocypeinae SCHUBERT, 1906, p. 640; Heterostegininae GALLOWAY, 1933, p. 421]

Median chambers subdivided into chamberlets; without lateral chambers, or with distinct lateral chambers, or with median layer covered by laminellated walls or by coarse pillars between which numerous large vertical canals occur. *Eoc.-Rec.*

Cyclocypeus W. B. CARPENTER, 1856, *271a, p. 555 [**C. mammilatus* CARTER, 1861, *287a, p. 461; SD (SM) CARTER, 1861, *287a, p. 461] [= *Heterocypeus* SCHUBERT, 1906, *1683, p. 640 (type, *Heterostegina cyclocypeus* A. SILVESTRI, 1905, *1761, p. 126) (non *Heterocypeus* COTTEAU, 1895)]. Microspheric generation initially like *Heterostegina*; megalospheric generation initially with bilocular embryonic chambers followed by heterostegine-like periembrionic chambers; later chambers in both generations annular, divided into rectangular chamberlets. [CARPENTER validly described *Cyclocypeus* in 1856 but included it in no named species. When CARTER (1861) referred his new species *C. mammilatus* to *Cyclocypeus*, this was the first specific taxon assigned and thus

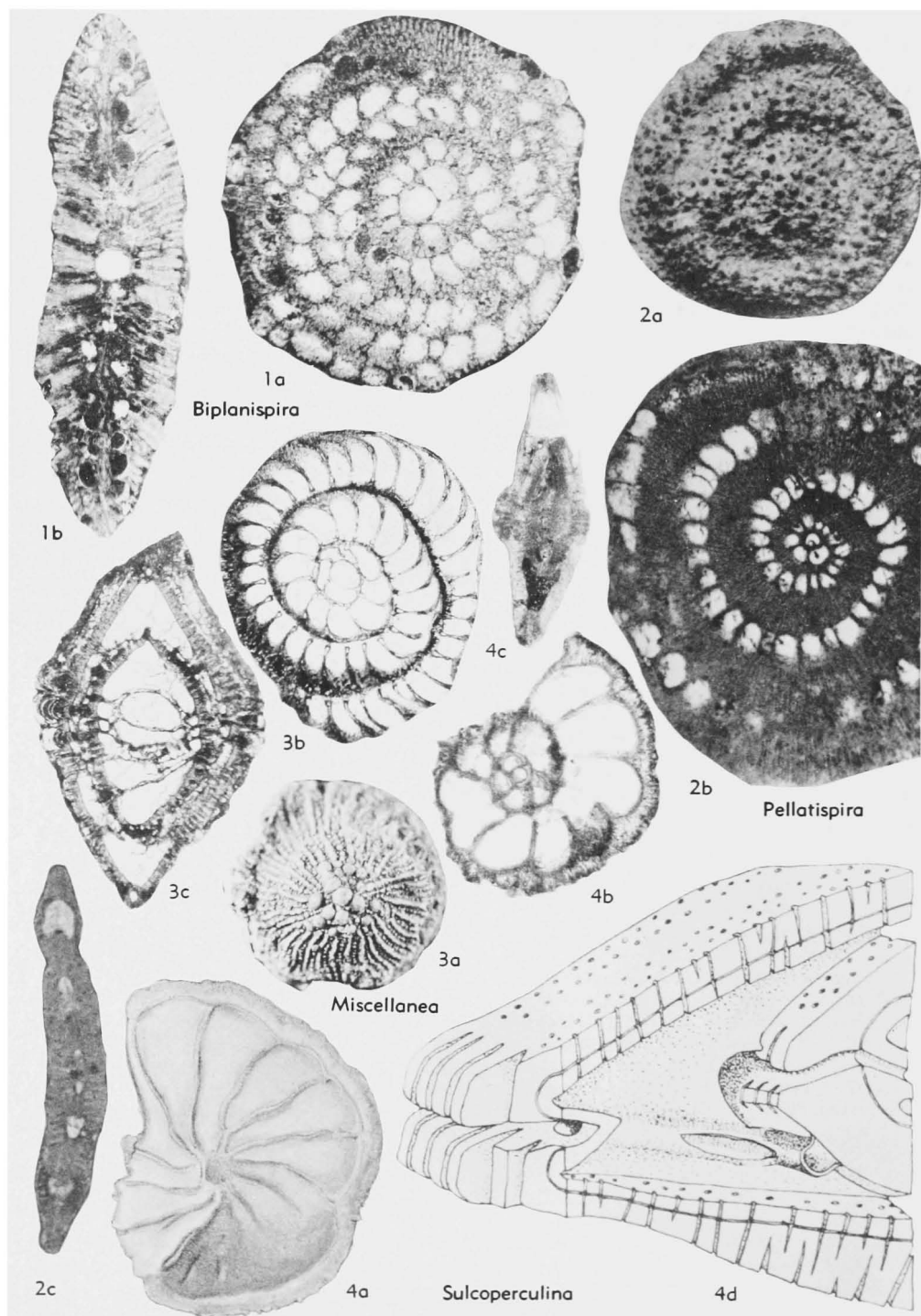


FIG. 520. Nummulitidae (Nummulitinae; 1, *Biplanispira*; 2, *Pellatispira*; 3, *Miscellanea*; 4, *Sulcoperculina*) (p. C647).

automatically was established as type-species.—
Ed.] *Eoc.-Rec.*

C. (Cycloclypeus). Test circular without rays or
marked concentric annular inflations. *Eoc.-Rec.*,
Eu.-Indo-Pac.Reg.—FIG. 521, 1. *C. (C.) car-

penteri, Rec., Bikini Atoll; 1a, med. sec., $\times 32$;
1b, transv. sec., $\times 16$ (*2113c).

C. (Katacycloclypeus) TAN, 1932, *1864, p. 39
[*C. *annulatus* MARTIN, 1880, *1229, p. 157;
OD]. Test with marked concentric annular in-

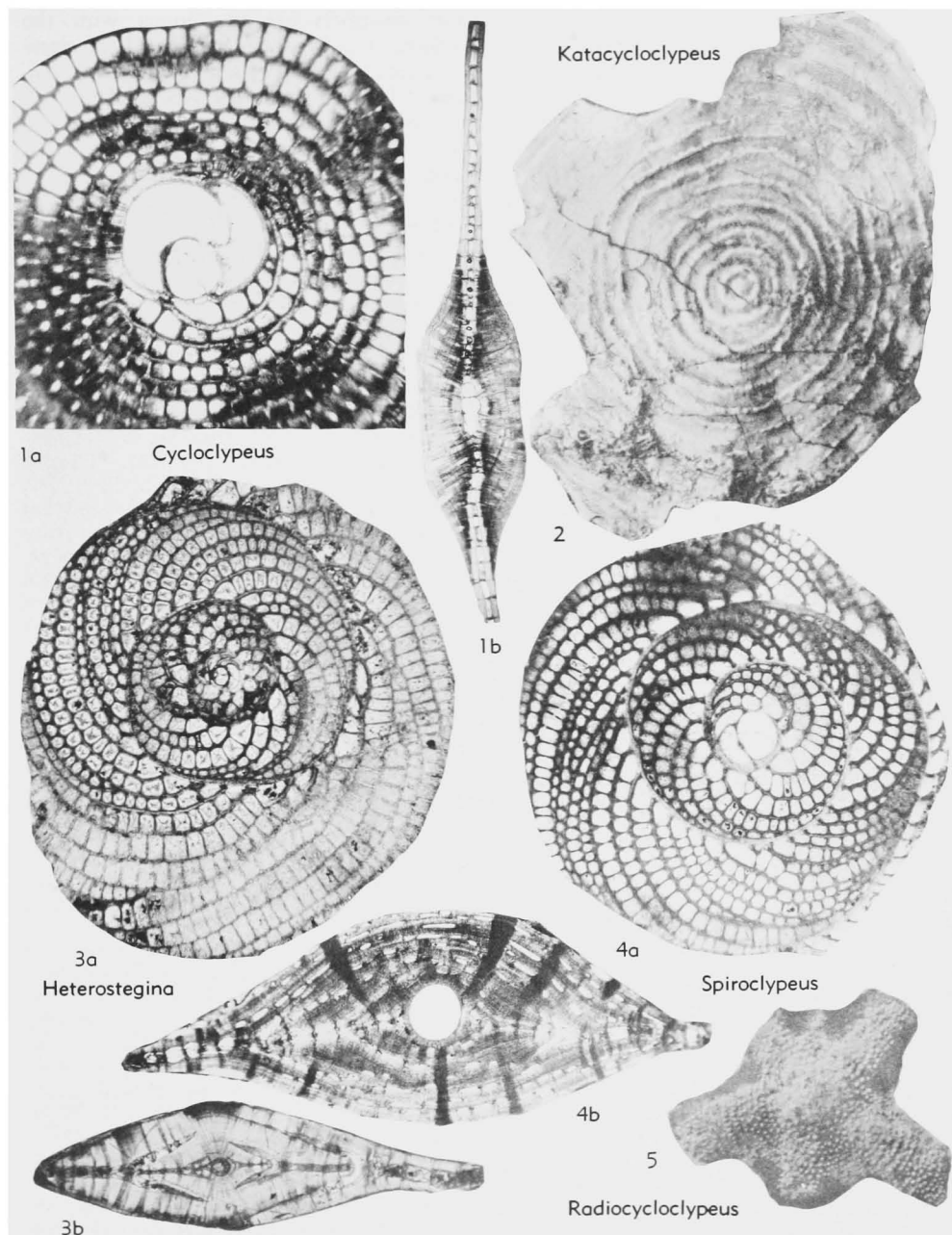


FIG. 521. Nummulitidae (Cycloclypeinae); 1, *Cycloclypeus* (*Cycloclypeus*); 2, *C.* (*Katacycloclypeus*); 3, *Heterostegina*; 4, *Spiroclypeus* (p. C647-C650). 5, *C.* (*Radiocycloclypeus*).

- flations. *L.Mio.*, Indo-Pac.Reg.—FIG. 521,2. **C. (K.) annulatus* MARTIN, *Mio.*, Fiji (Lau Is.); ext. view, $\times 0.8$ (*2116).
- C. (Radiocycloclypeus)** TAN, 1932, *1864, p. 39, 92 [**C. (R.) stellatus*; OD]. Test with radiating rays. *Mio.*, Indo-Pac.Reg.—FIG. 521,5. **C. (R.) stellatus*, Malay Arch. (Borneo); ext. view, $\times 6.5$ (*2033).
- Heterostegina** D'ORBIGNY, 1826, *1391, p. 304, 305 [**H. depressa*; SD PARKER, JONES & BRADY, 1865, *1419, p. 36] [= ?*Heterosteginella* SILVESTRI, 1937, *1787, p. 118 (nom. nud., type not designated); *Grzybowski* BIEDA, 1950, *137A, p. 167 (type, *G. multifida*)]. Like *Nummulites* but later chambers divided into rectangular chamberlets. *Eoc.-Rec.*, cosmop., trop.—FIG. 521,3. *H. antillea* CUSHMAN, *U.Oligo.*, C.Am. (Panama); *3a,b*, med., transv. secs., $\times 16$ (*363).
- Spiroclypeus** DOUVILLÉ, 1905, *615, p. 458 [**S. orbitoides*; OD]. Like *Heterostegina* but lateral chambers developed on each side of the median layer. *Eoc.-L.Mio.*, Indo-Pac.Reg.-Eu.; *Oligo.*, W. Indies.—FIG. 521,4. *S. tidoenganensis* VAN DER VLERK, *L.Mio.*, Saipan Is.; *4a,b*, med. and transv. secs., $\times 16$ (*2113c).

MIOGYPSINIDAE

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[Cornell University]

Family MIOGYPSINIDAE Vaughan, 1928

[nom. transl. TAN, 1936, p. 45 (ex Miogypsininae VAUGHAN in CUSHMAN, 1928, p. 354)] [= Miogypsinoidinae HANZAWA, 1947, p. 262]

Test trigonal, suborbicular, or digitate, evenly or modified lenticular, composed of equatorial layer either with well-developed lateral chambers or with appressed laminae on each side; megalospheric generation with bilocular embryonic chambers with rude or well-developed spire of perieembryonic chambers, situated apically, subapically, or subcentrally; microspheric generation with spire of chambers situated apically; spiral canal and intraseptal canal present; well-developed arcuate, rhombic, or elongate-hexagonal equatorial chambers interconnected by stolons (Fig. 522,1). *M.Oligo.-L.Mio.*

The primary differentiation of miogypsinid genera is based on characteristics shown by vertical sections. *Miogypsinoides* lacks lateral chambers (Fig. 522,2), the equatorial layer being covered on each side by zones of appressed laminae, whereas *Miogypsina* has well-developed lateral chambers on each side of the equatorial layer (Fig. 522,1).

Miogypsina is subdivided into two subgenera: *M. (Miogypsina)* and *M. (Miolepido-*

cyclina). Inasmuch as their recognition is based on the position of the embryonic apparatus, oriented equatorial sections are needed. In *M. (Miogypsina)* the embryonic apparatus is apically situated, so that either the embryonic chambers or the perieembryonic chambers are in contact with the peripheral zone of the test. In *M. (Miolepidocyclina)* the embryonic apparatus is separated from the peripheral zone of the test by one or more rows of equatorial chambers. Specific determinations within the subgenera are based on arrangements of the perieembryonic chambers in relation to the embryonic chambers, and secondarily on shape of the equatorial chambers and characteristics of the lateral chambers.

Present evidence indicates that the miogypsinids are specialized, short-ranged descendants of some type of rotaliid. Some investigators place the miogypsinids in the Rotaliidae (*85).

Miogypsina SACCO, 1893, *1607, p. 205 [**Nummulites globulina* MICHELOTTI, 1841, *1256, p. 297; OD] [= *Flabelliporus* DERVIEUX, 1894, *588, p. 59 (type, *F. dilatatus* = *Nummulites globulina* MICHELOTTI, 1841; SD herein); *Lepidosemicyclina* RUTTEN, 1911, *1596, p. 1135 (type, *L. thecideaeformis*; SD herein); *Miogypsinopsis* HANZAWA, 1940, *869, p. 773 (type, *Miogypsina gunteri* COLE, 1938, *356, p. 42)]. Lateral chambers present, well developed. *U.Oligo.-L.Mio.*

M. (Miogypsina). Megalospheric embryonic apparatus apically situated, without equatorial chambers between it and marginal fringe. *U. Oligo.-L. Mio.*, Eu.-Indo-Pac. Reg.-N. Am.-S. Am.—FIG. 522,3. *M. (M.) antillea* (CUSHMAN), *Oligo.*, C.Am. (Panama); *3a,b*, equat., vert. secs., $\times 40$ (*363).

M. (Miolepidocyclina) A. SILVESTRI, 1907, *1766, p. 80 [**Orbitoides (Lepidocyclina) burdigalensis* GÜMBEL, 1870, *840, p. 719; OD] [= *Heterosteginoides* CUSHMAN, 1918, *410, p. 97 (type, *H. panamensis*); *Miogypsinita* DROOGER, 1952, *630, p. 58 (type, *Miogypsina mexicana* NUTTALL, 1933, *1372, p. 175)]. Megalospheric embryonic apparatus subapically to subcentrally situated with normal equatorial chambers between it and marginal fringe. *U.Oligo.-L.Mio.*, Eu.-Afr.-Indo-Pac. Reg.-N.Am.-S.Am.—FIG. 522,4. **M. (M.) burdigalensis* (GÜMBEL), Burdigal., N. Afr. (Morocco); *4a*, equat. sec., $\times 25$ (*215); *4b*, vert. sec., $\times 48$ (*215).

Miogypsinoides YABE & HANZAWA, 1928, *2092, p. 535 [**Miogypsina dehaartii* VAN DER VLERK, 1924, *2012, p. 429; OD] [= *Conomiogypsinoides* TAN, 1936, *1866, p. 51 (type, *Miogypsina abunensis* TOBLER, 1927, *1938, p. 328); *Miogypsinella* HANZAWA, 1940, *869, p. 765, 770, 775 (type,

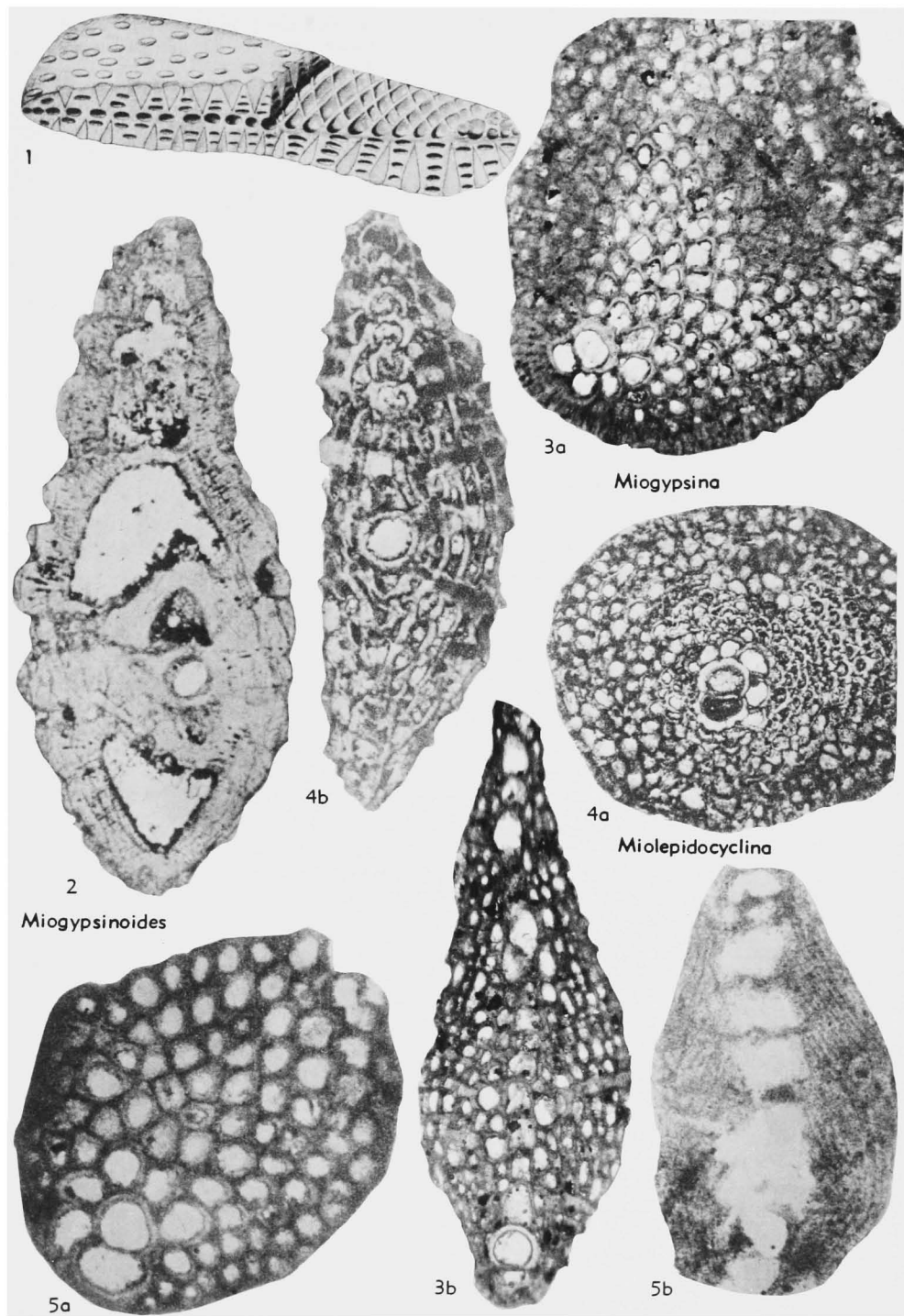


FIG. 522. Miogypsinae; 1, Diagrammatic illustration showing structure; 2, 5, *Miogypsinoides*; 3, *Miogypsina* (*Miogypsina*); 4, *M.* (*Miolepidocyclina*) (p. C650-C652).

M. borodinensis]). Lateral chambers absent. *M. Oligo.-L.Mio.*, Eu.-Indo-Pac.Reg.-N.Am.—FIG. 522,5. **M. dehaartii* (VAN DER VLERK), L.Mio., Indonesia (Moluccas Is.); *5a,b*, equat., vert. secs., $\times 40$ (*2012). [See also Fig. 522,2, *M. complanata* (SCHLUMBERGER), $\times 90$.]

Superfamily GLOBIGERINACEA Carpenter, Parker & Jones, 1862

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 307 (*pro* superfamily Globigerinidae MOROZOVA, 1957, p. 1110, and superfamily Globigerinaceae BANNER & BLOW, 1959, p. 4)] —[All cited names of superfamily rank; dagger(†) indicates *partim*]—[=Orthoklinostegia† EIMER & FICKERT, 1899, p. 685 (*nom. nud.*); =Bilamellicat REISS, 1957, p. 127 (*nom. nud.*)]

Test enrolled, planispiral or trochospiral or modified from such; chambers basically globular, later may be compressed or variously modified; double walls of lamellar radial hyaline calcite, distinctly perforate, may have canaliculate keels; aperture primarily formed, interiomarginal, or may be modified to become areal or terminal, single, or more rarely multiple, and may have secondary or accessory openings, may have apertural lips. [Habit planktonic, with resultant modifications including fine elongate spines which support the frothy areolated ectoplasm.] *M.Jur.-Rec.*

Family HETEROHELICIDAE Cushman, 1927

[Heterohellicidae CUSHMAN, 1927, p. 59] [=Gümbelinidae WEDEKIND, 1937, p. 112; =Heterohellicida COPELAND, 1956, p. 188 (*nom. van.*)]

Early stage trochospiral, planispiral, biserial or triserial, later may show serial reductions or proliferations; aperture large, simple and interiomarginal, or terminal in uniserial forms, without internal columellar processes. *M.Jur.-Oligo.*

Subfamily GUEMBELITRIINAE Montanaro Gallitelli, 1957

[Gümbeltriinae MONTANARO GALLITELLI, 1957, p. 136]

Primitively trochospiral, triserial or quadriserial, later may develop proliferation of chambers; aperture simple. *M.Jur.-Eoc.*

Guembelitra CUSHMAN, 1933, *458, p. 37 [**G. cretacea*; OD] [=Gümbelitra CUSHMAN, 1933, *458, p. 37 (obj.)]. Test triserial throughout; chambers inflated, globular; sutures distinct, depressed; aperture an interiomarginal arch at base of last-formed chamber. *L.Cret.-Eoc.*, cosmop.—FIG. 523,1. **G. cretacea*, U.Cret., USA (Tex.); *1a,b*, side, top views of holotype, $\times 312$ (*1303).

Gubkinella SULEYMANOV, 1955, *1852, p. 623 [**G. asiatica*; OD] [=Globigerina (*Conoglobigerina*) MOROZOVA in MOROZOVA & MOSKALENKO, 1961, *1318, p. 24 (type, *G. (C.) dagestanica*)]. Test

free, high trochospiral; in type-species with 4 inflated chambers to whorl; aperture a low interiomarginal arch. *M.Jur.(Bajoc.-Callov.) - U.Cret. (Senon.)*, USSR-Eu.-N. Am.-W. Indies (Trinidad). —FIG. 524,1. **G. asiatica*, U.Cret. (Senon.), USSR (Kyzyl-Kumy); *1a,b*, side, top views, $\times 200$ (*1852). —FIG. 524,2. *G. dagestanica* (MOROZOVA), *M.Jur.(L.Bathon.)*, USSR (Dagestan); *2a-c*, holotype, $\times 100$ (*1318).

[The original description of the genus indicated it to be quadriserial, belonging to the Heterohellicidae. *Globigerina graysonensis* TAPPAN, from the Albian-Cenomanian of North America seems most probably congeneric, having a similar high-spined test, low aperture, and 4 chambers in the final whorl, or as many as 5 or as few as 3 chambers in each whorl. N. K. BYKOVA, VASILENKO, VOLOSHINOVA, MYATLYUK & SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO (1959, *1509, p. 267, 268) transferred *Gubkinella* to the family Discorbidae, subfamily Discorbinae, and illustrated a specimen of the type-species showing up to 5 chambers in an early whorl. Because of the extremely inflated chambers, the widespread occurrence of some of the species, and its association, we believe this genus to be planktonic in habit. The subgenus *Conoglobigerina* was recently described for an apparently congeneric high trochospiral Jurassic species.]

Guembelitrilla TAPPAN, 1940, *1871, p. 115 [**G. graysonensis*; OD]. Test free, small, triserial in early stage, similar to *Guembelitra*, later becoming multiserial at top; chambers globular, increasing rapidly in size; sutures distinct, depressed; wall calcareous, finely perforate; aperture an interiomarginal arch at base of final chamber, rarely more than one. *U.Cret.(Cenoman.)*, USA.—FIG. 523,2,3. **G. graysonensis*; *2a,b*, side and top views of holotype; *3*, side view of paratype showing multiple apertures in final chamber, $\times 174$ (*1303).

Woodringina LOEBLICH & TAPPAN, 1957, *1169, p. 39 [**W. claytonensis*; OD]. Test free, early stage with single whorl of 3 chambers, followed by biserial stage; chambers inflated; wall calcareous, radial in structure, finely perforate; aperture a low arched slit, bordered above by slight lip. [Differs from *Tosaia* in having a much-reduced early coil consisting of a single whorl of 3 chambers, whereas *Tosaia* has an early trochoid stage followed by a triserial and finally a reduced biserial stage.] *Paleoc.(Dan.)*, USA (Ala.). —FIG. 523,4. **W. claytonensis*; *4a,b*, holotype, opposite sides, $\times 187$; *4c,d*, edge, and basal views, $\times 187$ (*1169).

Subfamily HETEROHELICINAE Cushman, 1927

[*nom. subst.* CUSHMAN, 1927, p. 59 (*pro* Spiroplectinae CUSHMAN, 1911, p. 4)] [=Gümbelininae CUSHMAN, 1927, p. 59]

Early stage planispiral or biserial, later may develop chamber proliferation or serial reduction; aperture simple and interiomarginal, or terminal in uniserial forms. *L. Cret.-Oligo.*

Heterohelix EHRENBURG, 1843, *672, p. 429 [**Spiroplecta americana* EHRENBURG, 1844, *673, p. 75; SD (SM) EHRENBURG, 1844, *673, p. 75] [=Spiroplecta EHRENBURG, 1844, *673, p. 75 (obj.); Gümbelina EGGER, 1899, *659, p. 31 (type, *Textularia globulosa* EHRENBURG, 1840) (*non*

Gümbelina KUNTZE, 1895). Test small, consisting of subglobular biserially arranged chambers, early portion of microspheric test commonly

planispiral; surface smooth or striate; aperture large, interiomarginal, symmetrical. *L.Cret.(Apt.)-U. Cret.(Maastricht.)*, cosmop.—FIG. 523,5. *H.

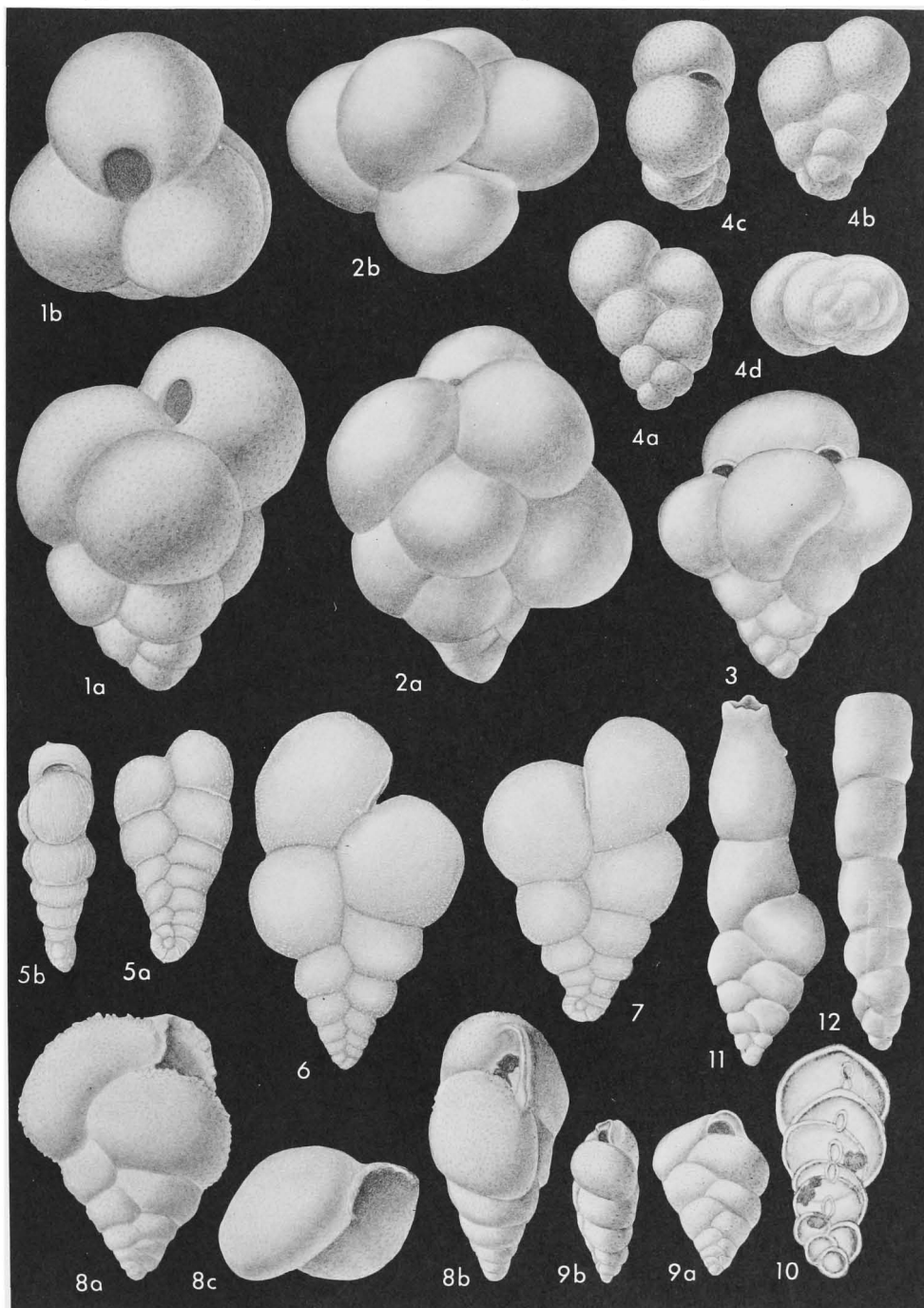


FIG. 523. Heterohelicidae (Guembelitrinae; 1, *Guembelitra*; 2,3, *Guembelitriella*; 4, *Woodringina*; Heterohelicinae; 5-7, *Heterohelix*; 8,9, *Chiloguembelina*; 10-12, *Bifarina*) (p. C652-C654).

americana (EHRENBERG), U.Cret.(L.Maastricht.), USA(Tex.); 5*a,b*, side, edge views (holotype of *H. navarroensis*), $\times 146$ (*1150).—FIG. 523, 6,7. *H. globulosa* (EHRENBERG), U.Cret.(Maastricht.), USA(Tex.); 6,7, megalospheric and microspheric tests, $\times 105$ (*1150).

[The synonymic status of *Guembelina* and *Heterohelix* was discussed in detail by MONTANARO GALLITELLI (1957, *1303, p. 137) who showed that as most species of "*Guembelina*" have a microspheric coil, no valid morphologic distinction is found between it and *Heterohelix*; hence *Guembelina* was suppressed as a junior synonym. In addition, *Guembelina* EGGER, 1899, is a homonym of *Guembelina* KUNTZE, 1895, as recently shown by us (*1178). The original specimens of *Heterohelix* (*Spiroplecta americana* EHRENBERG) are from Upper Cretaceous chalk in northeastern Mississippi and the upper Missouri region. Specimens from the Selma chalk of Mississippi show *H. americana* and *H. navarroensis* to be synonymous.]

Bifarina PARKER & JONES, 1872, *1417g, p. 198 [*Dimorphina saxipara* EHRENBERG, 1854, *680, pl. 32; OD] [= *Tubitextularia* ŠULC, 1929, *1849, p. 148 (type, *Pseudotextularia bohemia*); *Rectoguembelina* CUSHMAN, 1932, *452, p. 6 (type, *R. cretacea*, = *Bifarina nodosaria* WHITE, 1929, *2055, p. 45)]. Early stage biserial, as in *Heterohelix*, later uniserial, with terminal, rounded aperture, which may be produced on short neck. *L.Cret.* (*U.Alb.*)-*Paleoc.*, N.Am.-Eu.—FIG. 523,10. **B. saxipara* (EHRENBERG), U.Cret.(Maastricht.), USA (Miss.); original specimen mounted in balsam, enlarged (*700).—FIG. 523,11. *B. nodosaria* WHITE (=paratype of *Rectoguembelina cretacea* CUSHMAN, ?U. Cret.(Maastricht.) or *Paleoc.* (Midway.), USA(Ark.); $\times 224$ (*2117).—FIG. 523, 12. *B. bohemia* (ŠULC), U.Cret.(Senon.), Czech; topotype, $\times 148$ (*1303).

[GLAESSNER (1936, *792, p. 108) and MONTANARO GALLITELLI (1957, *1303, p. 143) noted the synonymy of *Rectoguembelina* CUSHMAN, 1932, and *Tubitextularia* ŠULC, 1929. In addition, both are synonyms of *Bifarina* PARKER & JONES, as based on the type-species, *Dimorphina saxipara* EHRENBERG. CUSHMAN (1946, *484, p. 131) noted that *Bifarina saxipara* "may even possibly be a *Rectoguembelina*, *Nodosarella*, or another such form." The type-species of *Bifarina* cannot be placed in a later described genus, however. *Bifarina* has in the past included a number of quite distinct forms, similar only in their early biserial and later uniserial stages. Only the type-species is congeneric with forms previously placed in *Rectoguembelina* or *Tubitextularia* (which generic names are thus junior synonyms). Other species included in *Bifarina* by CUSHMAN (1937, *472) correctly should be placed in *Rectobolivina*, viz., *B. hungarica* VADAZ, *B. vicksburgensis* (CUSHMAN), *B. tombigbeensis* HADLEY, in *Valvobifarina*, viz., *B. elongata* (MILLETT), *B. mackinnoni* (MILLETT), and *B. mackinnoni* var. *robusta* (SIDEBOTTOM), and possibly in *Tubulogenerina*, viz., *B. reticulosa* CUSHMAN, *B. zanzibarensis* CUSHMAN, or *Loxostomum*, viz., *B. adaeae* LIEBUS, *B. millepunctata* (TUTKOWSKY). GALLOWAY (1933, *762, p. 354) regarded *Rectobolivina* as a synonym of *Bifarina*, and placed *Bifarina nodosaria* WHITE in the genus *Rectoguembelina*, although correctly noting the synonymy of *Rectoguembelina cretacea* CUSHMAN and *Bifarina nodosaria* WHITE. *Bifarina* differs from *Rectobolivina* in having inflated chambers and a simple aperture, whereas *Rectobolivina* has an internal tube.]

Chiloguembelina LOEBLICH & TAPPAN, 1956, *1168, p. 340 [**Gümbelina midwayensis* CUSHMAN, 1940, *475, p. 65; OD]. Test free, flaring; inflated chambers biserially arranged, with tendency to become somewhat twisted; sutures distinct, depressed; wall calcareous, finely perforate, radial in structure, surface smooth to hispid; aperture a broad, low arch bordered by produced necklike

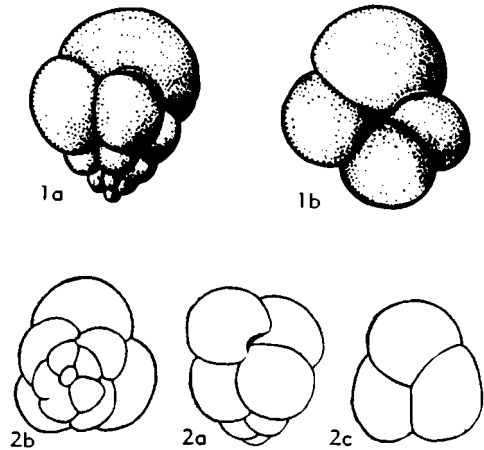


FIG. 524. Heterohelidae (Guembelitrinae; 1,2, *Gubkinella*) (p. C652).

extension of chamber, commonly forming more strongly developed flap at one side so that aperture appears to be directed toward one of flat sides of test. *Paleoc.-Oligo.*, cosmop.—FIG. 523,8. *C. crinita* (GLAESSNER), *Paleoc.*(Vincentown), USA (N.J.); 8*a-c*, side, edge, and top views, $\times 143$ (*1174).—FIG. 523,9. **C. midwayensis* (CUSHMAN), *Paleoc.*(Midway.), USA(Tex.); 9*a,b*, side, edge views, $\times 97$ (*1174).

[Differs from *Heterohelix* in the presence of an apertural necklike extension from the final chamber, in the tendency to develop a twisted test, and an asymmetrical aperture directed toward the flat side, instead of edge, of the test. Unlike true *Heterohelix*, it does not have an early coiled portion in the microspheric generation, all specimens being wholly biserial throughout.]

Gublerina KIKOÏNE, 1948, *1039, p. 26 [**G. cuvillieri* = *Ventilabrella ornatissima* CUSHMAN & CHURCH, 1929, *500, p. 512; OD] [= *Sigalia* REISS, 1957, *1528a, p. v (type, *Gümbelina* (*Gümbelina*, *Ventilabrella*) *deflaensis* SIGAL, 1952, *1746, p. 36)]. Test compressed, flabelliform, increasing rapidly in breadth; early stage planispiral, later biserial, with 2 series of chambers diverging widely, leaving broad nonseptate or incompletely divided central region, final stage may have chamber proliferation; sutures commonly thickened, nodose and elevated; wall calcareous, perforate, radial in structure, bilamellar, with double septa and septal peristomal canal; aperture arched. [*Sigalia* appears referable to *Gublerina*, the non-septate central area being poorly defined because of the early proliferation of chambers. The characteristic ornamentation of *Gublerina* is present.] *U. Cret.*, Eu.-N.Am.-N.Afr.-W.Indies(Cuba). — FIG. 525,1,2. **G. ornatissima* (CUSHMAN & CHURCH), Maastricht., S.Fr.; 1, side view of specimen treated with acid to remove outer wall, showing position of septa and central nonseptate area, $\times 74$ (*1303); 2, side view, showing early coil, nodose early biserial chambers, later flaring

biserial test with nonseptate central area although the surface grooves erroneously suggest septation, and final chamber proliferation, $\times 74$ (*1303).

—FIG. 525,3. *G. deflaensis* (SIGAL), Turon., Algeria, $\times 50$ (*1746).

Planoglobulina CUSHMAN, 1927, *428, p. 77 [*Güm-

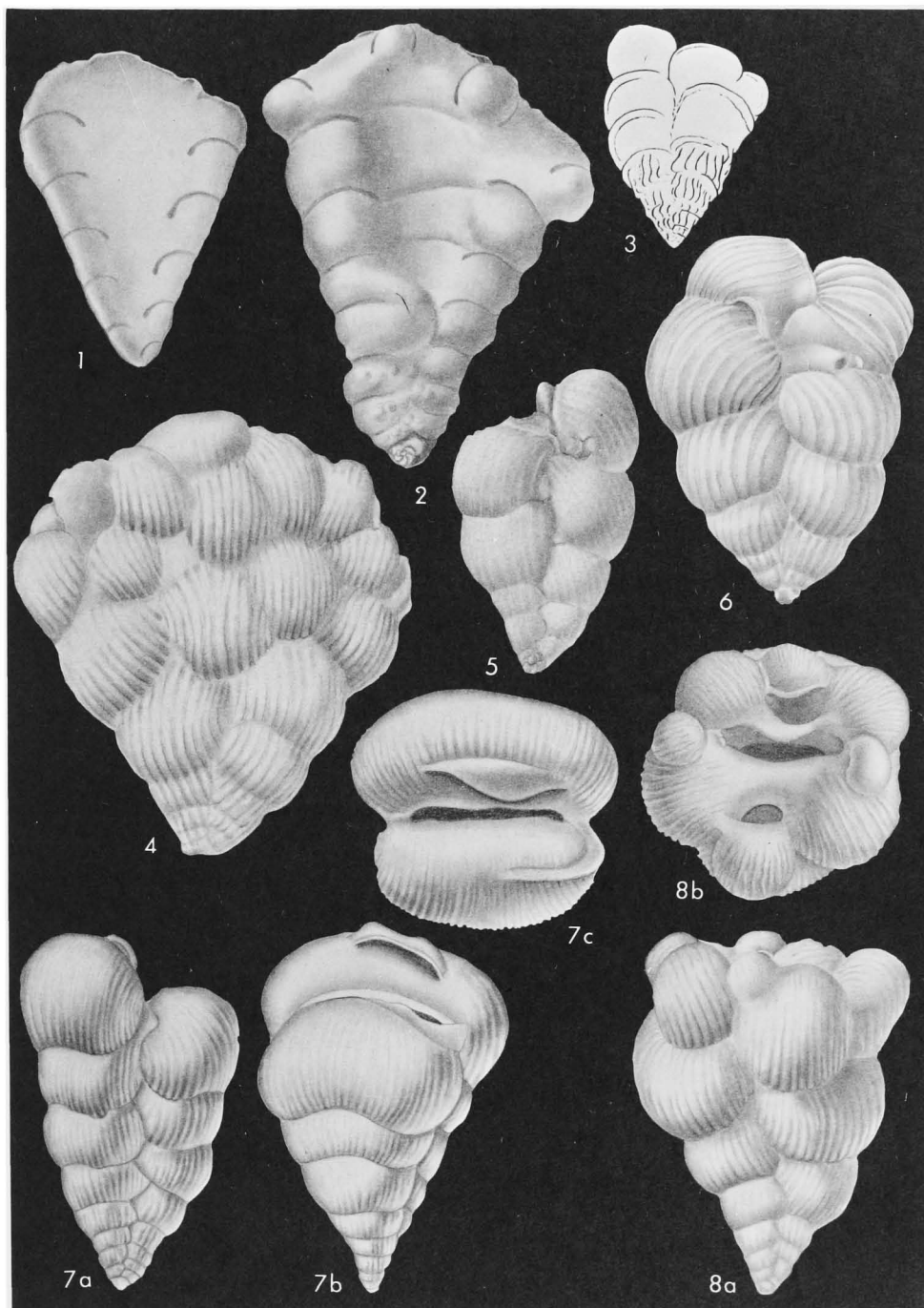


FIG. 525. Heterohelicidae (Heterohelicinae; 1-3, *Gublerina*; 4, *Planoglobulina*; 5,6, *Pseudoguembelina*; 7, *Pseudotextularia*; 8, *Racemiguembelina*) (p. C654-C656).

belina acervulinoides EGGER, 1899, *659, p. 36; OD [= *Ventilabrella* CUSHMAN, 1928, *436, p. 2 (type, *V. eggeri*)]. Early stage coiled in microspheric form, later biserial, and finally with chamber proliferation in plane of biseriality, resulting in flabelliform test; exterior commonly ornamented with longitudinal striae; aperture multiple, on final series of chambers. *U.Cret.*, Eu.-N.Am.—FIG. 525,4. **P. acervulinoides* (EGGER), Senon., Ger.; side view, $\times 116$ (*2117).

[*Ventilabrella* was shown by MONTANARO GALLITELLI (1957, *1303) to be a synonym of *Planoglobulina*. The type-species of *Planoglobulina* is *Gümbelina acervulinoides* EGGER, and CUSHMAN (1928, *436, p. 3) selected EGGER's specimen in pl. 14, fig. 20 (*659) as the type-specimen (=lectotype). In 1946, CUSHMAN (*484, p. 111) placed the same specimen in his synonymy of *Ventilabrella eggeri* CUSHMAN, the type-species of *Ventilabrella*.]

Pseudogümbelina BRÖNNIMANN & BROWN, 1953, *234, p. 150 [**Gümbelina excolata* CUSHMAN, 1926, *425, p. 20; OD]. Test biserial in adult, rarely with microspheric coil in early stage; chambers subglobular; surface may have longitudinal striae or costae; aperture an interiomarginal arch, extending laterally, secondary sutural apertures may occur near zigzag suture between pairs of chambers. *U.Cret.*, N.Am.-W.Indies (Cuba).—FIG. 525,5,6 **P. excolata* (CUSHMAN), Maastricht., USA (Tex.); 5, hypotype showing early coil, $\times 155$; 6, hypotype showing biserial development throughout and well-developed secondary apertures, $\times 116$ (*2117).

Pseudotextularia RZEHAk, 1891, *1604, p. 4 [**Cuneolina elegans* RZEHAk, 1891; OD (M)] [= *Pseudotextularia* RZEHAk, 1886, *1601, p. 6 (nom. nud.); *Bronnibrownia* MONTANARO GALLITELLI, 1955, *1300, p. 215, 220, 222 (nom. nud.); *Bronnimannella* MONTANARO GALLITELLI, 1956, *1302, p. 35 (type, *Gümbelina plummerae* LOETTERLE, 1937, *1188, p. 33)]. Early stage as in *Heterohelix*, later biserial chambers increasing rapidly in thickness and becoming laterally compressed, so that adult test has greater thickness than breadth, final chamber also may become nearly central in position; aperture a broad, low interiomarginal arch. *U.Cret.*, Eu.-N.Am.-S.Am.—FIG. 525,7. **P. elegans* (RZEHAk), Senon., USA (Tex.); 7a-c, side, edge, and top views, $\times 100$ (*1303).

[The nomen nudum *Pseudotextularia*, 1886, was originally used for a textularian form that was regarded as either a monstrosity or a new genus, but no description was given and no species included. In 1891, RZEHAk described *Cuneolina elegans*, stating that perhaps it represented a distinct genus, for which he had previously proposed the name *Pseudotextularia*. He thus validated the latter genus, whose type-species is *C. elegans*, by monotypy. The lectotype of *C. elegans* was designated by WHITE, 1929, *2055, p. 40, as RZEHAk, 1891, *1604, fig. 1a,b.]

Racemigümbelina MONTANARO GALLITELLI, 1957, *1303, p. 142 [**Gümbelina fructifera* EGGER, 1899, *659, p. 35; OD]. Test subconical, early stage may be planispiral in microspheric forms, later biserial with globular chambers increasing regularly in size and with proliferation at crown perpendicular to previous axis of growth; surface may be ornamented by longitudinal striae or cos-

tae; aperture an interiomarginal arch on one or many of terminal chambers. *U.Cret.*, Eu.-N.Am.—FIG. 525,8. **R. fructifera* (EGGER), Senon., USA (Tex.); 8a,b, side, top views, $\times 116$ (*1303).

Family PLANOMALINIDAE

Bolli, Loeblich, & Tappan, 1957

[nom. transl. SIGAL, 1958, p. 263 (ex subfamily Planomalinae BOLLI, LOEBLICH & TAPPAN, 1957, p. 21)]

Coiling planispiral, primary aperture equatorial, or symmetrically paired, umbilical portions of successive apertures remaining as relict secondary apertures. *L.Cret.* (*Apt.*)-*Paleoc.* (*Dan.*).

Planomalina LOEBLICH & TAPPAN, 1946, *1154, p. 257 [**P. apsidostroba* LOEBLICH & TAPPAN, 1946, = *Planulina buxtorfi* GANDOLFI, 1942, *768, p. 103; OD]. Test free, planispiral, biumbilicate, involute to partially evolute, lobulate in outline; chambers angular-rhomboid; sutures radial, curved, elevated; wall calcareous, finely perforate, radial in structure, test ornamented by keel and thickened and nodose sutures; aperture an interiomarginal, equatorial arch, with opening extending back at either side to septum at base of chamber, lateral umbilical portions of successive apertures remaining open as supplementary relict apertures, each with remnant of bordering apertural lip. *L.Cret.* (*Alb.*) - *U.Cret.* (*Cenoman.*), N.Am. - Eu.-Carib.-N.Afr.-Pak.—FIG. 526,1. **P. buxtorfi* (GANDOLFI), *L.Cret.* (*Alb.*), USA (Tex.); 1a,b, side, edge views of holotype of *P. apsidostroba*, $\times 84$ (*164).

Biglobigerinella LALICKER, 1948, *1081, p. 624 [**B. multispina*; OD]. Test free, planispiral, nearly or completely involute, biumbilicate, periphery rounded, peripheral margin lobulate; chambers globular, except for final 1 or 2 which may become broadly ovate, flattened, and finally replaced by 2 paired chambers, one on each side of plane of coiling, in some species tendency for chambers of final whorl to flare out in less involute coil is seen, with flange extending back on each side toward previous whorl, curving backward at umbilical margin, as in *Globigerinelloides*; sutures distinct, depressed, radial to curved or even sigmoid; wall calcareous, finely perforate, radial in structure, surface finely hispid to smooth or pitted; aperture an interiomarginal, equatorial, simple low arch in early stages, in later paired chambers one extraumbilical aperture present in each chamber of final pair. *L.Cret.* (*Apt.*)-*Paleoc.* (*Dan.*), N.Am.-Carib.—FIG. 526,4,5. **B. multispina*, *U.Cret.* (*Camp.*); 4, edge view of hypotype, USA (Tex.), $\times 119$ (*164); 5a,b, side, edge views of holotype, USA (Ark.), $\times 119$ (*164).

Globigerinelloides CUSHMAN & TEN DAM, 1948, *501, p. 42 [**G. algeriana*; OD] [= *Biticinella* SIGAL, 1956, *1747, p. 35 (type, *Anomalina breggiensis* GANDOLFI, 1942, *768, p. 102)]. Test free, planispiral, biumbilicate, involute to partially evo-

lute, lobulate in outline; chambers rounded to ovoid, may be somewhat elongated in specimens tending to become evolute; sutures depressed,

radial, straight to curved or sigmoid; wall calcareous, finely perforate, radial in structure, surface smooth or roughened; aperture a broad, low,

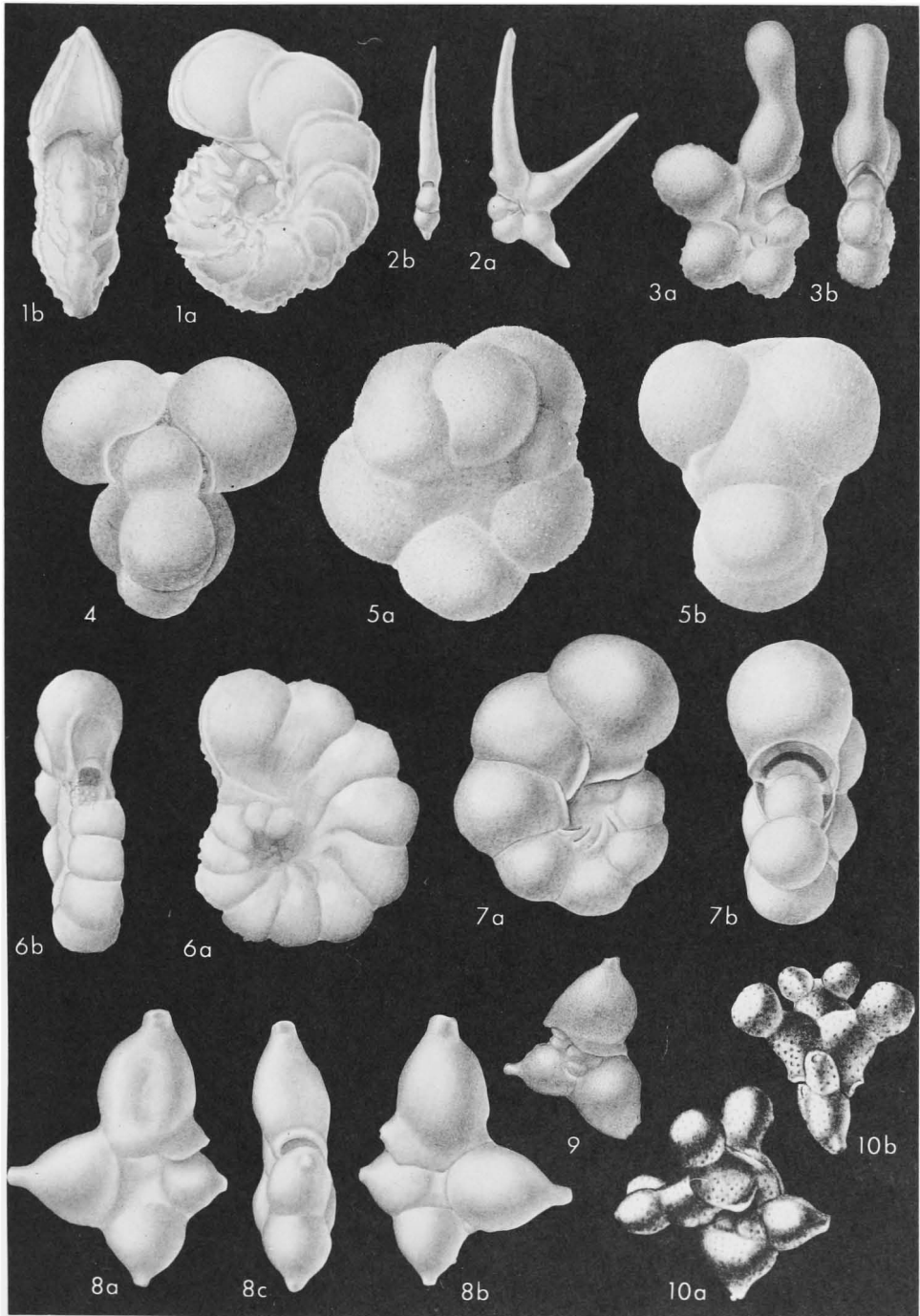


FIG. 526. Planomaliniidae; 1, *Planomalina*; 2, 3, *Hastigerinoides*; 4, 5, *Biglobigerinella*; 6, 7, *Globigerinelloides*; Schackoinidae; 8, 9, *Schackoina*; 10, *Leupoldina* (p. C656-C659).

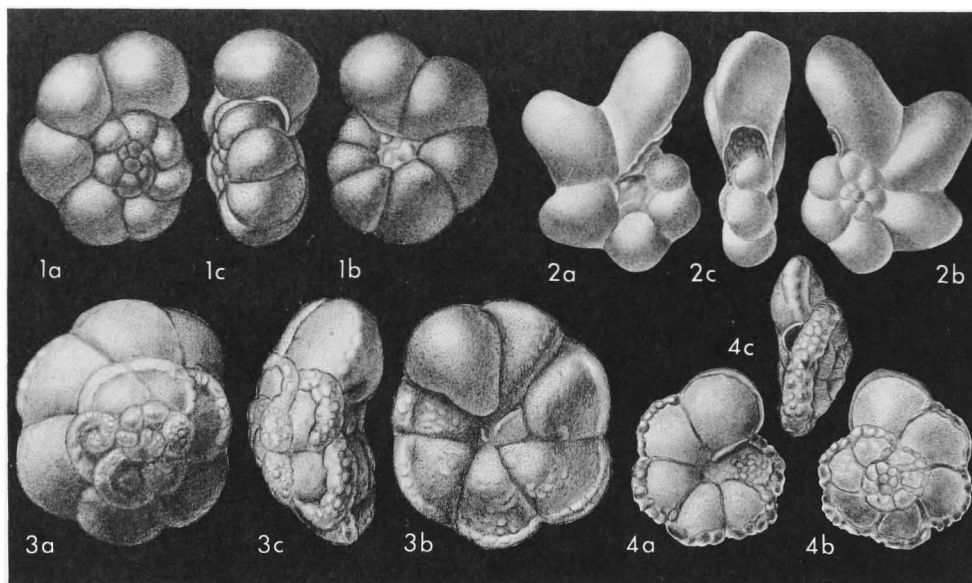


FIG. 527. Rotaliporidae (Hedbergellinae; 1, *Hedbergella*; 2, *Clavihedbergella*; 3,4, *Praeglobotruncana*) (p. C659).

interiomarginal equatorial arch, with lateral umbilical portions of successive apertures remaining open as relict apertures. *Cret.*, cosmop.—FIG. 526.6. **G. algeriana*, L.Cret.(Apt.), Algeria; 6a,b, side, edge views, $\times 56$ (*164).—FIG. 526.7. *G. eaglefordensis* (MOREMAN), L.Cret.(Alb.), Eng.; 7a,b, side, edge views of holotype of *Planomalina caseyi*, $\times 135$ (*164).

Hastigerinoides BRÖNNIMANN, 1952, *228, p. 52 [**Hastigerinella alexanderi* CUSHMAN, 1931, *450, p. 87; OD] [= *Eohastigerinella* MOROZOVA, 1957, *1316, p. 1112 (type, *Hastigerinella watersi* CUSHMAN, 1931, *450, p. 86)]. Test free, stellate in appearance, planispiral, biumbilicate, periphery rounded; early chambers globular, later chambers elongate-radial, much produced and tapering or clavate; sutures depressed, radial; wall calcareous, perforate, radial in structure, surface smooth, pitted or finely hispid; primary aperture interiomarginal, equatorial, a simple arch bordered above by protruding lip, with relict secondary apertures around umbilical region, representing umbilical portion of previous apertures, which may remain open or be closed. *L.Cret.(Apt.)-U.Cret.(Turon.)*, N. Am.-Eu.-Carib.—FIG. 526.2. **H. alexanderi* (CUSHMAN), *U.Cret.(Turon.)*, USA(Tex.); 2a,b, side, edge views, $\times 70$ (*164).—FIG. 526.3. *H. watersi* (CUSHMAN), *U.Cret.(Turon.)*, USA(Tex.); 3a,b, side, edge views, $\times 98$ (*164).

Family SCHACKOINIDAE Pokorný, 1958

[Schackoinidae POKORNÝ, 1958, p. 348]

Test trochospiral to nearly planispiral, each chamber with one or rarely more hol-

low tubulospines; aperture equatorial, and may have broad spatulate lip. *L.Cret.(Apt.)-U.Cret.(Maastricht.)*.

Schackoina THALMANN, 1932, *1894, p. 288 [**Siderolina cenomana* SCHACKO, 1897, *1635, p. 166; OD] [= *Hantkenina* (Schackoina) THALMANN, 1932, *1894, p. 288 (obj.)]. Test free, early portion may be more or less trochospiral, later becoming nearly planispiral; chambers radially elongate with one or more elongate, tapering, hollow tubulospines extending outward from mid-line of each chamber on periphery; sutures straight, radial, depressed; wall calcareous, finely perforate, surface smooth or very finely hispid; primary aperture an interiomarginal arch, extraumbilical and tending to become equatorial, may be bordered above by narrow lip. *L.Cret.(Apt.)-U.Cret.(Campan.-?Maastricht.)*, cosmop.—FIG. 526, 8,9. **S. cenomana* (SCHACKO), *U.Cret.(Cenoman.)*, Eu.(Ger.) (8), N.Am. (9); 8a-c, opposite sides and edge view, $\times 195$ (*164); 9, side view, USA (Kans.), $\times 158$ (*1183).

Leupoldina BOLLI, 1958, *161, p. 275 [**L. protuberans*; OD]. Differs from *Schackoina* in having tubulospines which are bulbous at their extremities and in developing 2 interiomarginal apertures in final chamber of mature forms, one on each side of chamber, much as in *Biglobigerinella*. [BOLLI (*161) modified the generic description of *Schackoina* to include forms with bulbous tubulospines similar to those of *Leupoldina*. It seems probable that forms with such bulbous tubulospines are in reality immature specimens of *Leupoldina* in which the double aperture has not developed, as they occur in the

same samples with *Leupoldina*.] *L.Cret.*(*Apt.*), W.Indies(Trinidad)-Eu.—FIG. 526,10. **L. protuberans*, Trinidad; 10a,b, side, edge views of holotype, $\times 106$ (*161).

Family ROTALIPORIDAE Sigal, 1958

[*Rotaliporidae* SIGAL, 1958, p. 264] [=Marginolamellidae HOFKER, 1951, p. 485 (*partim*) (*nom. nud.*)]

Coiling trochospiral; primary aperture extraumbilical-umbilical, with relatively prominent lip; may have secondary sutural apertures on umbilical side opening into posterior margin of chambers. *Cret.*

Subfamily HEDBERGELLINAE

Loeblich & Tappan, 1961

[*Hedbergellinae* LOEBLICH & TAPPAN, 1961, p. 309]

Primary aperture only, commonly with prominent apertural lip, those of previous chambers remaining as projections into umbilical region. *L.Cret.*(*Hauteriv.*)-*U.Cret.*(*Maastricht.*).

Hedbergella BRÖNNIMANN & BROWN, 1958, *236, p. 16 [**Anomalina lorneiana* D'ORBIGNY var. *trocoidea* GANDOLFI, 1942, *768, p. 98; OD] [=*Praeglobotruncana* (*Hedbergella*) BANNER & BLOW, 1959, *77, p. 18 (obj.); *Planogyrina* ZAKHAROVA-ATABEKYAN, 1961, *2098, p. 50 (type, *Globigerina gaultina* MOROZOVA, 1948, *1315, p. 41)]. Test free, trochospiral, biconvex, umbilicate, periphery rounded, with no indication of keel or poreless margin; chambers globular to ovate; sutures depressed, radial, straight to curved; wall calcareous, finely perforate, radial in structure, surface smooth to hispid or rugose; aperture an interiomarginal, extraumbilical-umbilical arch commonly bordered above by narrow lip or spatulate flap, and in forms with broad, open umbilicus, successive apertural flaps may remain visible to show serrate or scalloped border around umbilicus. [*Hedbergella* includes species which are otherwise similar to *Praeglobotruncana* but lacking a keel or poreless margin. The rounded chambers are reminiscent of *Globigerina* but the aperture is extraumbilical, rather than umbilical, and the umbilicus is commonly narrow.] *L.Cret.*(*Hauteriv.*)-*U.Cret.*(*Maastricht.*), cosmop.—FIG. 527, 1. **H. trocoidea* (GANDOLFI), *U.Cret.*(*Cenoman.*), Blake Plateau, Atl.O.; 1a-c, spiral, umbilical, and edge views, $\times 75$ (*2117).

Clavihedbergella BANNER & BLOW, 1959, *77, p. 8, 18 [**Hastigerinella subcretacea* TAPPAN, 1943, *1872, p. 513; OD] [=*Praeglobotruncana* (*Clavihedbergella*) BANNER & BLOW, 1959, *77, p. 8, 18 (obj.)]. Test free, low trochospiral, biconvex, broadly umbilicate, peripheral margin rounded, peripheral outline deeply lobulate, no keel or poreless margin; early chambers globular to ovate, later ones clavate to radial-elongate; sutures strongly constricted, radial, straight to curved; wall cal-

careous, finely perforate, radial in structure, surface smooth to hispid; aperture an interiomarginal, extraumbilical-umbilical arch, with narrowing bordering lip or spatulate flap (porticus). [Differs from *Hedbergella* in having radial-elongate chambers, and from *Hastigerinella* in having apertural flaps or portici. Although *Clavihedbergella* was described as ranging from upper Albian to Turonian, thus being more restricted than *Hedbergella* (*77, p. 17), we also have excellent examples of *Clavihedbergella* in Aptian strata of both hemispheres.] *L.Cret.*(*Apt.*)-*U.Cret.*(*Turon.*), cosmop.—FIG. 527,2. **C. subcretacea* (TAPPAN), *L. Cret.*(*Alb.*), USA(Okla.); 2a-c, umbilical, spiral, and edge views, $\times 78$ (*2117).

Praeglobotruncana BERMÚDEZ, 1952, *127, p. 52 [**Globorotalia delrioensis* PLUMMER, 1931, *1463, p. 199; OD] [=*Rotundina* SUBBOTINA, 1953, *1847, p. 164 (type, *Globotruncana stephani* GANDOLFI, 1942, *768, p. 130)]. Test free, trochospiral, biconvex to spiroconvex, umbilicate, periphery rounded to subangular, with more or less well-developed peripheral keel, which is most prominent in earlier development; chambers ovate to subangular; sutures on spiral side radial or curved, depressed to elevated, commonly thickened or beaded, on umbilical side depressed and radial; wall calcareous, finely perforate, radial in structure, surface smooth to hispid; aperture an interiomarginal, extraumbilical-umbilical arch, bordered by apertural lip. [Regarded as containing both carinate and noncarinate species by BOLLI, LOEBLICH & TAPPAN (1957, *164), the genus is now restricted to include only species which have a peripheral keel or poreless margin. The noncarinate species are now placed in *Hedbergella*.] *L. Cret.*(*U. Alb.*)-*U.Cret.*(*Cenoman.*), cosmop.—FIG. 527,3. *P. stephani* (GANDOLFI), *Cenoman.*, Switz.; 3a-c, opposite sides and edge view, $\times 75$ (*1183).—FIG. 527,4. **P. delrioensis* (PLUMMER), *Cenoman.*, USA(Tex.); 4a-c, umbilical, spiral, and edge views of topotype, $\times 75$ (*1183).

Subfamily ROTALIPORINAE Sigal, 1958

[*nom. transl.* BANNER & BLOW, 1959, p. 8 (*ex family Rotaliporidae* SIGAL, 1958)]

With primary aperture, and secondary sutural apertures on umbilical side. *L.Cret.*(*Alb.*)-*U.Cret.*(*Cenoman.*-?*Turon.*).

Rotalipora BROTZEN, 1942, *240, p. 32 [**R. turonica*, =*Globorotalia cushmani* MORROW, 1934, *1319, p. 199; OD] [=*Thalmaninella* SIGAL, 1948, *1743, p. 101 (type, *T. brotzeni*, =*Globorotalia greenhornensis* MORROW, 1934, *1319, p. 199)]. Test free, trochospiral, biconvex to planoconvex, umbilicate, periphery angular, with single keel; chambers angular-rhomboid; sutures curved on spiral side, depressed to elevated, and may be thickened or beaded, on umbilical side radial to slightly curved, flush to depressed; wall calcareous, perforate, radial in structure, surface

smooth to nodose; primary aperture interiornal and extraumbilical-umbilical in position with bordering lip, single secondary sutural aper-

ture per suture on umbilical side, or rarely 2 or more per suture, commonly also with bordering lip or thickened rim. [BOLLI, LOEBLICH & TAPPAN

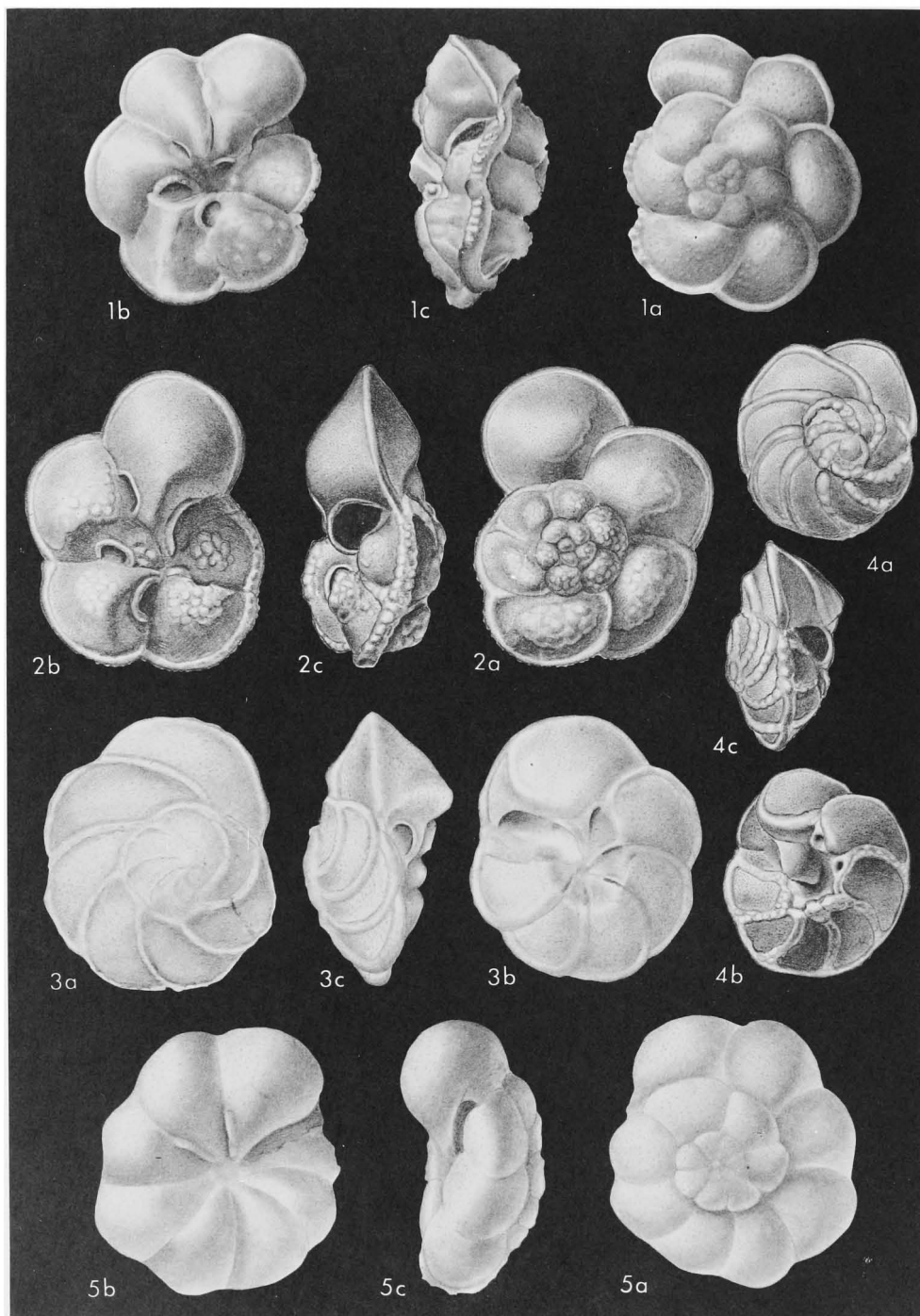


FIG. 528. Rotaliporidae (Rotaliporinae: 1-4, *Rotalipora*; 5, *Ticinella*) (p. C659-C662).

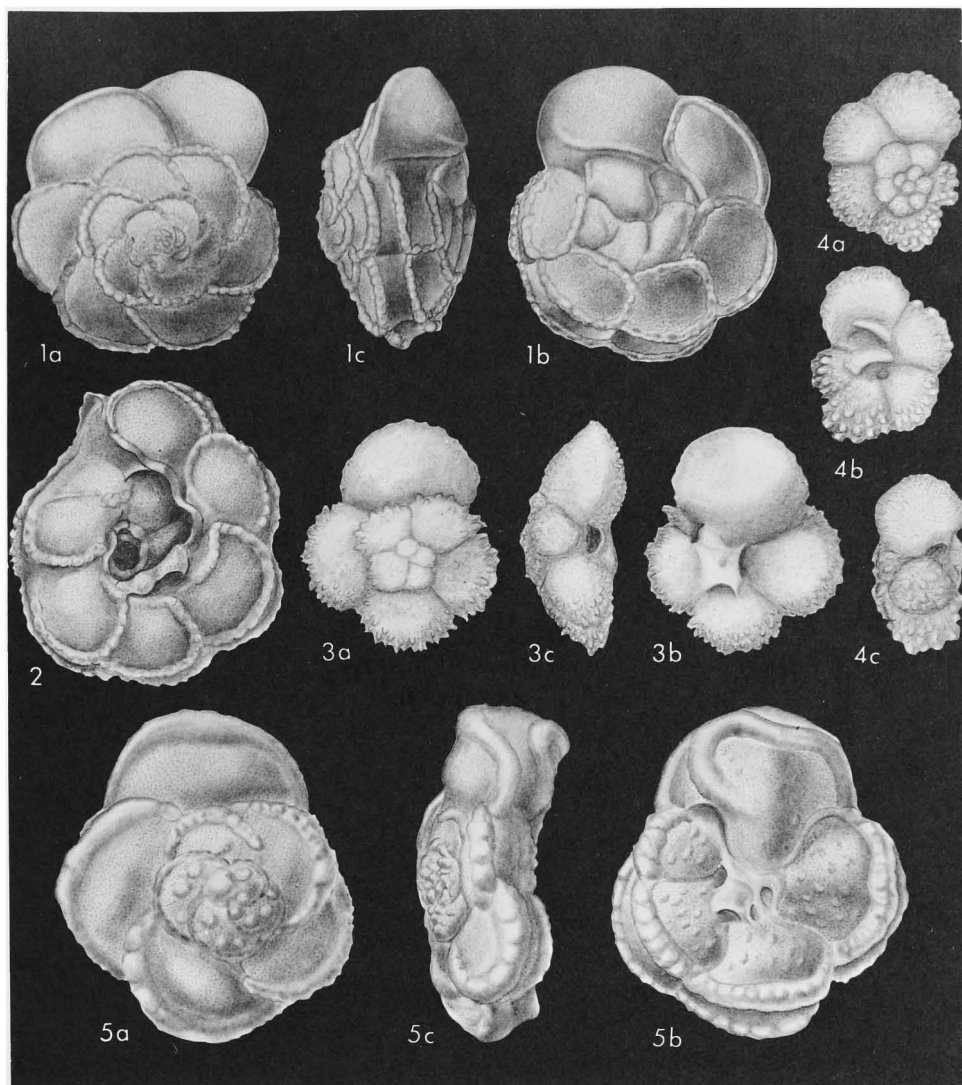


FIG. 529. Globotruncanidae; 1-4, *Globotruncana*; 5, *Abathomphalus* (p. C662-C663).

(1957, *164) included with this genus both the typically keeled species and the nonkeeled forms described as *Ticinella* by REICHEL (1950, *1522). The latter is here recognized as a distinct genus, characterized by the absence of a keel or poreless margin.] *U.Cret.(Cenoman.-?Turon.)*, cosmop. —FIG. 528,1,2. **R. cushmani* (MORROW); 1a-c, spiral, umbilical, and edge views, topotype of form described as *R. turonica* BROTZEN, Cenoman., ?Turon., Ger.-Pol.(Pomerania); 2a-c, spiral, umbilical, and edge views of topotype of *R. cushmani* (MORROW), Cenoman., USA(Kans.), $\times 63$ (*1183). —FIG. 528,3,4. *R. greenhornensis* (MORROW); 3a-c, Cenoman., N.Afr.(Algeria); opposite sides and edge view of topotype of *Thalmaninella brotzeni* SIGAL, $\times 75$; 4a-c,

Cenoman., USA(Kans.), opposite sides and edge view of topotype, $\times 60$ (*1183).

Ticinella REICHEL, 1950, *1522, p. 600 [*Anomalina roberti* GANDOLFI, 1942, *768, p. 100; OD] [= *Globotruncana (Ticinella)* REICHEL, 1950, *1522, p. 600 (obj.)]. Test free, trochospiral, biconvex to plano-convex, umbilicate, periphery rounded, and lacking keel or poreless margin, chambers ovate; sutures on spiral side curved, depressed to elevated, on umbilical side flushed to depressed, radial or slightly curved; wall calcareous, perforate, radial in structure, surface smooth to spinose; primary aperture interiomarginal, extra-umbilical-umbilical, and may be bordered above by lip, secondary sutural apertures on umbilical side, commonly one per suture, more rarely 2 or

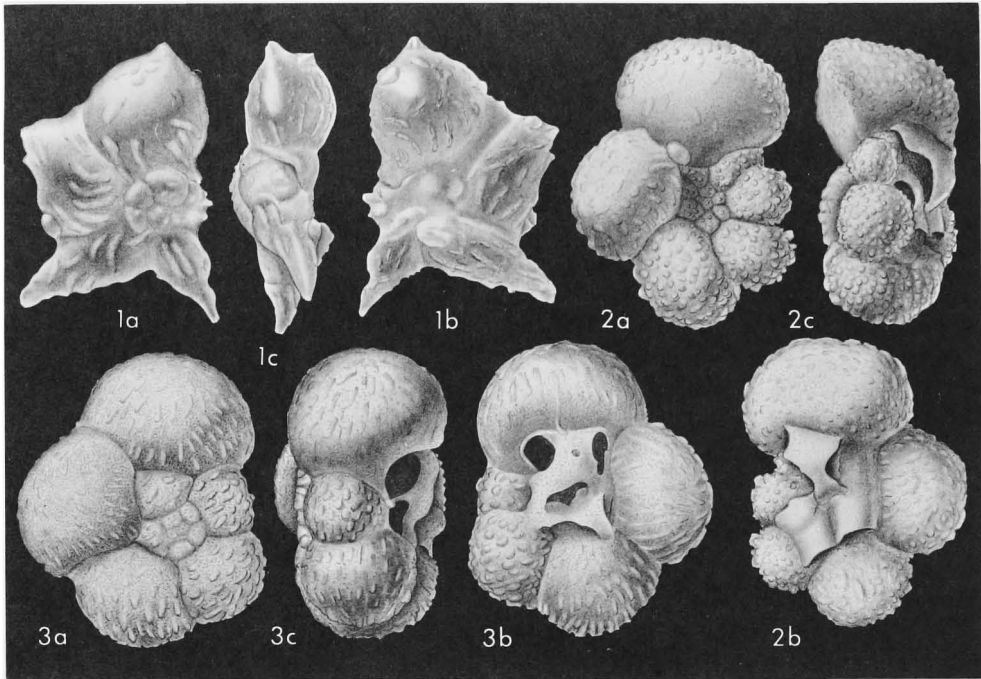


FIG. 530. Globotruncanidae; 1, *Plummerita*; 2, *Trinitella*; 3, *Rugoglobigerina* (p. C663).

more, and each may be bordered by narrow lip, which in some specimens may be sufficiently large to give appearance of a cover plate, although not as extensive as umbilical tegilla of the Globotruncanidae. *L.Cret.*(*U.Alb.*)-*U.Cret.*(*Cenoman.*), cosmop.—FIG. 528, 5. **T. roberti* (GANDOLFI), *U.Cret.*(*Cenoman.*), Eu.(Switz.); 5a-c, spiral, umbilical, and edge views of topotype, $\times 110$ (*1183).

Family GLOBOTRUNCANIDAE Brotzen, 1942

[*nom. transl.* MOROZOVA, 1957, p. 1111 (ex subfamily Globotruncaninae BROTZEN, 1942, p. 28)] [=Marginolamellidae HOFKER, 1951, p. 485 (*partim*) (*nom. nud.*); =Rugoglobigerininae SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 303]

Test trochospiral, chambers spherical to angular, commonly truncate or keeled; primary aperture umbilical, covered by spiral system of tegilla, with accessory intralaminar and infralaminar apertures. *U.Cret.*(*Turon.-Maastricht.*).

Globotruncana CUSHMAN, 1927, *431, p. 91 [**Pulvinulina arca* CUSHMAN, 1926, *425, p. 23; OD] [=Rosalinella MARIE, 1941, *1215, p. 237, 256, 258 (type, *Rosalina linneiana* D'ORBIGNY, 1839, *1611, p. 101); *Marginotruncana* HOFKER, 1956, *947, p. 319 (type, *Rosalina marginata* REUSS, 1846, *1538, p. 36); *Rugotruncana* BRÖNNIMANN & BROWN, 1956, *235, p. 546 (type, *R. tilevi*); *Bucherina* BRÖNNIMANN & BROWN, 1956, *235, p.

557 (type, *B. sandidgei*); *Globotruncanella* REISS, 1957, *1529, p. 135 (type, *Globotruncana citae* BOLLI, 1951, *158, p. 197, =*Globotruncana havanensis* VOORWIJK, 1937, *2025, p. 195); *Globotruncanita* REISS, 1957, *1529, p. 136 (type, *Rosalina stuarti* DE LAPPARENT, 1918, *1096, p. 11); *Helvetoglobotruncana* REISS, 1957, *1529, p. 137 (type, *Globotruncana helvetica* BOLLI, 1945, *156, p. 226)]. Test free, trochospiral, biconvex, spiroconvex or umbilicoconvex, broadly umbilicate, periphery rounded with poreless margin, with single keel or truncate with double keel; chambers ovate, hemispherical, angular rhomboid or angular truncate; sutures on spiral side curved or radial, depressed to elevated, may be limbate and beaded, sutures on umbilical side curved or radial, depressed or more rarely elevated; wall calcareous, perforate, radial in structure, surface smooth, rugose or beaded; primary apertures interiomarginal, umbilical, in well-preserved specimens covered by tegilla, which are perforated by accessory infralaminar and intralaminar apertures that become sole openings to exterior; tegilla commonly partially or wholly broken out in fossilization or preserved only as scalloped fragments. *U.Cret.*(*Turon.-Maastricht.*), cosmop.—FIG. 529, 1, 2. **G. arca* (CUSHMAN), L.Maastricht, USA (Tex.); 1a-c, spiral side, umbilical side with well-preserved tegilla covering entire umbilical region so as to obscure primary aperture, and edge view; 2, umbilical view, tegilla broken out, exposing primary umbilical aperture; all $\times 70$ (*164).—

FIG. 529,3. *G. havanensis* VOORWIJK, Maastricht, W.Indies(Cuba); 3a-c, opposite sides and edge view, $\times 79$ (*2117).—FIG. 529,4. *G. tilevi* (BRÖNNIMANN & BROWN), Maastricht, W.Indies (Cuba); 4a-c, opposite sides and edge view, $\times 79$ (*2117).

Abathomphalus BOLLI, LOEBLICH & TAPPAN, 1957, *164, p. 43 [**Globotruncana mayaroensis* BOLLI, 1951, *158, p. 198; OD]. Test free, trochospiral, biconvex to concavo-convex, almost nonumbilicate, periphery with single or double keel; sutures depressed, curved, and in some forms beaded on spiral side, depressed and radial on umbilical side; wall calcareous, perforate, radial in structure, commonly ornamented with fine nodes, peripheral keels and sutures may be beaded; primary aperture interiomarginal, extraumbilical, generally covered by continuous umbilical tegillum of irregular outline, with accessory infralaminar apertures situated at suture contacts with tegillum. *U.Cret.* (Maastricht.), W.Indies(Trinidad)-Mex.-Eu.-Afr.—FIG. 529,5. **A. mayaroensis* (BOLLI), Trinidad; 5a-c, spiral, umbilical, and edge views, $\times 76$ (*164).

[Differs from *Globotruncana* in lacking a wide and deep umbilicus with sharply angled rim and delicate tegilla extending from each chamber, and in having an interiomarginal, extraumbilical primary aperture. In *Abathomphalus* the umbilical area is not open, the final whorl of chambers all meeting ventrally, although their junction may be obscured by the single umbilical tegillum, which appears to be an extension from the final chamber. The accessory apertures are always infralaminar, not both infralaminar and intralaminar as in *Globotruncana*.]

Plummerita BRÖNNIMANN, 1952, *227, p. 146 [*pro Plummerella* BRÖNNIMANN, 1952 (non DE LONG, 1942)] [**Rugoglobigerina* (Plummerella) *hantkeninoides hantkeninoides* BRÖNNIMANN, 1952, *228, p. 37; OD] [= *Rugoglobigerina* (Plummerella) BRÖNNIMANN, 1952, *228, p. 37 (non Plummerella DE LONG, 1942) (obj.)]; *Rugoglobigerina* (Plummerita) BRÖNNIMANN, 1952, *227, p. 146 (obj.)]. Similar to *Rugoglobigerina* in form but with later chambers becoming radial-elongate; primary aperture interiomarginal, umbilical, with tegilla and infralaminar and intralaminar apertures. *U.Cret.* (Maastricht.), Carib.-USA.—FIG. 530,1. **P. hantkeninoides* (BRÖNNIMANN), W.Indies(Trinidad); 1a-c, opposite sides and edge view of holotype, $\times 128$ (*164).

Rugoglobigerina BRÖNNIMANN, 1952, *228, p. 16 [**Globigerina rugosa* PLUMMER, 1927, *1461, p. 38; OD] [= *Rugoglobigerina* (*Rugoglobigerina*) BRÖNNIMANN, 1952, *228, p. 17 (obj.)]; *Kuglerina* BRÖNNIMANN, 1956, *235, p. 557 (type, *Rugoglobigerina rugosa rotundata* BRÖNNIMANN, 1952, *228, p. 34)]. Test free, trochospiral, biconvex, umbilicate, periphery rounded; chambers rounded to spherical; sutures radial to slightly curved on spiral side, radial on umbilical side, depressed throughout; wall calcareous, perforate, radial in structure, surface typically rugose, with numerous large pustules which may coalesce into distinct ridges, radiating from mid-point of each cham-

ber on periphery, more rarely smooth; primary apertures interiomarginal, umbilical, in well-preserved specimens covered by tegilla perforated by accessory infralaminar and intralaminar apertures which are only openings to exterior, tegilla tending to be partially or wholly broken out in preservation. *U.Cret.* (Turon.-Maastricht.), cosmop.—FIG. 530,3. **R. rugosa* (PLUMMER), Maastricht., USA(Tex.); 3a-c, opposite sides and edge view, $\times 90$ (*164).

[*Rugoglobigerina* resembles *Globotruncana* in its apertural characters and presence of the umbilical tegilla, but differs in its prominent surface ornamentation and less angular chambers. *Rugoglobigerina* may be regarded as the form ancestral to *Globotruncana*; various species of the latter genus seem to have branched off from the main *Rugoglobigerina*-stem at different geologic times. *Rugoglobigerina* differs from *Globigerina* in having umbilical tegilla over the primary aperture, in having infralaminar and intralaminar accessory apertures, and commonly in displaying a characteristic rugose, highly ornamented surface.]

Trinitella BRÖNNIMANN, 1952, *228, p. 56 [**T. scotti*; OD]. Similar to *Rugoglobigerina* but with later chambers compressed and flattened on spiral side, producing subangular periphery; aperture umbilical in position, with tegilla and accessory apertures. *U.Cret.* (Maastricht.), Carib.-USA.—FIG. 530,2. **T. scotti*, USA(Tex.); 2a-c, opposite sides and edge view, $\times 98$ (*164).

Family HANTKENINIDAE Cushman, 1927

[Hantkeninidae CUSHMAN, 1927, p. 64]

Test planispiral or enrolled biserial; chambers spherical to elongate or clavate; primary aperture symmetrical and equatorial, single or multiple, and may have relict or areal secondary apertures. *Paleoc.-Rec.*

Subfamily HASTIGERININAE Bolli, Loeblich & Tappan, 1957

[Hastigerininae BOLLI, LOEBLICH & TAPPAN, 1957, p. 29]
[=Hastigerininae LOEBLICH & TAPPAN, 1961, p. 309
(nom. null.)]

Test planispiral; chambers spherical to clavate; primary aperture equatorial, without secondary apertures. *Paleoc.-Rec.*

Hastigerina THOMSON in MURRAY, 1876, *1331, p. 534 [**H. murrayi* (=Nonionina *pelagica* D'ORBIGNY, 1839, *1393, p. 27; OD (M)) [= *Globigerinella* CUSHMAN, 1927, *431, p. 87 (type, *Globigerina aequilateralis* BRADY, 1879, *196b, p. 285, = *Globigerina siphonifera* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 83)]. Test free, early stage may be slightly trochospiral, adult planispiral, ranging from involute to loosely coiled, biumbilicate, periphery broadly rounded; chambers spherical to ovate; sutures deeply depressed, radial; wall finely to coarsely perforate, radial in structure, surface smooth, hispid, or spinose; aperture interiomarginal, broad equatorial arch. *L.Mio.-Rec.*, cosmop.—FIG. 531,1. *H. siphonifera* (D'ORBIGNY), Rec., Pac.O.; 1a,b,

side, apert. views, $\times 54$ (*164).—FIG. 531,2-4.
 **H. pelagica* (D'ORBIGNY), Rec., S.Atl.O.; 2a,b,
 side, apert. views of hypotype (BMNH-ZF1563);

3, apert. view of lectotype of *H. murrayi* THOM-
 SON (=neotype of *Nonionina pelagica* D'ORBIGNY)
 (BMNH-ZF1562), specimen preserved in balsam,

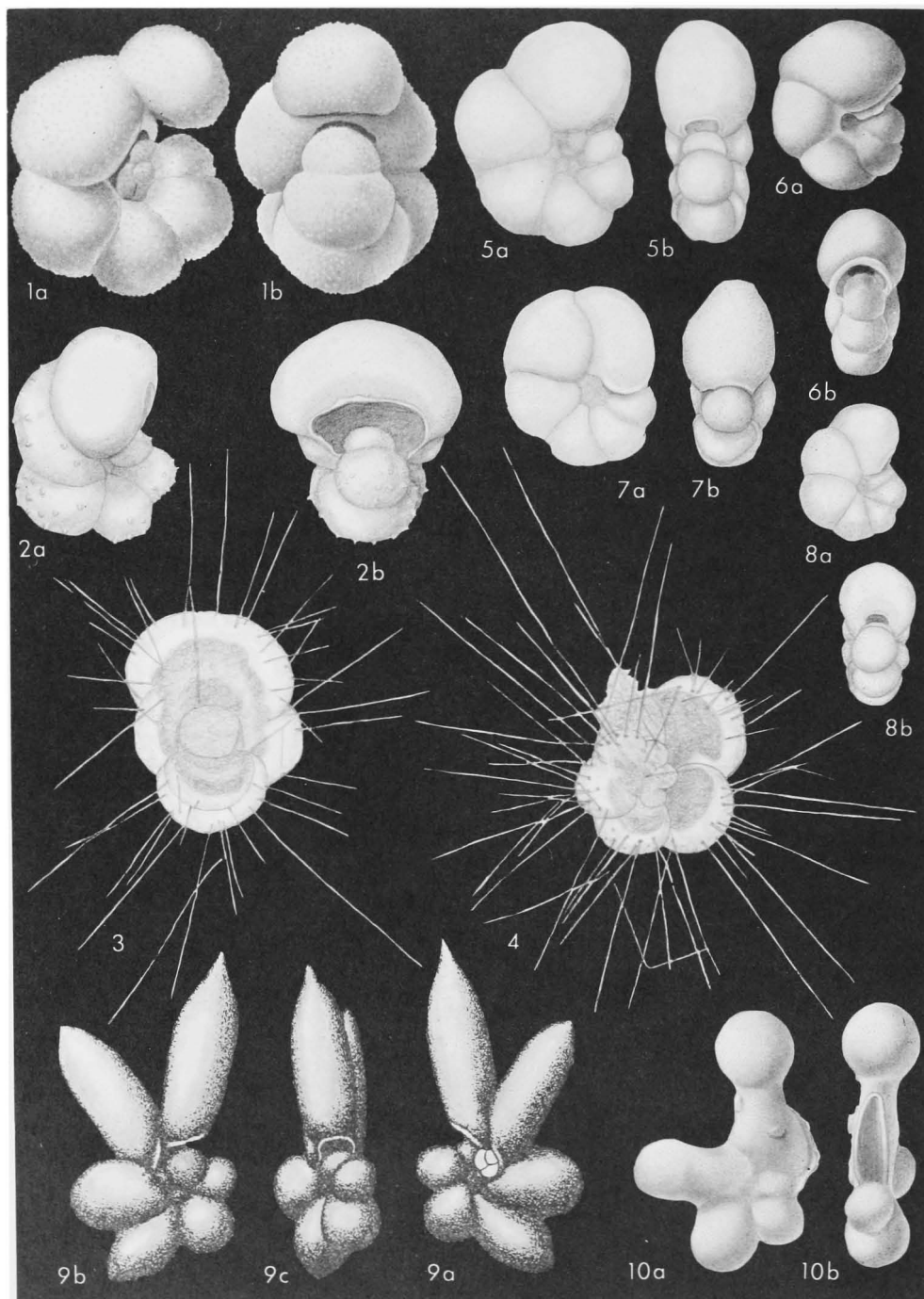


FIG. 531. Hantkeninidae (Hastigerininae: 1-4, *Hastigerina*; 5-8, *Globanomalina*; 9, *Bolliella*; 10, *Clavigerinella*) (p. C663-C666).

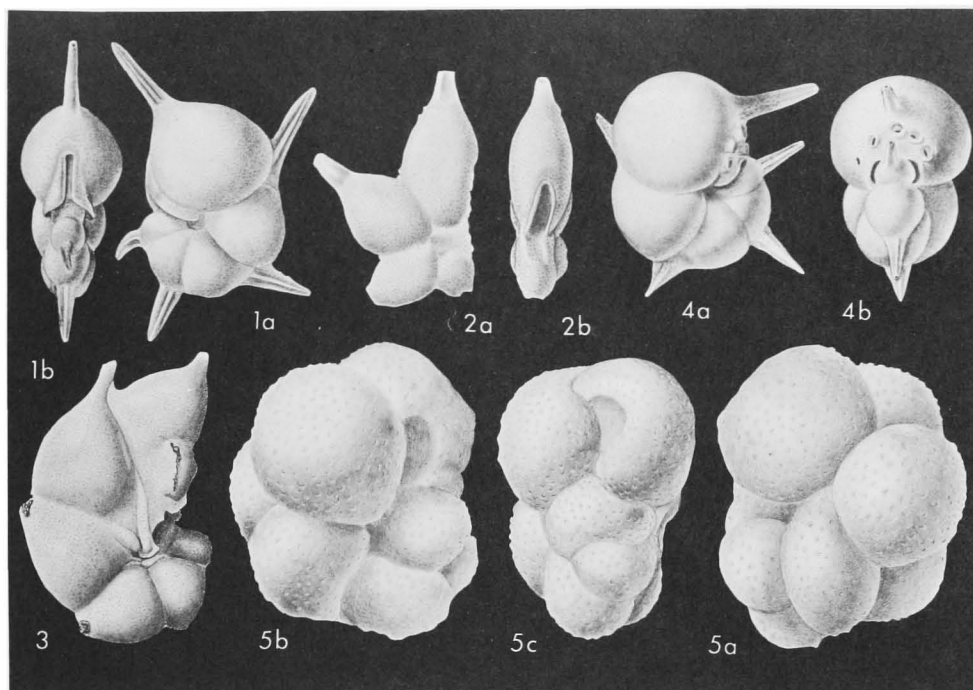


FIG. 532. Hantkeninidae (Hantkenininae; 1-3, *Hantkenina*; 4, *Cribrohanthkenina*; Cassigerinellinae; 5, *Cassigerinella*) (p. C666).

showing protoplasm preserved within test; 4, side view of paratype; all $\times 36$ (*164).

Bolliella BANNER & BLOW, 1959, *77, p. 12 [**Hastigerina* (*Bolliella*) *adamsi*; OD] [= *Hastigerina* (*Bolliella*) BANNER & BLOW, 1959, *77, p. 12 (obj.)]. Similar to *Hastigerina* but with radially elongate chambers in adult. *Rec.*, Pac.O.—FIG. 531,9. **B. adamsi*, opposite sides and apert. view of holotype, $\times 38$ (*77).

Clavigerinella BOLLI, LOEBLICH & TAPPAN, 1957, *164, p. 30 [**C. akersi*; OD]. Test free, planispiral, involute, radially lobulate in outline; early chambers spherical, later radially elongate or clavate; aperture an elongate interiomarginal, equatorial slit extending up apertural face and bordered laterally by wide flanges which narrow toward upper extremity of aperture where they join to form small lip. [*Clavigerinella* resembles *Hastigerinella* in the early globular chambers followed by later radial elongate and clavate chambers, but differs in being planispiral, with elevated equatorial aperture, instead of being trochospiral.] *M.Eoc.-U.Eoc.*, W. Indies (Trinidad)-N. Am.—FIG. 531,10. **C. akersi*, *M.Eoc.*, Trinidad; 10a,b, side, apert. view of holotype, $\times 49$ (*164).

Globanomalina HAQUE, 1956, *876, p. 147 [**G. ovalis*; OD] [= *Pseudohastigerina* BANNER & BLOW, 1959, *77, p. 19 (type, *Nonion micrus* COLE, 1927, *355, p. 22)]. Test free, planispiral to slightly asymmetrical, biumbilicate, chambers inflated, sutures curved and depressed; wall cal-

careous, finely perforate, radially built, and bilamellar, surface smooth; aperture an equatorial arch, with narrow lip, in some specimens with lip touching previous whorl at its periphery so as to form 2 lateral apertural openings. *Paleoc.-Oligo.*, cosmop.—FIG. 531,5. **G. ovalis*, *L.Eoc.*, Asia(Pak.); 5a,b, side, apert. views, $\times 79$ (*2117). —FIG. 531,6-8. *G. micra* (COLE), *M.Eoc.*, W. Indies(Trinidad) (6), Mex. (7,8); 6a,b, side, apert. views, $\times 109$ (*160); 7a,b, side and edge views of specimen with closely appressed final chamber closing aperture on periphery and leaving biglobigerinelloid double aperture; 8a,b, side and edge of typical specimen, $\times 109$ (*2117).

[*Globanomalina* was described originally as trochospiral and some species which have been assigned to this genus are trochospiral; they should be transferred to *Globorotaloides* as here redefined. The type-species of *Globanomalina* is involute on both sides, and although they are somewhat larger, topotype specimens are very similar to *Nonion micrus*, as figured by BANNER & BLOW (*77). The species are here regarded as congeneric, and *Pseudohastigerina* a synonym of *Globanomalina*. *Pseudohastigerina* was described as having an imperforate porticus (apertural lip) and to differ from *Globigerinelloides* in a reduced number of relic apertures. In topotypes of *Nonion micrus* a considerable degree of variation in the involution is found, some specimens being completely involute and a majority partially evolute. Although a distinct apertural lip is present, this is apparently perforate. In the rarer more involute specimens among middle Eocene topotypes and in Paleocene species, the apertural lip may attach to the previous whorl in the equatorial region, leaving the aperture open only laterally, as is common in *Biglobigerinella*. In a plate explanation given by BANNER & BLOW (*77, pl. 3, fig. 6) *Pseudohastigerina* was said to be monolamellar and to have imperforate septa. The apertural face (and hence septal face) is distinctly perforate, however. Furthermore, according to REISS (*1530, p. 68) the type-

species of *Pseudohastigerina* is like the Hantkeninidae (bilamellar) in wall structure as are all of the Globigerinacea.]

Subfamily HANTKENININAE Cushman, 1927

[*nom. transl.* CHAPMAN & PARR, 1936, p. 145 (*ex family* Hantkeninidae CUSHMAN, 1927)]

Test planispiral; chambers globular, elongate or spinate; aperture equatorial or areal and multiple. *Eoc.*

Hantkenina CUSHMAN, 1924, *419, p. 1 [**H. alabamensis*; OD] [= *Hantkenia* CUSHMAN, 1924, *419, p. 1 (*nom. null.*) (*non* FISCHER, 1885; *nec* PREVER, 1902); *Sporohantkenina* BERMÚDEZ, 1937, *118, p. 151 (type, *Hantkenina brevispina* CUSHMAN, 1924, *419, p. 2); *Hantkenina (Aragonella)* THALMANN, 1942, *1901, p. 811 (type, *H. mexicana* var. *aragonensis* NUTTALL, 1930, *1371, p. 284); *Hantkenina (Applinella)* THALMANN, 1942, *1901, p. 812 (type, *H. dumblei* WEINZIERL & APPLIN, 1929, *2044, p. 402; *Hantkenina (Hantkeninella)* BRÖNNIMANN, 1950, *220, p. 399 (type, *H. alabamensis* var. *primitiva* CUSHMAN & JARVIS, 1929, *509, p. 16)]. Test free, planispiral, involute, biconvex, biumbilicate; chambers rounded, ovate or radial elongate, generally with single relatively long, heavy spine at forward margin of each chamber on periphery and in the plane of coiling, although spines rarely are absent on one or more chambers; sutures depressed, radial; wall calcareous, finely perforate, radial in structure, surface finely hispid, especially in area just beneath aperture on previous whorl; primary aperture interiomarginal, equatorial, triradiate, 2 "rays" forming slit across base of final chamber face, third ray arising from center of this slit and extending up face toward peripheral spine, flaring slightly to become rounded at its upper end, vertical slit bordered laterally by apertural flanges which join above as narrow lip. *Eoc.* (*Ypres-Wemmel.*), N.Am.-Eu.-S.Am.-Afr.-M.East-Australia-N.Z.-E.Indies (Borneo).—FIG. 532.1. **H. alabamensis*, U.Eoc. (Jackson.), USA (Ala.); 1*a,b*, side, edge views, $\times 27$ (*164).—FIG. 532.2. *H. aragonensis* NUTTALL, Eoc., Mex.; 2*a,b*, side, apert. view of paratype, $\times 45$ (*164).—FIG. 532.3. *H. dumblei* WEINZIERL & APPLIN, Eoc., USA (Tex.); side view of lectotype, $\times 50$ (*164).

Cribohantkenina THALMANN, 1942, *1901, p. 812, 815, 819 [**Hantkenina (C.) bermudezi* (= *Hantkenina inflata* HOWE, 1928, *968A, p. 14); OD]. Test free, planispiral, biumbilicate; chambers subglobular, with prominent peripheral spine at forward margin of each chamber, succeeding chambers attached near base of spines, may partially or completely envelop spine of preceding chamber; sutures distinct, depressed, radial; wall calcareous, perforate, surface smooth, finely punctate, or finely spinose; primary aperture interiomarginal, equatorial, secondary multiple areal aperture con-

sisting of small rounded or elongate openings above primary interiomarginal aperture, in well-developed specimens terminal portion of chamber may form a protruding "pore-plate," which lacks fine perforations in area between apertural pores and may cover primary interiomarginal aperture, attaching to peripheral margin of previous whorl, primary interiomarginal aperture and secondary areal apertures commonly bordered by distinct protruding lips, and multiple secondary openings may rarely be filled by later-formed shell growth. [Differs from *Hantkenina* in having the secondary multiple areal aperture in the region between the final spine and the primary interiomarginal aperture.] U.Eoc., N. Am.-W. Indies (Cuba)-Afr.—FIG. 532.4. **C. inflata* (HOWE), Jackson, USA (Ala.); 4*a,b*, side, apert. views, $\times 50$ (*164).

Subfamily CASSIGERINELLINAE

Bolli, Loeblich & Tappan, 1957

[Cassigerinellinae BOLLI, LOEBLICH & TAPPAN, 1957, p. 30]

Test planispiral in early stage, later enroled biserial; chambers spherical to ovate; primary aperture equatorial in neanic stage, extraumbilical and alternating in adult. *Oligo-Mio.*

Cassigerinella POKORNÝ, 1955, *1475, p. 136 [**C. boudecensis*; OD]. Test free, robust, early portion planispiral and similar to *Hastigerina*, later with biserially arranged chambers continuing to spiral in same plane, biumbilicate, periphery broadly rounded; chambers globular to ovate and only few pairs arranged as in *Cassidulina* to each whorl of test; sutures distinct, depressed, radial to curved; wall calcareous, perforate, radial in structure, surface smooth to pitted; aperture interiomarginal, an extraumbilical arch alternating in position from one side to next in successive chambers. [Differs from *Cassidulina* in having a perforate radial rather than granular wall structure and in having an early planispiral stage.] *Oligo-Mio.*, Eu.-N. Am.-Carib.-S.Am.—FIG. 532.5. **C. boudecensis*, M.Oligo., Eu. (Czech.); 5*a-c*, opposite sides and edge view showing biserial enroled test and arched aperture, $\times 219$ (*164).

Family GLOBOROTALIIDAE Cushman, 1927

[Globorotaliidae CUSHMAN, 1927, p. 91] [= Marginolamellidae HOFKER, 1951, p. 485 (*partim*) (*nom. nud.*)]

Test trochospiral; chambers ovate, spherical or angular; primary aperture interiomarginal, extraumbilical-umbilical, and secondary sutural apertures may occur on spiral side. *Paleoc.-Rec.*

Subfamily GLOBOROTALIINAE Cushman, 1927

[*nom. transl.* CHAPMAN & PARR, 1936, p. 145 (*ex family* Globorotaliidae CUSHMAN, 1927)]

Primary aperture only, on umbilical side. *Paleoc.-Rec.*

Globorotalia CUSHMAN, 1927, *431, p. 91 [**Pulvinulina menardii* (D'ORBIGNY) var. *tumida* BRADY, 1877, *194, p. 535; OD] [=G. (*Truncorotalia*)

CUSHMAN & BERMÚDEZ, 1949, *497, p. 35 (type, *Rotalina truncatulinoides* D'ORBIGNY in BARKER-WEBB & BERTHELOT, 1839, *86, p. 132); *Planoro-*

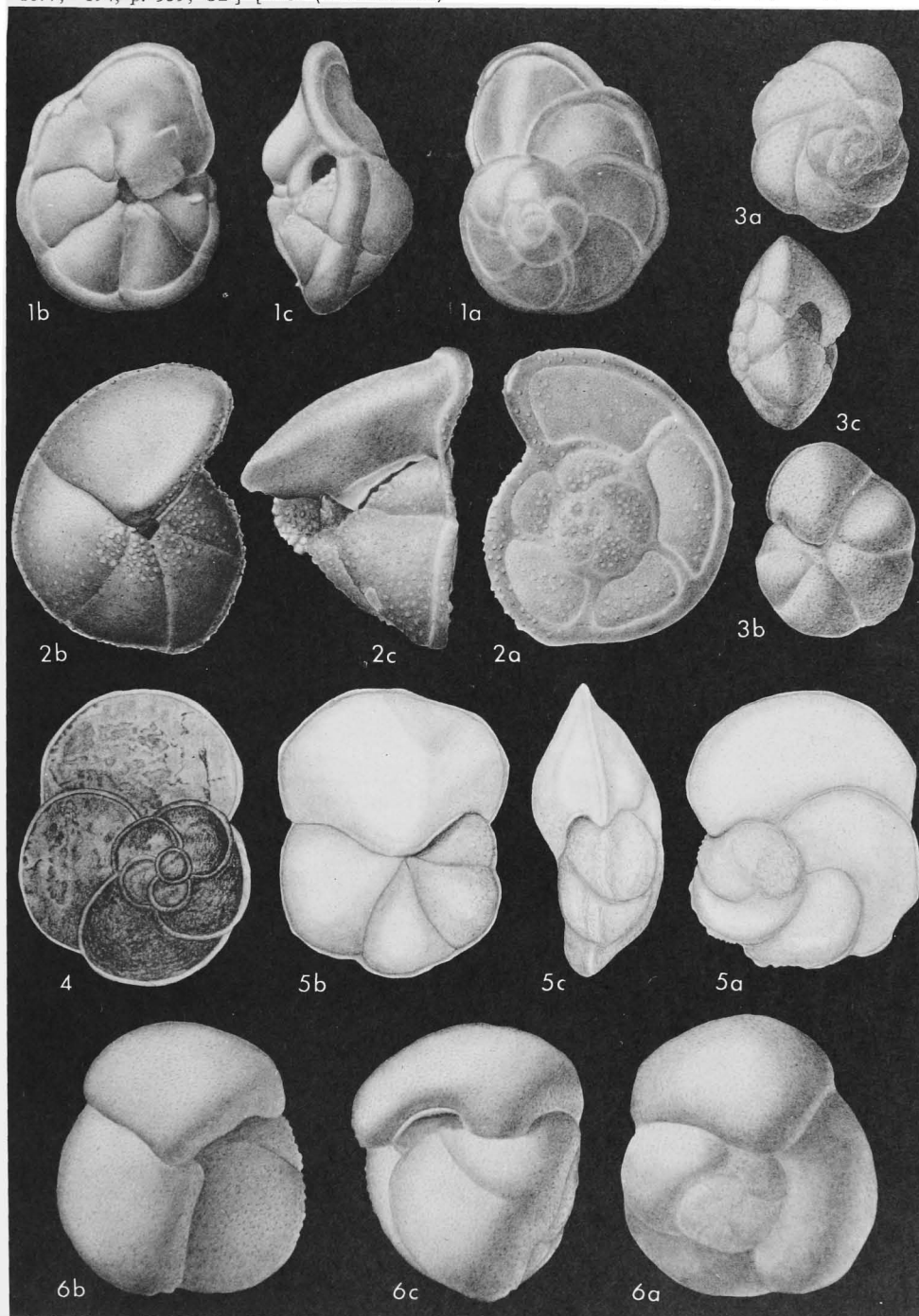


FIG. 533. Globorotaliidae (Globorotaliinae; 1-5, *Globorotalia*; 6, *Turborotalia*) (p. C667-C668).



FIG. 534. Globorotaliidae (Globorotaliinae; *Globorotalia*) (p. C667-C668).

talia MOROZOVA, 1957, *1316, p. 1110 (type, *Planulina membranacea* EHRENBURG, 1854, *680, p. 25); *Planorotalites* MOROZOVA, 1957, *1316, p. 1112 (type, *Globorotalia pseudoscutula* GLAESSNER, 1937, *793, p. 32); *G. (Astrorotalia)* TURNOVSKY, 1958, *1956, p. 81 (type, *G. (A.) stellaria*)). Test free, trochospiral, periphery carinate, chambers angular, rhomboid, or angular-conical; sutures may be thickened, depressed to elevated; wall calcareous, finely perforate, but with nonporous keel or peripheral band, surface smooth to cancellate or hispid; aperture interiomarginal, an extraumbilical-umbilical arch bordered by lip, varying from narrow rim to broad spatulate or triangular flap. *Paleoc.-Rec.*, cosmop.—FIG. 533,1. **G. tumida* (BRADY, Post-Tert., W.Pac.O.(New Ireland); 1a-c, opposite sides and edge view, $\times 44$ (*164). —FIG. 533,2; 534. *G. truncatulinoides* (D'ORBIGNY), Rec., N.Atl.O.(Canary Is.), (533.2), N.Pac.O. (Bikini Atoll) (534); 533,2a-c, opposite sides and edge view of topotype, $\times 70$ (*164); 534, equat. sec. showing radial bilamellar wall structure,

$\times 75$ (*1533).—FIG. 533,3. *G. pseudoscutula* GLAESSNER, Paleoc., USA(N.J.); 3a-c, opposite sides and edge view, $\times 73$ (*1174).—FIG. 533, 4,5. *G. membranacea* (EHRENBURG), Plio., Eu. (Sicily); 4, lectotype, here designated, enlarged (*680); 5a-c, opposite sides and edge view of topotype, $\times 79$ (*2117).

[Although the keeled and nonkeeled forms were previously regarded by us as congeneric (*164), the nonperforate peripheral band or keel is here considered to merit generic distinction; hence the nonkeeled genus *Turborotalia* is recognized as valid. *Planorotalia* MOROZOVA, 1957, is based on the species *Planulina membranacea* EHRENBURG, to which a Paleocene species commonly has been referred. The species was recorded originally as occurring in the Weisser Kalkstein, Antilebanon, Syria (*680, pl. 25, fig. 41), and Cattolica, Sicily (*680, pl. 26, fig. 43). The Syrian specimen may not even be a planktonic species. The specimen of EHRENBURG's fig. 43 (here reproduced) generally is regarded as more typical, hence is here designated as lectotype. A specimen from the type locality in Sicily, which is of Pliocene, rather than Paleocene age, is illustrated also to show the full character of this species. The Paleocene species is to be referred to *G. pseudomenardii* BOLL.]

Turborotalia CUSHMAN & BERMÚDEZ, 1949, *497, p. 42 [**Globorotalia centralis* CUSHMAN & BERMÚDEZ, 1937, *491, p. 26; OD] [= *Globorotalia (Turborotalia)* CUSHMAN & BERMÚDEZ, 1949, *497, p. 42 (obj.); *Acarinina* SUBBOTINA, 1953, *1847, p. 219 (type, *A. acarinata*)]. Test free, trochospiral, periphery noncarinate; chambers ovate or rounded; sutures commonly depressed; wall finely perforate, surface smooth to hispid; aperture interiomarginal, extraumbilical-umbilical, with bordering lip. [Differs from *Globorotalia* in lacking a keel or nonporous peripheral margin.] *Paleoc.-Rec.* cosmop.—FIG. 533,6. **T. centralis* (CUSHMAN & BERMÚDEZ), Eoc., W.Indies(Cuba); 6a-c, opposite sides and edge view of holotype, $\times 84$ (*164).

Subfamily TRUNCOROTALOIDINAE

Loeblich & Tappan, 1961

[*Truncorotaloidinae* LOEBLICH & TAPPAN, 1961, p. 309]

Primary aperture on umbilical side, and secondary sutural apertures on spiral side. *L.Eoc.-M.Eoc.*

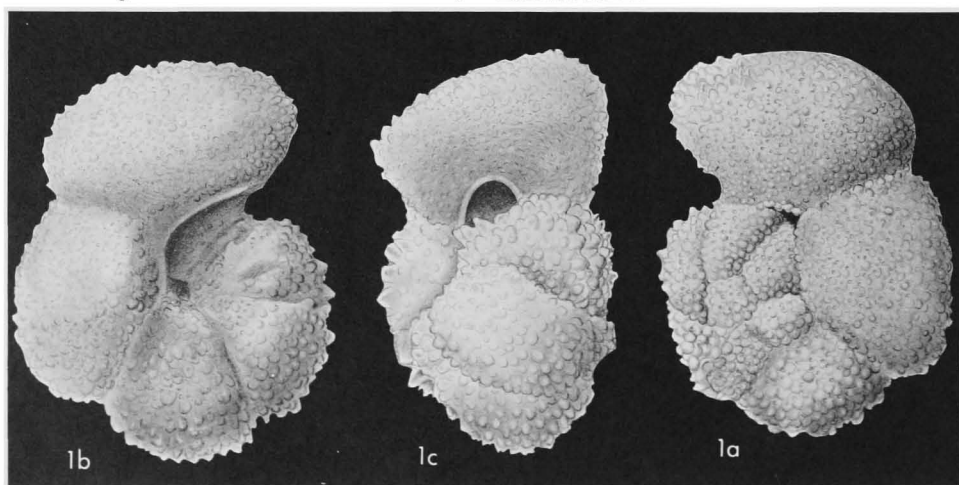


FIG. 535. Globorotaliidae (Truncorotaloidinae; 1, *Truncorotaloides*) (p. C669).

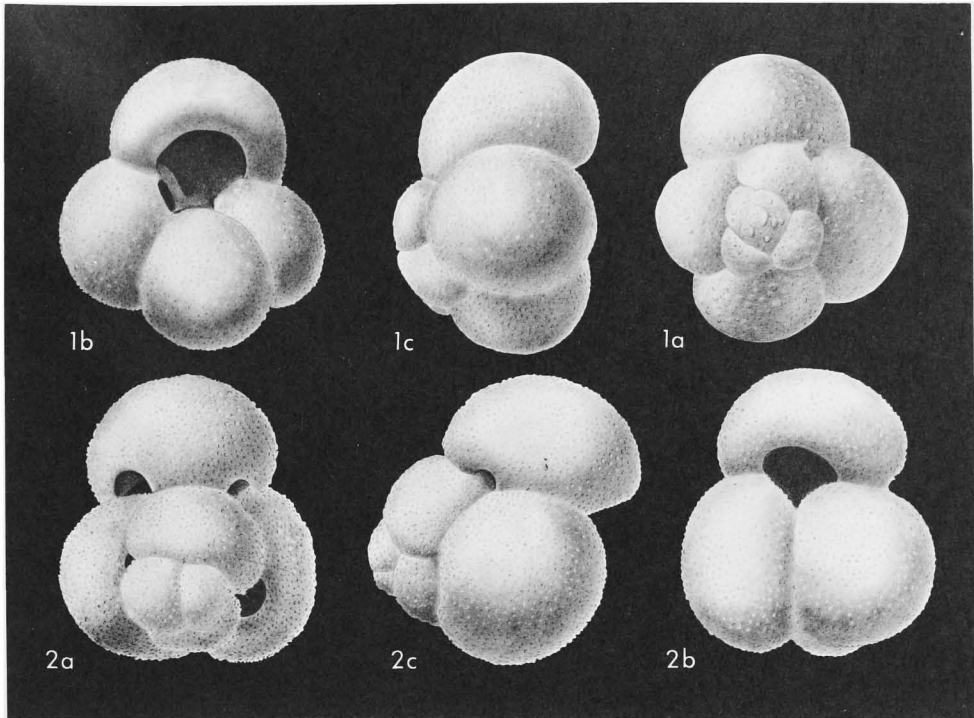


FIG. 536. Globigerinidae (Globigerininae; 1, *Globigerina*; 2, *Globigerinoides*) (p. C669-C670).

Truncorotaloides BRÖNNIMANN & BERMÚDEZ, 1953, *233, p. 817 [*T. rohri*; OD]. Test similar to *Globorotalia* but with secondary sutural apertures on spiral side. *L.Eoc.-M.Eoc.*, W.Indies (Trinidad)-Mex.-USA-Eu.—FIG. 535, 1. **T. rohri*, M.Eoc., Trinidad; 1a-c, opposite sides and edge view of holotype, $\times 130$ (*164).

Family GLOBIGERINIDAE Carpenter, Parker & Jones, 1862

[*nom. correct.* SCHULZE, 1877, p. 29 (*pro* family Globigerinida CARPENTER, PARKER & JONES, 1862, p. 171) (*nom. conserv.* ICZN Opin. 552)]—[All names cited are of family rank; dagger(†) indicates *partim*]—[=Hélicosteguest d'ORBIGNY, 1826, p. 268 (*nom. neg.*; *nom. nud.*); [=Uvellingat EHRENBURG, 1839, table opp. p. 120 (*nom. nud.*); =Turbinoidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =Uvellingat SCHMARDT, 1871, p. 164]—[=Orbulinida SCHULTZE, 1854, p. 52; =Orbulinetta HAECKEL, 1894, p. 164; =Orbulinidae GALLOWAY, 1933, p. 326; =Globigerinidae SCHWAGER, 1876, p. 479; =Globigerinoidae SCHWAGER, 1877, p. 20; =Globigerininae BÜTSCHLI in BRONN, 1880, p. 200; =Globigerinidos GADEA BUISÁN, 1947, p. 19 (*nom. neg.*)]

Test trochospiral, streptospiral or globular, chambers spherical, ovate or clavate; primary aperture umbilical or spiroumbilical, may have secondary sutural or areal apertures, bullae, and accessory infralaminar apertures. *U.Cret.(Maastricht.)-Rec.*

Subfamily GLOBIGERININAE Carpenter, Parker & Jones, 1862

[*nom. correct.* CUSHMAN, 1927, p. 87 (*pro* subfamily Globigerininae CARPENTER, PARKER & JONES, 1862, p. 181)]—[All names cited are of subfamily rank]—[=Globigerinina

JONES in GRIFFITH & HENFREY, 1875, p. 320; =Globigerinidae SCHWAGER, 1877, p. 20; =Pulleniatininae CUSHMAN, 1927, p. 89; =Globorotaloidinae BANNER & BLOW, 1959, p. 7]

Test trochospiral to streptospiral; primary aperture umbilical or spiroumbilical, and may have secondary sutural apertures. *U. Cret.(Maastricht.)-Rec.*

Globigerina d'ORBIGNY, 1826, *1391, p. 277 [*G. bulloides*; SD PARKER, JONES & BRADY, 1865, *1419, p. 36] [=*Globigenera* SOWERBY, 1842, *1819, p. 154 (*nom. null.*); *Rhynchospira* EHRENBURG, 1845, *675, p. 358 (type, *R. indica*); *Pylo-dexia* EHRENBURG, 1858, *683, p. 28 (type, *P. tetratrias*)]. Test free, trochospiral, chambers spherical to ovate; wall calcareous, perforate, radial in structure, surface may be smooth, pitted, cancellated, hispid or spinose; aperture interiomarginal, umbilical, with tendency in some species to extend to slightly extraumbilical position, previous apertures remaining open into umbilicus. *Paleoc.-Rec.*, cosmop.—FIG. 536, 1. **G. bulloides*, Rec., Adriatic Sea (Porto Corsini, Italy); 1a-c, opposite sides and edge view of hypotype, $\times 87$ (*164).

Beella BANNER & BLOW, 1960, *78, p. 26 [*Globigerina digitata* BRADY, 1879, *196b, p. 286; OD] [=*Globorotalia* (B.) BANNER & BLOW, 1960, *78, p. 26 (obj.)]. Test similar to *Globigerina*, but final chambers becoming radial-elongate, periphery non-carinate; aperture interiomarginal, extra-umbilical-umbilical. [Because of the distinctive

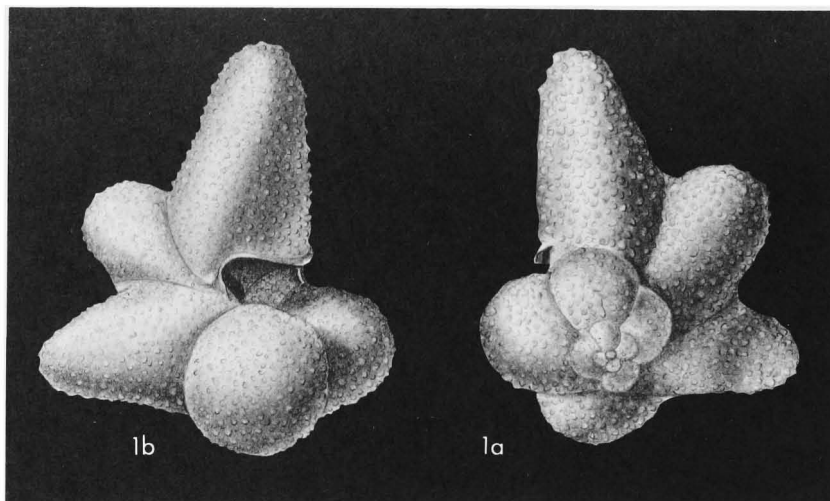


FIG. 537. Globigerinidae (Globigerininae; 1, *Beella*) (p. C669-C670).

chamber form, *Beella* is elevated to generic status.] *Mio.-Rec.*, S.Atl.O.-Carib.—FIG. 537, 1. **B. digitata* (BRADY), *Rec.*, Atl.O.; 1a,b, opposite sides of hypotype, $\times 93$ (*164).

Globigerinoides CUSHMAN, 1927, *431, p. 87 [**Globigerina rubra* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 82; OD]. Test similar to *Globigerina* but with secondary sutural apertures on spiral side. *L.Eoc.-Rec.*, cosmop.—FIG. 536, 2. **G. ruber* (D'ORBIGNY), *Rec.*, Carib.; 2a-c, opposite sides and edge view of hypotype, $\times 73$ (*164).

Globigerinopsis BOLLI, 1962, *163A, p. 281 [**G. aguasayensis*; OD]. Test free, trochospiral; chambers spherical to ovate; wall calcareous, perforate, radial in structure, surface smooth, punctate, cancellate, hispid or spinose; aperture in the early stage interiomarginal, umbilical, later becoming spiroumbilical. [Differs from *Globigerina* in the spiroumbilical aperture and from *Hastigerinella* in lacking the radially elongate or clavate chambers.] *Mio.*, W.Indies (Dominican Republic)-S.Am. (E.Venez.).—FIG. 537A, 1. **G. aguasayensis*, *Mio.*, Venez.; 1a-c, opposite sides and edge of holotype, showing extended aperture on the spiral side, $\times 43$ (*163A).

Globoconusa KHALILOV, 1956, *1037, p. 249 [**G. conusa* (= *Globigerina daubjergensis* BRÖNNIMANN, 1953, *230, p. 340); OD]. Test small, trochospiral, similar to *Globigerina*, but commonly with strongly convex spiral side; chambers inflated and globular, increasing rapidly in size; wall characteristically spinose; aperture a small rounded umbilical opening, with one or more tiny secondary sutural openings on spiral side against early whorl. [The type-species, *G. conusa*, was described from the Danian of Azerbaïdzhan, but is apparently conspecific with *Globigerina daubjergensis*, originally described from Denmark, but of world-wide occurrence in Danian strata. Although *Globoconusa* was described as high-spired,

the type-species is quite variable as to height of spire.] *Paleoc.* (Dan.), Eu.-N.Am.-Carib.-USSR-S. Am.—FIG. 538, 1, 2. **G. daubjergensis* (BRÖNNIMANN), Sweden (1), USA (Tex.) (2); 1a-c, opposite sides and edge of low-spired hypotype; 2a-c, opposite sides and edge of high-spired hypotype, $\times 146$ (*1174).

Globoquadrina FINLAY, 1947, *717e, p. 290 [**Globorotalia dehiscens* CHAPMAN, PARR, & COLLINS, 1934, *326, p. 569; OD]. Test free, trochospiral, umbilicate; aperture interiomarginal, umbilical, covered above by apertural flap which may vary from narrow rim to elongate toothlike projection, and in openly umbilicate forms earlier apertures remain open into umbilicus. [*Globoquadrina* differs from *Globigerina* in having prominent apertural flaps covering each aperture.] *U.*

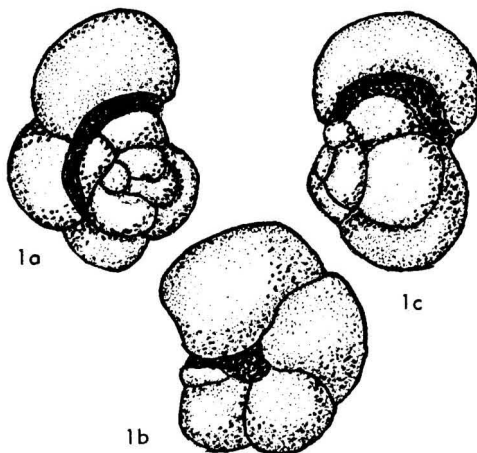


FIG. 537A. Globigerinidae (Globigerininae; 1, *Globigerinopsis*) (p. C670).

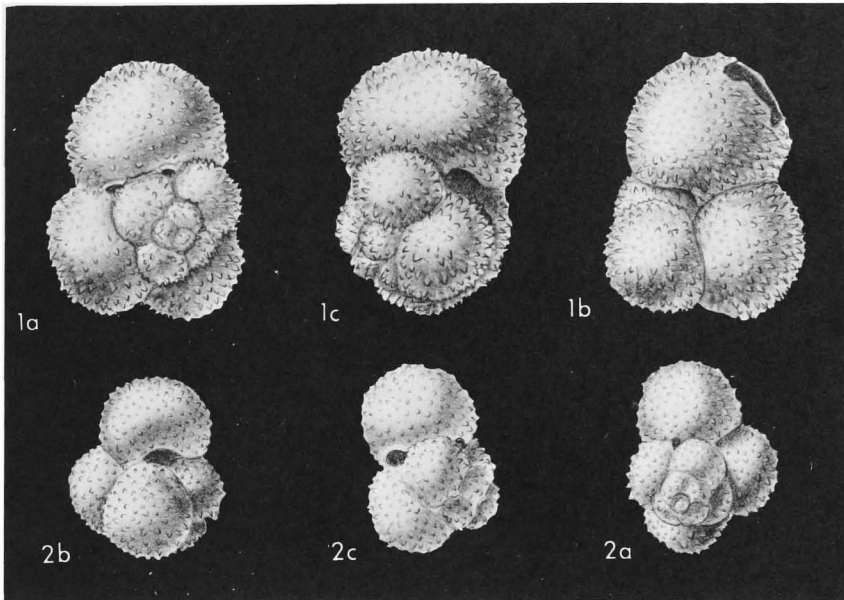


FIG. 538. Globigerinidae (Globigerininae; 1,2, *Globoconusa*) (p. C670).

Eoc.-Mio., Australia-N.Z.-Carib.—FIG. 539,6. **G. dehiscens* (CHAPMAN, PARR, & COLLINS), Mio., Australia; 6a-c, opposite sides and edge view of hypotype, $\times 107$ (*164).—FIG. 539,5. *G. altispira* (CUSHMAN & JARVIS), Mio., Jamaica; umbilical view of holotype, showing prominent umbilical toothlike projections comprising apertural flaps of final whorl of chambers, $\times 54$ (*164).

Globorotaloides BOLL, 1957, *159, p. 117 [**G. variabilis*; OD] [= *Globigerina* (*Eoglobigerina*) MOROZOVA, 1959, *1317, p. 1115 (type, *G. (E.) eobulloidis*)]. Test free, low trochospiral coil; chambers subglobular to spherical; sutures depressed; wall calcareous, finely perforate, surface smooth to pitted or hispid; aperture interiomarginal, extraumbilical to umbilical in position, and may have small lip. *U.Cret.* (Maastricht.)—*Rec.*, cosmop.—FIG. 540,1,2. **G. variabilis*, Mio., W.Indies (Trinidad); 1a-c, opposite sides and edge view of holotype; 2a-c, paratype, all $\times 67$ (*159).—FIG. 540,3. *G. eobulloidis* (MOROZOVA), Paleoc. (Dan.), USSR (Crimea); 3a-c, opposite sides and edge view of holotype, $\times 100$ (*1317).

[*Globorotaloides* was originally described as having an asymmetrical final chamber of bulla-like form. Gerontic specimens with atypical final chamber, of larger or smaller than normal size and commonly asymmetrical in position may occur in many species of planktonic and benthonic genera; hence, this feature is not regarded as of generic importance. The genus is here recognized as differing from *Globorotalia* and *Tuborotalia* in its globular chamber form and higher aperture of umbilical or nearly umbilical position. The type-species shows a relationship to both *Globigerina* and *Globoquadrina*, and *Globorotaloides* may have been ancestral to both. It first appears in the latest Maastrichtian.]

Hastigerinella CUSHMAN, 1927, *431, p. 87 [**Hastigerina digitata* RHUMBLER, 1911, *1572a, p. 202 (non *Globigerina digitata* BRADY, 1879) = *Hasti-*

gerinella rhumbleri GALLOWAY, 1933, *762, p. 333; OD]. Test free, trochospiral, early portion with globular chambers, later chambers radially elongate, clavate or cylindrical, with elongate spines concentrated at outer ends of chambers, but commonly broken away in fossil or dead shells; aperture a broad interiomarginal, extraumbilical-umbilical arch, gradually increasing in extent to reach periphery or become spiroumbilical. [With the recognition of *Beella* as a valid genus and *Globigerina digitata* BRADY as its type, the species *Hastigerina digitata* RHUMBLER is no longer a homonym, as the 2 species were not originally placed in the same genus and are not now considered to be congeneric.] *Rec.*, Atl.O.-Pac.O.—FIG. 539,4. **H. digitata* (RHUMBLER), Atl.O.; 4a,b, opposite sides, $\times 8.5$ (*1572a).

Pulleniatina CUSHMAN, 1927, *431, p. 90 [**Pullenia obliqueloculata* PARKER & JONES, 1865, *1418, p. 368; OD]. Test free, globose, trochospiral to streptospiral, early portion as in *Globigerina*, with open umbilicus, later chambers completely enveloping entire umbilical side of previous trochospiral coil, and thus appearing involute; aperture interiomarginal, in young a broad umbilical arch, as in *Globigerina*, in adult a broad low extraumbilical arch at base of final enveloping chamber, bordered above by thickened lip but because of streptospiral plan of growth, not directly opening into earlier umbilicus. [*Pulleniatina* resembles *Globigerina* in early development but differs in its later streptospiral coiling with embracing final chamber and its characteristic extraumbilical peripheral aperture. It differs from *Globigerapsis* in having a single aperture, rather than multiple

apertures in the final chamber against sutures of the early coil.] *Plio.-Rec.*, cosmop.—FIG. 539, 1,2. **P. obliqueloculata* (PARKER & JONES), Rec.,

S.Atl.O. (1), Pac.O. (2); 1a-c, opposite sides and edge of paratype, $\times 82$; 2, dissected hypotype showing neanic *Globigerina* stage with typical

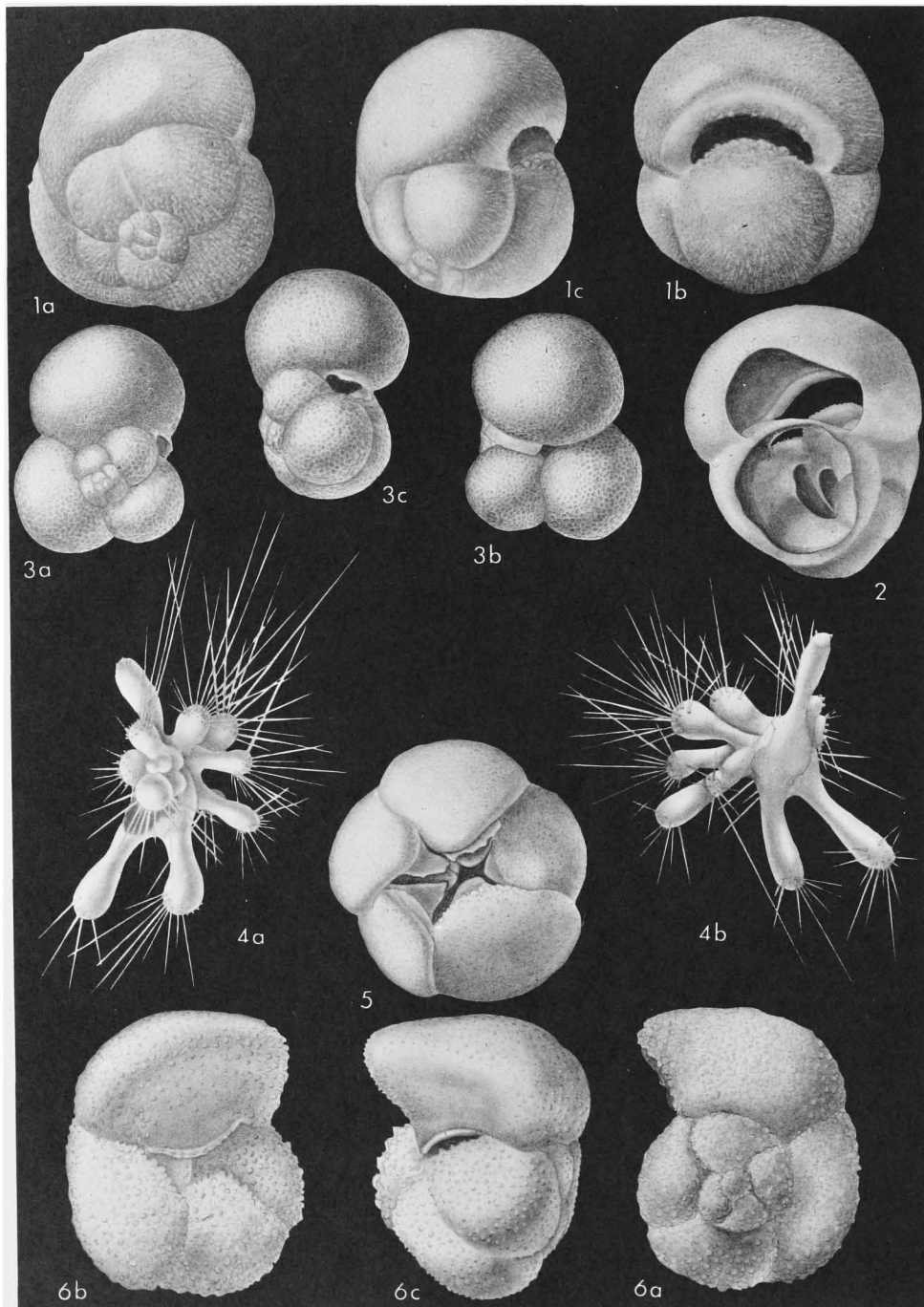


FIG. 539. Globigerinidae (Globigerininae; 1,2, *Pulleniatina*; 3, *Subbotina*; 4, *Hastigerinella*; 5,6, *Globoquadrina*) (p. C670-C673).

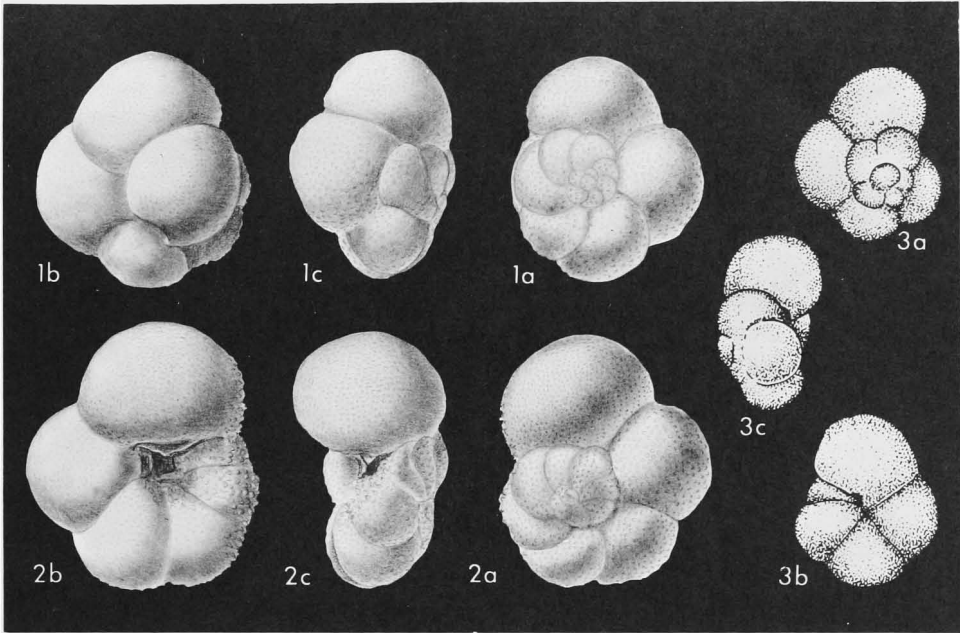


FIG. 540. Globigerinidae (Globigerininae; 1-3, *Globorotaloides*) (p. C671).

umbilical aperture and change in plane of coiling with later development, $\times 57$ (*164).

Subbotina BROTZEN & POZARYSKA, 1961, *243, p. 160 [**Globigerina triloculinoides* PLUMMER, 1927, *1461, p. 134; OD]. Test trochospiral; chambers increasing rapidly in size and strongly inflated; sutures depressed; wall calcareous, perforate, radial in structure, surface reticulate or pitted, rather than spinose; aperture umbilical-extraumbilical, with distinct lip. [Originally defined solely on the basis of wall surface, the present genus apparently includes species which are closely similar in form and apertural character. The coarsely pitted surface is found in species with low and slightly extraumbilical aperture and distinctive lip, none of which are found in typical *Globigerina*.] *Paleoc. (Dan.)-Rec.*, cosmop.—FIG. 539, 3. **S. triloculinoides* (PLUMMER), Midway, USA (Tex.); 3a-c, opposite sides and edge view of topotype, $\times 73$ (*1174).

Subfamily SPHAEROIDINELLINAE

Banner & Blow, 1959

[Sphaeroidinellinae BANNER & BLOW, 1959, p. 5]

Test trochospiral; chambers with flange-like margins; wall with secondary thickening and reduced perforations; primary aperture umbilical, may have secondary sutural apertures. *Mio.-Rec.*

Sphaeroidinella CUSHMAN, 1927, *431, p. 90 [**Sphaeroidina dehiscentis* PARKER & JONES, 1865, *1418, p. 369; OD]. Early portion trochospiral, with 2 or 3 much-embracing chambers of final whorl enveloping early whorl, chambers with

marginal flanges extending out toward those of opposing chambers and partially obscuring arched apertures; wall calcareous, perforate, pores extremely large and closely arranged in early stage, giving an almost lattice-like appearance, area between pores raised and cancellated; in later chambers somewhat irregularly fimbriate or scalloped flange of clear shell material, relatively poreless, is formed around chamber base, tending to coalesce laterally and become much produced, exterior surface of final chambers becoming smooth and glassy due to external secondary deposit; primary aperture in young interior marginal and umbilical, as in *Globigerina*, but later covered by embracing final chamber; one or more sutural secondary apertures may occur on opposite sides of final chamber, and may be partially obscured by overhanging chamber flanges which parallel sutures, or chambers may be distinctly separated, with wide open area between flanges of opposing chambers, with small arched bullae crossing the sutural slit and partially covering apertural regions, walls of bullae smoothly finished and with finer pores than in chambers, although similarly spaced. *U.Mio.-Rec.*, cosmop.—FIG. 541, 1-3. **S. dehiscentis* (PARKER & JONES), Rec., Pac.O. (1,3), Atl.O. (2); 1a,b, side and edge views of paratype, showing well-developed sutural flanges; 3, small paratype showing bulla over sutural aperture; 2, dissected hypotype showing neanic *Globigerina* stage with large pores and umbilical aperture; all $\times 38$ (*164).

Sphaeroidinellopsis BANNER & BLOW, 1959, *77, p. 15 [**Sphaeroidinella dehiscentis subdehiscentis* BLOW,

1959, *149, p. 195; ODJ. Test trochospiral, similar to *Globigerina*, with wall structure like that of *Sphaeroidinella*, primary wall covered by sec-

ondary layer reducing porosity; primary aperture umbilical, with bordering lip, no sutural secondary apertures. *L.Mio.-U.Mio.*, S.Am.-Carib.-Indon.-N.

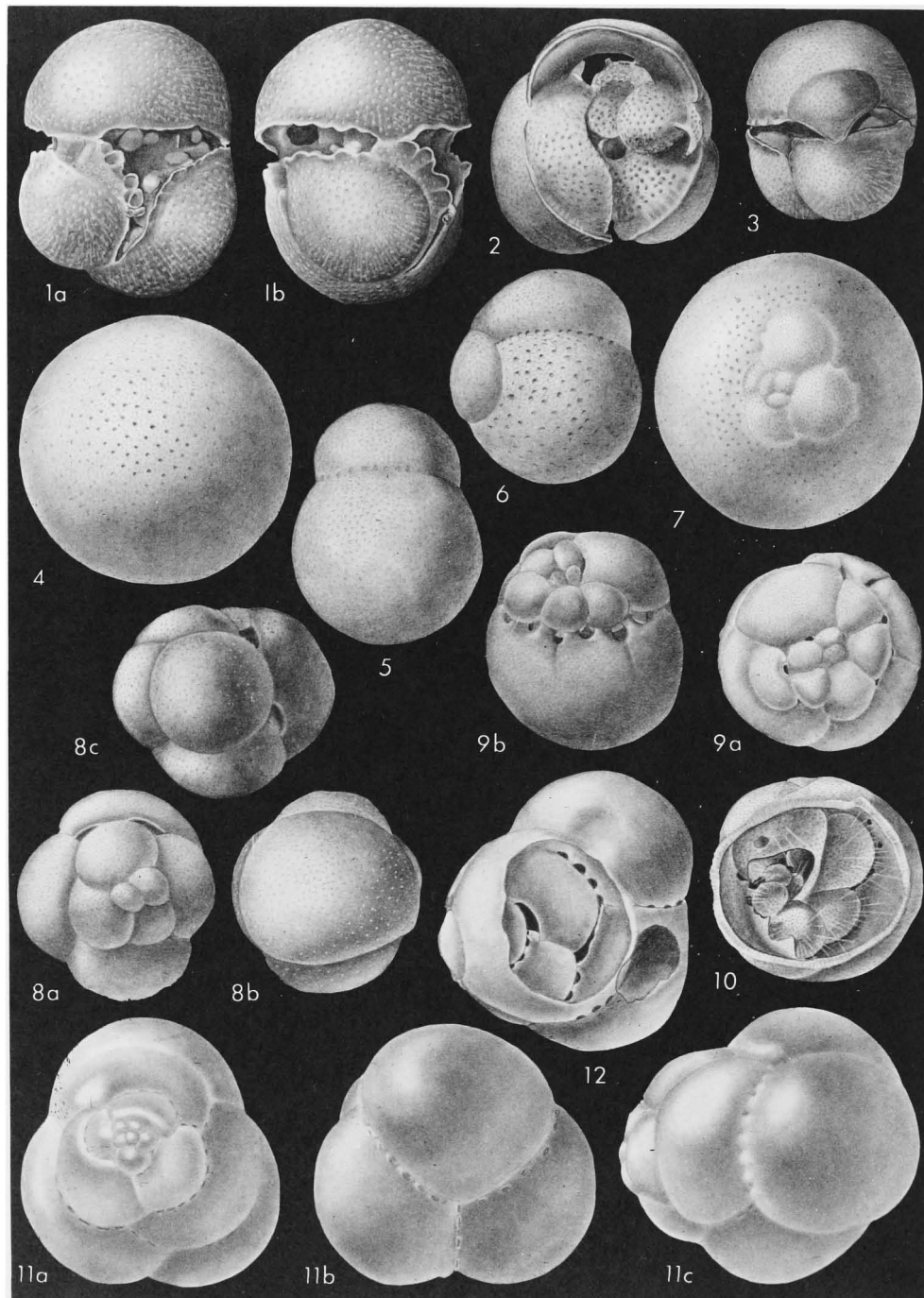


FIG. 5-11. Globigerinidae (Sphaeroidinellinae; 1-3, *Sphaeroidinella*; Orbulininae; 4-7, *Orbulina*; 8, *Globigerapsis*; 9,10, *Porticulasphaera*; 11,12, *Candeina*) (p. C673-C676).

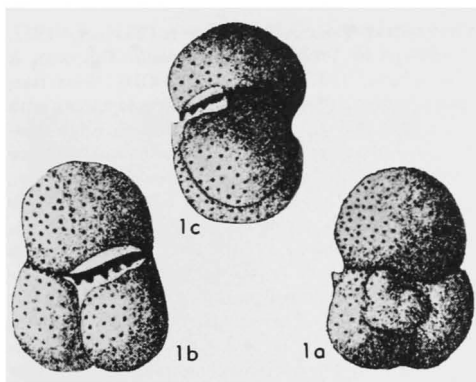


FIG. 542. Globigerinidae (Sphaeroidinellinae; 1, *Sphaeroidinellopsis*) (p. C673-C675).

Z.-Eu.—FIG. 542, 1. **S. subdehiscens* (Blow), Mio., Venez.; 1a-c, opposite sides and edge of holotype, $\times 47$ (*77).

Subfamily ORBULININAE Schultze, 1854

[*nom. transl.* CUSHMAN, 1927, p. 89 (*ex* family Orbulinidae SCHULTZE, 1854)] [=Candeininae CUSHMAN, 1927, p. 90]

Test trochospiral to streptospiral, later stage enveloping or globular; primary aperture not visible in adult, secondary apertures multiple and sutural or areal. *Eoc.-Rec.*

Orbulina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 2 [**O. universa*; OD (M)] [=Coscinosphaera STUART, 1866, *1845, p. 328 (type, *C. ciliosa*); *Candorbulina* JEDLITSCHKA, 1934, *986, p. 20 (type, *C. universa*); *Biorbulina* BLOW, 1956, *148, p. 69 (type, *Globigerina bilobata* D'ORBIGNY, 1846, *1395, p. 164)]. Test free, adult generally spherical and composed of a single chamber, rarely 2- or 3-chambered, early chambers trochospiral in microspheric form, in adult the globigerine coil may remain visible at one side or may be completely enveloped by final spherical chamber, or test may consist of number of completely enveloping, concentric globular chambers (probably megalospheric form); primary aperture interiomarginal, umbilical in early globigerine stage where this is present, areal in adult, with numerous small openings scattered over one side or over much of test, small sutural secondary openings commonly found around early globigerine chambers of specimens where these are visible at surface; in sexual reproduction gametes formed within spherical test, accompanied by gradual resorption of wall of early globigerine chambers and in Recent forms by descending vertical migration in water column from surface to depth of about 300 m., gametes then escaping through large perforations in wall; gametes biflagellate, with homogeneous nucleus, no axostyle, and with large oily inclusion (*1105); cytoplasm with abundant areolated ectoplasm surrounding test; pseudopodia

elongate, radiating, numerous and rigid. *L.Mio.-Rec.*, cosmop.—FIG. 541, 4-7. **O. universa*, Rec., Atl.O. (4-6), Mio., USA (Fla.) (7); 4, typical spherical microspheric specimen, with globigerine stage completely enclosed, $\times 40$; 5, 6, 2- and 3-chambered (probably megalospheric forms), $\times 40$; 7, microspheric hypotype with globigerine stage visible at side of test, $\times 70$ (*164).

[Surface specimens of *Orbulina* commonly contain embryonic globigerine chambers (*200, *1105), which are resorbed during gamete formation and accompanied by gradual descent of specimens in water column. BRADY (*200, p. 609, 610) noted that specimens taken from the bottom had thicker walls, which were commonly laminated, "affording clear evidence that the increase in thickness has taken place . . . by the formation of successive layers . . ." The enclosed spheres are loose and easily separated. Furthermore, 2-chambered shells were not infrequent in bottom-ooze, and rarely 3-chambered ones occur. LE CALVEZ (*1105) postulated that a benthonic stage might alternate with the planktonic one in *Orbulina* (as in *Tretomphalus*), but no direct evidence is available, the life cycle of the planktonic species being yet only partially known owing to the difficulties in culturing them. Possibly these bottom-specimens represent a megalospheric test, the so-called *Biorbulina* representing specimens with the proloculus visible at the side, just as the early coiled stage of the microspheric form can be seen at one side of some planktonic specimens, and specimens with concentric spherical chambers (*200, pl. 81, fig. 26) may represent completely involute megalospheric tests, just as some of the surface specimens completely enclose the small globigerine chambers of the microspheric test (*200, pl. 81, fig. 13). Further studies of living specimens of the planktonic genera are needed.]

Candeina D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 107 [**C. nitida*; OD (M)]. Test free, trochospiral, relatively high-spined; chambers inflated; primary aperture in early stage interiomarginal, umbilical, later with tiny secondary sutural apertures on each side of primary aperture; no primary opening in adult tests, small rounded sutural secondary apertures almost completely surrounding later chambers. [In its development *Candeina* is similar to *Globigerina* and then to *Globigerinoides*, but differs in the absence of a primary aperture in the adult, and in the numerous small sutural secondary openings on both spiral and umbilical sides of the adult.] *Mio.-Rec.*, cosmop.—FIG. 541, 11, 12. **C. nitida*, Rec., Atl.O.; 11a-c, opposite sides and edge of hypotype showing numerous sutural secondary apertures, $\times 82$; 12, dissected hypotype showing neanic *Globigerinoides* stage with primary umbilical aperture, $\times 77$ (*164).

Globigerapsis BOLL, LOEBLICH & TAPPAN, 1957, *164, p. 33 [**G. kugleri*; OD]. Test free, subglobular; early portion trochospiral, with subglobular chambers, final chamber embracing and covering umbilical region of early coil; primary aperture interiomarginal, umbilical in young stage, covered in adult by enveloping final chamber, with 2 or more arched sutural secondary apertures at lower margin of final chamber, at contact with sutures of earlier whorl. *Eoc.*, Carib.-N.Am.-S.Am.-Eu.-N.Z.-Japan.—FIG. 541, 8. **G. kugleri*, W. Indies (Trinidad); 8a-c, opposite sides and edge view of holotype, showing early trochospiral stage and later embracing chamber with sutural openings, $\times 72$ (*164).

[Differs from *Globigerinatheka* in lacking the small angular bullae covering the secondary apertures. It differs from *Globigerinoides* in the absence of an umbilical primary aperture in the adult and from *Globigerinoides* and *Porticulusphaera* in lacking multiple apertures in earlier chambers. SAITO (1962, *1620, p. 219, 220) erroneously regarded *G. kugleri* as a synonym of *Globigerina mexicana*, because of the poor original figures of the latter. As the holotypes of the 2 species are specifically distinct, as here recognized, *G. kugleri* is not a synonym of *G. mexicana*. SAITO also "emended" the generic description and erroneously "designated" *G. mexicana* as type-species for *Globigerapsis*, though it was already the type-species for *Porticulusphaera*. As comparison of the holotypes of *G. kugleri* and *P. mexicana* shows them to be both specifically and generically distinct, SAITO's generic emendations are invalid. New type designations are impossible under the Rules of Zoological Nomenclature as these have been previously designated and are irrevocably fixed; hence *Globigerina mexicana* cannot be regarded as the type-species of *Globigerapsis*.]

Porticulusphaera BOLLI, LOEBLICH & TAPPAN, 1957, *164, p. 34 [**Globigerina mexicana* CUSHMAN, 1925, *421, p. 6 = *Porticulusphaera beckmanni* SAITO, 1962, *1620, p. 221; OD]. Test free, subglobular, early portion trochospiral, final chamber much inflated to almost spherical and strongly enveloping, covering umbilical region of early coil; primary aperture in early portion interiomarginal umbilical, covered by final enveloping chamber of adult, secondary sutural openings on spiral side. *M.Eoc.*, N.Am.-Eu.-Carib.-Japan.—FIG. 541,9,10. **P. mexicana* (CUSHMAN), W.Indies (Trinidad); 9*a,b*, spiral side and edge view of hypotype, showing early trochospiral coil, final enveloping chamber and secondary sutural apertures; 10, dissected hypotype showing neanic *Globigerina*-stage with umbilical aperture, coarse perforations, fine spines, and thick radially perforated final chamber wall, $\times 45$ (*164).

[*Porticulusphaera* resembles *Orbulina* in its strongly embracing although less inflated final chamber but differs in having the early coil always visible and in having secondary sutural openings but no areal secondary apertures. SAITO (1962, *1620, p. 219-221) erroneously designated a new type-species (*P. beckmanni* SAITO, 1962) for *Porticulusphaera* in an "emendation" of the genus. The originally designated type-species cannot be changed according to the International Rules. On the basis of the poor original figures of *G. mexicana* (the true type-species of *Porticulusphaera*), SAITO believed *Globigerapsis kugleri* to be a synonym. Examination of the holotype in the U.S. National Museum shows *G. mexicana* to be distinct from *G. kugleri* and similar to the better-preserved specimens here illustrated, even though not all the generic characters were well shown in the original figures. *Porticulusphaera beckmanni* is a junior synonym of *Globigerina mexicana*. Erroneous later identification as *G. mexicana* of other specimens has no bearing on the status of the species, which must include only forms conspecific with the holotype. SAITO's "emendations" of *Globigerapsis* and *Porticulusphaera* are therefore invalid, as are the "designations" of new type-species for these genera.]

Subfamily CATAPSYDRACINAE

Bolli, Loeblich & Tappan, 1957

[Catapsydracinae BOLLI, LOEBLICH & TAPPAN, 1957, p. 36] [*=Globigerinitellinae* SIGAL, 1958, p. 263; *=Globigerinitellinae* BERMÚDEZ, 1961, p. 1.261]

Test trochospiral to enveloping; chambers spherical to ovate; primary aperture umbilical, may have secondary sutural or areal apertures, one or more apertural bullae present in adult, with infralaminar accessory apertures. *M.Eoc.-Rec.*

Catapsydrax BOLLI, LOEBLICH & TAPPAN, 1957, *164, p. 36 [**Globigerina dissimilis* CUSHMAN & BERMÚDEZ, 1937, *491, p. 25; OD]. Test free, similar to *Globigerina* in early development, with primary umbilical aperture; adult with single umbilical bulla over aperture, and with one or more accessory infralaminar apertures. *M.Eoc.-Mio.*, Carib.-N.Am.-Eu.—FIG. 543,1,2. **C. dissimilis* (CUSHMAN & BERMÚDEZ), Eoc., Cuba (1), Oligo., W.Indies (Trinidad) (2); 1*a-c*, opposite sides and edge view of holotype; 2*a,b*, edge and umbilical views of hypotype; all $\times 46$ (*164).

Globigerinatella CUSHMAN & STAINFORTH, 1945, *525, p. 68 [**G. insueta*; OD]. Test free, subglobular, early portion trochospiral, final chamber embracing and obscuring interiomarginal, umbilical primary aperture, later chambers with secondary sutural and areal apertures which are surrounded by distinct lips and may be covered by small knobby pustule-like areal bullae and more irregular spreading sutural bullae, all bullae with infralaminar accessory apertures. *L.Mio.*, Carib.-N.Am.-Pac.O.—FIG. 543,3,4. **G. insueta*, L. Mio., W.Indies (Trinidad); 3*a,b*, spiral and edge views of paratype showing early trochospiral stage, enveloping final chamber, and areal and sutural bullae; 4, dissected topotype showing areal aperture exposed when bulla is partially removed and infralaminar accessory openings at margin of remaining part of the bulla, $\times 93$ (*164).

Globigerinatheka BRÖNNIMANN, 1952, *226, p. 27 [**G. barri*; OD]. Test free, globular, early chambers trochospiral, as in *Globigerina*, later with large enveloping final chamber covering previous umbilical side, as in *Orbulina*; sutures depressed, radial; primary aperture interiomarginal, umbilical, but covered in adult by final enveloping chamber, secondary sutural apertures on spiral side, covered by small bullae, each with one or more infralaminar accessory apertures. [*Globigerinatheka* is similar to *Globigerapsis* but has bullae covering the sutural apertures.] *M.Eoc.-U.Eoc.*, W.Indies (Trinidad). —FIG. 543,5. **G. barri*, M.Eoc.; 5*a-c*, opposite sides and edge of hypotype, $\times 72$ (*164).

Globigerinita BRÖNNIMANN, 1951, *224, p. 18 [**G. naparimaensis*; OD] [= *Turborotalita* BLOW & BANNER in EAMES, BANNER, BLOW & CLARKE, 1962, *651, p. 122 (type, *Truncatulina humilis* BRADY, 1884, *200, p. 665)]. Test free, trochospiral, final chamber modified and extending across umbilical region; primary aperture interiomarginal and umbilical, but in adult covered by modified final chamber which extends across umbilical region, one or more small arched supplementary apertures present at umbilical margin of final chamber. *Mio.-Rec.*, cosmop.—FIG. 543, 8. **G. naparimaensis*, Mio., W.Indies (Trinidad); 8*a-c*, opposite sides and edge view of holotype, with primary umbilical aperture visible on penultimate chamber through thin-walled modified last chamber which has 2 supplementary apertures,

×163 (*164).—FIG. 543,9. *G. parkerae* LOEB-
LICH & TAPPAN, Rec., Gulf Mex.; 9a,b, umbilical
and edge of holotype, ×140 (*1170).

[*Turborotalita* was based on species with the umbilical-
extraumbilical aperture covered by a bulla that "may take
the apparent form of a modified final chamber, which
spreads ventrally partially or wholly to conceal the ventral

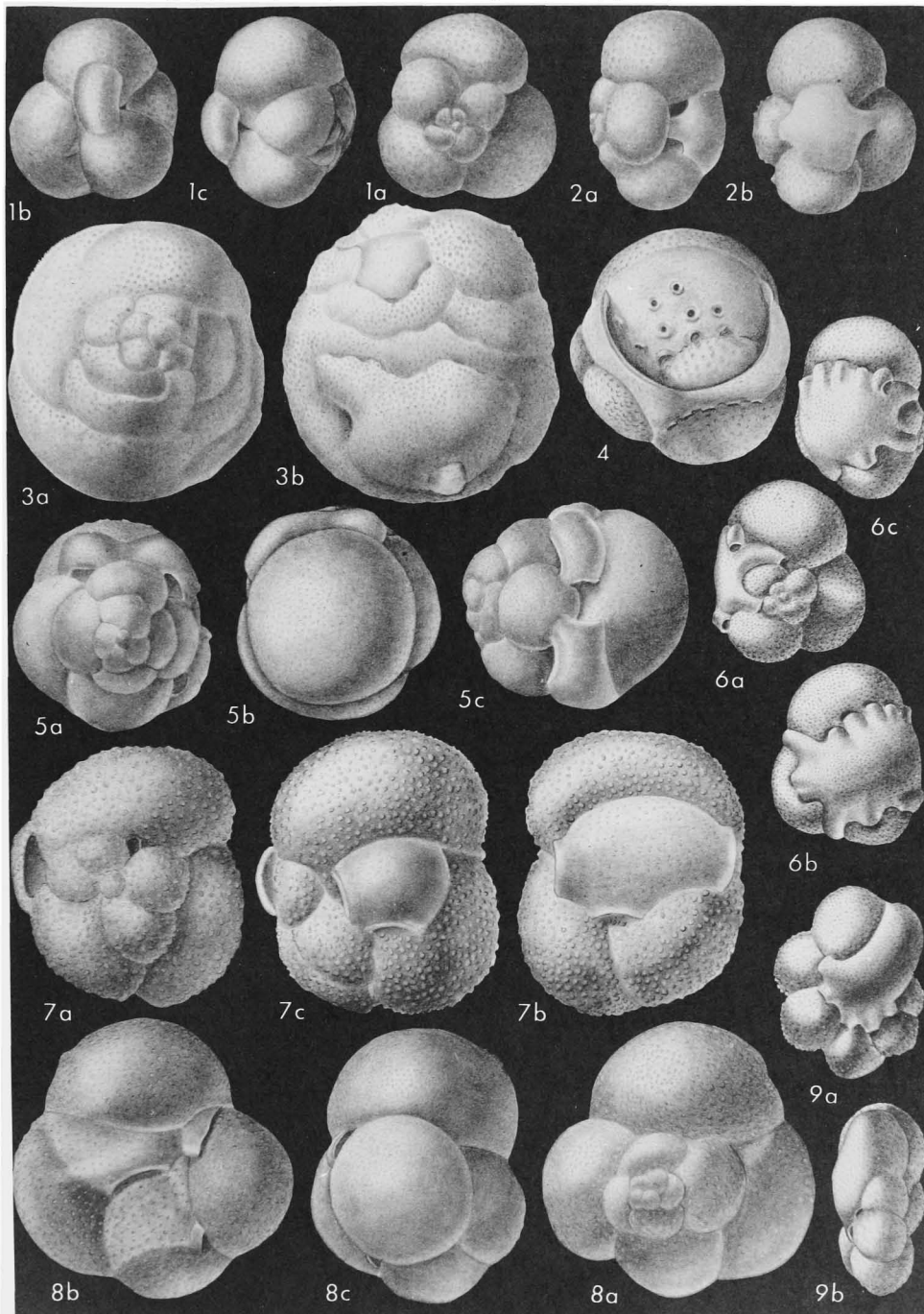


FIG. 543. Globigerinidae (Catapsydracinae; 1,2, *Catapsydrax*; 3,4, *Globigerinatella*; 5, *Globigerinatheka*; 6, *Tinophodella*; 7, *Globigerinoita*; 8,9, *Globigerinita*) (p. C676-C678).

umbilicus." *Globigerinita parkerae* was also included in this genus by BLOW & BANNER. As can be seen in the illustration of the holotype of *G. naparimaensis* given here (Fig. 543.8), the primary aperture is extraumbilical and covered by a modified final chamber. Specimens included by various authors in *Globigerinita*, but which have true bullae rather than such a modified final chamber, are correctly referred to *Tinophodella*.]

Globigerinita BRÖNNIMANN, 1952, *226, p. 26 [**G. morugaensis*; OD]. Test free, trochospiral; primary aperture umbilical in position, as in *Globigerina*, with one or more secondary sutural apertures on spiral side, as in *Globigerinoides*, with primary aperture covered by umbilical bulla, secondary apertures of spiral side may be covered by sutural bullae, with commonly 2 or 3 accessory infralaminal apertures at margins of each bulla. *U.Mio.*, W.Indies(Trinidad).—FIG. 543.7. **G. morugaensis*; 7a-c, opposite sides and edge view of holotype, $\times 130$ (*164).

Tinophodella LOEBLICH & TAPPAN, 1957, *1170, p. 113 [**T. ambitacrena*; OD]. Test free, trochospiral, similar to *Globigerina*; primary aperture interiomarginal, umbilical, but in adult completely covered by irregular umbilical bulla expanding along earlier sutures, numerous accessory apertures along bulla margins at junction with sutures of earlier chambers and along contact with primary chambers. [Differs from *Globigerinita* in having a distinct umbilical bulla with numerous small accessory apertures opening beneath its margin, whereas *Globigerinita* has a modified final chamber with supplementary apertures.] *Mio.-Rec.*, Atl. O.-Carib.-Eu.—FIG. 543.6. **T. ambitacrena*, Rec., Atl.; 6a-c, opposite sides and edge of holotype showing distinct umbilical bulla with marginal accessory apertures, $\times 73$ (*1170).

Superfamily ORBITOIDACEA

Schwager, 1876

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 310 (*pro* superfamily Orbitoidaceae BRÖNNIMANN, 1958, p. 167)]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹superfamily, ²family group, ³group); dagger(†) indicates *partim*]—[=²Fenestrifera GRAY, 1858, p. 270; =¹Orthoklinostegia EIMER & FICKERT, 1899, p. 685 (*nom. nud.*); =²Flexostyliidae RUMBLER in KÜENTHAL & KRUMBACH, 1923, p. 87; =¹Bilamellidae REISS, 1957, p. 127 (*nom. nud.*); =¹Discocyclinidea PURI, 1957, p. 139]

Test basically coiled, with radially laminated calcite walls, primarily formed double septa, walls of 2 layers, outer lamella covering all previously deposited parts of test as well as forming new chamber, inner lining confined to each chamber and wedging out at margins, present on distal face of chamber interior, on its roof and lateral walls. *Cret.-Rec.*

Family EPONIDIDAE Hofker, 1951

[*nom. correct.* THALMANN, 1952, p. 984 (*pro* Eponidae HOFKER, 1951, p. 321)]—[Superscript numbers indicate taxonomic rank assigned by authors (¹family, ²subfamily; dagger(†) indicates *partim*] [=¹Radiolidae CROUCH, 1827, p. 41 (*nom. nud.*); =¹Radiolidae† BRODERIP, 1839, p. 321;

=¹Cyclospiridae EIMER & FICKERT, 1899, p. 702 (*pro* Cyclospira EIMER & FICKERT, 1899, *non* HALL & CLARKE, 1894); =²Pulvinulininae SCHUBERT, 1921, p. 152; =¹Pulvinulinidae HOFKER, 1951, p. 448; =²Eponidinae SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 269]

Test free, low trochospiral coil or may be uncoiled; aperture basal or areal, single or multiple, and may be covered by plate or spongy material. *Paleoc.-Rec.*

Eponides DE MONTFORT, 1808, *1305, p. 127 [**Nautilus repandus* FICHTEL & MOLL, 1798, *716, p. 35; OD] [=*Pulvinulus* LAMARCK, 1816, *1089, p. 14 (obj.); *Placentula* LAMARCK, 1822, *1090, p. 620 (type, *P. pulvinata*, =*Nautilus repandus* FICHTEL & MOLL, 1798) (*non* *Placentulae* SOLDANI, 1795, *1810, p. 237, pl. 161a-d); *Pulvinulina* PARKER & JONES in CARPENTER, PARKER, & JONES, 1862, *281, p. 200, 210 (obj.); *Eponidopsis* REISS, 1960, *1533, p. 16 (type, *Eponides lornensis* FINLAY, 1939, *717a, p. 522)]. Test free, trochospiral, biconvex, periphery angled to distinctly carinate with narrow to broad depression in umbilical region (pseudoumbilicus), septa double, with intraseptal passages, sutures curved on spiral side, nearly radial to curved or sigmoid on umbilical side; wall calcareous, finely perforate, radial in structure, bilamellar, with septa primarily doubled, surface may have secondarily formed pustules or ridges formed on previous whorl below aperture; primary aperture an interiomarginal arch without internal tooth plate, intercameral foramen may be restricted and partly areal in position. *Eoc.-Rec.*, cosmop.—FIG. 544.1. **E. repandus* (FICHTEL & MOLL), Rec., Italy(Gulf Naples); 1a-c, opposite sides and edge view of neotype, $\times 39$ (*1186).

[The validity of *Eponides* has recently been questioned because of poor original figures and illustrations and later erroneous references to it of dissimilar forms. For greater stability in nomenclature, a neotype was selected for *Nautilus repandus* from the type area (LOEBLICH & TAPPAN, 1962, *1186, p. 35, 36) and is here illustrated. The recently proposed *Eponidopsis* is a junior synonym of *Eponides*, *Pulvinulus*, *Placentula*, and *Pulvinulina*, and all of the last 3 would have priority over *Eponidopsis* if *Eponides* were suppressed as a *nomen dubium*, as suggested by REISS (1960, *1533). Selection of a neotype places the genus *Eponides* on a firm basis, however.]

Cibicorbis HADLEY, 1934, *846, p. 26 [**C. herricki*; OD] [=*Sakhiella* HAQUE, 1956, *876, p. 155 (type, *S. nammalensis*)]. Test trochospiral, periphery angled and carinate, biconvex to planoconvex, spiral side evolute and flattened, umbilical side elevated and involute, later chambers tending to become inflated; chambers broad, low, arched, increasing more rapidly in breadth than in height, resulting in somewhat flaring outline; sutures curved, distinct, thickened and elevated; wall calcareous, coarsely perforate, radial in structure, viz., in *C. nammalensis* (HAQUE), unknown in *C. herricki*, lamellar character not described; aperture an interiomarginal slit on umbilical side, extending from near umbilicus to periphery and covered by large apertural flap which projects over umbilical region. *Paleoc.-Oligo.*, Carib.(Cuba)-

Asia(Pak.).—FIG. 544,2. **C. herricki*, Oligo., Cuba; 2a-c, opposite sides and edge view of paratype, $\times 60$ (*2117).—FIG. 544,3. *C. nammalensis*

(HAQUE), Paleoc., Pak.; 3a-c, opposite sides and edge view of holotype, $\times 23$ (*876).

Cincoriola HAQUE, 1958, *877, p. 103 [pro *Punjabia*

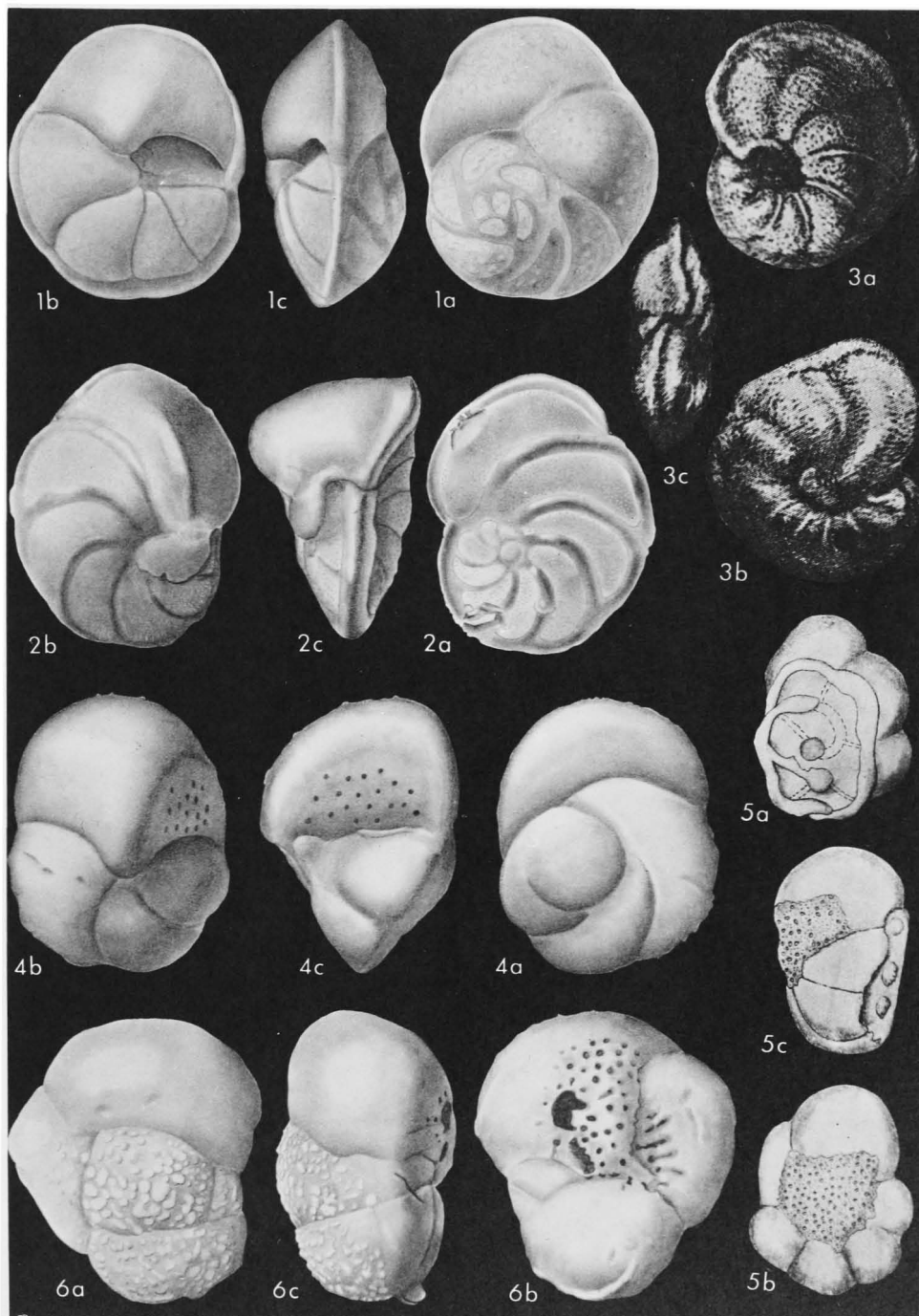


FIG. 544. Eponididae; 1, *Eponides*; 2,3, *Cibicorbis*; 4, *Cribrogloborotalia*; 5, *Cincoriola*; 6, *Hofkerina* (p. C678-C680).



FIG. 545. Eponididae; 1,2, *Hofkerina* (p. C680).

HAQUE, 1956, *876, p. 152 (obj.) (*non* EAMES, 1952)) [*Punjabia ovoidea* HAQUE, 1956, *876, p. 153; OD]. Test trochospiral, spiral side truncate, flattened, evolute, opposite side umbilicate, involute, umbilical region covered with a perforate plate; wall calcareous, radially built, lamellar character unknown; aperture an interiomarginal slit near umbilicus or consisting of perforations in umbilical plate. *Paleoc.*, Asia (Pak.).—FIG. 544, 5. **C. ovoidea* (HAQUE); 5a-c, opposite sides and edge of holotype, $\times 36$ (*876).

Cribrogloborotalia CUSHMAN & BERNÍDEZ, 1936, *490, p. 63 [*C. marielina*; OD]. Test free, trochospiral, plano-convex, with flattened spiral side and elevated umbilical side, margin of apertural face sharply angled, resulting in subconical chambers; wall calcareous, finely perforate, wall structure and lamellar structure unknown; aperture consisting of numerous rounded areal pores scattered over sharply defined apertural face. *Eoc.*, Carib. (Cuba)-USA (Fla.).—FIG. 544, 7. **C. marielina*, Cuba; 7a-c, opposite sides and edge view of holotype, $\times 36$ (*2117).

[Similar to *Eponides* in the sharply angled apertural face, differing in presence of the areal aperture and absence of an interiomarginal one. It differs from *Poroeponides* in

the sharply angled apertural face, absence of an interiomarginal aperture, in the elevated, rather than depressed, umbilical side, and the closed umbilical area. It is not considered to be related to the planktonic *Globorotalia*.]

Hofkerina CHAPMAN & PARR, 1931, *324, p. 237 [*Pulvinulina semiornata* HOWCHIN, 1889, *966, p. 14; OD]. Test free, large, to 2.2 mm. diam., trochospirally coiled, chambers few and inflated, periphery broadly rounded, noncarinate, spiral side with "pillars" in wall, umbilical side inflated, may have slight umbilical depression; wall calcareous, finely perforate, radial in structure, thick and laminated, bilamellar, surface of spiral side ornamented with numerous irregular pustules; primary aperture a small, arched opening, interiomarginal and umbilical in position, additional areal openings and sutural pores occur in umbilical depression of final chamber, and primary opening may not be present in large specimens, openings from umbilical area into chambers of last whorl may form by resorption. [Originally assigned to the Victoriellidae, *Hofkerina* was placed in the Pegidiidae by GALLOWAY (*762) and definitely excluded from the Victoriellidae by GLAESSNER & WADE (*797) because of the finely perforate wall and absence of axial spaces when seen in vertical section. It is here placed in the Eponididae, and considered closely related to *Sestronophora*, from which it differs in lacking a peripheral keel, in having a thick wall, and in the presence of "pillars."] *Mio.*, Australia (Vict.).—FIG. 544, 6; 545, 1, 2. **H. semiornata* (HOWCHIN); 544, 6a-c, opposite sides and edge view, $\times 21$ (*2117); 545, 1, horiz. sec. of paratype showing thick, bilamellar wall; 2, axial sec., arrow showing position of intercameral foramen, $\times 48$ (*797).

Neocribrella CUSHMAN, 1928, *436, p. 6 [*Discorbina globigerinoides* PARKER & JONES, 1865, *1418, p. 385, 421; OD]. Test free, trochospiral, umbilicus closed, chambers few, inflated, subglobular, rapidly enlarging; wall calcareous, perforate, radial in structure, lamellar character not known; umbilical region covered by platelike area with numerous large pores serving as an aperture. [A lectotype, here designated, was isolated by us from the original material of PARKER & JONES. The lectotype (BMNH-P41661) and paratypes (P41660) are from the Middle Eocene (Lutetian) of Grignon, France.] *M.Eoc. (Lutet.)*, Eu.—FIG. 546, 1. **N. globigerinoides* (PARKER & JONES), Fr.; 1a-c, opposite sides and edge view of topotype, $\times 78$ (*2117).

Neoeponides REISS, 1960, *1533, p. 17 [*Rotalina schreibersii* D'ORBIGNY, 1846, *1395, p. 154; OD] [= *Cyclospira* EIMER & FICKERT, 1899, *692, p. 702 (obj.) (*non* HALL & CLARKE, 1894)]. Test free, trochospiral, plano-convex to inequally bi-convex, periphery angled and carinate; sutures thickened, oblique and curved on elevated spiral side, radial on umbilicate opposite side, depressed and thickened near umbilical margin, septa pri-

marily double (bilamellar) with intraseptal passages; wall calcareous, coarsely perforate, radial in structure, secondary thickening of septa near

umbilical margin may form an elevated ring; primary aperture an interiomarginal arch extending from periphery to umbilicus, bordered by im-

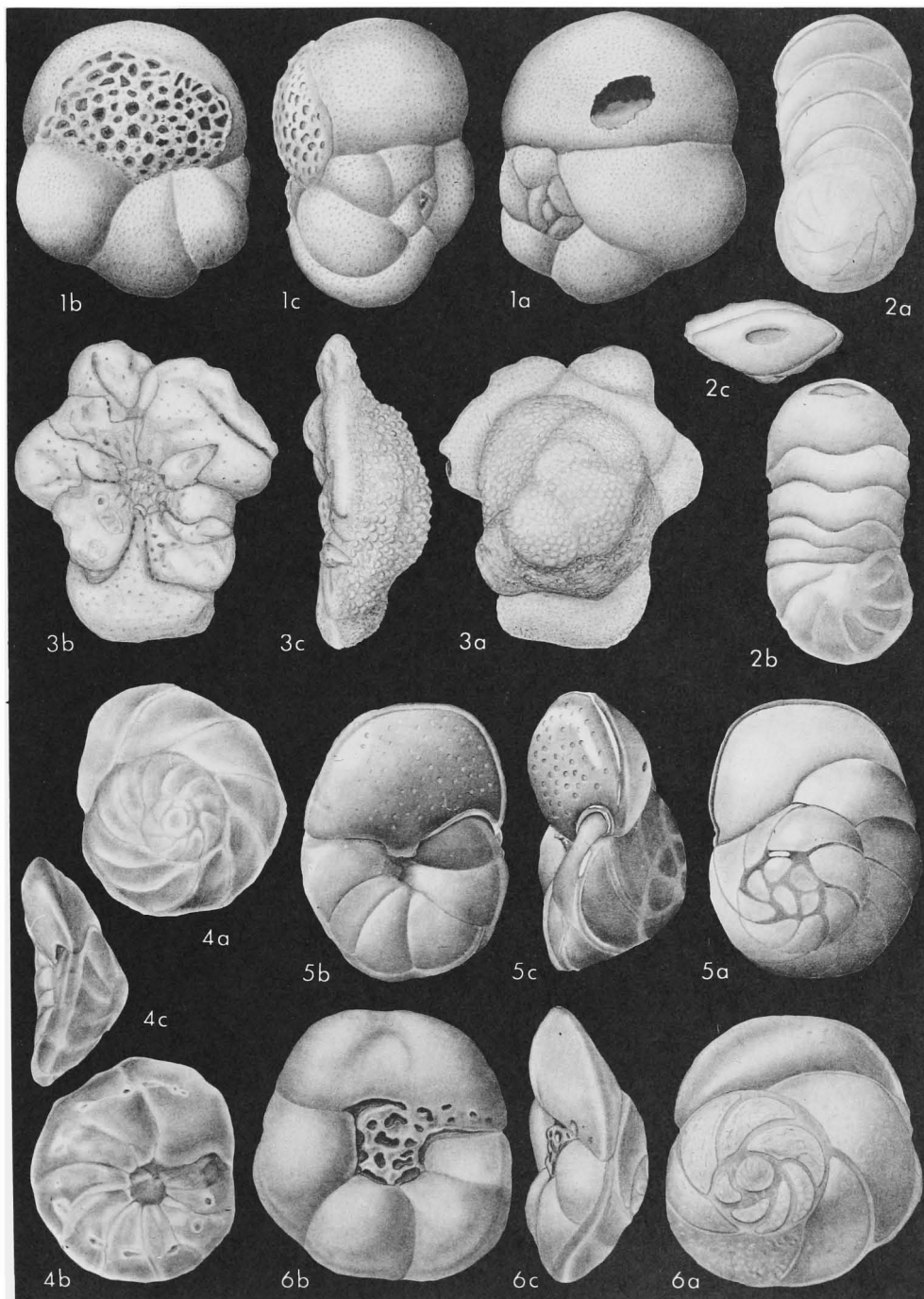
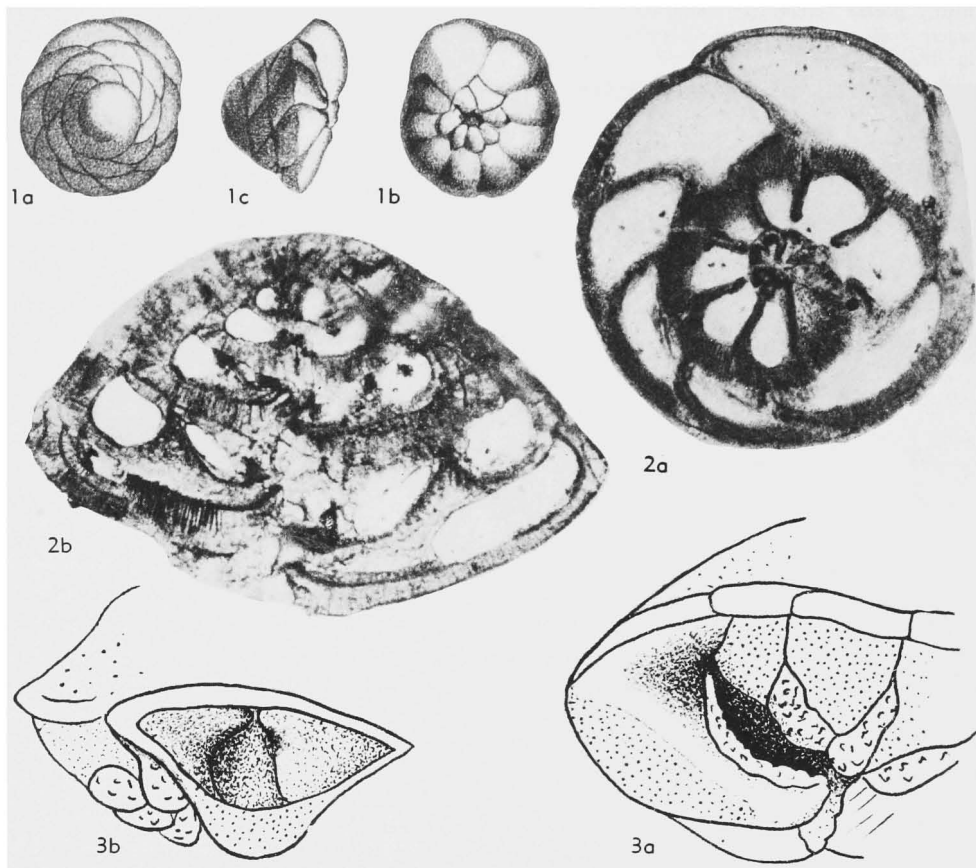


FIG. 546. Eponididae; 1, *Neocribrella*; 2, *Rectoeponides*; 3, *Planopulvinulina*; 4, *Paumotua*; 5, *Poroeponides*; 6, *Sestronophora* (p. C680, C682-C684).

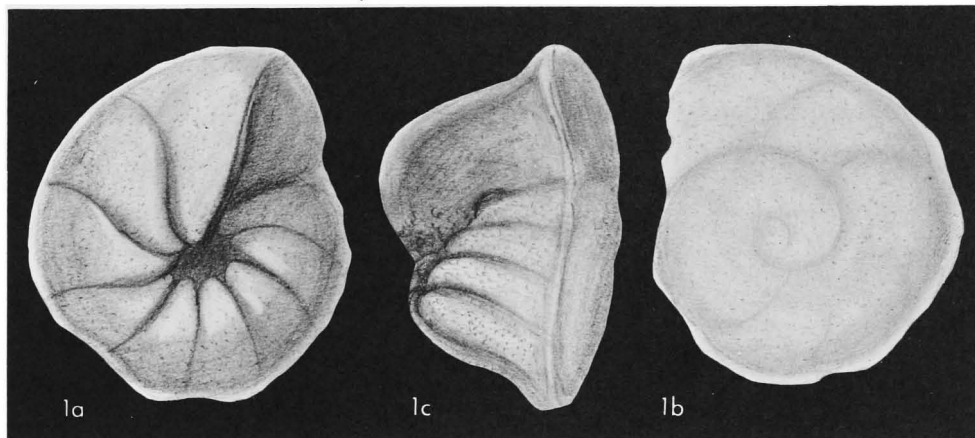
FIG. 547. Eponididae; 1-3, *Neoeponides* (p. C680-C682).

perforate lip which may be pustulose or granular. [*Neoeponides* was described as a new genus by REISS but was preoccupied by the isogenotypic *Cyclospira* EIMER & FICKERT, 1899, which is a homonym of *Cyclospira* HALL & CLARKE, 1894.] *Paleoc. - Rec.*, Eu.-Asia (Israel)-Afr.-Pac. O.-Medit. Sea.-Red Sea-Atl.O.—FIG. 547, 1-3. **N. schreibersii* (D'ORBIGNY), Mio., Aus. (1), Israel (2a), Morocco (2b); 1a-c, opposite sides and edge view of holotype, $\times 17$ (*700); 2a, equat. sec. showing sulcus at inner edge of septa, $\times 55$; 2b, axial sec. with recurved edge of septa resulting in appearance of tooth plate, $\times 70$; 3a, apert. view, $\times 180$; 3b, chamber interior with recurved inner edge (inframarginal sulcus), $\times 180$ (*1533).

Paumotua LOEBLICH, 1952, *1151, p. 192 [*Eponides terebra* CUSHMAN, 1933, *460, p. 89; OD]. Test free, trochoid, plano-convex, umbilical side flattened and umbilicate, spiral side convex, chambers numerous; wall calcareous hyaline; aperture a low interiomarginal arch between periphery and umbilicus, supplementary apertures in row paral-

leling periphery and in line with main aperture on umbilical side, consisting of one or more open pores or slits which increase in size and number as chambers increase in size. [Differs from *Eponides* in possessing supplementary apertures on the umbilical side and from *Poroeponides* in having fewer pores per chamber and in having these on earlier chambers rather than restricted to the final chamber.] *Rec.*, Pac.O.—FIG. 546, 4. **P. terebra* (CUSHMAN), Paumotu Is.; 4a-c, opposite sides and edge view of holotype, $\times 36$ (*1151).

Planopulvinulina SCHUBERT, 1921, *1694, p. 153 [*Pulvinulina dispansa* BRADY, 1884, *200, p. 687; SD CUSHMAN, 1928, *439, p. 273]. Test attached, large, plano-convex, early chambers in irregular trochoid spire, later chambers more irregularly arranged, variable in size and outline, and spreading over attachment; spiral side strongly tuberculate, with numerous fine pores filling area between tubercles, early chambers with coarser and more closely spaced tubercles, peripheral and more spreading chambers having smaller and more

FIG. 548. Eponididae; 1, *Pseudogloborotalia* (p. C683).

widely spaced tubercles and more numerous pores between them, umbilical surface flattened, rather smooth, outer margin of chambers with numerous fine pores like those of spiral surface; wall calcareous, hyaline, wall microstructure not known; aperture consisting of widely spaced large pores scattered over surface and in sutural rows on umbilical side. [The lectotype, here designated (BMNH-ZF3641, ex ZF2210) is one of the original syntypes of BRADY but not that originally figured, which, although larger, is incomplete. The remaining paratypes are BMNH-ZF2210.] *Late Tert.-Rec.*, Atl.O.—FIG. 546.3. **P. dispansa* (BRADY), Rec., off coast of Madeira Is.; 3a-c, opposite sides and edge view of lectotype, $\times 12$ (*2117).

Poroeponides CUSHMAN, 1944, *478, p. 34 [*Rosalina lateralis* TERQUEM, 1878, *1889, p. 25; OD]. Test free, trochospiral, plano-convex to biconvex, periphery angled and carinate, umbilical region excavated; chambers numerous, sutures oblique and curved on spiral side, radial on umbilical side; wall calcareous, perforate; primary aperture an interiomarginal arch extending from umbilicus to peripheral keel, with narrow bordering lip, small umbilical flap projects from mid-point of chamber into umbilical area, in addition rounded areal pores are scattered over face of final chamber on umbilical side, and some of those of earlier chambers may also remain open. [Differs from *Eponides* in having an areal multiple aperture and in the last chamber having a broad, flattened umbilical side, without the sharply defined apertural face defined by a distinct angle in the final chamber, as in *Eponides*. The umbilical region is depressed (pseudoumbilicus) in *Poroeponides*.] *Plio.-Rec.*, Medit. Sea.-Is. Rhodes-Atl.O.-Pac.O.—FIG. 546.5. **P. lateralis* (TERQUEM), Rec., USA (R.I.); 5a-c, opposite sides and edge view, $\times 44$ (*2117).

Pseudogloborotalia HAQUE, 1956, *876, p. 184 [**P. ranikotensis*; OD]. Test trochospiral, plano-convex,

periphery angular to keeled, spiral side flat, with sutures obscure, but oblique and curved, umbilical side strongly elevated, with incised straight and radial sutures; wall calcareous, perforate, radial in microstructure, surface smooth and unornamented; aperture a low interiomarginal arch, between periphery and umbilical shoulder. *Paleoc.*, Asia (Pak.).—FIG. 548.1. **P. ranikotensis*; 1a-c, opposite sides and edge view of topotype, $\times 72$ (*2117).

[Originally regarded as related to *Globorotalia*, this genus is here transferred to the Eponididae, as it does not appear to be a planktonic form. It is similar in general appearance to *Globorotalites* but differs in having a radially built wall. *Planulina membranacea* EHRENBERG, included in *Pseudogloborotalia* by HAQUE (1956, *876), had been selected as type-species of *Planorotalia* MOROZOVA, 1957, which on the basis of restudied topotypes is here regarded as synonymous with *Globorotalia*.]

Rectoeponides CUSHMAN & BERMÚDEZ, 1936, *489, p. 31 [**R. cubensis*; OD]. Test in early stage trochospiral, carinate, later uniserial, rectilinear and compressed; wall calcareous, finely perforate, microstructure unknown; aperture in adult terminal, an elongate slit slightly to one side of final chamber, on umbilical side of test. *Paleoc.-U.Eoc.*, Carib.(Cuba)-Eu.—FIG. 546.2. **R. cubensis*, U. Eoc., Cuba; 2a-c, opposite sides and apert. view, $\times 44$ (*2117).

Sestronophora LOEBLICH & TAPPAN, 1957, *1172, p. 229 [**S. arnoldi*; OD] [= *Sestranophora* RESIG, 1962, *1536, p. 55 (*nom. null.*)]. Test free, large, to 2 mm. diam., trochospiral, nearly plano-convex, periphery acute, carinate, spiral side strongly convex, with chambers of greater breadth than height, somewhat oblique and overlapping at periphery, opposite side flat, with broad umbilicus covered by series of plates arising from umbilical margin of each chamber and pierced by numerous very large openings which open into umbilical area beneath and which also connect laterally beneath plate into various chamber cavities; sutures distinct, somewhat thickened, gently curved and inclined back along periphery, depressed on spiral

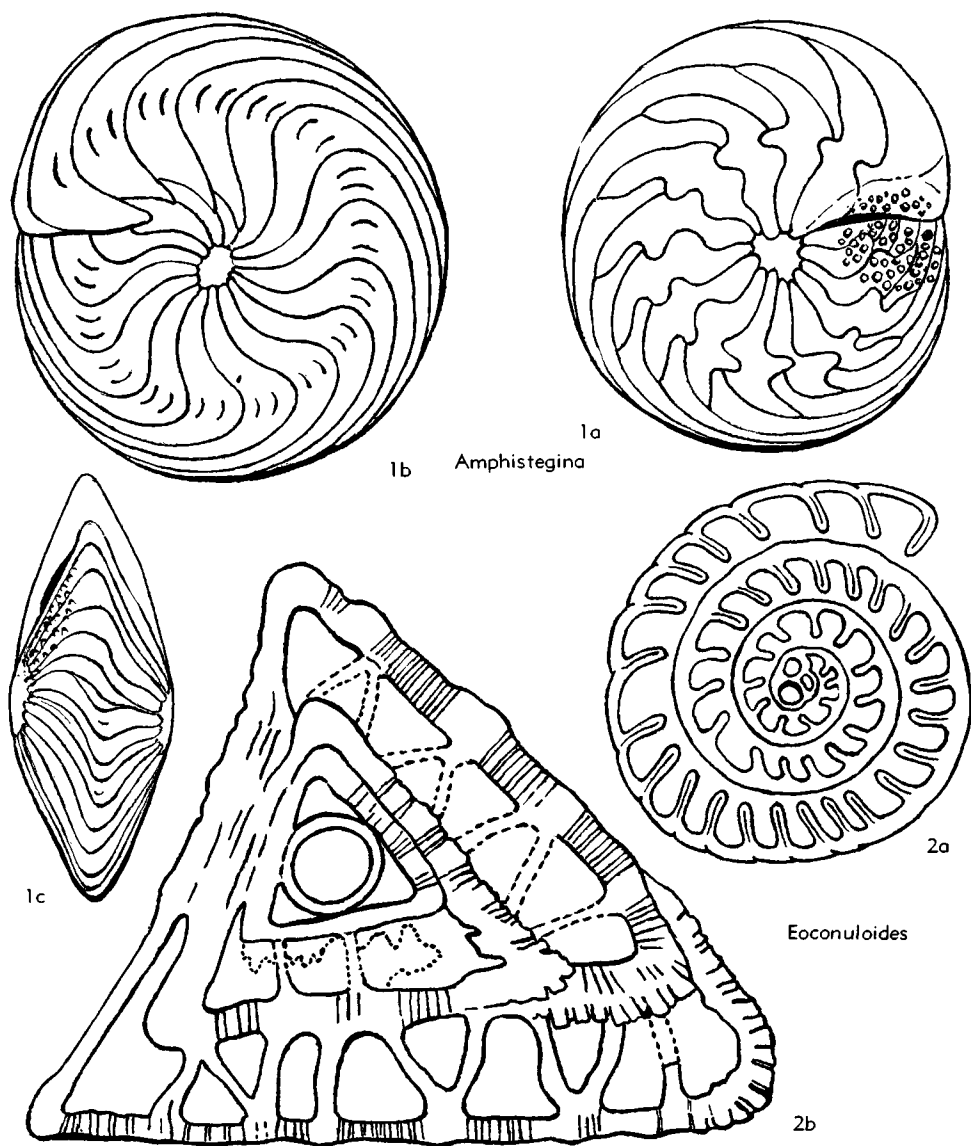


FIG. 549. Amphisteginidae; 1, *Amphistegina*; 2, *Eoconuloides* (p. C685).

side, nearly radial and more strongly depressed on umbilical side; wall calcareous, finely perforate, surface smooth; aperture a low slitlike interior-marginal opening on umbilical side, with few small accessory pores in ventral face of final chamber. *Plio.-Pleist.*, N.Am.(USA)-Eu.(Eng.).—FIG. 546,6. **S. arnoldi*, *Pleist.*, USA(Calif.); 6a-c, opposite sides and edge view of holotype, $\times 21$ (*1172).

[Differs from *Eponides* in having umbilical perforated covering plates and supplementary areal openings on the umbilical side of the final chamber. It is similar to *Poroeponides* in having a few areal openings, but differs in possessing complex perforated umbilical plates. The type-species shows an ontogenetic development through *Eponides*- and *Poroeponides*-like juvenile stages, as illustrated by RESIG (1962, *1536). Such "biformed" ontogenetic stages are characteristic of many foraminiferal genera, but adult stages must be used in classification, and as the type-species of *Eponides* and *Poroeponides* do not have a *Seurionophora*-like adult, the three genera are regarded as distinct.]

AMPHISTEGINIDAE

By R. W. BARKER

[Shell Development Company, Houston, Texas]

Family AMPHISTEGINIDAE Cushman, 1927

[Amphisteginidae CUSHMAN, 1927, p. 79] [=Family Enthomostegues D'ORBIGNY, 1826, p. 304 (*partim*) (*nom. nud.*, *nom. neg.*); =family Helicotrochina EHRENBURG, 1839, opp. p. 120 (*partim*) (*nom. nud.*); =Amphistegininae CHAPMAN & PARR, 1936, p. 144]

Test free, calcareous, trochoid to asymmetrically lenticular; multichambered, chambers arranged in complex spiral, which (in some genera) splits up into chamberlets on ventral side or extends into peripheral flange; surface smooth, granulate or papillate; aperture consisting of narrow slit at inner margin of last chamber, usually with thin lip and generally surrounded by granulate area; no canal system (*431). [Warm, shallow water.] ?*Cret.*, *Eoc.-Rec.*

Amphistegina D'ORBIGNY, 1826, *1391, p. 304 [*A. vulgaris*; SD PARKER, JONES & BRADY, 1865, *1419, p. 36] [=*Omphalophacus* EHRENBURG, 1840, *667, opp. p. 120 (type, *O. hemprichii*)]. Lenticular, generally unequally biconvex, with low turbinoid spire; multichambered, chambers equitant, with alar prolongations as in *Nummulites*; dorsal septa simple, radiate, falciform, and may undulate near umbo; ventral septa divided by deep, commonly imbricate constrictions forming secondary lobes that have appearance of secondary chamberlets in rosette around umbo; walls thick, laminated, and traversed by pores (*223, *1391, *1419). ?*U.Cret.*, *Eoc.-Rec.*, cosmop.—FIG. 549, 1. *A. gibbosa* D'ORBIGNY, *Rec.*, W.Indies; 1a-c, ext. views, $\times 30$ (*2110).

Boreloides COLE & BERNÚDEZ, 1947, *371, p. 197 [*B. cubensis*; OD]. Structurally similar to *Eoconuloides* but test subspherical to fusiform, with thick spiral wall resembling basal layer of alveolinellids but vitreocalcareous and perforate; apertural characters unknown (*371, *1519). [Originally placed in Alveolinellidae; transfer to Amphisteginidae suggested by REICHEL.] *M.Eoc.*, Carib.(Cuba).—FIG. 550, 1. *B. cubensis*; 1a,b, transv. and axial secs., $\times 40$ (*371).

Eoconuloides COLE & BERNÚDEZ, 1944, *370, p. 340 [*E. wellsi*; OD]. Test conical, spiral, involute, final chambers subdivided on conical peripheral face into small chamberlets; embryonic apparatus bilocular, consisting of subspherical initial chamber and smaller second chamber; spiral wall thick initially, with irregularly developed pillars, but thinner in final stage and with less prominent pillars (*370). [*Eoconuloides* is readily distinguished from other amphisteginids by its conical form. Probably it developed from *Helicostegina* by axial elongation of the test.] *M.Eoc.*, Carib.(Cuba).—FIG. 549, 2. *E. wellsi*; 2a,b,

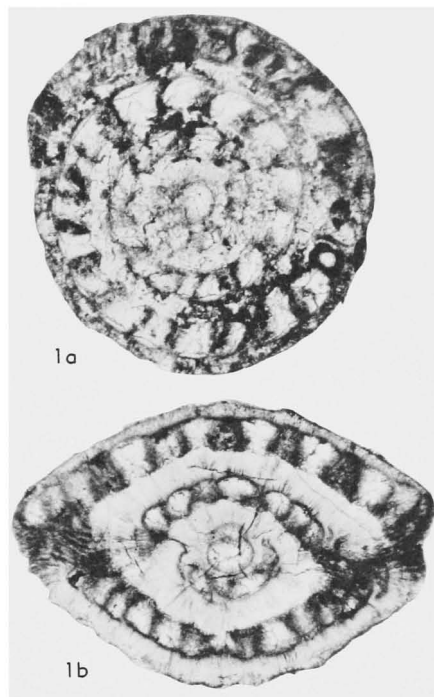


FIG. 550. Amphisteginidae; 1, *Boreloides* (p. C685).

transv. and axial secs. of topotype, $\times 62$, $\times 75$ (*2110).

Tremastegina BRÖNNIMANN, 1951, *222, p. 256 [*Amphistegina senni* CUSHMAN in VAUGHAN, 1945, *1995, p. 49; OD]. Similar to *Amphistegina*, differing in presence of parallel furrows and ridges on ventral surface near margin, absence of granulation near aperture and in form of apertures, which may consist of slidlike openings situated ventrally or ventromarginally in septa of dorsal chambers, with backward projecting lips (countersepta) or otherwise comprise circular pores in ventral chambers where septa cross parallel furrows, pores near periphery communicating between ventral and dorsal chambers (*222). [This genus probably constitutes a link between *Amphistegina* and *Helicostegina*.] *Eoc.*, W.Indies-C.Am.—FIG. 551, 1. *T. senni* (CUSHMAN). *M. Eoc.*, Barbados Is.; 1a,b, side and edge ext. views; 1c,d, transv. and axial secs.; all $\times 50$ (*222).

Family CIBICIDIDAE Cushman, 1927

[*nom. transl.* CHAPMAN, PARR & COLLINS, 1934, p. 556, 570 (ex subfamily Cibicidinae CUSHMAN, 1927)]—[dagger(+) indicates *partim*]—[=Turbinacea† and Turbinacea† de BLAINVILLE, 1825, p. 390 (*nom. nud.*); =Turbinoidae† D'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =Turbinoidae† REUSS, 1860, p. 151 (*nom. nud.*); =Cibicidae HOFER, 1951, p. 332 (*nom. van.*)]

Test free or attached, trochospiral to nearly planispiral, or later spreading, irregular or cyclical; wall coarsely perforate, radial

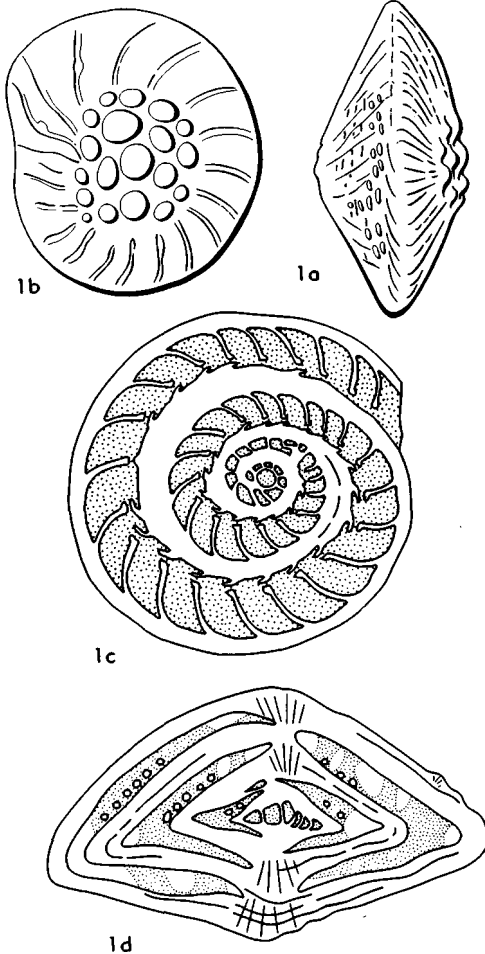


FIG. 551. Amphisteginidae; 1, *Tremastegina* (p. C685).

in structure, septa double (bilamellar); aperture interiomarginal, may extend onto spiral side, and peripheral supplementary apertures may occur. *Cret.-Rec.*

Subfamily PLANULININAE Bermúdez, 1952

[Planulininae BERMÚDEZ, 1952, p. 91]

Test free, trochospiral to nearly planispiral; aperture single. *U.Cret.-Rec.*

Planulina D'ORBIGNY, 1826, *1391, p. 280 [**P. ariminensis*; SD GALLOWAY & WISSLER, 1927, *766, p. 66]. Test discoidal, compressed, low trochospiral, spiral side evolute, umbilical side partially evolute, periphery truncate, with thick marginal imperforate keel; sutures strongly arched, thickened, nonperforate, septa double (bilamellar); wall calcareous, radial in structure, finely perforate but with scattered large pores in addition,

secondarily added lamellae covering umbilical region; aperture an equatorial, interiomarginal arch, with narrow bordering lip, extending somewhat onto less evolute umbilical side, beneath the flap-like chamber margin, both apertural lip and lip-like margin of umbilical flaps imperforate. *U. Cret.-Rec.*, cosmop.—FIG. 552,1; 553. **P. ariminensis*, Rec., Italy (552,1), Plio., Italy (553); 552,1a-c, opposite sides and edge view of topotype, $\times 46$ (*2117); 553, equat. sec. showing lamellar structure and bilamellar septa, $\times 80$ (*1531).

Cibicidina BANDY, 1949, *70, p. 91 [**C. walli*; OD]. Test free, trochoid, plano-convex, periphery acutely angled and keeled; all chambers partially visible on flattened to concave spiral side although coil is partially involute, only chambers of final whorl visible from convex, umbilicate opposite side; sutures slightly depressed; wall calcareous, finely perforate, surface unornamented; aperture a low interiomarginal arch, against peripheral margin of previous whorl and extending very slightly onto spiral side. [Differs from *Cibicides* in being partially involute on the spiral side and in being more finely perforate. It was originally placed in the Rotaliidae, and transferred to the Anomaliniidae by BERMÚDEZ (1952, *127, p. 88).] *Eoc.*, N.Am.—FIG. 552,4. **C. walli*, USA (Ala.); 4a-c, opposite sides and edge view of topotype, $\times 78$ (*2117).

Hyalinea HOFKER, 1951, *928c, p. 416, 508, 513 [**Nautilus balthicus* SCHRÖTER, 1783, *1677, p. 20; OD] [= *Hofkerinella* BERMÚDEZ, 1952, *127, p. 74 (nom. subst. errore pro *Hyalinea* HOFKER, 1951) (obj.)]. Test free, discoidal, slightly trochospiral to nearly planispiral, partially to nearly completely evolute on both sides, periphery angled, with broad imperforate keel; chambers numerous, about 10 to 12 in last of slowly enlarging whorls, thickened wall on all margins, including peripheral keel, septa, apertural face, and umbilical flaps at each side of chamber which form thickened ring of nodes along spiral suture; sutures slightly curved, thickened and elevated, nonperforate; wall calcareous, finely perforate, radial in structure, with septa and marginal keel nonperforate; aperture an equatorial interiomarginal arch with narrow bordering lip, and with low slits extending laterally beneath small umbilical chamber flaps along spiral suture on both sides of test, small rounded opening on each side beneath thickened umbilical flap communicating with chamber interior which remains open in earlier chambers until closed by lamellar thickening. *Pleist.-Rec.*, Eu.-Atl.O.-Pac.O.-Japan.—FIG. 552,2,3. **H. balthica* (SCHRÖTER), Rec., N.Sea; 2a-c, opposite sides and edge view showing nearly planispiral test with umbilical flaps and equatorial aperture; 3, optical sec. showing umbilical chamber openings; all $\times 72$ (*2117).

[*Hyalinea* is similar to *Planulina* in its flattened discoidal, partially evolute test, but differs in having lateral aper-

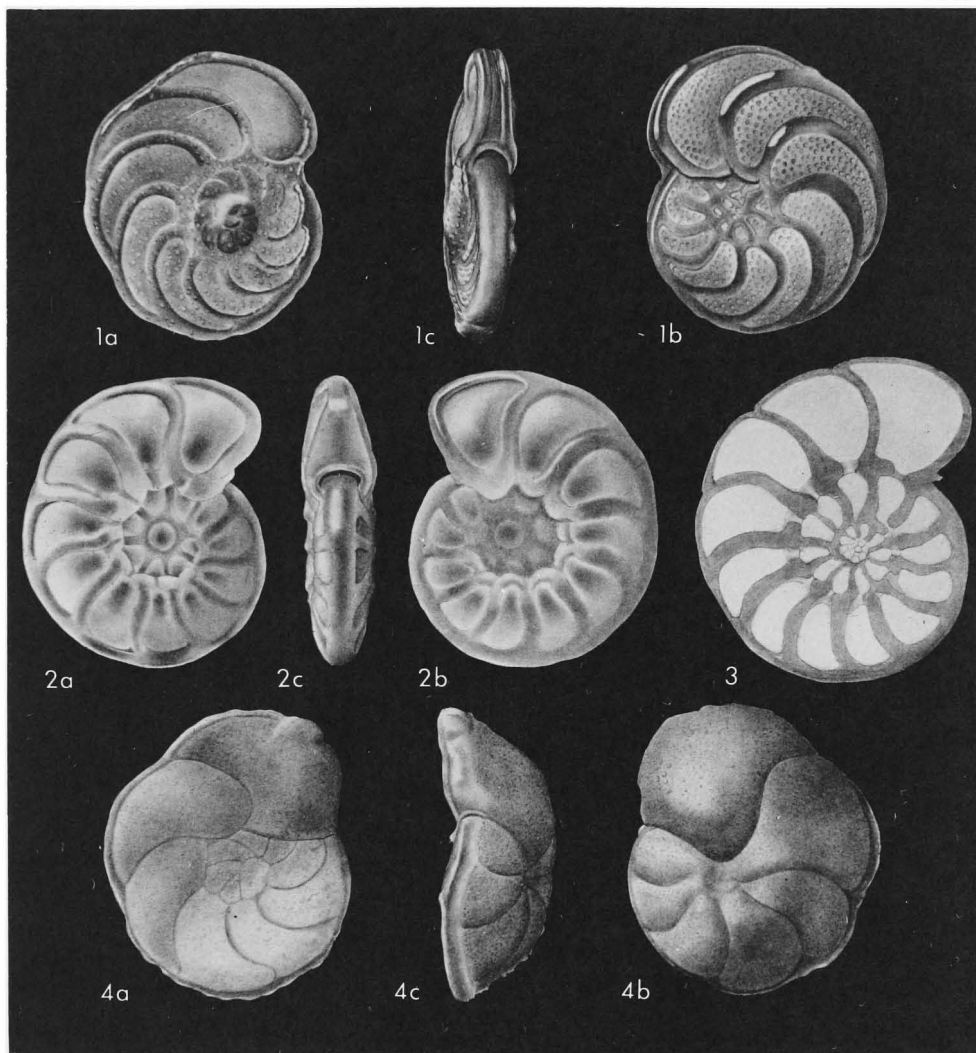


FIG. 552. Cibicididae (Planulininae; 1, *Planulina*; 2,3, *Hyalinae*; 4, *Cibicidina*) (p. C686-C687).

tural extensions along the spiral sutures on both sides. The openings beneath the umbilical flaps were regarded by HOFKER (*928c) as a primitive canal system, suggesting a relationship to *Rotalia*. They are here interpreted as supplementary apertures rather than a true canal system. Although regrettably similar in spelling to *Hyalina* AGASSIZ, 1837, and *Hyalina* SCHUMACHER, 1817 (non STUDER, 1820; nec ALBERS, 1850; nec JUNG, 1942), the difference in spelling of *Hyalina* HOFKER is not among those regarded as constituting homonymy by the *International Code of Zoological Nomenclature*; hence according to Art. 56, "Even if the difference between two genus-group names is due to only one letter, these two names are not to be considered homonyms." Thus the replacement name *Hofkerinella* was unnecessary and invalid; the name is a junior objective synonym.]

Subfamily CIBICIDINAE Cushman, 1927

[Cibicidinae CUSHMAN, 1927, p. 93] [=Truncatulinae SCHUBERT, 1921, p. 151; =Orbitorotalininae HOFKER, 1933, p. 125 (nom. nud.)]

Test attached by spiral side; primary aperture equatorial, may extend onto spiral side,

advanced forms may have multiple aperture. *Cret.-Rec.*

[NYHOLM (1961, *1380) has demonstrated a considerable variation in form of Recent *Cibicides lobatulus*. The so-called "monothalamous test resembling *Crithionina* or *Webbina*" described by NYHOLM is not a true test but an enclosure within which the young schizont develops. It is better referred to as a reproductive or growth cyst, similar to those reported in many other Recent foraminifers. Although attached forms obviously show great morphological variation, and some atypical specimens of *C. lobatulus* resemble "*Dyocibicides*, *Annulocibicides*, *Cyclocibicides*, *Stichocibicides*, or *Rectocibicides* according to the conditions of growth," random specimens may be found in many Recent and fossil species and genera which show characters of other genera. These may indicate a possible genetic relationship, but it will be necessary to restudy assemblages of each of the type-species of these other genera before they can be definitely regarded as synonymous. The supposed planorbulinoid stage reported by NYHOLM to be developed by *Cibicides* is somewhat doubtful, as it has been impossible to verify this in cultures. The mere association of planorbulinoid forms and *Cibicides* on the same ascidians is not definitive; since young forms found with planorbulinoid

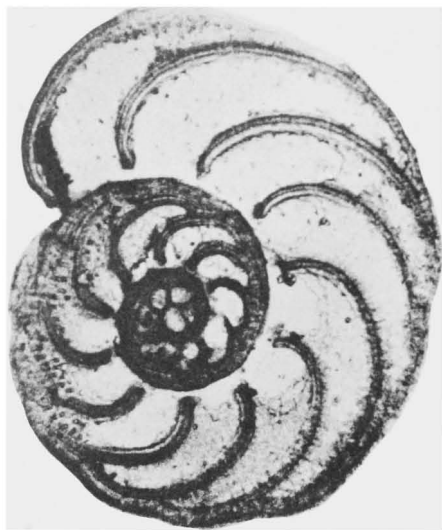


FIG. 553. Cibicididae (Planulininae; *Planulina*)
(p. C686).

adults invariably produced new planorbulinids, not young *Cibicides*, their assumed relationship to *Cibicides* seems doubtful. The detailed work on *Planorbulina mediterraneensis* by LE CALVEZ (*1106) followed its life cycle completely and showed a regular alternation of generations of planorbulinoid forms, but no relationship to *Cibicides*. The various genera here included in the Cibicidinae are tentatively placed together until further studies are made of the many assemblages; they are not regarded as having close affinities with the Planorbulinidae.]

Cibicides DE MONTFORT, 1808, *1305, p. 122 [**C. refulgens*; OD] [= *Storilus* DE MONTFORT, 1808, *1305, p. 130 (type, *S. radiatus*); *Polyxenes* DE MONTFORT, 1808, *1305, p. 138 (type, *P. cribratus*); *Cymbicides* COSTA, 1839, *390, p. 186 (nom. null.); *Truncatulina* D'ORBIGNY, 1826, *1391, p. 278 (obj.); *Lobatula* FLEMING, 1828, *722, p. 232 (type, *L. vulgaris*); *Soldanina* COSTA, 1856, *392, p. 246 (type, *S. exagona*); ?*Craterella* DONS, 1942, *609, p. 136 (type, *C. albescens*); (non *Craterella* SCHRAMMEN, 1901; nec KOFOID & CAMPBELL, 1929); ?*Crateriola* STRAND, 1943, *1844, p. 211 (type, *Craterella albescens* DONS, 1942, *609, p. 135)]. Test attached; plano-convex, trochospiral, spiral side flat to excavated, evolute, umbilical side strongly convex, involute, apertural face sharply angled, distinct from umbilical side, periphery angular, with nonporous keel; wall calcareous, radial in microstructure, bilamellar, coarsely perforate on spiral side, large pores of earlier chambers may be closed by lamellar thickening of wall, finely perforate on umbilical side, apertural face nonporous; aperture a low interior-marginal opening with narrow lip, may extend along spiral suture on spiral side. *Cret.-Rec.*, cosmop.—FIG. 554,1. **C. refulgens*, Rec., Atl.O.; 1a-c, opposite sides and edge view, $\times 61$ (*2117).

[NYHOLM (1961, *1380) showed the great variability in form of this attached genus, and described the agglutinated coniform reproductive cysts in which the young

schizonts developed. *Craterella* DONS, 1942, and the substitute name *Crateriola* STRAND, 1943, are based on small, attached, conical or hemispherical agglutinated specimens, about 0.15 to 0.85 mm. diam., with an opening at the apex, occurring on the underside of rocks in tide pools near Trondheim Fjord, Norway. These are identical to the reproductive cysts described by NYHOLM, 1961, for *Cibicides* from the same general area; hence, *Crateriola* is here regarded as a probable synonym, based on an ontogenetic stage of *Cibicides*. As noted in connection with the subfamily description, it seems premature to regard *Dyocibicides*, *Cyclocibicides*, and other genera as synonyms of *Cibicides*, as was suggested by NYHOLM, until assemblage studies can be made of the type-species of each of these nominal genera. *Planorbulina* and *Gypsina* were also regarded as probable growth forms of *Cibicides* by NYHOLM, but their relationship to *Cibicides* seems still unproved, since cultures of these forms could not be maintained to prove their relationship; the earlier studies of the type-species of *Planorbulina* by LE CALVEZ (*1106) followed its life cycle completely without observing a *Cibicides*-like stage. Wood (1949, *2073, p. 252) stated that *Cibicides refulgens* is granular in structure, but this was later corrected by Wood & HAYNES (1957, *2076, p. 46). Some species previously referred to *Cibicides* have been noted by Wood & HAYNES (*2076) and REISS (1959, *1531) to be granular, but these are referable to other genera. *Cibicides* is here restricted to coarsely perforate, plano-convex forms with radial microstructure of the wall.]

Annulocibicides CUSHMAN & PONTON, 1932, *520, p. 1 [**A. projectus*; OD]. Test similar to *Cyclocibicides* but lacking large sutural pores on spiral side, with all apertural openings peripheral and produced on slight necks. *Mio.*, USA (Fla.).—FIG. 554,2. **A. projectus*; 2a-c, opposite sides and edge view of holotype, $\times 37$ (*2117).

Caribbeanella BERMÚDEZ, 1952, *127, p. 121 [**C. polystoma*; OD] [= *Oinomikadoina* MATSUNAGA, 1954, *1236, p. 163 (type, *O. ogiensis*); *Pseudocibicidoides* UJÍÉ, 1956, *1963, p. 263 (type, *P. katasensis*)]. Test free, plano-convex to biconvex, trochospiral, all whorls visible on flattened spiral side, only final whorl visible on umbilical side, periphery may be angular in early stages but commonly rounded; chambers increasing gradually in size; sutures arched backward at periphery on spiral side, nearly radial on umbilical side, may be thickened and imperforate; wall calcareous, later chambers very coarsely perforate, radial in structure; primary aperture a low arch on periphery and extending somewhat onto umbilical side, bordered above by prominent nonperforate lip, smaller secondary apertures, which also have distinct lip, at basal backward margin of each chamber on periphery, and additional series of supplementary apertures on spiral side consisting of low arches near inner margin of the later chambers against previous whorl, these also bordered by slight lips, final chamber thus possessing 3 openings, with 2 remaining open on each previous chamber of final whorl. *Plio.-Rec.*, Carib.-Atl.O.-Japan.—FIG. 555,1. *C. katasensis* (UJÍÉ), Rec., Japan; 1a-c, opposite sides and edge view of holotype showing equatorial and umbilical openings, $\times 58$ (*1963).—FIG. 555,2. **C. polystoma*, Rec., Atl.; 2a-c, opposite sides and edge view of topotype, $\times 111$ (*2117).—FIG. 555,3,4. *C. ogiensis* (MATSUNAGA), Plio., Japan; 3a-c, opposite sides and edge view of topotype; 4, spiral side of larger specimen showing 3 apert. openings in final chamber, $\times 57$ (*2117).

[The original description of *Caribeanelle* made no mention of secondary spiral apertures at the inner margin of the later chambers. These are less prominent in *C. poly-stoma* than in Recent specimens of *Oinomiakadoina ogien-*

sis. As the two type-species are similar in all characters, *Oinomiakadoina* is a junior synonym of *Caribeanelle*. The original description of *Caribeanelle* (*127) further stated that the peripheral apertures corresponded to earlier pri-

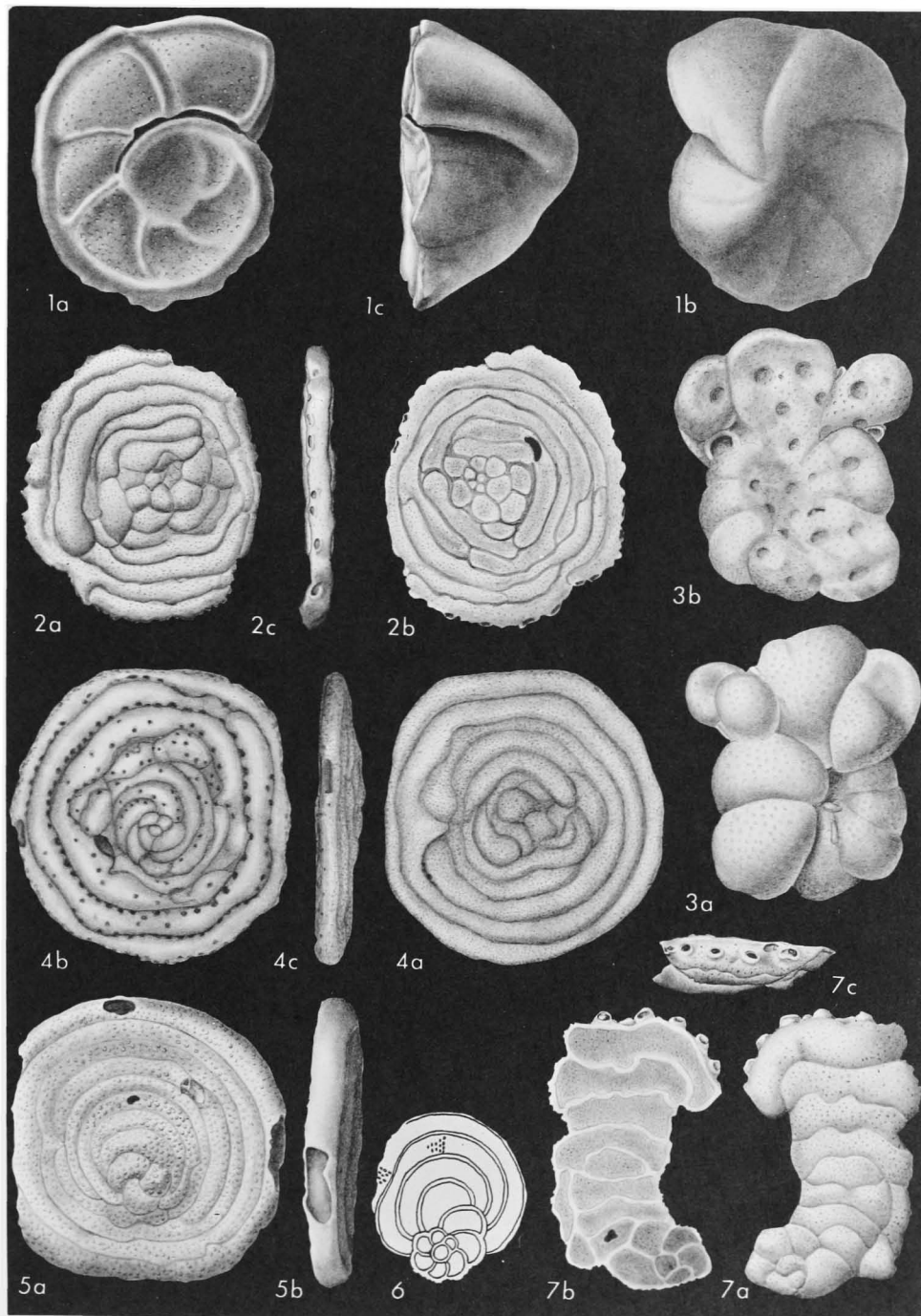


FIG. 554. Cibicididae (Cibicidinae; 1, *Cibicides*; 2, *Annulocibicides*; 3, *Cibicidella*; 4, *Cyclolobocibicides*; 5, 6, *Cycloloboculina*; 7, *Rectocibicides*) (p. C688, C690, C692).

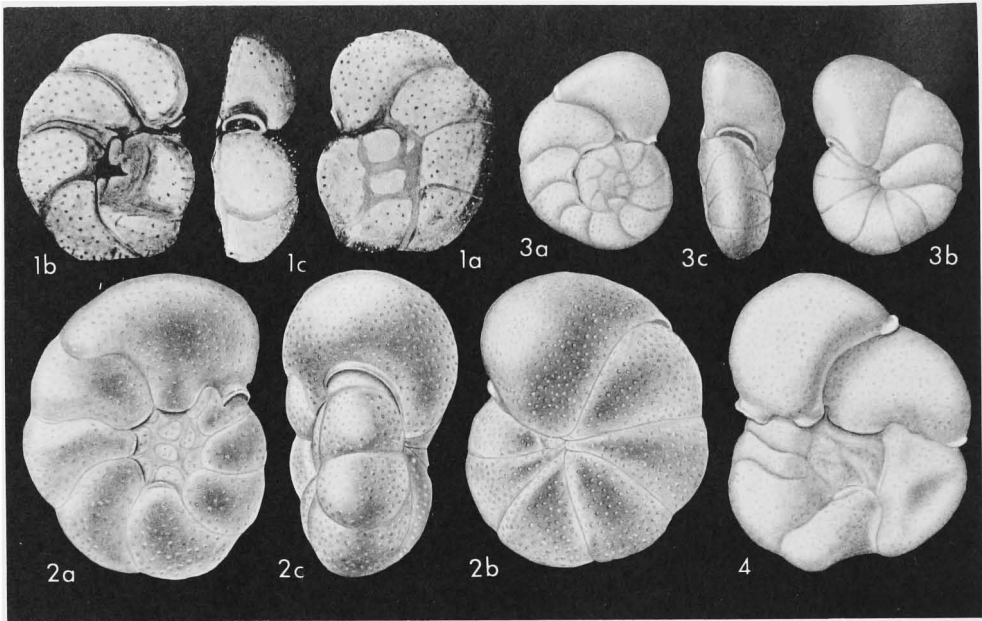


FIG. 555. Cibicididae (Cibicidinae; 1-4, *Caribeanella*) (p. C688-C690).

many apertures that remained open. Since these secondary apertures are on the rear portion of each chamber and open into the chamber in front of them, not into the one preceding, they cannot be relict openings. Furthermore, they are at the dorsal angle of the suture and periphery, whereas the primary apertures are interiomarginal and peripheral, against the preceding whorl. The third set of openings along the spiral suture were not mentioned in either original generic description, though they are present in both type-species. *Pseudocibicidoides* was described as having an umbilical opening on the umbilical side and a rounded equatorial aperture with prominent lip. Topotypes of the type-species show the umbilical opening along the spiral suture and the large equatorial aperture; also though less developed in this species, the peripheral openings at posterior margins of the chambers are observable in at least some of the better-preserved specimens. Thus *Pseudocibicidoides* is also regarded as a synonym of *Caribeanella*.]

Cibicidella CUSHMAN, 1927, *431, p. 93 [**Truncatulina variabilis* D'ORBIGNY, 1826, *1391, p. 279; OD]. Test attached, early stage trochospiral, as in *Cibicides*, later chambers added irregularly; wall calcareous, radial in structure, coarsely perforate; aperture in early stage as in *Cibicides*, more than one of irregularly arranged chambers in adult stage possessing arched apertural opening against attachment, each with narrow but distinct nonporous lip. *Mio.-Rec.*, Eu.—FIG. 554,3. **C. variabilis* (D'ORBIGNY), *Rec.*, *Medit.*; 3a,b, opposite sides, $\times 30$ (*2117).

Cyclocibicides CUSHMAN, 1927, *431, p. 93 [**Planorbulina vermiculata* D'ORBIGNY, 1826, *1391, p. 280; OD]. Test attached, discoidal, almost flat in early stage, early chambers trochospirally arranged, attached by spiral side, later with irregular chambers and finally with annular chambers; sutures distinct; wall calcareous, radial in structure, coarsely perforate on unattached side; apertures consisting of large sutural pores on attached spiral side, and scattered peripheral

pores, chambers connected internally by large pores through walls. *Rec.*, *Medit. Sea.*—FIG. 554,4. **C. vermiculata* (D'ORBIGNY), 4a-c, opposite sides and edge view of lectotype, $\times 27$ (*2117).

[*Cyclocibicides* differs from *Cibicidella* in the later annular chambers, which have a multiple aperture instead of a single rounded opening with surrounding lip. A lectotype was selected from the D'ORBIGNY collection in the Muséum National d'Histoire Naturelle, Paris (no. 12353) and here designated and refigured; it is from the Mediterranean.]

Cycloloculina HERON-ALLEN & EARLAND, 1908, *906, p. 533 [**C. annulata*; SD CUSHMAN, 1927, *433, p. 190] [= *Cycloloculina* SHARP, 1910, *1722, p. 5 (*nom. null.*)]. Test discoidal, about 1 mm. diam., peripheral margin smooth, rounded; planispiral or slightly asymmetrical in early stage, later chambers uncoiled and enveloping, finally annular; wall calcareous, of radially built calcite, coarsely perforate, "pores" consisting only of regularly arranged large openings that serve as apertures, no fine perforations; aperture consisting of large perforations. *Paleoc.-Mio.*, Eu.-N.Am.-Asia (Pak.).—FIG. 554,5,6. **C. annulata*, Tert., Eng.; 5a,b, side and edge views, $\times 71$ (*2117); 6, early stage in transmitted light, $\times 75$ (*2075).

Dyocibicides CUSHMAN & VALENTINE, 1930, *532, p. 30 [**D. biserialis*; OD] [= *Rectocibicidella* McLEAN, 1956, *1201, p. 370 (type, *R. robertsi*)]. Test elongate, attached, early stage trochospirally coiled, attached by spiral side, later uncoiling and irregularly biserial or staggered uniserial, periphery carinate; wall calcareous, coarsely perforate; aperture terminal, elongate, with bordering lip. *Eoc.-Rec.*, N.Am.-S.Am.-Eu.-Japan.—FIG. 556, 1. **D. biserialis*, *Rec.*, USA (Calif.); 1a-c, opposite sides and top view of holotype, $\times 74$ (*2117).

—FIG. 556,2. *D. robertsi* (McLEAN), Mio., USA (Va.); 2a-d, opposite sides, edge, and top views of holotype, $\times 45$ (*1201).

Falsocibicides POIGNANT, 1958, *1471, p. 117 [**F. aquitanicus*; OD]. Test attached, large, asymmetrical, trochospiral, plano-convex, spiral side flattened, peripheral outline lobulate, peripheral margin rounded, noncarinate; few chambers to whorl, increasing rapidly in size; internally thin plate divides aperture horizontally and extends back to previous foramen; wall calcareous, coarsely perforate; aperture large, rounded, equatorial and interiomarginal in position, extending somewhat onto spiral side with supplementary apertures at umbilical margin of chambers on umbilical side and more rarely secondary opening at opposite margin of final chamber on periphery, all apertures bordered by distinct nonperforate lips, spiral side also may have relict apertures or umbilical uncovered remnants of primary apertures of earlier chambers, relict apertures variable in occurrence within a species. *Oligo*.(Stamp.)-Mio.(Burdigal.), Fr.—FIG. 557,1-3. **F. aquitanicus*, Oligo.(Stamp.); 1a-c, opposite sides and

edge view of holotype showing large rounded equatorial aperture; 2, sec. showing internal plate extending between foramina of final whorl; 3, umbilical side of paratype showing umbilical supplementary apertures with bordering lips and border of additional peripheral aperture visible between last 2 chambers; all $\times 30$ (*1471).

Planorbulinoides CUSHMAN, 1928, *436, p. 6 [**Planorbulina retinaculata* PARKER & JONES in CARPENTER, PARKER & JONES, 1862, *281, p. 209; PARKER & JONES, 1865, *1418, p. 380; OD]. Test attached, early stage trochospiral, later chambers added irregularly, as in *Cibicidella*, finally chambers irregularly and loosely arranged to form spreading network; wall calcareous, coarsely perforate, apertures at ends of short projecting necks, as in *Annulocibicides* and *Rectocibicides*, situated at chamber margins against attachment. [A search for the type-specimen in the British Museum (Natural History) was fruitless, and the species is apparently rare. It was stated to be "parasitic on shells, East and West Indies."]*Rec.*, E.Indies-W.Indies.—FIG. 558. **P. retinaculata* (PARKER & JONES), locality not stated, $\times 15$ (*1418).

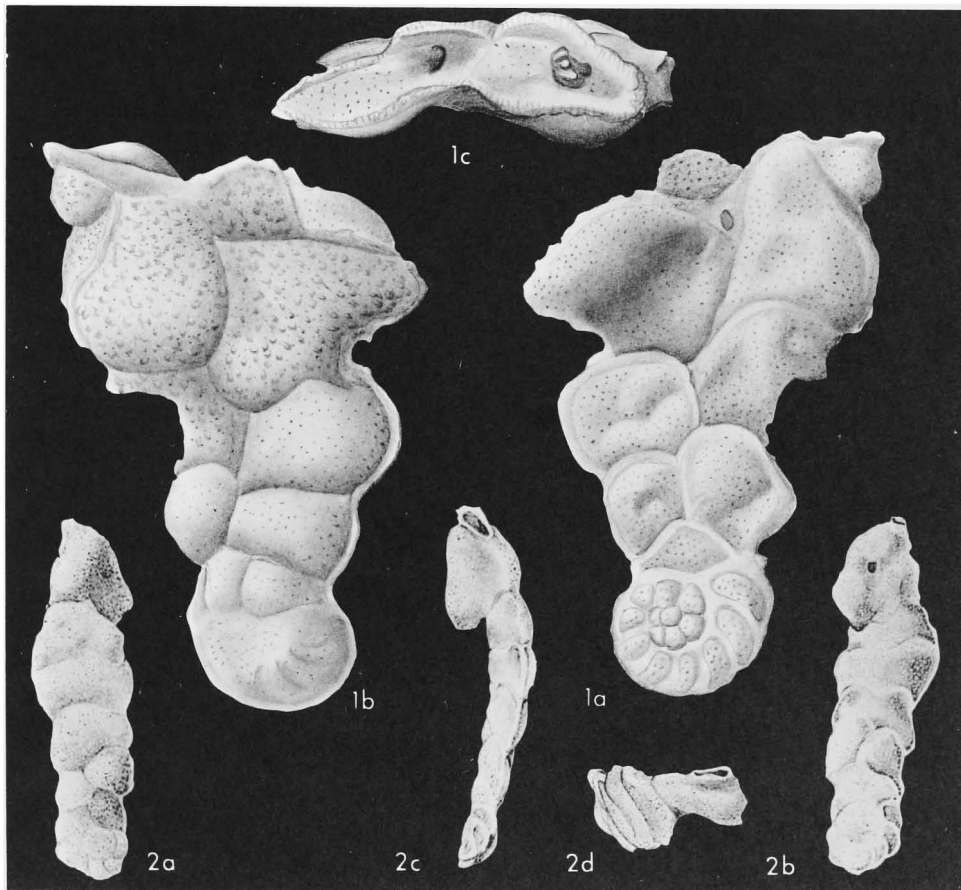


FIG. 556. Cibicididae (Cibicidinae; 1,2, *Dyocibicides*) (p. C690-C691).

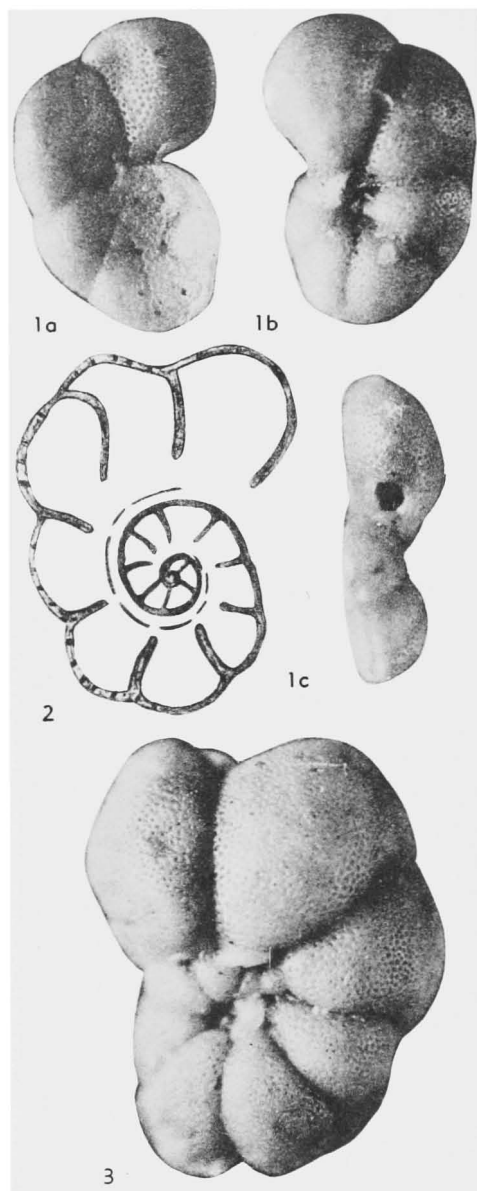


FIG. 557. Cibicididae (Cibicidinae; 1-3, *Falsocibicides*) (p. C691).

Rectocibicides CUSHMAN & PONTON, 1932, *520, p. 2 [*R. miocenicus*; OD]. Test attached, early portion coiled, later with broad low chambers uniserially arranged; wall calcareous, coarsely perforate; aperture a series of ovate openings on slight projections from terminal face, each surrounded by lip. [Differs from *Dyocibicides* in being more regularly uniserial in later stages and in having a multiple aperture. Differs from *Karrer* in be-

ing coarsely perforate and in having a multiple aperture.] *Mio.*, USA (Fla.).—FIG. 554, 7. **R. miocenicus*; 7a-c, opposite sides and apert. view of paratype, $\times 49$ (*2117).

Stichocibicides CUSHMAN & BERMÚDEZ, 1936, *489, p. 33 [*S. cubensis*; OD]. Test attached, early portion in slight trochoid coil of one or more volutions, attached side showing earlier volutions, free convex side partially or completely involute, coil followed by uniserially arranged chambers, periphery with nonporous marginal keel; wall calcareous, coarsely perforate; aperture nearly terminal, rounded opening just above attachment. [Differs from *Karrer* in the angled, keeled periphery and coarsely perforate wall. *Dyocibicides* differs from *Stichocibicides* in having a biserial stage, and *Rectocibicides* has multiple terminal apertures.] *Eoc.*, Cuba-N.Am.-Haiti.—FIG. 559, 1-3. **S. cubensis*, Cuba; 1a,b, opposite sides of paratype; 2a,b, opposite sides of paratype; 3a-c, opposite sides and apertural view of holotype; all $\times 35$ (*2117).

Family PLANORBULINIDAE Schwager, 1877

[*nom. transl.* CUSHMAN, 1927, p. 95 (ex subfamily Planorbulinidae SCHWAGER, 1877, p. 20)]—[In synonymic citations superscript numbers refer to taxonomic rank assigned by authors (¹family, ²subfamily); dagger (†) indicates *partim*] —[=*Helicosteguest* d'ORBIGNY, 1826, p. 268 (*nom. neg.*; *nom. nud.*); =¹Turbinoidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*); =²Planorbulinidae GALLOWAY, 1933, p. 297]

Test attached, early stage trochospiral, later with numerous chambers forming discoidal, cylindrical, conical, or subglobular

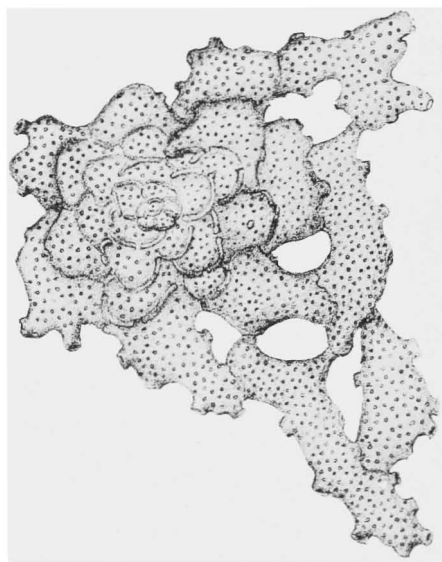


FIG. 558. Cibicididae (Cibicidinae; *Planorbulinoides*) (p. C691).

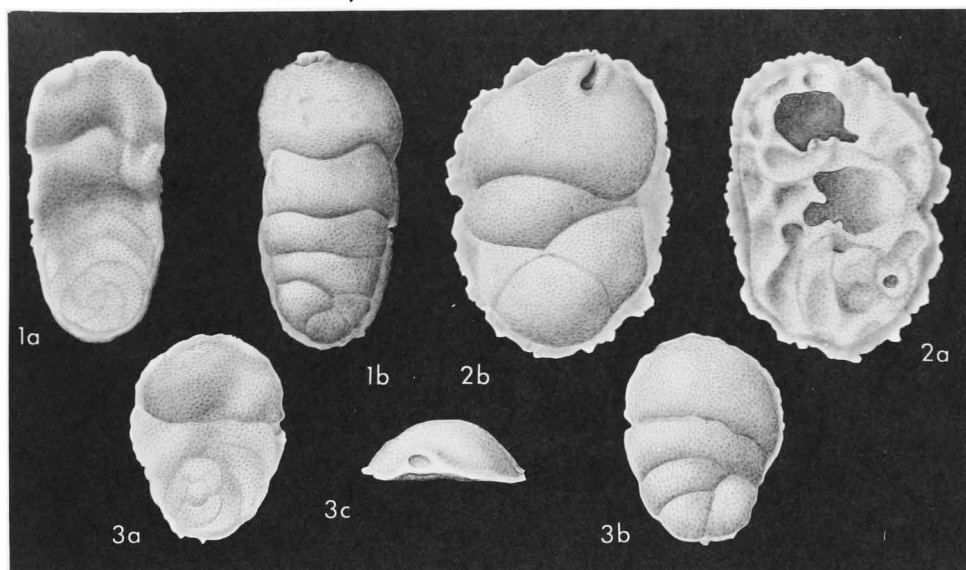


FIG. 559. Cibicididae (Cibicidinae; 1-3, *Stichocibicides*) (p. C692).

test; aperture single or multiple, peripheral. *Eoc.-Rec.*

Planorbulina D'ORBIGNY, 1826, *1391, p. 280 [**P. mediterranensis*; SD CUSHMAN, 1915, *404e, p. 27] [= *Asterodiscus* EHRENBURG, 1840, *667, table opposite p. 120 (type, *A. forskalii*); *Spirobotrys* EHRENBURG, 1844, *674, p. 246, 247 (type, *S. aegaea*)]. Test discoidal, trochospiral, attached by spiral side, tests of both generations similar in size, proloculus of microspheric forms (about 4 per cent of specimens) 11-14 μ diam., that of megalospheric forms (96 per cent) 23-56 μ diam., coiling random, early portion spirally coiled, chambers each with single aperture, later 2 apertures developing on each chamber (Fig. 560,2), each giving rise to new biapertural chamber, thus making numerous spirals of chambers; wall calcareous, on pseudochitinous membrane, coarsely perforate, radiate in structure, early spire brownish due to thickness and pigmentation of pseudochitinous membrane, which is perforated only by apertures, not finer wall perforations; aperture multiple, peripheral, commonly 1 or 2 interior-marginal rise to semilunar openings on each chamber of final whorl, each with narrow bordering lip, smaller supplementary openings occur on both sides for extrusion of pseudopodia, appearing on third chamber of spiral side and on eighth chamber of ventral side in type-species; cytoplasm greenish-brown to salmon-rose, except during sexual reproduction when pigments are eliminated, central area of dense plasma with abundant fine refringent granules (microsomes), numerous fine vacuoles, a nucleus, and peripheral vegetative zone crowded with nutritive and excretive particles lacking microsomes and rich in ectoplasm; pseudopodia rectilinear, anastomosing

slightly, about equal in length to test diameter, with slow circulation of granules; during vegetative reproduction (schizogony) some 60 to 100 embryos develop by division of parent nucleus and protoplasm, while protected by temporary encrusted "cyst," much of parent test becoming dissolved. *Eoc.-Rec.*, cosmop.—FIG. 560,1,2; 561. **P. mediterranensis*, Rec., USA (Fla.) (560,1), Medit. (560,2); 560,1a-c, opposite sides and edge view, $\times 44$ (*2117); 560,2, central part of equat. sec. of microspheric specimen, $\times 100$ (*1106); 561, biflagellate gamete, $\times 6,000$ (*1103).

[Embryos at first have only pseudochitinous membrane; the calcareous test begins to be formed at about the 4-chamber stage by a progressive enrichment of the outer face of the pseudochitinous cover with calcium carbonate. After embryos attain 5 chambers, they gradually dislodge the sandy protective cyst and escape, move a short distance away, settle on the substratum by their flat spiral side, and begin to build additional chambers. Both uninucleate and plurinucleate megalospheric forms occur. These have been regarded by some as representing the A2 and A1 generations of trimorphism, but because the microspheric form in cultures invariably gives rise to uninucleate megalospheric forms only, trimorphism has not been proved (*1106). The youngest plurinucleate A1 specimen observed already had 18 chambers. The A1 generation always gave rise in turn to the microspheric B generation and after many rapid nuclear divisions, microspheric adults gave rise to many biflagellate gametes, which utilized all of the parent cytoplasm. The gametes have 2 unequal flagella inserted together at the base of the anterior part near a fatty inclusion. Commonly they escape from the parent test during the night.]

Euannularia COLE & BERMÚDEZ, 1944, *370, p. 342 [**E. eocenica*; OD]. Test discoidal, flat to concavo-convex, may be umbonate on convex side, biloculine embryonic stage of megalospheric form consisting of proloculus, which is slightly or completely embraced by second chamber, later chambers in annular rings in single layer, chambers nearest center with arched outer walls, those of later annuli nearly rectangular and alternating in position with those of preceding and following

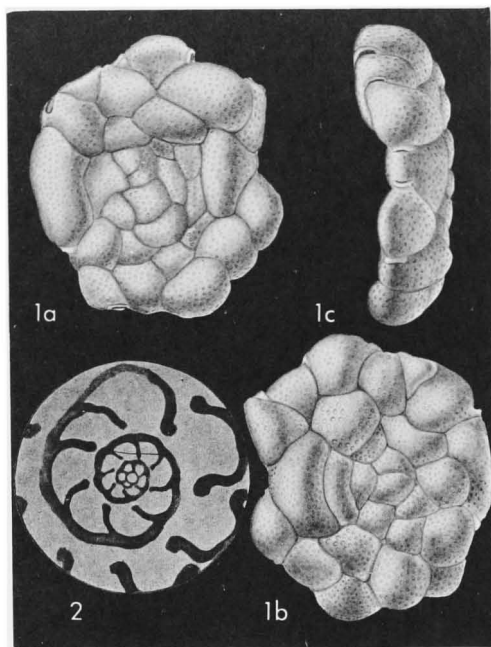


FIG. 560. Planorbulinidae; 1,2, *Planorbulina* (p. C693).

annuli; wall calcareous, coarsely perforate, with some thickening of shell material in central position; numerous stoloniferous apertures. [The early stage is similar to *Linderina* but later chambers tend toward *Cyclotypeus* in form (*370).] *M. Eoc.*, Carib.(Cuba).—FIG. 562,1-4. **E. eocenica*; 1, ext., holotype and smaller paratypes, $\times 10$; 2a,3, horiz. secs., $\times 41$; 2b, central portion of 2a, $\times 163$; 4, vert. sec., $\times 41$ (*370).

Linderina SCHLUMBERGER, 1893, *1656, p. 120 [**L. brugesi*; OD (M)]. Test discoidal, centrally thickened, 1-3.5 mm. diam.; megalospheric form with biloculine embryonic stage, later chambers arched, in concentric series in single plane, those of successive series alternating in position; wall calcareous, perforate, umbonal lamellar thickening pronounced, surface with numerous granules or pillars in central area; apertures at each side of base of chambers, as in position of stolons in orbitoidids. *Eoc.-Mio.*, Eu.-Afr.-N.Am.-E.Indies (Indon.).—FIG. 562,5-10. **L. brugesi*, U.Eoc., Fr.; 5, ext., $\times 40$; 6, horiz. sec., central part, showing perforations of umbonal thickening, $\times 36$; 7, equat. sec. showing stolon-like apertures, $\times 135$ (*1352); 8, horiz. sec. of early portion of megalospheric test showing biloculine embryo and later arched chambers, $\times 75$; 9,10, transv. secs. of microspheric and megalospheric tests showing equat. chambers and umbonal lamellar thickenings, $\times 73$ (*1656).

Planorbulinella CUSHMAN, 1927, *431, p. 96 [**Planorbulina vulgaris* D'ORBIGNY var. *larvata*

PARKER & JONES, 1865, *1418, p. 380; OD]. Test trochoid in early stage and may be attached, later chambers developing in annular series, those of outer row alternating with ones within, forming nearly bilaterally symmetrical test; wall calcareous, coarsely perforate, radial in structure, bilamellar; apertures 2 to each chamber, rarely one in median line on periphery, each with narrow bordering lip. *Eoc.-Rec.*, Pac.O.-Australia-N.Z.-Cuba-Atl.O.-N.Am.—FIG. 563,1,2. **P. larvata* (PARKER & JONES), Rec., Australia; 1a-c, opposite sides and edge view, $\times 40$ (*2117); 2, part of transv. sec., $\times 100$ (*928a).

Family ACERVULINIDAE Schultze, 1854

[*nom. correct.* EIMER & PICKERT, 1899, p. 702 (*pro* family Acervulinida SCHULTZE, 1854, p. 53)] [=Gypsininae SILVESTRI, 1905, p. 5; Acervulininae GALLOWAY, 1933, p. 308]

Test free or attached, early spiral stage followed by spreading chambers, in one or many layers; no canal system; no aperture except for mural pores. *Eoc.-Rec.*

Acervulina SCHULTZE, 1854, *1695, p. 67 [**A. inhaerens*; SD GALLOWAY & WISSLER, 1927, *766, p. 67] [=Aphrosina CARTER, 1879, *295, p. 500 (type, *A. informis*)]. Test attached, early chambers coiled, later encrusting, with irregularly arranged inflated chambers; wall calcareous, coarsely perforate; no aperture other than coarse perforations. *U.Tert.-Rec.*, Eu.-N.Am.-Pac.O.-Ind.O.—FIG. 564. **A. inhaerens*, Rec., Italy; ext. of specimen attached to *Corallina*, $\times 72$ (*1695).

Borodinia HANZAWA, 1940, *869, p. 790 [**B. septentrionalis*; OD]. Test encrusting, with chambers of successive layers alternating in position, septa and walls approx. 12-25 μ in thickness, outer wall 37-75 μ in thickness and coarsely perforated; apertural stolons 37 μ in diameter, at opposite ends of septum. *Mio.(Aquit.)*, Daito Is. (formerly Borodino Is.) [off E. China Sea E. of Okinawa]. —FIG. 565,1. **B. septentrionalis*; 1a, transv. sec. showing thickened outer wall of layer, $\times 13$; 1b, tang. sec. through part of outer wall at upper right and part of chambered zone (scale not given by author) (*869).

Gypsina CARTER, 1877, *292, p. 172 [**Polytrema*

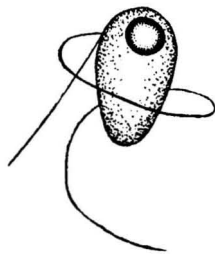


FIG. 561. Planorbulinidae; *Planorbulina* (p. C693).

planum CARTER, 1876, *291, p. 211, =*Gypsina melobesioides* CARTER, 1877, *292, p. 172; SD CARTER, 1880, *296, p. 445] [= *Discogypsina* A.

SILVESTRI, 1937, *1787, p. 156 (type, *Tinoporus vesicularis* (PARKER & JONES) GÖES, 1882, *801, p. 104; *Hemigypsina* BERMÚDEZ, 1952, *127, p.

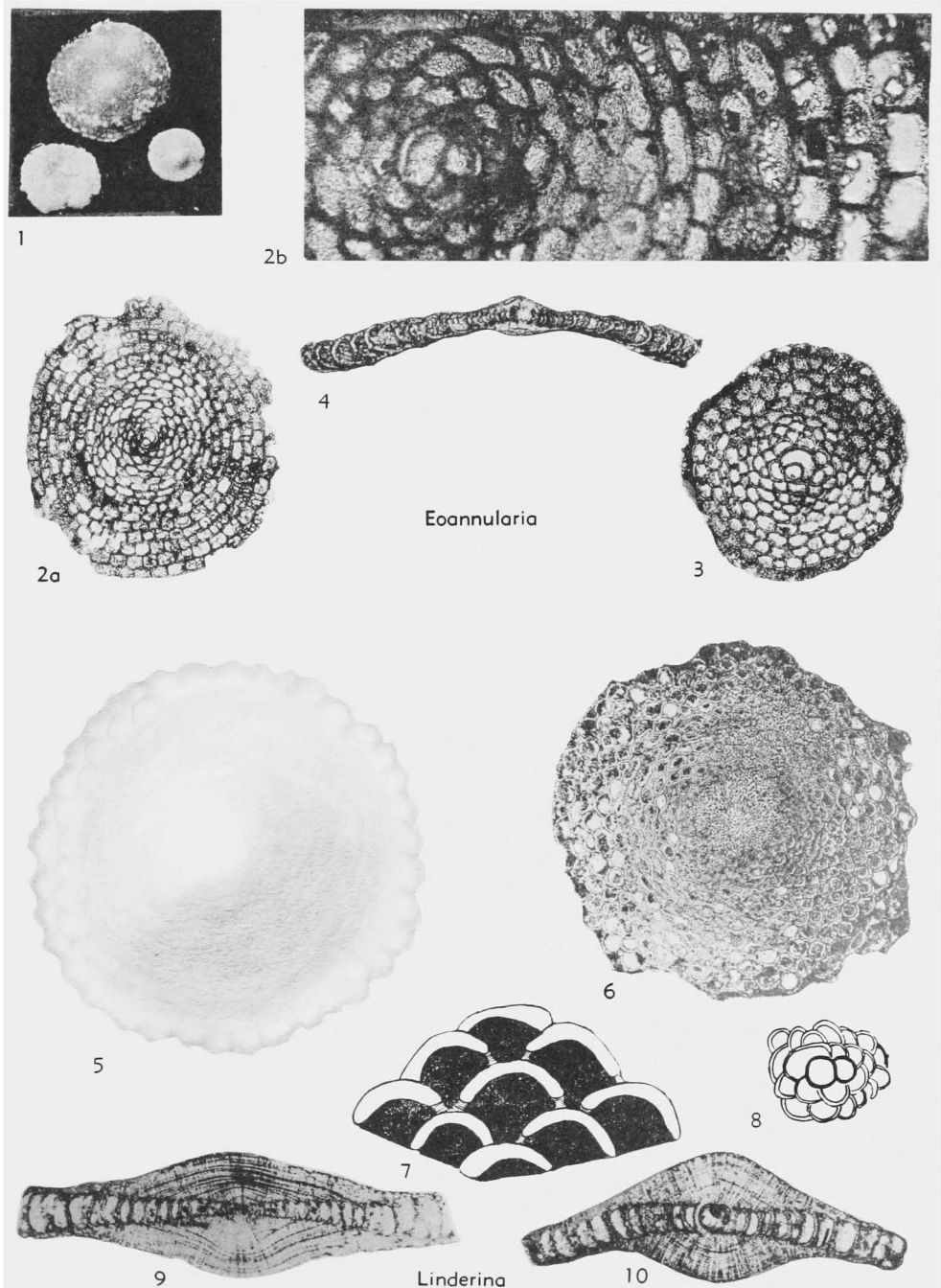


FIG. 562. Planorbulinidae; 1-4, *Eoannularia*; 5-10, *Linderina* (p. C693-C694).

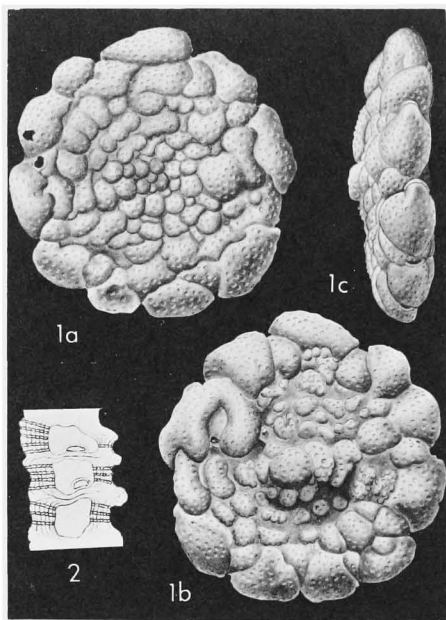


FIG. 563. Planorbulinidae; 1,2, *Planorbulinella* (p. C694).

124 (type, *Gypsina mastelensis* BURSCH, 1947, *254, p. 37)]. Test relatively large, attached, encrusting or forming hemispherical mass; chambers roughly circular to rectangular or polygonal in outline and perforated by few large foramina, each about 5μ in diameter, with chambers of one layer alternating with those of row below, upper walls slightly convex outward, may have irregular

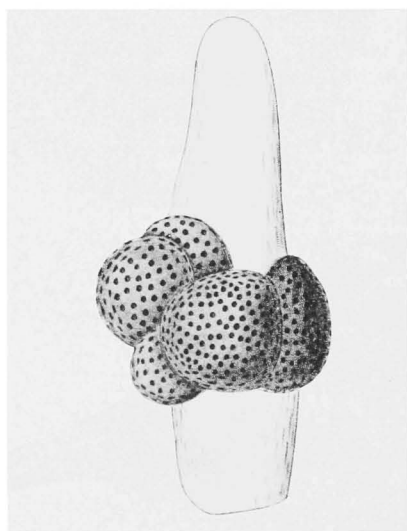


FIG. 564. Acervulinidae; *Acervulina* (p. C694).

knobby projections of groups of chambers, which are more polygonal in outline near center of these knobs; chamber walls of fibrous crystalline calcite, imperforate, embedded tetraxonid sponge spicules within it, but no other foreign matter, walls elevated at surface to form meshwork of clearly defined areolae about 120μ in diameter; no aperture other than large septal wall perforations visible on surface within meshwork of chamber walls. *Eoc.-Rec.*, cosmop.—FIG. 566, 1-4. **G. plana* (CARTER), Rec., Mauritius Is.; 1, ext., $\times 1$; 2, sec. perpendicular to surface, $\times 75$; 3, diagram. sec. of specimen encrusting another shell, showing chambers, radially built walls, and perforated septa; 4, sec. through center of a knob, showing less regular chambers and perforated septa, $\times 96$ (*1139).—FIG. 566,5-8. *G. mastelensis* BURSCH, L.Oligo., E.Indies(Indon.); 5, holo-

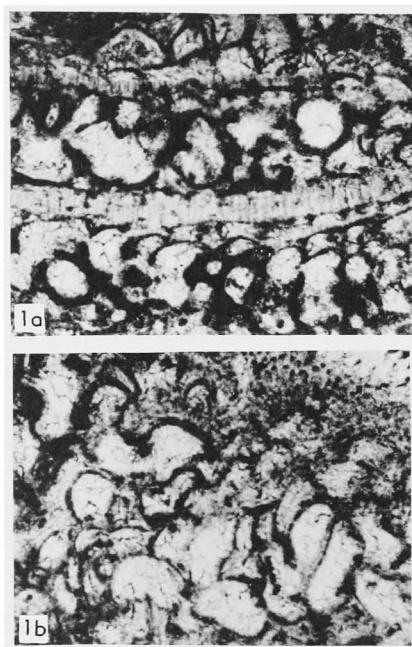


FIG. 565. Acervulinidae; 1, *Borodinia* (p. C694).

type, axial sec., $\times 33$; 6, nearly equat. sec. of paratype, $\times 33$; 7, diagram. sec., early portion in equat. sec., $\times 200$; 8, schematic axial sec., enlarged (*254).—FIG. 567,1,2. *G. vesicularis* (PARKER & JONES), Rec., Australia; 1a-c, side, base, top views of paratype, $\times 26$; 1d, portion of surface, $\times 88$; 2a,b, ext. edge view and vertically broken face of paratype, $\times 17$ (*2117).

[*Orbitolina concava* var. *vesicularis* PARKER & JONES was designated the type-species of *Gypsina* by CUSHMAN (1915, *404e, p. 74), but the type had already been fixed by CARTER (1880, *296, p. 445). A lectotype was selected and isolated by us in the British Museum (Natural History), and is here designated for *O. concava vesicularis* PARKER &

JONES, 1860, BMNH-ZF3600 (ex. 94.4.3.1737) and paratypes BMNH-ZF3601 (ex 94.4.3.1737, 1738) from JUKES No. 2, 14 fathoms, north of Sir C. HARDY's inside reefs, north-east coast of Australia. Recent studies by NYHOLM (*1381)

suggest that *Gypsina* is a stage in the life cycle of *Cibicides*. The transformation from one "genus" to the other has not been followed in isolated specimens in cultures, and the mere association of the 2 forms in the same biotope

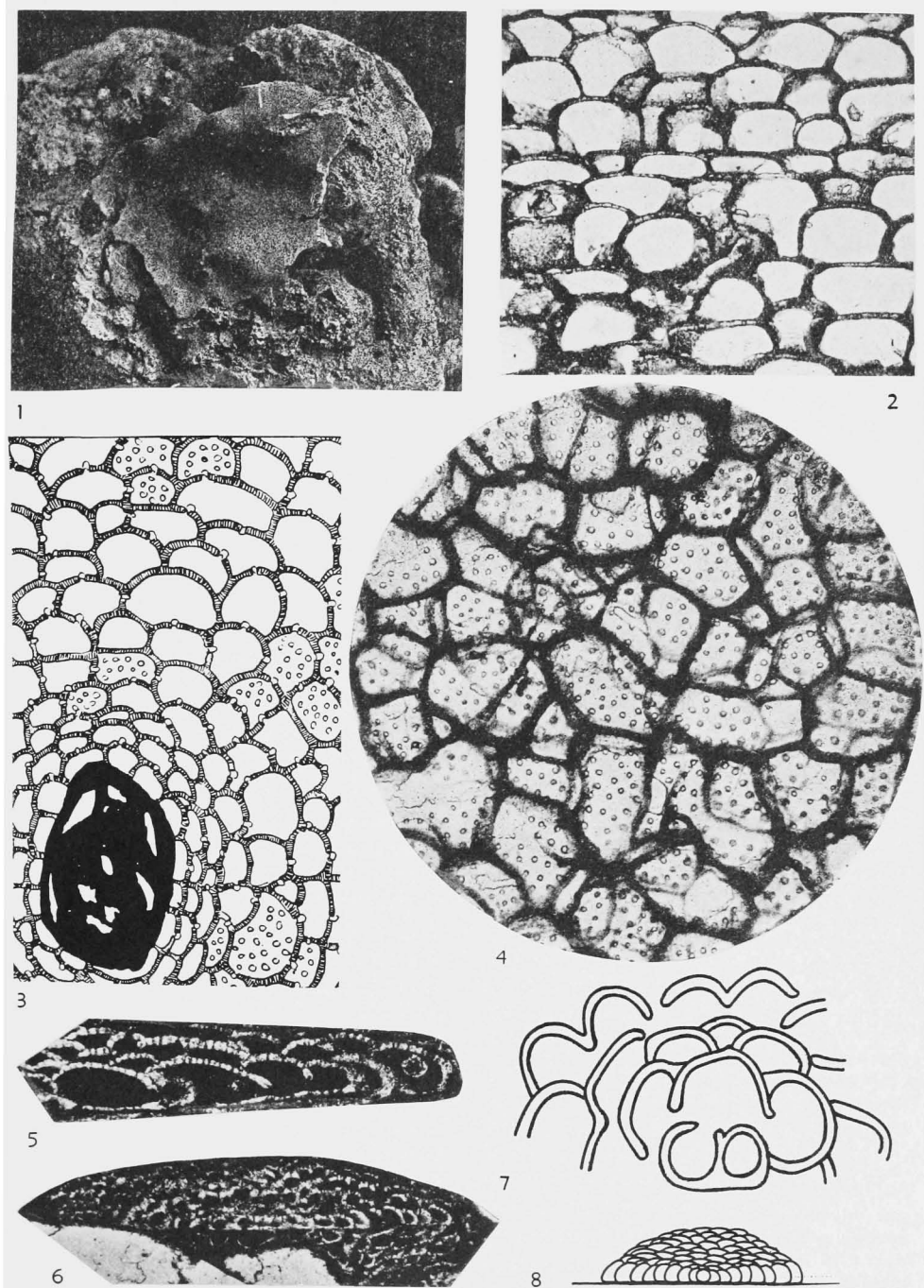


FIG. 566. Acervulinidae; 1-8, *Gypsina* (p. C694-C698).

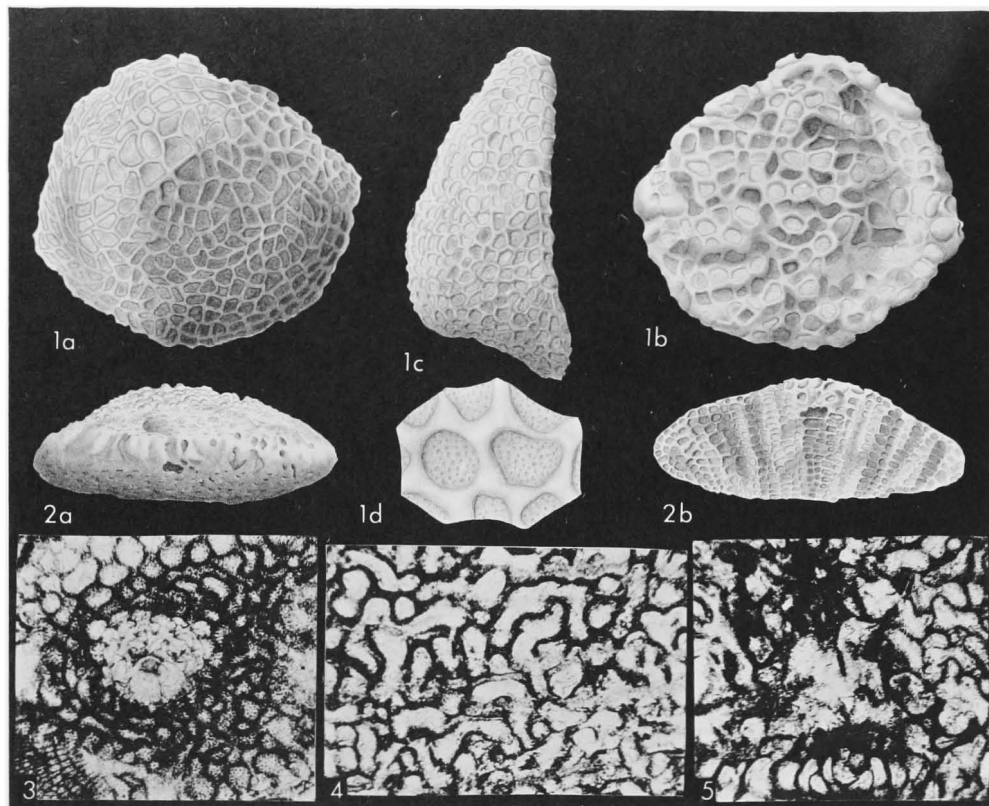


FIG. 567. Acervulinidae; 1, 2, *Gypsina*; 3-5, *Ladoronia* (p. C694-C698).

is not conclusive proof of their identity. Both are herein recognized as distinct.]

Ladoronia HANZAWA, 1957, *873, p. 68 [*Acervulina* (*Ladoronia*) *vermicularis*; OD] [= *Acervulina* (*Ladoronia*) HANZAWA, 1957, *873, p. 68 (obj.)]. Test attached, encrusting, early chambers in raspberry-like arrangement as in *Planorbulinella*, later chambers as in *Acervulina*, but elongate and irregularly sinuous as seen in horizontal section; intercameral stolons connecting chambers of same layer and fine pores connecting those of successive layers. *Mio.*, N.Pac.O. (Saipan Is.).—FIG. 567, 3-5. **L. vermicularis*; 3, horiz. sec. showing early stage in center of figure; 4, horiz. sec. showing irregular chambers; 5, vert. sec. showing early stage (juvenarium) at base of figure; all $\times 40$ (*873).

Planogypsina BERMÚDEZ, 1952, *127, p. 124 [*Gypsina vesicularis* var. *squamiformis* CHAPMAN, 1901, *317, p. 200; OD]. Test large, discoidal, early stage with globular, planispirally arranged chambers, later chambers added irregularly and elongate to vermiform in outline; septal pores perforating walls; no aperture present other than pores. [A lectotype for the type-species was selected by us at the British Museum (Natural History) (BMNH-ZF3647, ex 03.2.5.14) and para-

types (BMNH 03.2.5.14), from Recent, Sample 8 of CHAPMAN, 1901, at 26 fathoms, 4 miles from Mission Church, Funafuti Lagoon.] *U.Tert.-Rec.*, SW.Pac.O.—FIG. 568, 1. **P. squamiformis* (CHAPMAN), *Rec.*, Funafuti Atoll; 1a-c, top, base, and edge views of paratype, $\times 29$ (*2117).

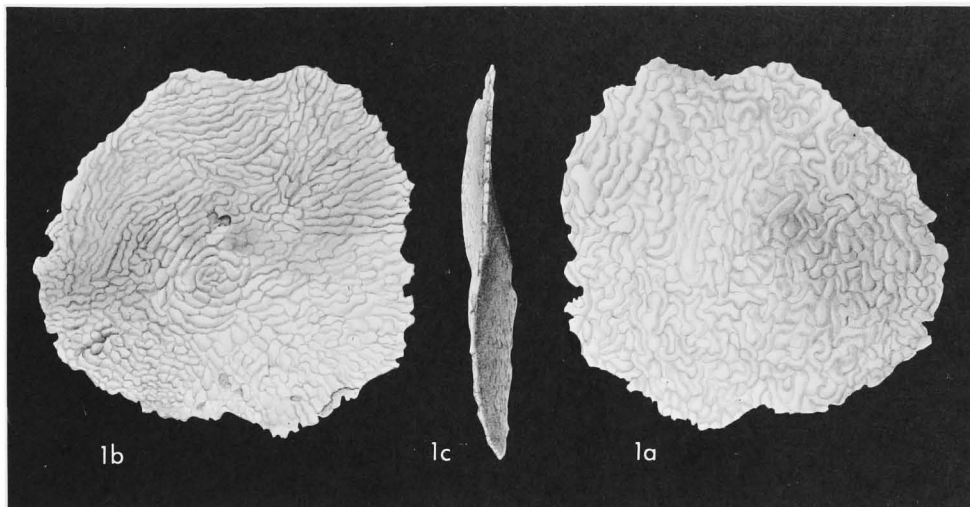
Sphaerogypsina GALLOWAY, 1933, *762, p. 309 [*Ceriodora globulus* REUSS, 1848, *1539, p. 33; OD]. Test similar to *Gypsina*, but forming globular masses. *Eoc.-Rec.*, Eu.-Carib.-Pac.—FIG. 569, 1, 2. **S. globulus* (REUSS), *Mio.* (Torton.), Czech.; 1, ext., enlarged (*1478); 2, sec., $\times 20$ (*873).

Family CYMBALOPORIDAE Cushman, 1927

[Cymbaloporidae CUSHMAN, 1927, p. 81]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹family, ²subfamily)]—[=¹Cymbaloporetidae CUSHMAN, 1928, p. 8; =²Cymbaloporinae CHAPMAN & PARK, 1936, p. 143; =¹Halkyardiidae KUDO, 1931, p. 201]

Test trochospiral, later chambers in annular series in single flat or conical layer; apertures numerous, variously arranged circular pores. *U.Cret.-Rec.*

Cymbalopora VON HAGENOW, 1851, *859, p. 104 [*C. radiata*; OD (M)]. Test low conical, early

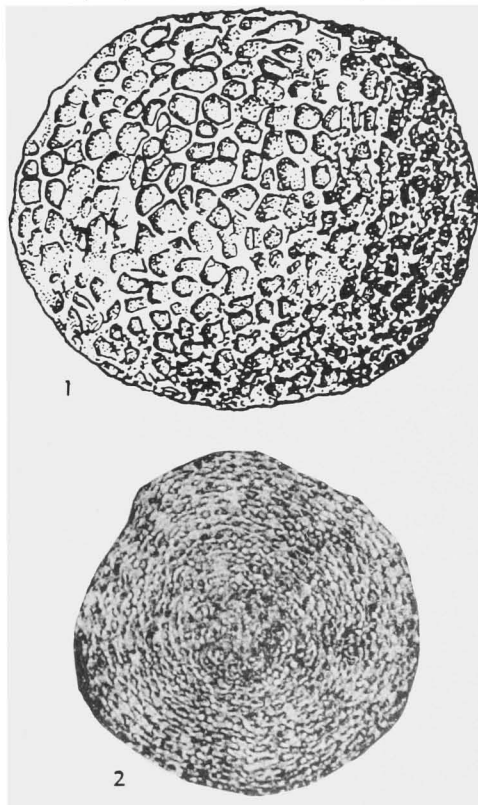
FIG. 568. Acervulinidae; 1, *Planogypsina* (p. C698).

chambers trochospirally arranged, later in annular series, as in *Cymbaloporella*, umbilicus open, commonly portions of chamber surfaces broken away near umbilicus; sutures completely obscured on spiral side, radial and depressed on umbilical side; wall calcareous, coarsely perforate, lamellar, lamellae obscuring sutures and chambers on spiral side where only large perforations can be seen; apertures at open umbilical ends of chambers. *U.Cret.*, Eu.—FIG. 570,1; 571. **C. radiata*, Maastricht., Neth.; 570,1a-c, opposite sides and edge view, $\times 56$ (*2117); 571, vert. sec. showing recrystallized wall, which has not completely obliterated lamellar structure, and coarse pores on spiral side, $\times 107$ (*948).

[HOFKER (*928c, p. 477) regarded the wall as arenaceous and *Cymbalopora* as related to the Valvulinidae. Topotypes examined by us are distinctly calcareous, although the structure of the recrystallized wall is poorly preserved in this and many other associated calcareous species in the Maastrichtian chalk tuffs. Furthermore, HOFKER's figures (here reproduced) clearly show the lamellar development in *C. radiata*. Also, as noted by REISS (*1531, p. 355) lamellar structure is found only in the calcareous perforate foraminifers (suborder Rotaliina) and never in the agglutinated forms (suborder Textulariina).]

Archaeocyclus A. SILVESTRI, 1908, *1771, p. 134 [**Planorbulina cenomaniana* SEGUENZA, 1882, *1714, p. 200; OD (M)]. Test large, discoidal, flat to concavo-convex, to 1.6 mm. diam., proloculus large, followed by coiled early portion of about 5 chambers to whorl, later in annular series with chambers of successive series alternating in position; sutures oblique; wall calcareous, perforate, bilamellar, with thin, dark, median layer; aperture in early stage interiomarginal, later with stolon-like pores at sides of each chamber. *U.Cret.(Cenoman.)*, Eu.(Italy).—FIG. 572,1,2. **A. cenomaniana* (SEGUENZA); 1a, ext., $\times 35$; 1b, portion of surface, $\times 100$; 1c, same in balsam to show internal structure, $\times 100$; 2, part of test with upper surface removed by HCl treatment, mounted in balsam, $\times 100$ (*1714).

Cymbaloporella CUSHMAN, 1927, *431, p. 81 [**Cymbalopora tabellaeformis* BRADY, 1884, *200, p. 637; OD]. Test discoidal, early chambers trochospiral, later in annular series; all visible

FIG. 569. Acervulinidae; 1,2, *Sphaerogypsina* (p. C698).

from spiral side except where lamellar thickening obscures early portion, only final annulus visible from opposite side; wall calcareous, coarsely per-

forate, radial in structure, bilamellar; apertures in adult a series of openings at sides of chambers. *Eoc.-Rec.*, cosmop.—FIG. 570,2. **C. tabellae-*

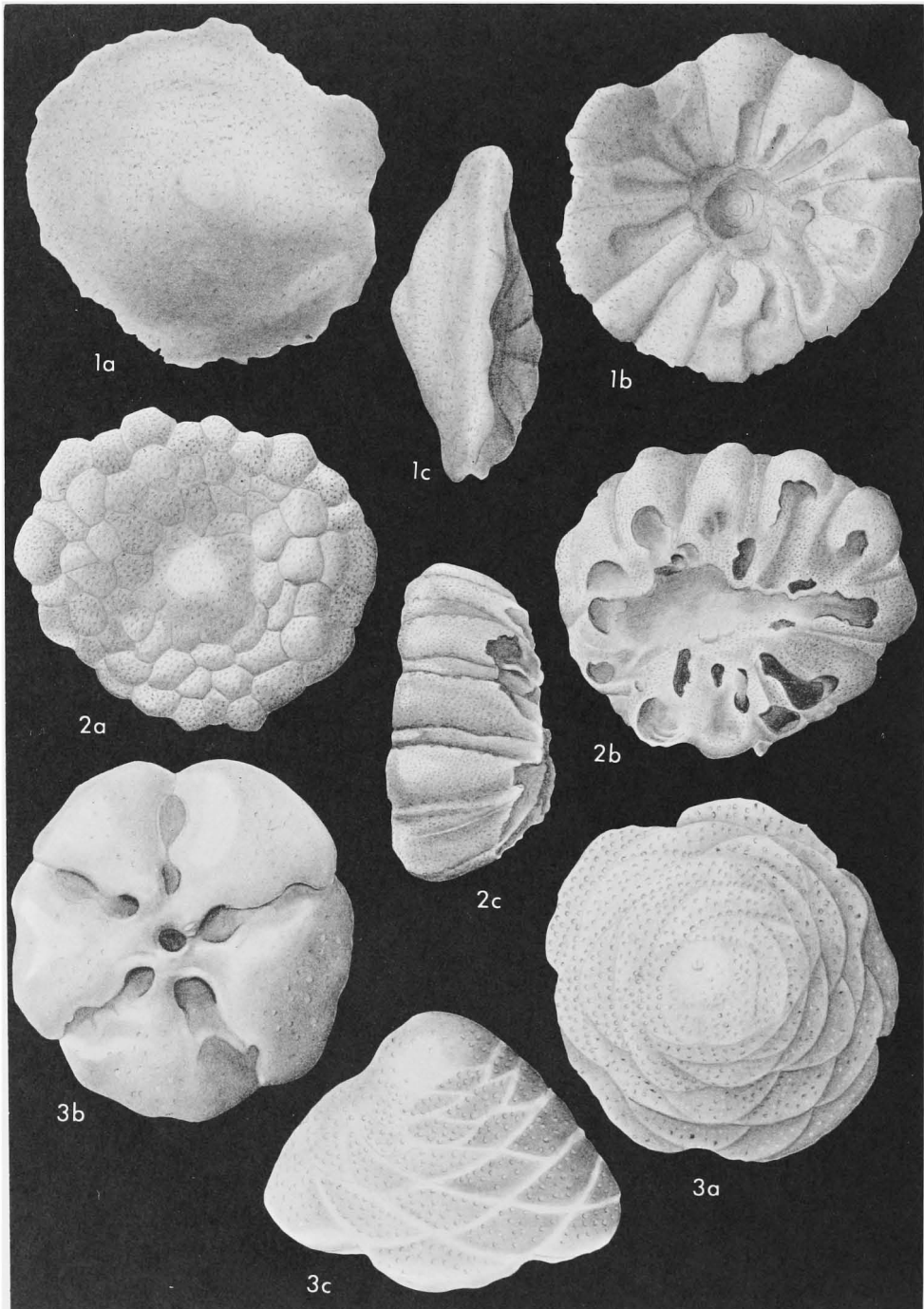


FIG. 570. Cymbaloporidae; 1, *Cymbalopora*; 2, *Cymbaloporella*; 3, *Cymbaloporetta* (p. C698-C701).

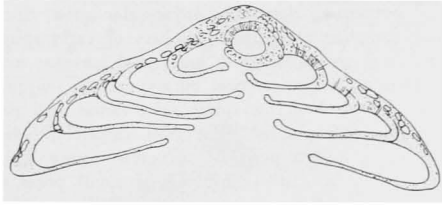


FIG. 571. Cymbaloporidae; *Cymbalopora* (p. C698-C699).

formis (BRADY), Rec., S.Pac.O. (Samoa Is.); 2a-c, opposite sides and edge view, $\times 63$ (*2117).

Cymbaloporetta CUSHMAN, 1928, *436, p. 7 [*Rosalina squamosa* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 91; OD]. Test conical, early chambers trochospiral, later alternating in annular series, as in *Halkyardia*, with few chambers in each series, all chambers visible on highly convex spiral side, only few visible in last annulus on umbilical side; sutures oblique and flush on spiral side, deeply depressed and radial on umbilical side, with deep openings left between adjacent chambers, umbilicus small, open; wall calcareous, spiral side coarsely perforate, umbilical side nonporous,

radial in structure, bilamellar; apertures consisting of one or more sutural openings at each side of chambers on umbilical side. *Mio.-Rec.*, cosmop.

—FIG. 570,3; 573. **C. squamosa* (D'ORBIGNY), Rec., Bahama Is. (570,3), Carib. (573); 3a-c, opposite sides and edge view, $\times 86$ (*2117); 573, axial sec., $\times 160$ (*951).

Eofabiania KÜPPER, 1955, *1070, p. 135 [*E. grahami*; OD]. Test conical, concavo-convex, early portion trochospiral, structure similar to *Fabiania* but without lateral chamberlets, exterior unknown. [HANZAWA (*874, p. 121) suggested that *Eofabiania* may be a synonym of *Fabiania*. Poorly known only from thin sections, the present genus is here tentatively recognized by the absence of lateral chamberlets, although these are not always well shown in axial sections of true *Fabiania*.] *M.Eoc.*, USA (Calif.). —FIG. 574,1,2. **E. grahami*; 1a,b, axial sec. of paratype and sketch of same; 2, sketch of axial sec. of holotype; all $\times 38$ (*1070).

Fabiania A. SILVESTRI, 1924, *1778, p. 7 [*Patella* (*Cymbiola*) *cassisi* OPPENHEIM, 1896, *1390, p. 55, 56; OD] [= *Eodictyoconus* COLE & BERMÚDEZ, 1944, *370, p. 336 (type, *Pseudorbitolina cubensis* CUSHMAN & BERMÚDEZ, 1936, *490, p. 59);

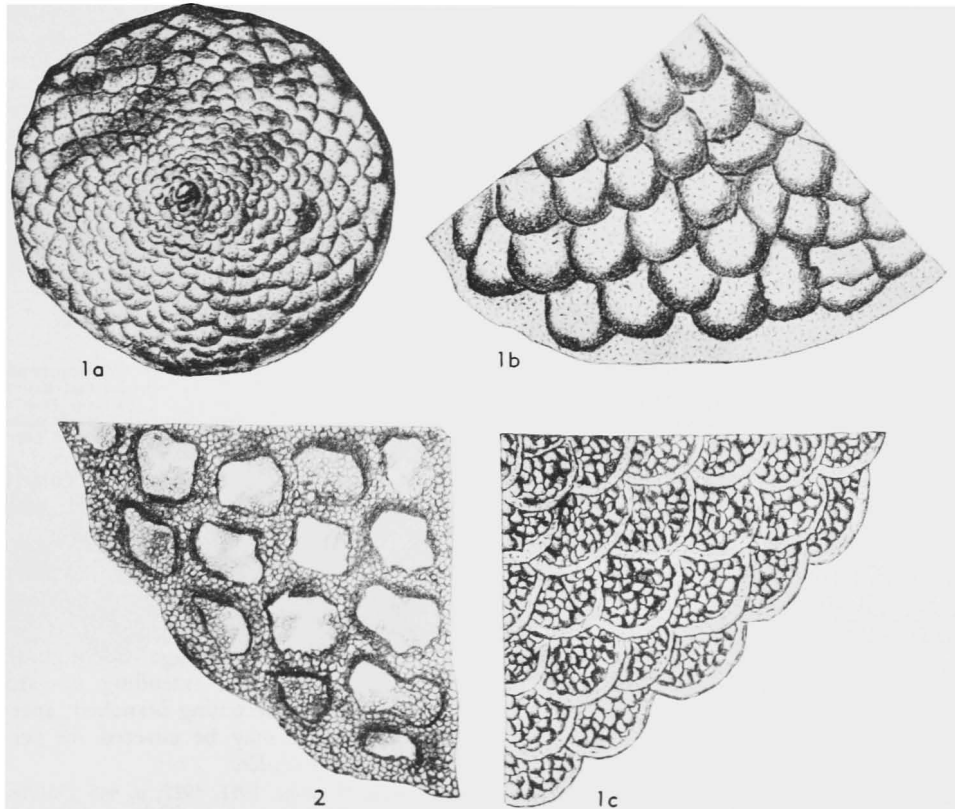


FIG. 572. Cymbaloporidae; 1,2, *Archaeocyclus* (p. C699).

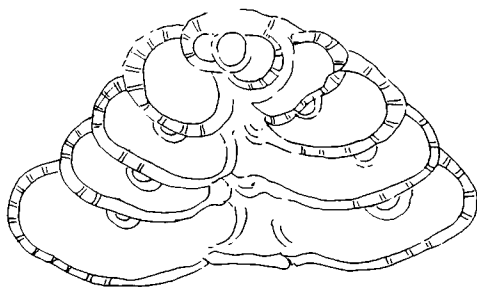


FIG. 573. Cymbaloporidae; *Cymbaloporetta* (p. C701).

Tschoppina KEIJZER, 1945, *1030, p. 213 (type, *Pseudorbitolina cubensis* CUSHMAN & BERMÚDEZ, 1936, *490, p. 59)]. Test of regular or flattened conical form with bluntly rounded apex; early stage of 3 simple globose chambers with basal aperture and thickened perforate wall, later chambers in cyclical series or tiers, area just beneath external wall subdivided by horizontal and vertical partitions forming coarse alveoli, which again are subdivided by thinner, shorter partitions into 2 or 3 smaller alveoli; sutures of chamber tiers visible externally but alveolar walls less distinct except on abraded specimens; wall calcareous, thick, bilamellar, outer wall coarsely perforate, wall of umbilical side and partitions imperforate. *Eoc.*, Eu.-Japan-Carib.(Cuba)-Pac. O. — FIG. 574,3-5. **F. cassis* (OPPENHEIM), Auvers., Italy (3), Lutet., Italy (4,5); 3, ext., $\times 13$; 4, horiz. sec., $\times 24$ (*1781); 5, tang. vert. sec., $\times 12$ (*1781). — FIG. 574,6,7. *F. cubensis* (CUSHMAN & BERMÚDEZ), Cuba; 6, horiz. sec. enlarged; 7, axial sec., $\times 41$ (*370).

Gunteria CUSHMAN & PONTON, 1933, *522, p. 25 [**G. floridana*; OD]. Test compressed, flabelliform to reniform in outline, embryonic stage of large globular undivided chambers, later with concentric chambers divided by numerous transverse and radial partitions into chamberlets, as in *Fabiania*; sutures indistinct externally, except on abraded specimens; wall calcareous, perforate; aperture consisting of 2 rows of pores on terminal face. *M.Eoc.*, USA (Fla.)-Carib.(Cuba). — FIG. 575,1,2; 576,1,2. **G. floridana*, Fla. (575,1,2), Cuba (576,1,2); 575,1a,b, side and top views of paratype, $\times 12.5$; 575,2, portion of apert. view of another paratype, $\times 33$ (*2117); 576,1,2, axial and transv. secs., $\times 20$ (*372).

Halkyardia HERON-ALLEN & EARLAND in HALKYARD, 1918, *861, p. 107 [**Cymbalopora radiata* var. *minima* LIEBUS, 1911, *1135, p. 952; SD CUSHMAN, 1928, *439, p. 288]. Test small, plano-convex to lenticular with spiral side more strongly convex, periphery subacute, peripheral margin lobulate; early chambers in irregular or "raspberry" type of arrangement, later chambers small

and numerous, alternating in annular series, thick wall lamellae obscuring chambers of early spire; umbilical area filled with horizontal lamellae and connecting hollow vertical pillars; sutures oblique, curved and flush on spiral side, radial and depressed on umbilical side; wall calcareous, distinctly perforate, radial in structure, inner walls nonporous; aperture consisting of small pores at periphery. [Although topotypes of *H. minima* were stated by WOOD (*2073, p. 250) to be radial in structure, the genus was regarded as microgranular by HOFKER (*951, p. 117).] *Eoc.*, Eu.-Pac.O.-N.Am. — FIG. 575,5. **H. minima* (LIEBUS), *Eoc.*(Barton.), Fr.; 5a-c, opposite sides and edge view, $\times 130$ (*2117). — FIG. 575,6-8. *H. bikiniensis* COLE, *Eoc.*, Bikini Atoll; 6, vert. sec. showing umbilical pillars and thickened spiral wall; 7, transv. sec. nearer base cutting umbilical pillars and showing thickened outer wall; 8, transv. sec. near apex, cutting embryonic chambers; all $\times 40$ (*361).

Pyropilus CUSHMAN, 1934, *463, p. 100 [**P. rotundatus*; OD]. Early chambers trochospirally coiled, later added irregularly to form elongate mass, with all chambers visible on originally spiral side and only last series visible on opposite side around elongate or irregular umbilical depression; wall calcareous, coarsely perforate, with thin inner pseudochitinous layer; aperture consisting of numerous large pores along sutures and on apertural face on umbilical side of test, sutural openings remaining open on all chambers of final whorl. [Lamellar and microstructure of the wall have not been described, but general appearance suggests its relation to the Cymbaloporidae.] *Rec.*, Pac.O. — FIG. 575,3,4. **P. rotundatus*, S.Pac.O. (Rangiroa Atoll); 3a-c, opposite sides and edge view of holotype; 4, umbilical side of large paratype, $\times 49$ (*2117).

Family HOMOTREMATIDAE Cushman, 1927

[*nom. correct.* LOEBLICH & TAPPAN, herein (*pro* Homotrematidae CUSHMAN, 1927, p. 97)] [=Victoriellidae CHAPMAN & CRESPIN, 1930, p. 111; =Polytrematidae CHAPMAN, PARR & COLLINS, 1934, p. 556, 573 (*recte* Polytrematidae); =Miniacinidae THALMANN, 1938, p. 208; =Eorupteriidae COLE, 1957, p. 337]

Test attached, early chambers irregularly trochospiral, later variously modified; wall coarsely perforate. *U.Cret.-Rec.*

Subfamily HOMOTREMATINAE Cushman, 1927

[*nom. transl.* CHAPMAN & PARR, 1936, p. 144; (*ex* Homotrematidae CUSHMAN, 1927); Homotrematinae *nom. correct.* POKORNÝ, 1958, p. 333]

Test attached, early stage trochospiral, later growth irregular, extending upward from attachment, becoming branched; apertures large, and may be covered by perforated plate. *Eoc.-Rec.*

Homotrema HICKSON, 1911, *922, p. 445 [**Millepora rubra* LAMARCK, 1816, *1088, p. 202; OD

(M)]. Test attached, large, 2 to 8 mm. diam., variable in form, may be globose, hemispherical, encrusting with irregular swellings, with trun-

cated conical projections or erect branches, possibly environmentally controlled; early chambers in spiral or "raspberry" arrangement, later cham-

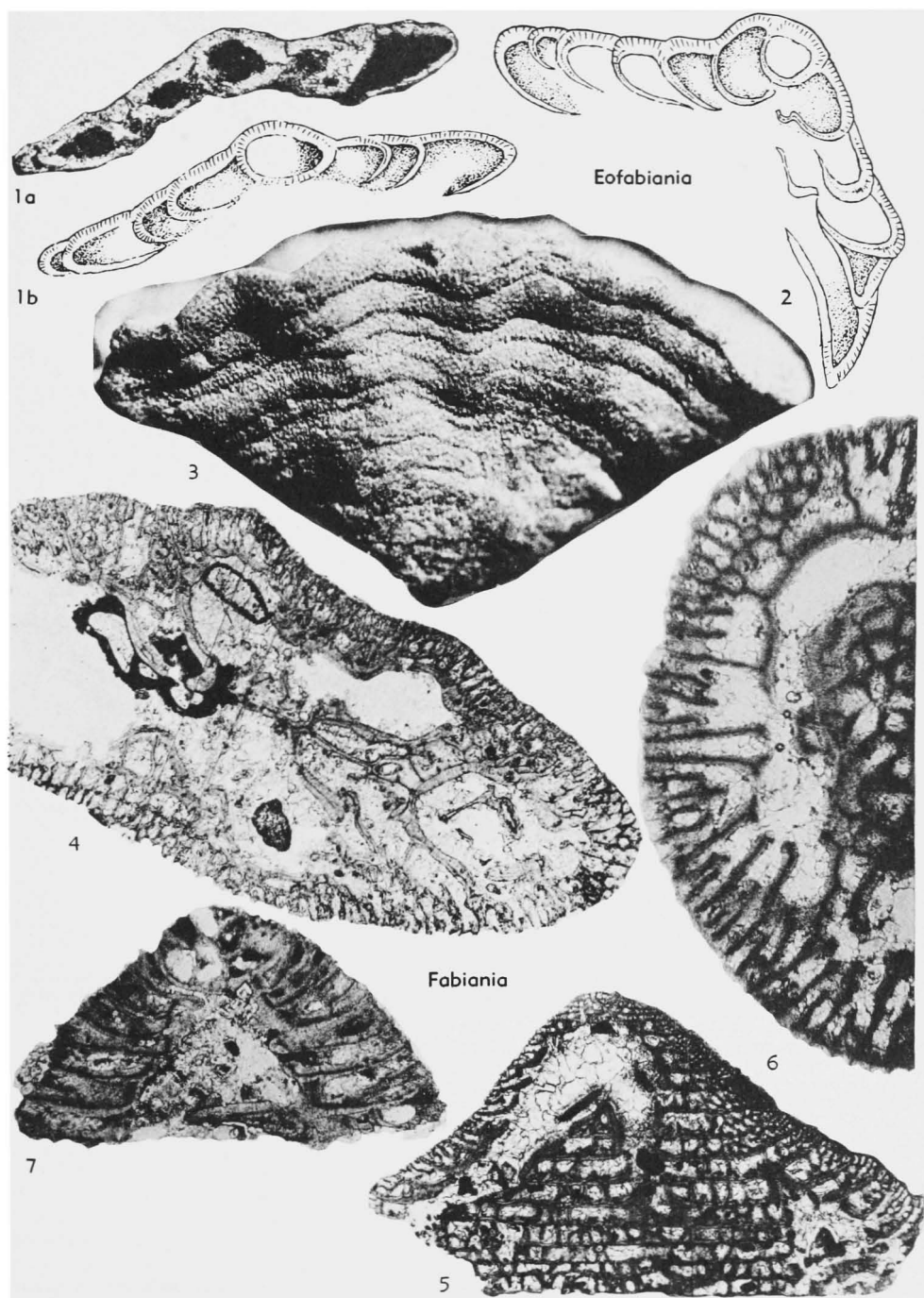


FIG. 574. Cymbaloporidae; 1, 2, *Eofabiania*; 3-7, *Fabiania* (p. C701-C702).

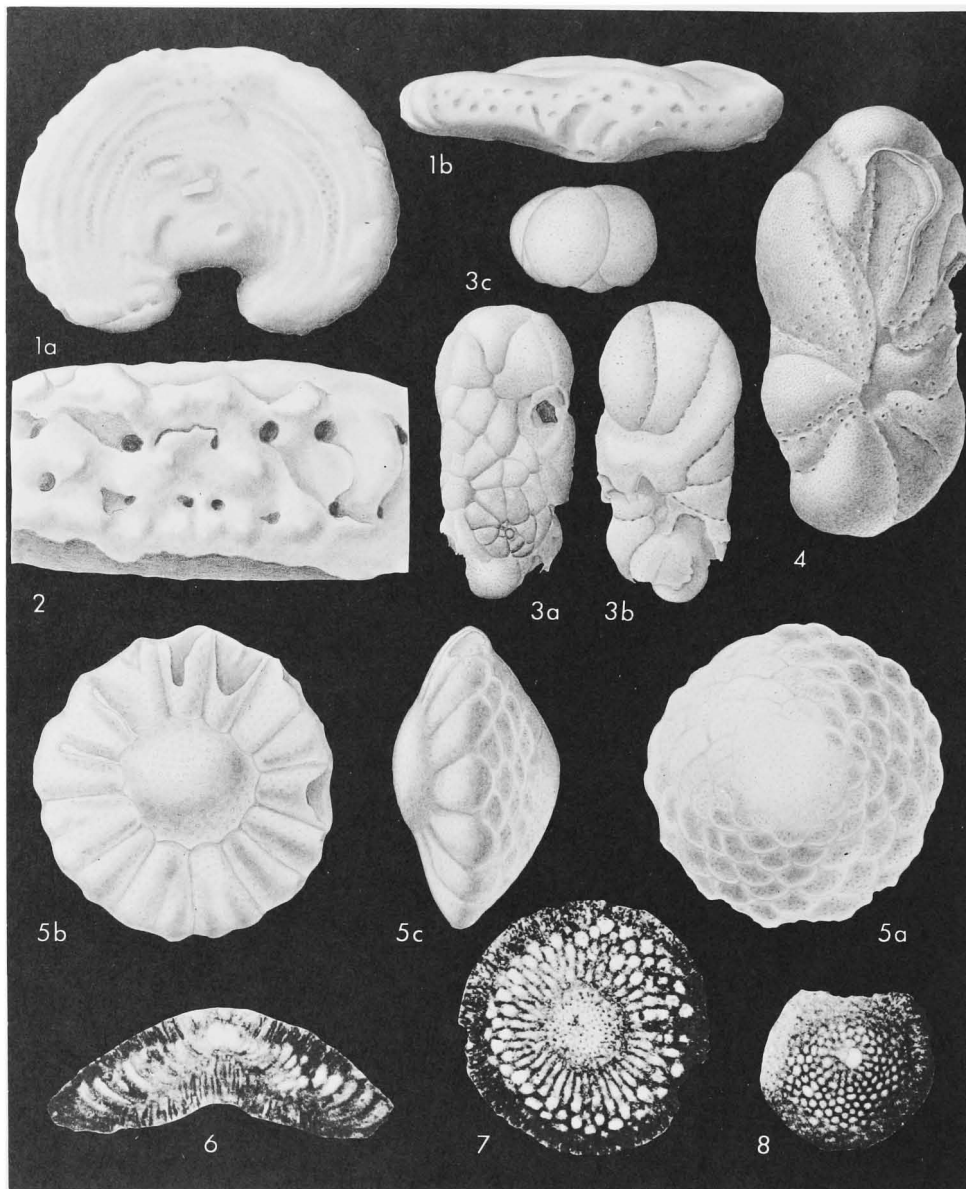


FIG. 575. Cymbaloporidae; 1,2, *Gunteria*; 3,4, *Pyropilus*; 5-8, *Halkyardia* (p. C702).

bers in roughly concentric layers, outer surface with cribrate areolae surrounded by imperforate rims (chamber walls), beneath areolae containing large passages and irregular hollows, partially due to resorption; as additional layers of chambers are added, new cribrate plates appear above earlier ones, and at intervals continuous cribrate wall may cover imperforate areolae, later forming new areolae, earlier layer being covered simultaneously by nonperforate material; some large openings not covered by perforated plates may show protruding sponge spicules cemented by protoplasmic

material; wall of early spiral portion pseudochitinous and insoluble, later portion calcareous, red; aperture consisting of large pores in areolae and large irregular openings with contained sponge spicules. *Rec.*, Atl.O.-Carib.-Ind.O.-Pac.O. —FIG. 577, 1-3. **H. rubrum* (LAMARCK), Ind.O. (1), Indon. (2), Bermuda (3); 1, ext. of branching form, $\times 4.5$ (*922); 2, partially sectioned specimen showing perforated plates, imperforate areolae at surface, and inner walls with irregular openings, $\times 17$ (*928a); 3, continuous cribrate layer added over earlier areolae, $\times 170$ (*702).

Miniacina GALLOWAY, 1933, *762, p. 305 [*pro Pustularia* GRAY, 1858, *812, p. 270, 271 (type, *P. rosea*) (non SWAINSON, 1840)] [*Millepora miniacea* PALLAS, 1766, *1407, p. 251; OD]. Test encrusting or branching, branches commonly more elongate and slender than in *Homotrema*, to 7 mm. in height; early stage with spiral or "raspberry" chamber arrangement, later with layers of perforated laminae, pores about 5μ diam., adjacent laminae connected by hollow pillars with imperforate double walls, which grow upward from foramina of previous lamina, central portion of branches with irregularly twisted elongate vertical tubes without perforate walls, which arise near base and extend to tips of branches; wall calcareous, red, pink, or white, surface with openings of 2 sizes, smaller wall perforations, and larger "pillar pores" or foramina $30\text{--}80\mu$ diam. *Rec., Medit. Sea-Malay Arch.-Ind.O.-S.Pac.O.*—FIG. 577,4-7. **M. miniacea* (PALLAS), Indon.; 4a,b, ext. of encrusting and branching types, $\times 4.5$; 5, diagram. transv. sec. of branch showing concentric layers of chambers, hollow "pillar pores" or foramina, and smaller perforations (*922); 6, surface showing small perforations and larger foramina, $\times 50$ (*922); 7, part of transv. sec. showing pores, foramina, and double walls of "pillar pores," $\times 175$ (*928a).

Sporadotrema HICKSON, 1911, *922, p. 447 [*Polytrema cylindricum* CARTER, 1880, *296, p. 441; OD]. Test attached, large, to 27 mm. in height, early juvenile stage coiled, later with large cylindrical branches; chambers large, at periphery of branches, communicating by large open passages, central portion of branches occupied by irregularly shaped tubes that spiral up trunk and branches and may open at tips of branches; inner septal walls nonperforate; wall calcareous, surface coarsely perforate, pores irregularly scattered, large ones at surface resulting from fusion within wall of numerous fine pores at inner surface of wall, lacking both areolae, found in *Homotrema*, and "pillar pores" of *Miniacina*, may incorporate siliceous sponge spicules in varying amounts; color, red, yellow, or orange. *Eoc.-Rec., Pac.O.-Ind.O.*—FIG. 578,1-4. **S. cylindricum* (CARTER), *Rec., Ind.O. (1,2,4)*, Indon. (3); 1, ext. showing branching form, $\times 2$ (*922); 2, portion of branch, enlarged (*922); 3, diagram. long. sec. showing large peripheral chambers, internal long. stoloniferous tubes, finely porous inner chamber surface, pores fusing in wall to form fewer and larger openings at surface, enlarged (*928a); 4, surface showing large pores formed by fusion of small inner pores, $\times 50$ (*922).

Subfamily VICTORIELLINAE

Chapman & Crespin, 1930

[*nom. transl.* LOEBLICH & TAPPAN, herein (ex family Victoriellidae CHAPMAN & CRESPIN, 1930, p. 111)]

Test attached, early chambers trochospiral, later extending upward from base in



FIG. 576. Cymbaloporidae; 1,2, *Gunteria* (p. C702).

loose spiral or becoming irregular rounded mass; wall calcareous, perforate, radial in structure, bilamellar; aperture interiomarginal. *U.Cret.-Rec.*

Victoriella CHAPMAN & CRESPIN, 1930, *323, p. 111, 112 [*Carpenteria proteiformis* var. *plecte* CHAPMAN, 1921, *321, p. 320, =*Carpenteria conoidea* RUTTEN, 1914, *1598, p. 47; OD (M)]. Test conical, commonly attached at apex, juvenile stage free, in low trochospiral coil of few chambers, when temporary or permanent attachment occurs direction of coiling may reverse and coiling is high-spired in adult, umbilicus depressed or forming axial hollow; chambers inflated, 3 or 4 to whorl, not embracing; sutures depressed but wall lamellae obscure early ones; septa of 3 layers, 2 layers of preceding chamber and inner lamella of following one; wall calcareous, thick, coarsely perforate, except for imperforate area surrounding aperture, radiate in structure, bilamellar, no canals between layers, but some interlocular spaces may occur in walls, numerous round to elliptical bosses interspaced between perforations, formed by pillar-like thickenings in wall which displace wall perforations; aperture umbilical in position, with thick lip on 3 sides. *U. Eoc.-Mio., Australia-N.Guinea-N.Z.-Eu.*—FIG. 579,1-3. **V. conoidea* (RUTTEN), Oligo., Australia; 1, ext., $\times 25$; 2a, vert. sec. showing wall pillars,

layering, and bilamellar structure, $\times 46$; *2b*, portion enlarged to show 3-layered septa with single lamella of final chamber (at left) attached

to bilamellar septal face of penultimate chamber, $\times 85$; *3a*, diagram showing early chamber arrangement with proloculus and early whorl ob-

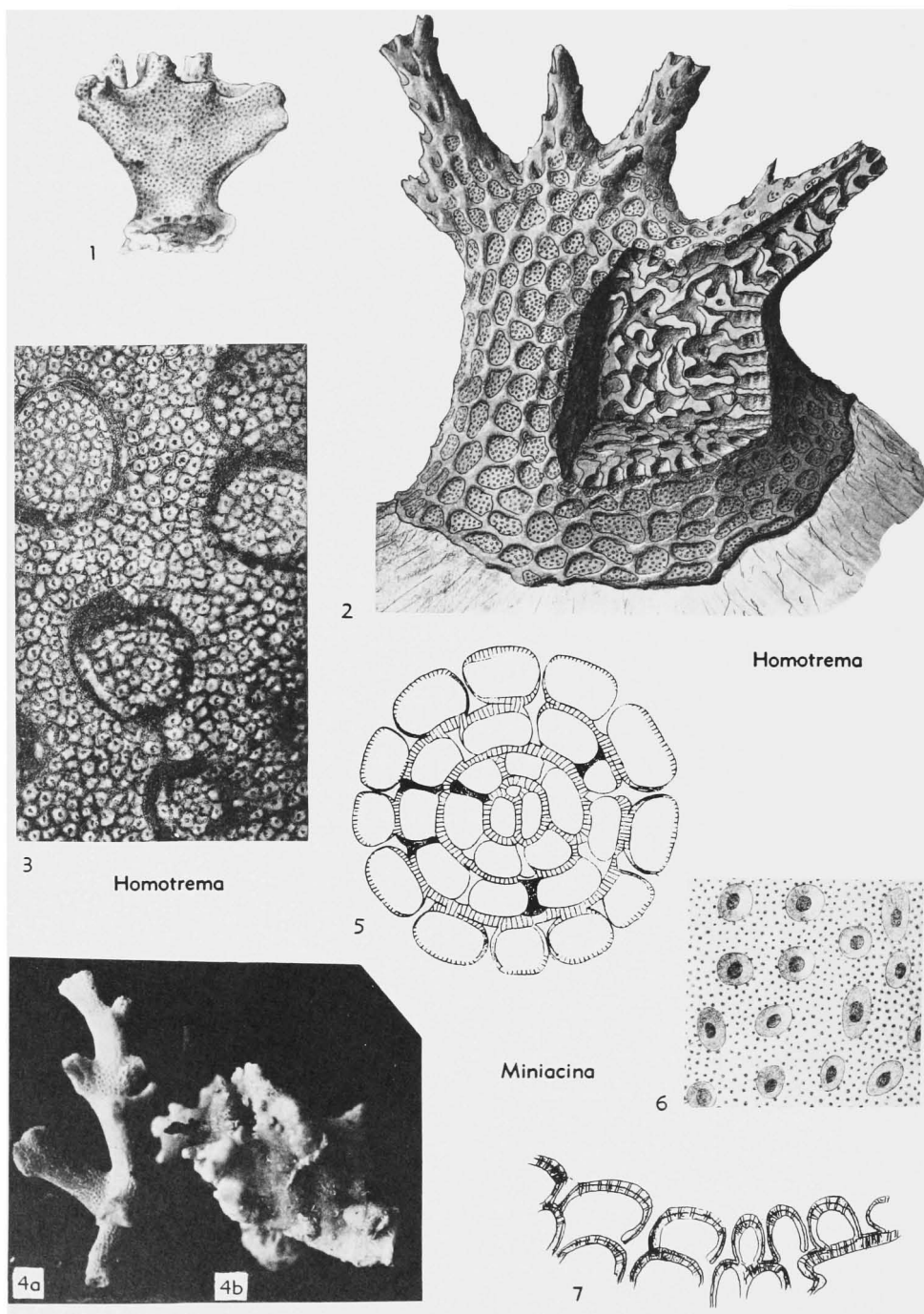


FIG. 577. Homotrematidae (Homotrematinae; 1-3, *Homotrema*; 4-7, *Miniacina*) (p. C702-C705).

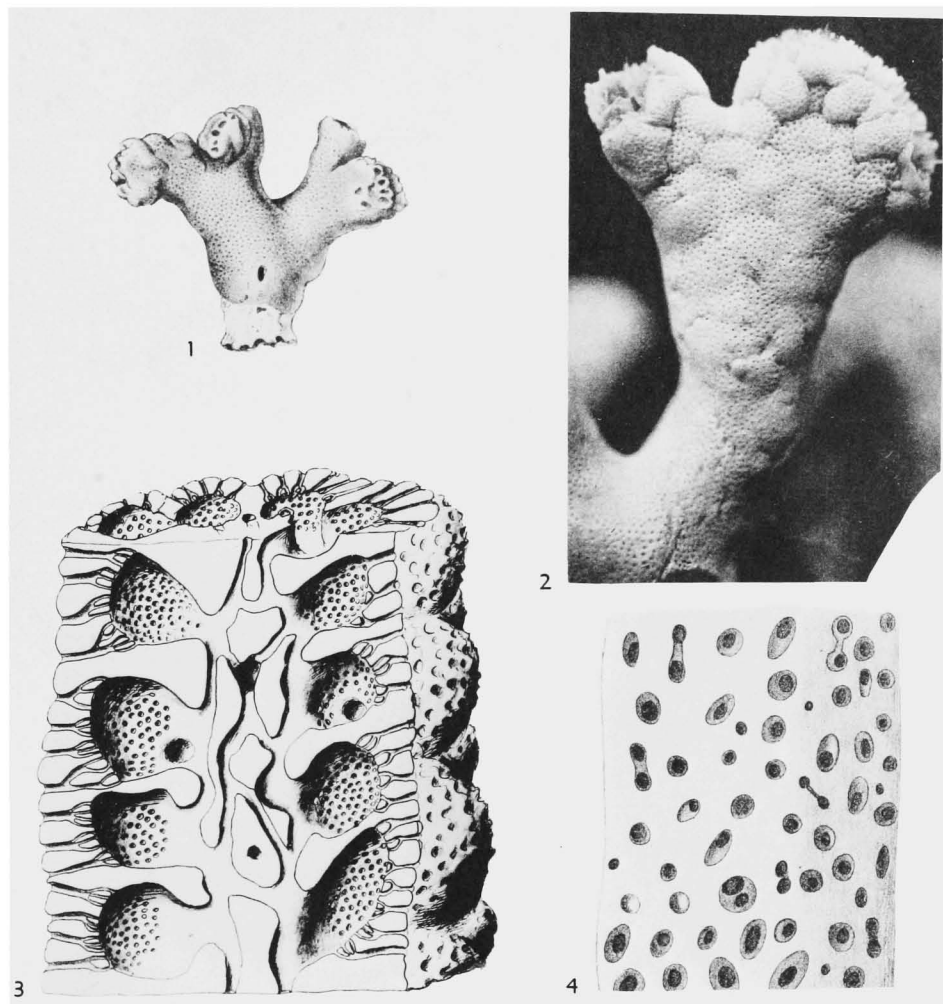


FIG. 578. Homotrematidae (Homotrematinae; 1-4, *Sporadotrema*) (p. C705).

lique to later axis of coiling around axial hollow, attachment surface at side of third or fourth chamber, radial wall structure (shown only at right of figure), $\times 40$; 3b, portion of previous figure enlarged to show pillars and their displacement of pores, $\times 120$ (*797).

Carpenteria GRAY, 1858, *812, p. 269, 270 [**C. balaniiformis*; OD (M)] [= *Neocarpenteria* CUSHMAN & BERMÚDEZ, 1936, *489, p. 34 (type, *N. cubana*); *Carpenterella* BERMÚDEZ, 1949, *124, p. 313 (type, *C. truncata*) (non *Carpenterella* COLLENETTE, 1933; nec KRASHENINNIKOV, 1953); *Bermudezella* THALMANN, 1951, *1899d, p. 224 (nom. subst. pro *Carpenterella* BERMÚDEZ, 1949, non COLLENETTE, 1933); *Haerella* BELFORD, 1960, *110, p. 112 (type, *H. conica*)]. Test attached, plano-convex, trochospiral, all chambers visible from flat, attached spiral side, only those of last whorl visible on convex, centrally umbilicate op-

posite side, peripheral keel may spread slightly over attachment; wall calcareous, distinctly perforate over umbilical surface of chambers, radial in structure, only keel and small area around umbilical area and apertural margin being non-perforate, thickened shell material produced into pillar-like extensions around umbilicus on older specimens; aperture slitlike, extending from periphery along base of final chamber into open umbilicus. *U.Cret.-Rec.*, Pac.O.-Australia-W.Indies (Cuba-Carib.).—FIG. 580,1. **C. balaniiformis*, Rec., Funafuti Atoll; 1a-c, opposite sides and edge view, $\times 20$ (*2117).—FIG. 580,2. *C. conica* (BELFORD), *U.Cret.* (Campan.), W.Australia; 2a-c, opposite sides and edge view of holotype, $\times 37$ (*110).—FIG. 580,3. *C. truncata* (BERMÚDEZ), M.Oligo., Haiti; 3a-c, opposite sides and edge view of holotype, $\times 39$ (*2117).—FIG. 580,4. *C. cubana* (CUSHMAN & BERMÚDEZ), Eoc., Cuba;

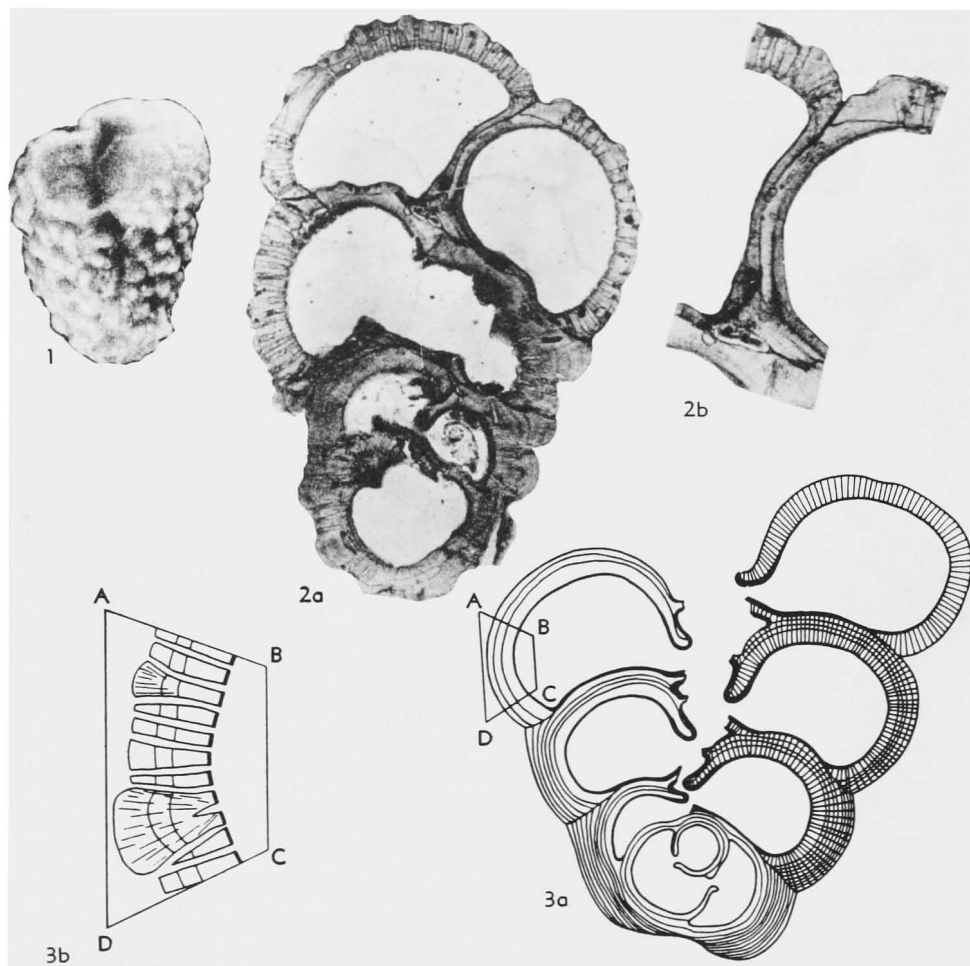


FIG. 579. Homotrematidae (Victoriellinae; 1-3, *Victoriella*) (p. C705-C707).

4a-c, opposite sides and edge view of paratype, $\times 76$ (*2117).

[The original description of *Carpenteria* was somewhat generalized, and GRAY's types from the Philippine Islands are not preserved. The present redefinition is based on the type-species as shown by the specimen figured by CHAPMAN (1900, *314, p. 13, pl. 4, fig. 2) (BMNH Cat. No. 03.2.5.124, from off Funafuti at 115-200 fathoms, here redrawn). GRAY's original figures also show a low conical form which undoubtedly suggested the specific name of the type-species (barnacle-formed). Later workers have erroneously included much higher or uncoiled forms in *Carpenteria*. *Neocarpenteria* was proposed for a plano-convex trochoid form with semicircular ventral marginal aperture. This semicircular opening in the type-specimen (here redrawn) is merely an irregular remnant of the broken final chamber and the true aperture is not shown. CUSHMAN & BERMÚDEZ (*489, p. 34) stated, "There seems to be a tendency to grow upward slightly on the ventral side, suggesting the type of development seen in *Carpenteria*." As the type-species of *Carpenteria* does not grow upward into a cylindrical form and the apertural distinction is nonexistent, the name *Neocarpenteria* is a junior synonym. *Carpenterella* was defined by BERMÚDEZ (1949, *124) to include similar plano-convex forms with a slitlike interiomarginal aperture. It was said to differ from *Carpenteria* in having a simple trochoid form and not becoming uniserial. A homonym of *Carpenterella* COLLENETTE, 1933, *Carpenterella* BERMÚDEZ was later renamed

Bermudezella, but as the type-species of *Carpenteria* is also a low, rather than uniserial, form, both *Carpenterella* BERMÚDEZ and *Bermudezella* THALMANN are junior synonyms. The high cylindrical forms previously placed in *Carpenteria* should be referred to *Biarrizina*.]

Eorupertia YABE & HANZAWA, 1925, *2090, p. 77 [pro *Uhligina* YABE & HANZAWA, 1922, *2088, p. 71 (non SCHUBERT, 1899)] [**Uhligina boninensis* YABE & HANZAWA, 1922, *2088, p. 72; OD] [= *Gyroidinella* Y. LE CALVEZ, 1949, *1112, p. 27 (type, *G. magna*); *Neogyroidina* BERMÚDEZ, 1949, *124, p. 255 (type, *Gyroidina protea* CUSHMAN & BERMÚDEZ, 1937, *491, p. 22)]. Test trochospirally coiled, cylindrical or subconical in form, attached at spiral side of early stage, umbilicate, with chambers coiled about axial hollow, periphery angular to rounded; wall calcareous, radial in structure, perforate, except in apertural region, bilamellar, 2 laminae separated by dark layer, pillars developed in wall, septa 3-layered as in *Victoriella* and may enclose interseptal spaces; aperture umbilical, interiomarginal, slitlike, with

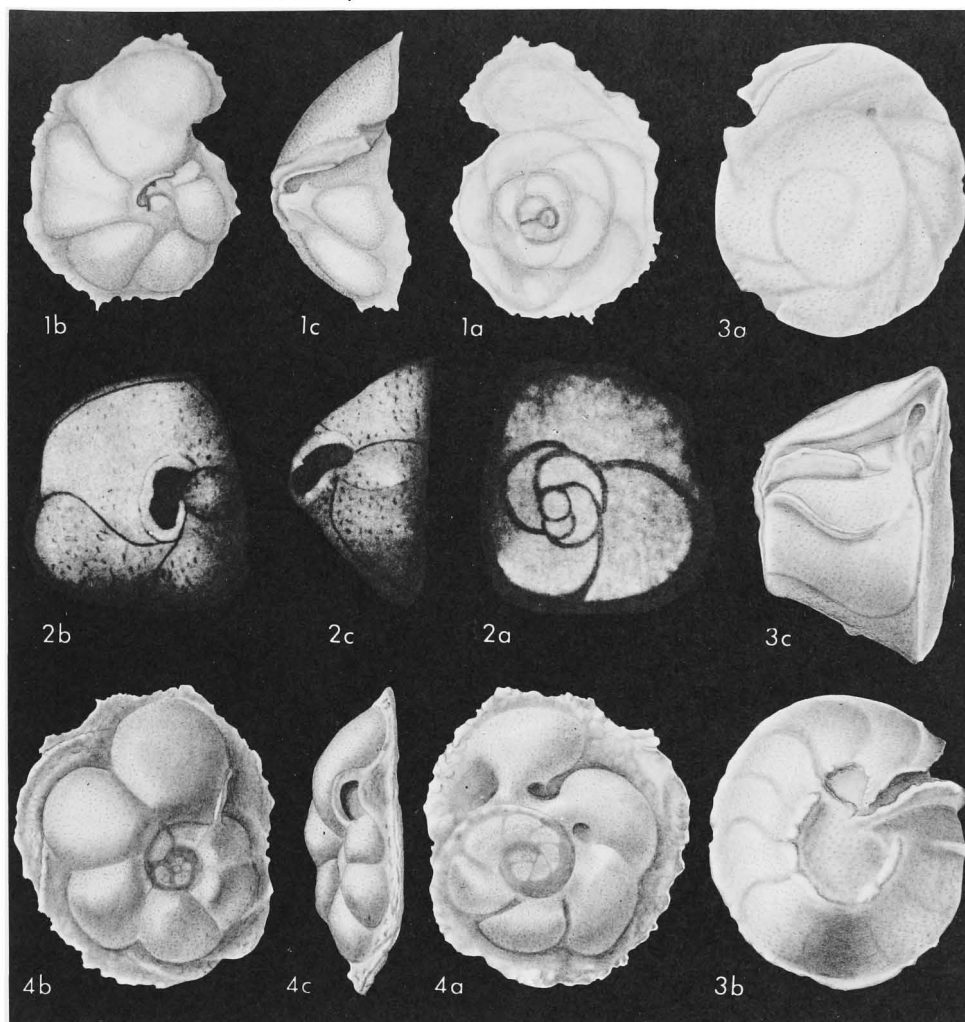


FIG. 580. Homotrematidae (Victoriellinae; 1-4, *Carpenteria*) (p. C707-C708).

lip. [The synonymy of *Gyroidinella* with *Eoruperia* was demonstrated by REISS (*1528c, p. 6).] *M. Eoc.-U. Eoc.*, W.Pac.O. (Bonin Is.)-Eu.-S. Am.-M. East-Carib.-N. Am.-Japan. — FIG. 581, 1-6. **E. boninensis* (YABE & HANZAWA), *Eoc.*, Haha-jima, Japan; 1, ext., $\times 10$; 2, 3, long. secs. at side of axial hollow and nearly axial long. sec., $\times 20$; 4, transv. sec. showing chambers around axial hollow, $\times 20$; 5, diagram showing bilamellar wall and pillars, $\times 20$; 6, diagram of wall showing relation of pores and conical pillars (*2090). — FIG. 582, 1-3. *E. magna* (Y. LE CALVEZ), *M. Eoc.* (Lutet.), Fr. (1), *Eoc.*, Israel (2, 3); 1a-c, opposite sides and edge view, $\times 23$ (*2117); 2, horiz. sec., $\times 14$ (*1528c); 3, axial section, $\times 37$ (*1528c).

Maslinella GLAESSNER & WADE, 1959, *797, p. 203 [*M. chapmani*; OD]. Test large, early stage low, trochospiral, later pseudoplanispiral and semi-

involute with axis of coiling perpendicular to that of early stage, but asymmetrical; chambers inflated, periphery subangular to rounded, increasing gradually in size; sutures straight to curved, radial, thickened and limbate on spiral side of test; wall calcareous, thick, coarsely perforate, radial in structure, bilamellar, 3-layered septa and apertural face nonperforate; aperture low interior-marginal equatorial opening with thickened lip. *U. Eoc.*, Australia. — FIG. 583, 1-4. **M. chapmani*; 1a-c, opp. sides and edge view of holotype showing coarsely perforate wall and thickened sutures, $\times 25$; 2, edge view of paratype showing apert., $\times 25$; 3, part of median horiz. sec. showing 3-layered septa and thickened apert. lips, $\times 46$; 4, vert. sec. showing nepionic coil in plane of coiling and later coil at right angles to it, and thick wall with pillars and pores, $\times 95$ (*797).

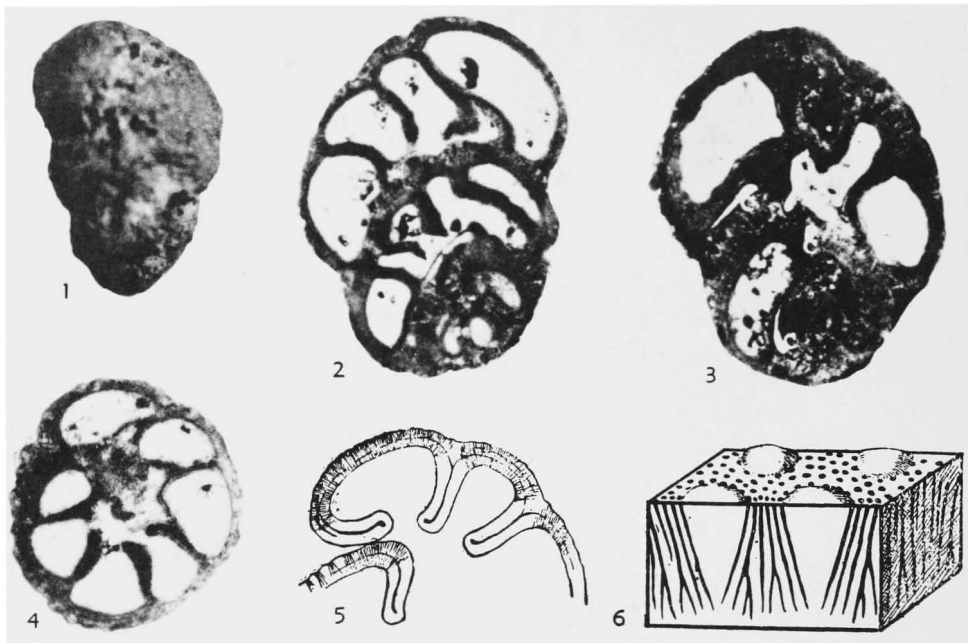


FIG. 581. Homotrematidae (Victoriellinae; 1-6, *Eorupertia*) (p. C708-C709).

ORBITOIDIDAE

By W. STORRS COLE

Family ORBITOIDIDAE Schwager, 1876

[*nom. correct.* EIMER & FICKERT, 1899, p. 688 (*pro* Orbitoides SCHWAGER, 1876, p. 481)] [=subfamily Orbitoidinae PREVER, 1904, p. 111; =family Orbitoidinae SILVESTRI, 1907, p. 12 (*nom. van.*); =Orbitoidae SILVESTRI, 1937, p. 155; =Orbitoidida COPELAND, 1956, p. 188; =Clypeorbininae SIGAL in PIVETEAU, 1952, p. 259; =Lepidorbitoididae POKORNÝ, 1958, p. 388 (*ex* Lepidorbitoidinae VAUGHAN in CUSHMAN, 1933, p. 285); =Pseudorbitellinae HANZAWA, 1962, p. 148]

Test biconcave to spherical, with embryonic chambers enclosed by thick perforate wall, or with thinner-walled bilocular embryonic chambers followed by several relatively large periembryonic chambers; equatorial and lateral chambers not differentiated, or equatorial chambers covered on each side with distinct zones of lateral chambers; equatorial chambers arcuate or short, spatulate; with stolons, but without canal system. *U.Cret.-Paleoc.*

An analysis of the initial chambers of microspheric specimens of *Orbitoides* led KÜPPER (*1068) to postulate that the orbitoidids were derived from a calcareous, biserial ancestor similar in structure to certain genera referred to the Guembelininae of the Heterohelicalidae. Two genera, *Lepidorbitoides* (U.Cret.) and *Actinosiphon* (Paleoc.), which have been associated tra-

ditionally with the lepidocyclines, are here assigned provisionally to the Orbitoididae.

Although *Lepidorbitoides* and *Actinosiphon* resemble the lepidocyclines in form and structure, they cannot be related to them, inasmuch as the first true lepidocycline appeared in the middle Eocene. As the structures of certain species of *Orbitoides* are similar to those of *Lepidorbitoides*, it seems logical to postulate that *Lepidorbitoides* was derived from *Orbitoides* and in turn generated *Actinosiphon* as the final representative of this dominantly Upper Cretaceous family.

Orbitoides D'ORBIGNY in LYELL, 1848, *1192, p. 12 [**Lycophris faujasii* DEFRANCE, 1823, *579b, p. 271; =*Orbitolites media* D'ARCHIAC, 1837, *35, p. 178; SD JONES, PARKER, & BRADY, 1866, *1002, appendix I] [=Hymenocyclus BRONN, 1853, *214a, p. 94 (type, *Lycophris faujasii* DEFRANCE, 1822, *579b, p. 271); *Simplorobites* DEGRIGORIO, 1882, *815, p. 10 (type, *Nummulites papyracea* BOUBÉE, 1832, *176A, p. 445); *Silvestrina* PREVER, 1904, *1482, p. 113, 122 (type, *Orbitoides apiculata* SCHLUMBERGER, 1901, *1661, p. 465); *Schlumbergeria* A. SILVESTRI, 1910, *1771A, p. 118 (type, *Linderina? douvillei*); *Orbitella* DOUVILLÉ, 1915, *621, p. 666 (type, *Orbitolites media* D'ARCHIAC, 1837, *35, p. 178); *Monolepidorbis* ASTRE, 1927, *54, p. 388 (type, *M. sanctae-pelagiae*); Gallo-

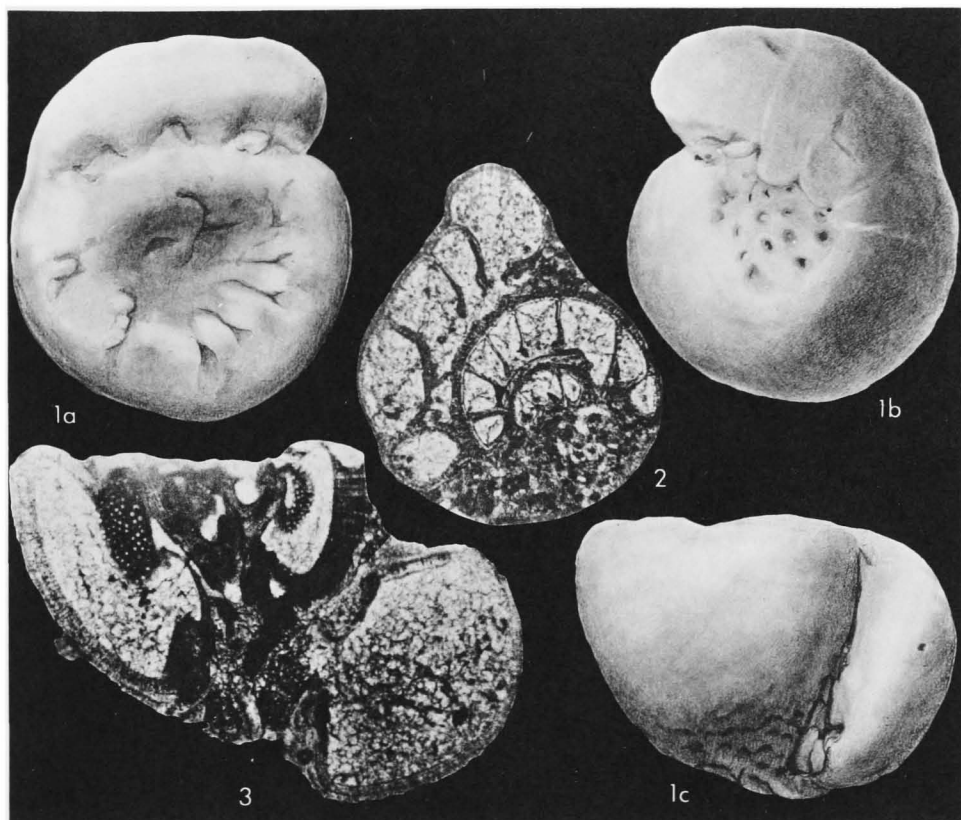


FIG. 582. Homotrematidae (Victoriellinae; 1-3, *Eorupertia*) (p. C708-C709).

wayina ELLIS, 1932, *699, p. 1 (type, *G. browni*); *Hellenocyclina* REICHEL, 1949, *1521, p. 482 (type, *H. beotica*). Embryonic chambers surrounded by thick, perforated wall, bilocular to quadrilocular, or teratologically with more than 4 irregularly arranged chambers; equatorial chambers arcuate; lateral chambers reduced or well developed, slit-like. *U.Cret.*, Eu.-Asia(India)-N.Am.—FIG. 584, 3. **O. faujasii* (DEFrance), Fr.; 3a,b, equat. sec. vert. sec., $\times 40$, $\times 20$ (*2113c).

Actinosiphon VAUGHAN, 1929, *1990, p. 163, 166 [**A. semmesi*; OD] [= *Orbitosiphon* RAO, 1940, *1498, p. 414 (type, *Lepidocyclina* (Polylepidina) *punjabensis* DAVIES in DAVIES & PINFOLD, 1937, *563, p. 53)]. Embryonic chambers bilocular, large, completely surrounded by a ring of about 11 perieembryonic chambers; equatorial chambers in rude radial rows with communication by large median stolon. *Paleoc.*, N.Am.(Mex.)-Indo-Pac. Reg.—FIG. 585, 1. **A. semmesi*, Mex.; equat. sec., $\times 80$ (*2122).

Lepidorbitoides A. SILVESTRI, 1907, *1766, p. 80 [**Orbitolites socialis* LEYMERIE, 1851, *1133, p. 191] [= *Clypeorbis* H. DOUVILLÉ, 1915, *621, p. 668, 669 (type, *Orbitoides mamillata* SCHLUMBERGER, 1902, *1662, p. 259); *Orbitocyclina* VAUGHAN, 1929, *1993, p. 291 (type, *Lepidorbit-*

oides minima DOUVILLÉ, 1927, *628A, p. 291); *Orbitocyclinoides* BRÖNNIMANN, 1944, *216, p. 5 (type, *Orbitocyclina* (*O.*) *schencki*); *Pseudorbitella* HANZAWA, 1962, *875, p. 148 (type, *P. americana*; OD)]. Embryonic chambers bilocular, small, with or without perieembryonic chambers; equatorial chambers arcuate to hexagonal; lateral chambers well developed. *U.Cret.*, Eu.-N.Am.-Carib.-Asia.

L. (Lepidorbitoides). Test circular, *U.Cret.*, Eu.-Asia(India)-N.Am., trop.—FIG. 584, 1. **L. (L.) socialis* (LEYMERIE), Fr.; 1a,b, equat. sec., vert. sec., $\times 40$, $\times 20$ (*2113c).

L. (Asterorbis) VAUGHAN & COLE, 1932, *1996, p. 611 [**A. rooki*; OD] [= *Cryptasterorbis* M. G. RUTTEN, 1935, *1599, p. 533 (type, ?*Asterorbis cubensis* PALMER, 1934, *1408, p. 249)]. Test stellate. *U.Cret.*, N.Am.-Carib., trop. zone.—FIG. 585, 2. **L. (A.) rooki*, Cuba; 2a,b, equat. and vert. secs., $\times 16$ (*2113c).

Omphalocyclus BRÖNN, 1852, *214a, p. 95 [**Orbulites macroporus* LAMARCK, 1816, *1088, p. 197; OD]. Embryonic chambers of megalospheric generation similar to those of *Orbitoides*, but with lateral chambers of same kind and not differentiated from equatorial chambers. *U.Cret.*, Carib.-Asia.

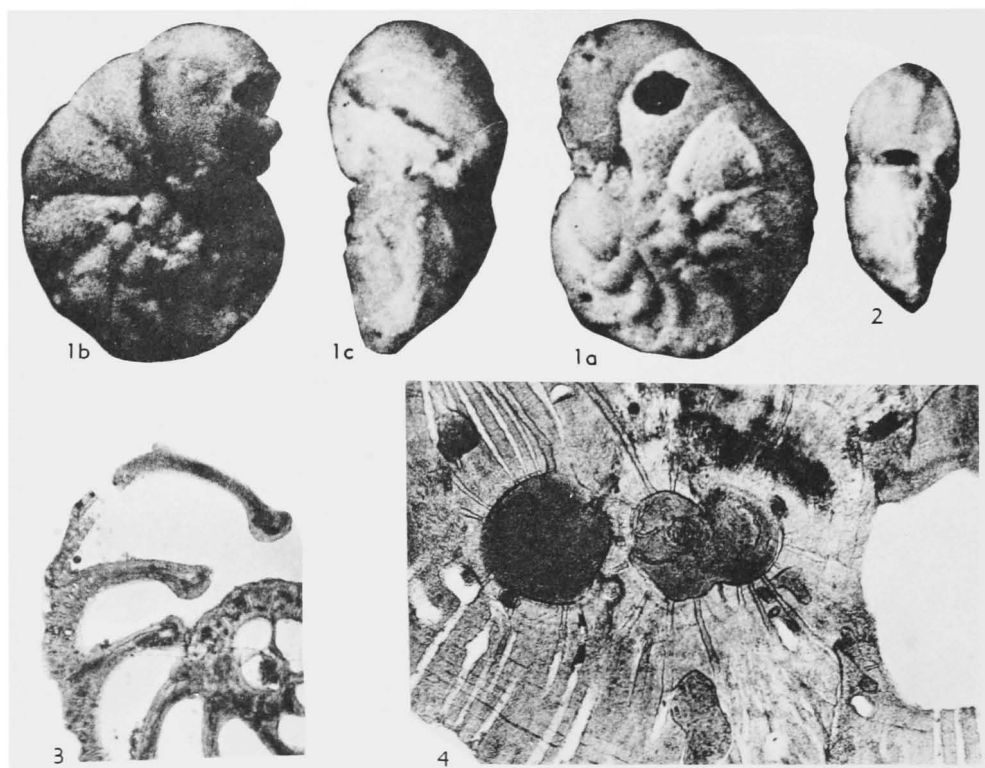


FIG. 583. Homotrematidae (Victoriellinae; 1-4, *Maslinella*) (p. C709).

O. (Omphalocyclus). Test strongly biconvex. *U. Cret.*, Eu.-Asia (India)-Carib. (Cuba). — FIG. 584,2. **O. (O.) macroporus* (LAMARCK), Cuba; 2a,b, equat. sec., vert. sec., $\times 40$, $\times 20$ (*2113c).
O. (Torreina) D. K. PALMER, 1934, *1408, p. 237 [*T. torrei*; OD]. Test nearly spherical. *U. Cret.*, Carib. — FIG. 584,4. **O. (T.) torrei*, Cuba; equat. sec., $\times 20$ (*1408).

DISCOCYCLINIDAE

By W. STORRS COLE

Family DISCOCYCLINIDAE

Galloway, 1928

[*nom. transl.* VAUGHAN & COLE in CUSHMAN, 1940, p. 327 (ex Discocyclininae GALLOWAY, 1928, p. 55) [=Orthophragminidae WEDEKIND, 1937, p. 123, 124; =Orthophragmininae WEDEKIND, 1937, p. 125; =Asterocyclinidae BRÖNNIMANN, 1951, p. 208; =Orbitoclypeidae POKORNÝ, 1958, p. 393 (ex Orbitoclypeinae BRÖNNIMANN, 1946, p. 612)]]

Test circular or stellate, thin or inflated, composed of equatorial layer with lateral chambers on each side; megalospheric generation with subspherical initial chamber partly or completely embraced by larger second chamber; microspheric generation with initial coil of small chambers; equatorial chambers rectangular to faintly hexagonal in plan; radial chamber walls, when

present, arranged in annuli; equatorial chambers connected by annular and radial stolons with adjacent chambers in same annulus and with adjacent chambers in next inner and next outer annulus; intraseptal and intramural canal system present (Fig. 586,1a). *Paleoc.-Eoc.*

BRÖNNIMANN (*218) suggested that this family should be divided into two subfamilies; Discocyclininae, in which the equatorial layer is composed of chambers and chamberlets (Fig. 586,1b), and Orbitoclypeinae, in which the equatorial layer is composed only of chambers (Fig. 586,2).

However, since the chambers of *Discocyclina* (*Discocyclina*) *anconensis* BARKER (Fig. 586,1d) are the same as those of typical representatives of the Orbitoclypeinae, it is doubtful if this family should be divided.

VAUGHAN (*1995) demonstrated that representatives of the Discocyclinidae possess interseptal canals (Fig. 586,1c), but BRÖNNIMANN (*221) interpreted these canals as a system of fissural interseptal spaces and,

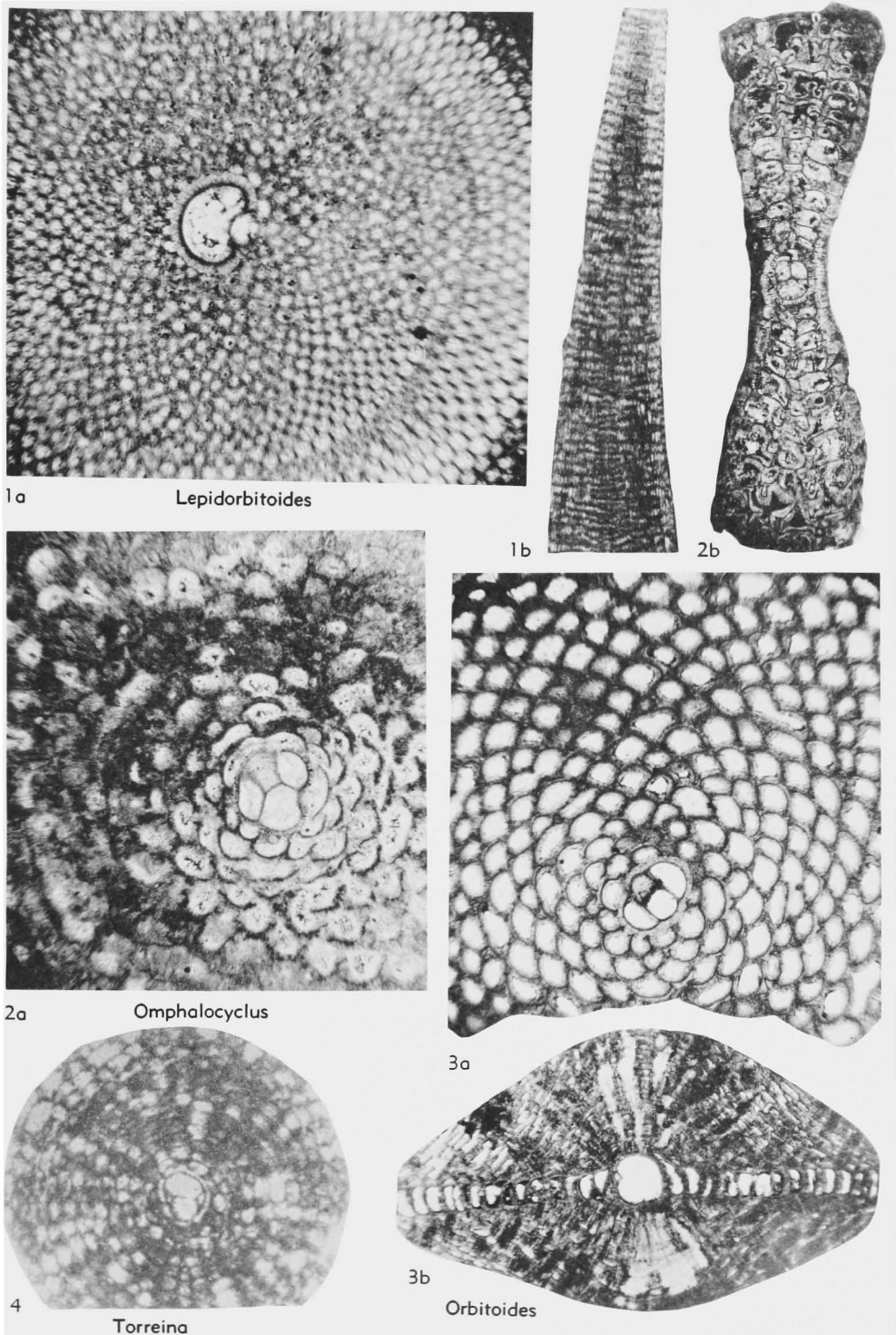


FIG. 584. Orbitoididae; 1, *Lepidorbitoides* (*Lepitorbitoides*); 2, *Omphalocyclus* (*Omphalocyclus*); 4, *O. (Torreina)*; 3, *Orbitoides* (p. C710-C712).

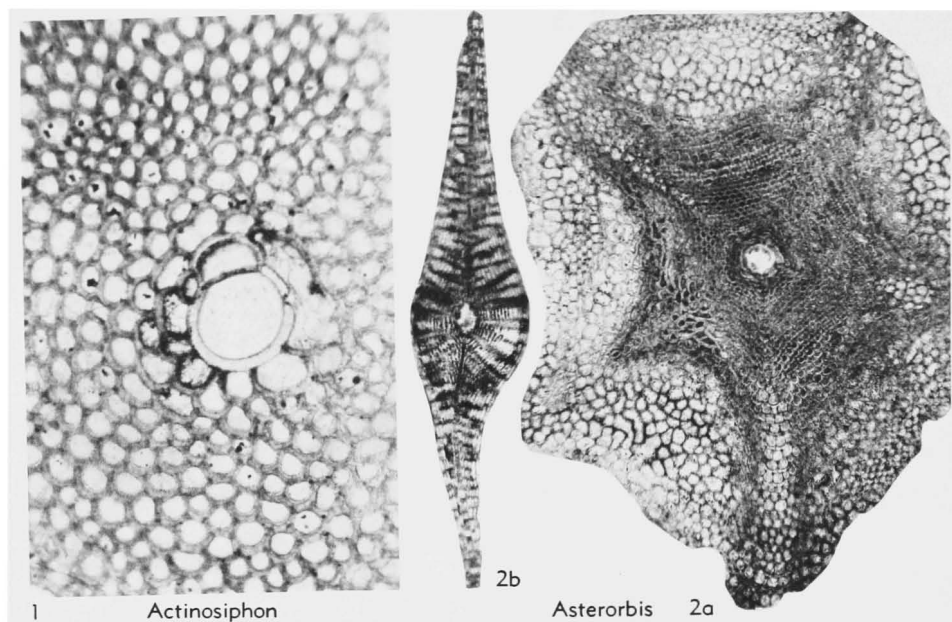


FIG. 585. Orbitoididae; 1, *Actinosiphon*; 2, *Lepidorbitoides* (*Asterorbis*) (p. C711).

therefore, not true canals of the kind developed in the nummulitids. VAUGHAN (*1995) derived the Discocyclinidae from a *Nummulites*-like ancestor because of the presence of both intraseptal canals and annular canals which he assumed were “the morphological representation of the canals in the marginal plexus of the Camerinidae [Nummulitidae]” (*1995, p. 52). BRÖNNMANN (*221, p. 211) questioned this origin for the Discocyclinidae.

Discocyclina GÜMBEL, 1870, *840, p. 687 [*Orbitulites pratti* MICHELIN, 1846, *1255, p. 278; SD GALLOWAY, 1928, *761, p. 56] [= *Rhipidocyclina* GÜMBEL, 1870, *840, p. 688 (type, *Orbitoides* (R.) *multiplicata* GÜMBEL, 1870); *Orthophragmina* MUNIER-CHALMAS, 1891, *1326, p. 17, 18, 19 (type, *Orbitulites pratti* MICHELIN, 1846, *1255, p. 278); *Orbitoclypeus* A. SILVESTRI, 1907, *1769, p. 106 (type, *O. himerensis*); *Exagonocyclina* CHECCHIA-RISPOLI, 1907, *330, p. 188 (type, *Orbitoides* (E.) *schopeni*, = *Orbitoclypeus himerensis* A. SILVESTRI); *Nodocyclina* HEIM, 1908, *893A, p. 271 (type, *Orthophragmina umbilicata* DEPRAT, 1905, *583, p. 497); *Eudiscodina* VAN DER WEIJDEN, 1940, *2042, p. 15 (type, *Orthophragmina archiaci* SCHLUMBERGER, 1903, *1663, p. 277); *Umbilicodiscodina* VAN DER WEIJDEN, 1940, *2042, p. 15 (type, *Orbitulites discus* RÜTI-MEYER, 1850, *1594, p. 116); *Tryblodiscodina* VAN DER WEIJDEN, 1940, *2042, p. 15 (type, *Orthophragmina chudeau* SCHLUMBERGER, 1903,

*1663, p. 282); *Hexagonocyclina* CAUDRI, 1944, *304, p. 362 (type, *Orbitoclypeus ?cristensis* VAUGHAN, 1924, *1988, p. 814); *Bontourina* CAUDRI, 1948, *305, p. 477 (type, *B. inflata*)]. Test circular in plan, discoidal or lenticular, with or without raised radiating ribs; annular stolon proximally situated; radial chamber walls of equatorial chambers in adjacent annuli usually alternating in position. *Paleo-Eoc.*, *Eu.-Indo-Pac.* *Reg.-N.Am.-S.Am.*

D. (Discocyclina). Test circular in plan; not stellate; without costae. *Paleo-Eoc.*, *Eu.-Indo-Pac.-N.Am.-S.Am.*—FIG. 587,1. *D. (D.) *pratti* (MICHELIN), *Eoc.* (Auvers.), *Eu.*, 1a, ext. view, $\times 5$ (*2042); 1b, equat. sec. with embryonic chambers, peribryonic chambers and equat. chambers, $\times 40$ (*2042); 1c, equat. chambers with proximally situated annular stolon, $\times 85$ (*1994).

D. (Aktinocyclina) GÜMBEL, 1870, *840, p. 688 [*Orbitulites radians* D'ARCHIAC, 1848, *37A, p. 405; SD DOLLFUS, 1889, *607, p. 1226] [= *Actinocyclina* GÜMBEL, 1870, *840, p. 707 (*nom. null.*)]. With elevated rays formed by local increase in number of lateral chambers; rays not terminating in protuberant angles as in *Asterocyclina*. *Eoc.* (Lutet.-Priabon.), *Eu.*—FIG. 587,2. *D. (A.) *radians* (D'ARCHIAC), Priabon.; 2a, ext. view, $\times 10$ (*2119); 2b, equat. sec. with embryonic chambers, peribryonic chambers and equat. chambers, $\times 50$ (*217); 2c, vert. sec., $\times 22$ (*1995).

Asterocyclina GÜMBEL, 1870, *840, p. 689 [*nom. subst. pro Asterodiscus* SCHAFHÄUTL, 1863 (*non*

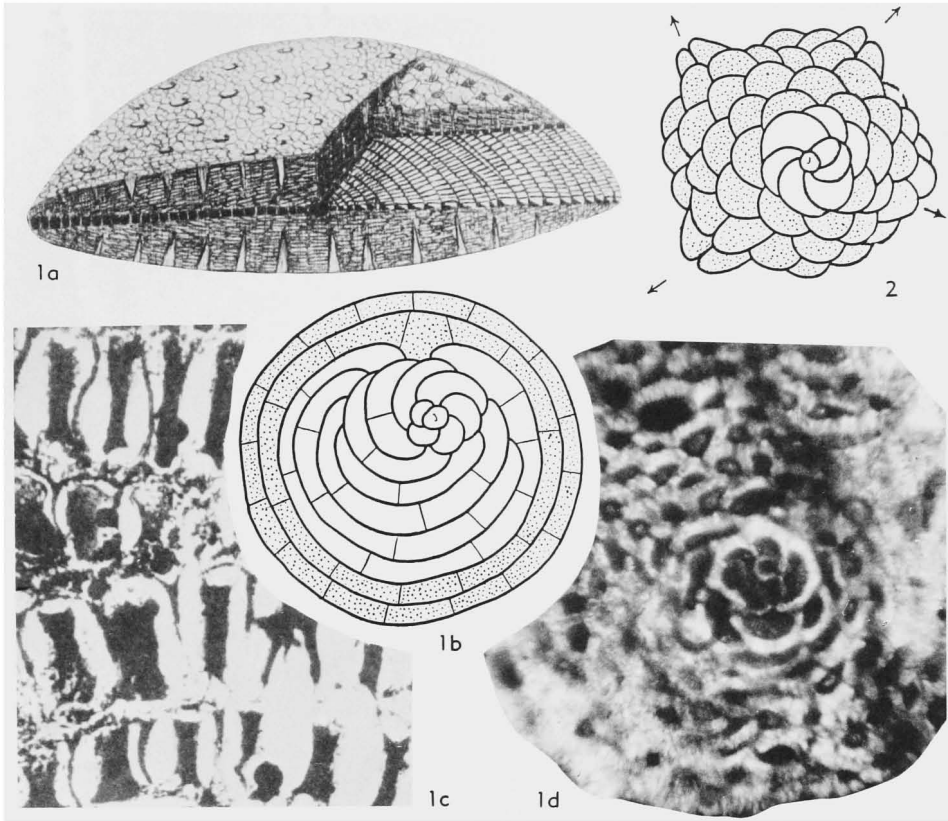


FIG. 586. Discocyclinidae: 1, *Discocyclina*, structural features shown by oblique view of partly sectioned test (1a) and equatorial section (1b) (diagrammatic, not to scale), vertical section showing canals, $\times 400$ (1c), and equatorial section, $\times 180$ (1d) (1a, *2121; 1b, *217; 1c, *1995; 1d, *2113c); 2, *Asterocyclina*, equatorial section (diagrammatic, not to scale) (*217).

EHRENBERG, 1840)] [**Asterodiscus pentagonalis* SCHAFHÄUTL, 1863, *1638, p. 107, =**Calcarina? stellata* D'ARCHIAC, 1846, *37, p. 199; OD (M)] [=?*Asteriacites* VON SCHLOTHEIM, 1822, *1649, p. 71 (type, *A. patellaris*); *Cisseis* GUPPY, 1886, *842, p. 584 (type, *C. astericus*) (non LAPORTE & GORY, 1839); *Asterodiscus* SCHAFHÄUTL, 1863, *1638, p. 107 (type, *A. pentagonalis*); *Asterodiscocyclina* BERRY, 1928, *130, p. 406 (type, *Orthophragmina* (*A.*) *stewarti*); *Orthocyclina* VAN DER VLIERK, 1933, *2011, p. 93 (type, *O. soerocanensis*); *Iso-discodina* VAN DER WEIJDEN, 1940, *2042, p. 15 (type, *Orthophragmina pentagonalis* DEPRAT, 1905, *583, p. 507)]. Test stellate, with radial zones of elongate equatorial chambers in equatorial plane. *M.Eoc.-U.Eoc.*, Eu.-Indo-Pac.Reg.-N.Am.-S. Am.—FIG. 587.3a. **A. stellata* (D'ARCHIAC), Lutet.-Auvers, Fr.; ext. view, $\times 4$ (*2120).—FIG. 587.3b,c. *A. georgiana* (CUSHMAN), U.Eoc. (Ocala), USA; vert. and equat. secs., $\times 40$ (*2113b). [See note, p. C796.]

Pseudophragmina DOUVILLÉ, 1923, *626, p. 106

[**Orthophragmina floridana* CUSHMAN, 1817, *408, p. 116; OD]. Test circular in plan, discoidal, or lenticular; annular stolon distally situated; radial chamber walls complete, incomplete, absent or indistinct, but when present, in alignment in adjacent annuli. *Paleoc.-Eoc.*, N.Am.-S. Am.-Asia (India).

P. (Pseudophragmina). Distal part of radial chamber walls degenerate, in places represented by rows of granules. *M.Eoc.-U.Eoc.*, N.Am.-S.Am.—FIG. 588.1. **P. (P.) floridana* (CUSHMAN), U.Eoc. (Ocala), USA (Fla.); 1a, equat. sec. with embryonic chambers, periembrionic chambers and equat. chambers, $\times 40$; 1b, equat. sec. with radial chamber walls in alignment, incomplete at their distal ends, $\times 40$; 1c, vert. sec. with embryonic chambers, equat. layer and lateral chambers; $\times 20$ (*2113c).

?P. (Asterophragmina) RAO, 1942 *1499, p. 9 [**P. (A.) pagoda*]. Possibly a defective specimen of *Asterocyclina*. *U.Eoc.*, Asia (Burma).

P. (Atheocyclina) VAUGHAN & COLE in CUSHMAN,

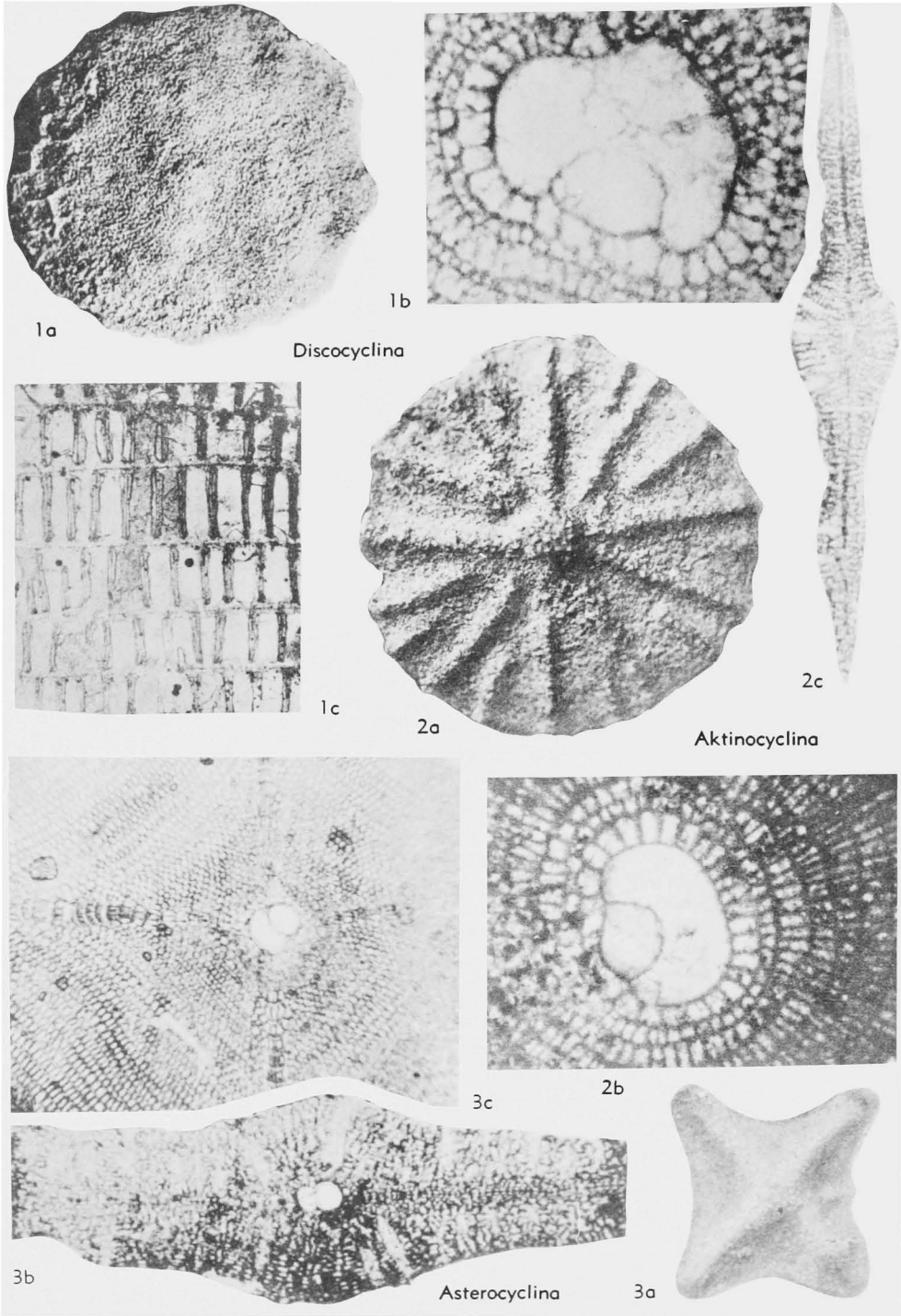


FIG. 587. Discocyclinidae; 1, *Discocyclina* (*Discocyclina*); 2, *D.* (*Aktinocyclus*); 3, *Asterocyclina* (p. C714-C715).

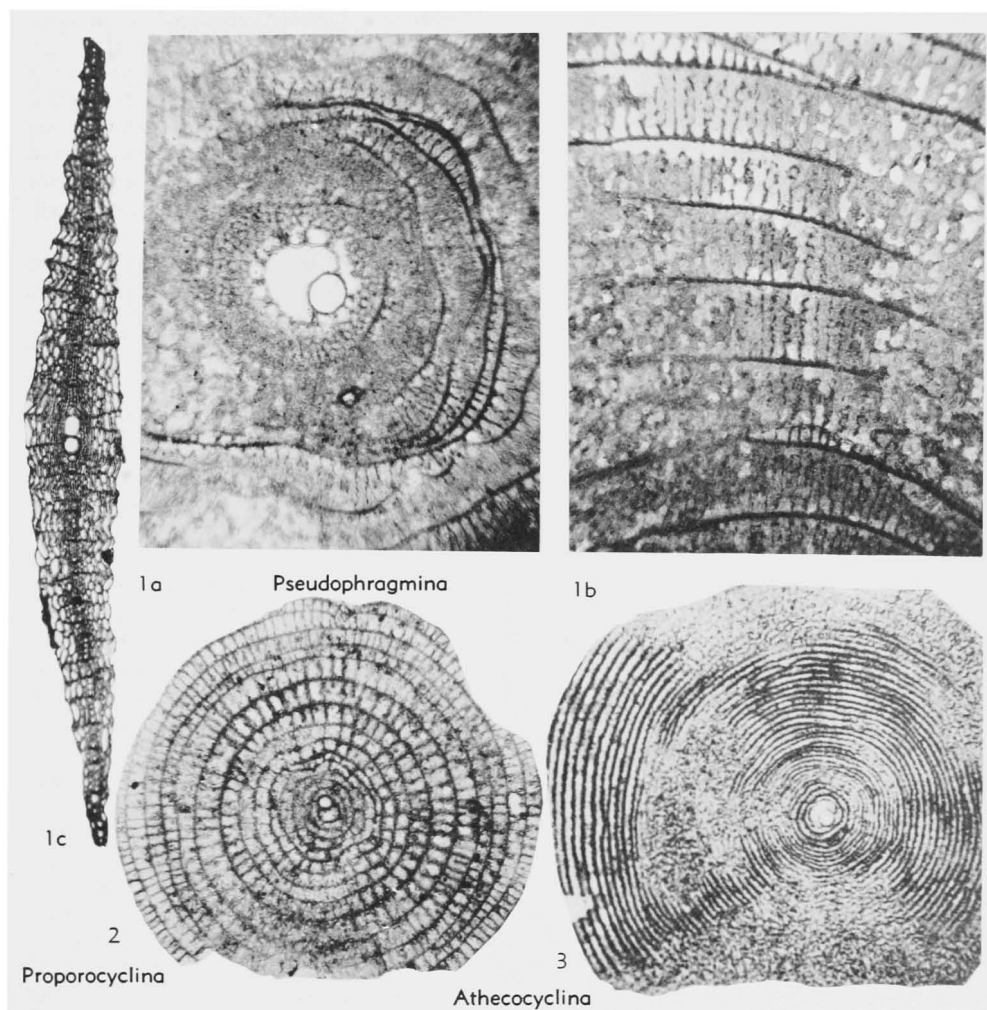


FIG. 588. Discocyclinidae; 1, *Pseudophragmina* (*Pseudophragmina*); 2, *P.* (*Proporocyclina*); 3, *P.* (*Athecocyclina*) (p. C715-C717).

1940, *474, p. 330 [*Discocyclina cooki* VAUGHAN, 1936, *1994, p. 256]. Radial chamber walls absent or indistinct. *Paleoc.-M.Eoc.*, N. Am.-S. Am.—FIG. 588.3. **P.* (*A.*) *cookei* (VAUGHAN), L.Eoc. (Wilcox), USA (Ala.); equat. sec., $\times 15$ (*1994).

P. (*Proporocyclina*) VAUGHAN & COLE in CUSHMAN, 1940, *474, p. 330. [*Discocyclina perpusilla* VAUGHAN, 1929, *1992, p. 9]. Radial chamber walls complete. *Paleoc.-Eoc.*, N. Am.-S. Am.—FIG. 588.2. **P.* (*P.*) *perpusilla* (VAUGHAN), M.Eoc. (Guayabal F.), Mex.; equat. sec., $\times 40$ (*2113c).

LEPIDOCYCLINIDAE

By W. STORRS COLE

Family LEPIDOCYCLINIDAE Scheffen, 1932

[Lepidocyclinidae SCHEFFEN, 1932, p. 251-252] [=Helicoleninidae POKORNÝ, 1958, p. 395 (*nom. transl. ex Helicoleninidae* TAN, 1936)]

Test circular or radiate, compressed to inflated lenticular, composed of distinct equatorial layer overlain on each side by zones of lateral chambers or by laminated shell material with vacuoles; embryonic chambers bilocular, followed by distinct, long spiral of periembrionic chambers, or by short spiral of these chambers, or by reduced sequences of periembrionic chambers on periphery of embryonic chambers; equator-

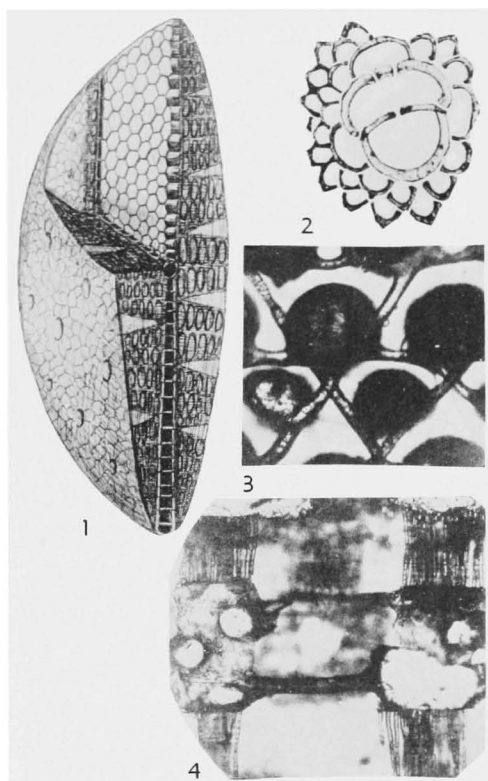


FIG. 589. Lepidocyclinidae; 1-4, structural features. —1. Oblique view of sectioned *Lepidocyclina* (*Lepidocyclina*) test showing equatorial chambers and lateral regions with pillars (diagrammatic, not to scale) (*2121). —2. Embryonic apparatus of *L. (Nephrolepidina)* with 3 primary periembryonic chambers and 6 coils of additional periembryonic chambers (*2120A). —3,4. Decalcified Canada balsam preparations of *L. (L.) montgomeryensis* showing (3) diagonal and annular stolons of 6-stolonal system in part of equatorial section, and (4) fine tubules that perforate roofs and floors as seen in part of vertical section, annular stolons and 3 apertures for stolons visible at left, both $\times 140$ (*1998).

ial chambers arcuate, ogival, rhombic, spatulate or hexagonal; chamber walls perforate with definite stolons, without canal system (Fig. 589,1). *M.Eoc.-M.Mio.*

The Helicolepidininae and Lepidocyclininae seemingly were derived from an *Amphistegina*-like ancestor. BARKER & GRIMSDALE (*84) have presented convincing evidence that such an ancestor could have generated two distinct lines, one developing into the Helicolepidininae, in which the equatorial layer is characterized by a well-developed

sequence of chambers arranged in an open spire that persists beyond the initial periembryonic spire, and the other producing the Lepidocyclininae, in which the spiral and even the periembryonic chambers are reduced in importance so that the equatorial plane is composed only of the embryonic and equatorial chambers in advanced genera.

The evolutionary development postulated by BARKER & GRIMSDALE (*84) is accepted as the logical one, though certain disagreements concerning details should be noted. GRIMSDALE (*827), by analysis of the stolon systems, argued for a diphyletic origin of the lepidocyclines, dividing them into "lineage Y" with a "crossed stolon system" and "lineage X" with an "uncrossed stolon system." GRIMSDALE derived "lineage Y" from an *Amphistegina*-like ancestor, but did not identify the origin of "lineage X." COLE (*366) postulated that *Lepidocyclina* (*Poly-lepidina*) *antillea* CUSHMAN, the first true species of *Lepidocyclina*, which occurs in middle Eocene strata of the Caribbean region, was the original species from which the stratigraphically succeeding forms of *Lepidocyclina* were derived.

Although formerly *Lepidorbitoides* (Upper Cretaceous) and *Actinosiphon* (Paleocene) have been included in the Lepidocyclininae by many authors because the internal structure of their tests is similar to that of the lepidocyclines, these genera must be excluded from the Lepidocyclininae for stratigraphic reasons. The first representatives of the Lepidocyclinidae appear in the middle Eocene of the Caribbean region long after the disappearance of *Actinosiphon*.

The classification of the Lepidocyclinidae is based mainly on internal structures which are studied by means of equatorial and vertical thin sections. Although external shape and the sculpture of the surface of the test are important, internal structures normally reflect the surface features. For example, specimens with papillate surfaces have well-developed pillars, as the pillar heads project above the surface of the test so as to form the individual papillae, and stellate or rayed specimens have the equatorial chambers arranged so that this condition is shown in equatorial thin sections.

The major emphasis in classification of

genera and subgenera is based upon kind of megalospheric embryonic chambers observed, development of the perieembryonic chambers, and characteristics of the equatorial chambers. These are shown best by equatorial thin sections, but vertical thin sections are helpful, particularly in determining whether the equatorial layer lies in a single plane or whether it becomes multiple or otherwise modified.

Generic determinations often can be made from vertical thin sections, but this kind of section is most useful for discrimination of species. The kind and arrangement of lateral chambers, the presence or absence of pillars, and relationships of the equatorial layer to the covering zones are features which assist in separating one species from another. However, the entire test must be studied in detail.

Because it is important that a correct correlation be made between equatorial and vertical thin sections in populations with several species present, matrix-free individuals should be ground to the equatorial plane. This plane can then be studied by reflected light. After several individuals are found with the same structures in the equatorial plane, some of them should be used for the making of vertical thin sections. Thus, equatorial thin sections may be correlated with vertical sections. Where individuals cannot be freed from the matrix, correlation may be made by means of the numerous tangential and oblique sections of specimens which normally show in thin sections made through the matrix and entombed specimens. These tangential and oblique sections often will show in a single rock sample structures both of the equatorial layer and the covering zones, although none of the zones will be exposed in its entirety.

In addition to the correlation between equatorial and vertical thin sections and in order to be absolutely certain that sections made from different individuals represent the same species, the association between megalospheric and microspheric specimens of the same species must be made also. If more than one species occurs in a given population difficulties may be encountered in recognizing which pairs represent a given species. Although microspheric individuals of a given species are larger than the megalospheric individuals, correspondence

of all internal structures is found except for initial chambers of the equatorial layer. Thus, it is often possible to correlate specimens of the two generations by shape of the equatorial chambers, kind and arrangement of the lateral chambers, and degree of development of the pillars.

In megalospheric specimens the initial chambers (embryonic stage) are bilocular, consisting of an initial chamber (protoconch) followed by a second chamber (deuteroconch). These chambers have size relationships to each other varying from equality, as in *Lepidocyclina* s.s., to a second chamber so large that it completely encloses the initial chamber except along the area of juncture of the two chambers, as in some species of *Lepidocyclina* (*Eulepidina*).

However, this size relationship of the embryonic chambers is not an absolute criterion for generic or subgeneric designation, since individuals of a given species commonly exhibit variable relationships in size of the embryonic chambers. Moreover, abnormality of the initial chambers is a common occurrence. Specimens showing this commonly have an unusually large embryonic chamber with a sequence of smaller chambers lying around the margin. Although such specimens have been assigned to distinct genera, VAUGHAN & COLE (*1998) and COLE (*368) have attributed this development to one possible phase in the reproductive mechanism, inasmuch as some associated specimens have more than one set of otherwise typical embryonic chambers.

The initial (embryonic) chambers in most genera are surrounded partially or completely by perieembryonic (nepionic) chambers before the equatorial (ephebic) chambers are developed. The first chamber (primary auxiliary) of any perieembryonic sequence is connected to the second embryonic chamber by one or more stoloniferous passages, whereas the other perieembryonic chambers (auxiliary) are not so connected. Four perieembryonic sequences have been recognized: (1) **uniserial**, in which there is a single coil of perieembryonic chambers which encircles the embryonic chambers in one direction; (2) **biserial**, in which two perieembryonic coils originate from two distinct initial perieembryonic chambers; (3) **quadriseserial**, in which four

periembrionic coils originate, though these are developed from only two initial periembrionic chambers; and (4) **multiserial**,

in which more than four coils of periembrionic chambers and two initial periembrionic chambers are present (Fig 589,2).

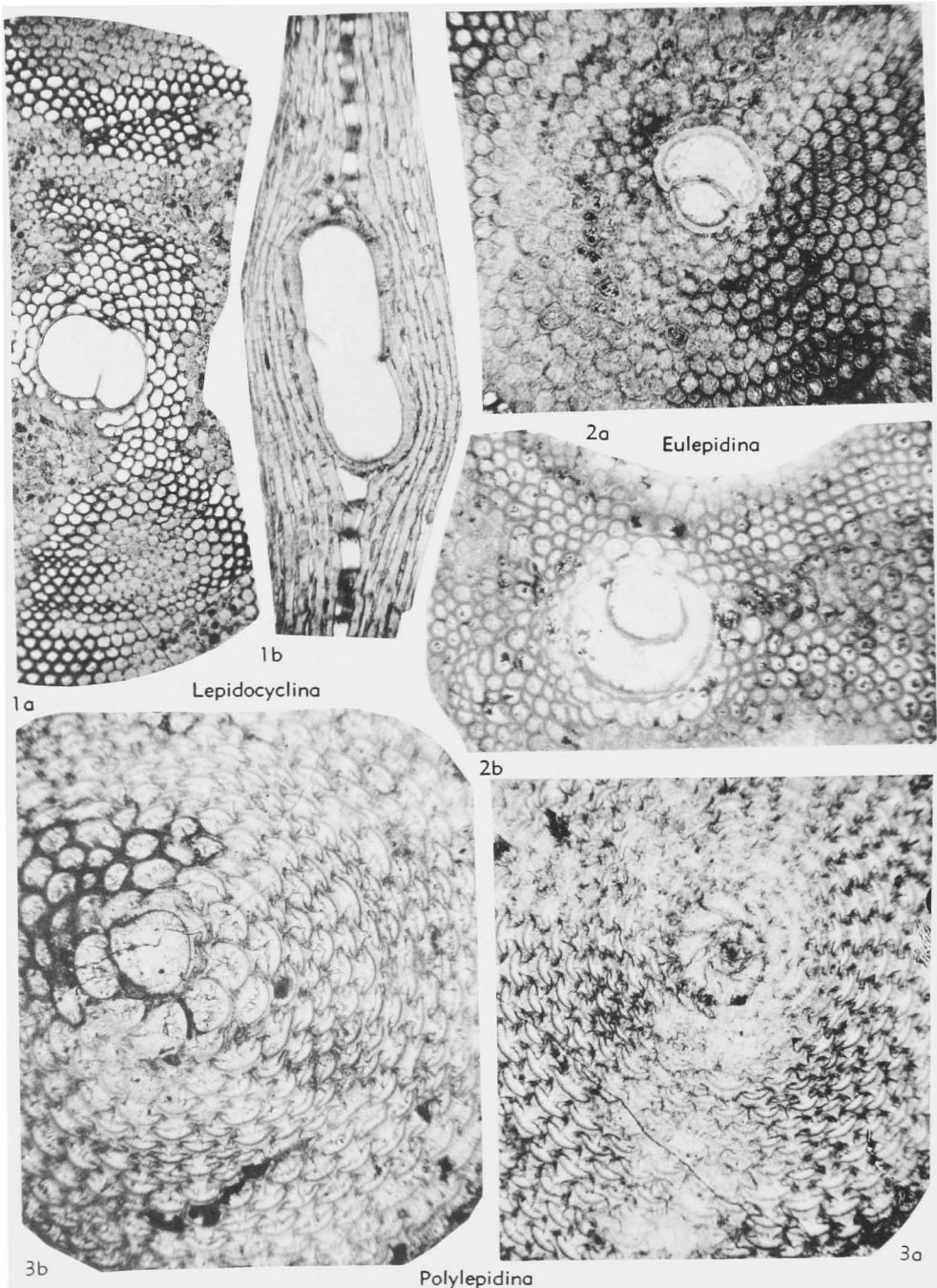


FIG. 590. Lepidocyclinidae (Lepidocyclininae: 1, *Lepidocyclina* (*Lepidocyclina*); 2, *L.* (*Eulepidina*); 3, *L.* (*Polylepidina*)) (p. C721-C724).

The arrangement of the peribryonic chambers is useful both in specific and generic classification, but too much dependence cannot be placed on this characteristic alone, since it has been demonstrated that individuals of a given species may develop more than one of the peribryonic sequences.

The equatorial chambers are connected by stolon systems, of which five kinds, based on number and arrangement of the stolons, are recognized. Stolon systems are best studied in tests which have been infiltrated by colored matrix or in empty tests infiltrated artificially by Canada balsam or other material. In such tests it is possible to dissolve the substance of the test so that the infiltrating material outlines the stolon system (Fig. 589,3,4).

The lateral chambers lying above and below the equatorial layer may or may not be separated by conical masses of compact material known as pillars. Although the presence or absence of pillars and the degree of their development and characteristics have been much used in specific determinations, the value of these features may be questioned (Fig. 589,1). The development or lack of development of pillars may be a clue for specific determination, however. Conversely, the shape, arrangement, and configuration of the lateral chambers is extremely important. The chamber cavities may be open or slitlike. The floors and roofs of the chambers may be thin or thick, straight or rounded, and the chambers may be aligned in regular tiers or overlapping.

The equatorial chambers, viewed in vertical section, commonly are doubled in the peripheral zone and somewhat rarely are separated into two layers by a wedge of shell material. Although this doubling of the peripheral equatorial chambers may be significant for recognition of certain genera (e.g., *Pseudolepidina*), in others (e.g., *Lepidocyclina*), the doubled equatorial chambers are interrupted as structures of specific importance, or in some specimens of infraspecific occurrence, without being common to all specimens of the species.

Although numerous classifications of larger Foraminiferida have been attempted, based upon detailed analysis of a single internal structure (e.g., peribryonic chambers, stolon systems, lateral chambers), they

have not been successful. Any natural classification must be based on a synoptic analysis of the whole test. The relationship and combination of all internal structures ultimately defines the genus. Unfortunately, many generic names have been based upon the relative development of single structures which characterize individual specimens only and are not even specific characters.

Subfamily LEPIDOCYCLININAE Scheffen, 1932

[*nom. transl.* TAN, 1936, p. 277 (ex *Lepidocyclinidae* SCHEFFEN, 1932) [= *Lepidocyclinae* VAUGHAN & COLE in CUSHMAN, 1940, p. 357 (*nom. van.*)]

Embryonic and peribryonic chambers with thin walls, peribryonic chambers present or lacking; lateral chambers normally numerous, well developed and distinctly separated from equatorial layer. *M. Eoc.-M. Mio.*

Lepidocyclina GÜMBEL, 1870, *840, p. 689 [*Nummulites mantelli* MORTON, 1833, *1320, p. 291; SD H. DOUVILLÉ, 1898, *613, p. 594] [= *Cyclosiphon* EHRENBERG, 1855, *681, p. 288 (*nom. reject.*, ICZN Op. 127); *Astrolepidina* A. SILVESTRI, 1931, *1785, p. 35 (type, *Lepidocyclina asterodisca* NUTTALL, 1932, *1371A, p. 34; SD COLE, herein)]. Embryonic chambers bilocular; equatorial chambers arcuate, rhombic, hexagonal or spatulate. *M. Eoc.-M. Mio.*, cosmop. [Trop.].

L. (*Lepidocyclina*) [= *Isolepidina* H. DOUVILLÉ, 1915, *622, p. 724 (type, *Nummulites mantelli* MORTON, 1833, *1320, p. 291)]. Embryonic chambers equal or subequal, separated by straight wall; equatorial chambers arcuate, hexagonal or spatulate, with 6- or 8-stolon system. *Oligo.-L. Mio.*, N.Am.-S.Am.—Fig. 590,1. *L. (*L.*) *mantelli* (MORTON), *Oligo.*, USA (Fla.); *1a,b*, equat. sec., vert. sec., $\times 20, \times 40$ (*2113c).

L. (*Eulepidina*) H. DOUVILLÉ, 1911, *620, p. 59, 68 [*Orbitoides dilatata* MICHELOTTI, 1861, *1257, p. 17; SD YABE, 1919, *2085, p. 41] [= *Nephrolepidina* H. DOUVILLÉ, 1911, *620, p. 59, 70, 73 (type, *Nummulites marginata* MICHELOTTI, 1841, *1256, p. 297); *Amphilepidina* H. DOUVILLÉ, 1922, *625, p. 552 (type, *Orbitoides sumatrensis* BRADY, 1875, *192, p. 536); *Tryblilepidina* VAN DER VLERK, 1928, *2014, p. 10, 13 (type, *Lepidocyclina ephippioides* JONES & CHAPMAN in ANDREWS, 1900, *997, p. 251, 256); SD BERRY, 1929, *131, p. 37; *Multilepidina* HANZAWA, 1932, *865, p. 447 (type, *Lepidocyclina* (M.) *irregularis*); *Cyclolepidina* WHIPPLE, 1934, *2053, p. 143 (type, *Lepidocyclina* (C.) *suvaensis*)]. Embryonic chambers bilocular, smaller initial chamber slightly or completely surrounded by larger second chamber except along area of attachment, or teratologically with large chamber, on periphery of which are smaller chambers; equatorial chambers arcuate, rhombic, spatulate to hexagonal. *U. Eoc.-M. Mio.*, N.Am.-

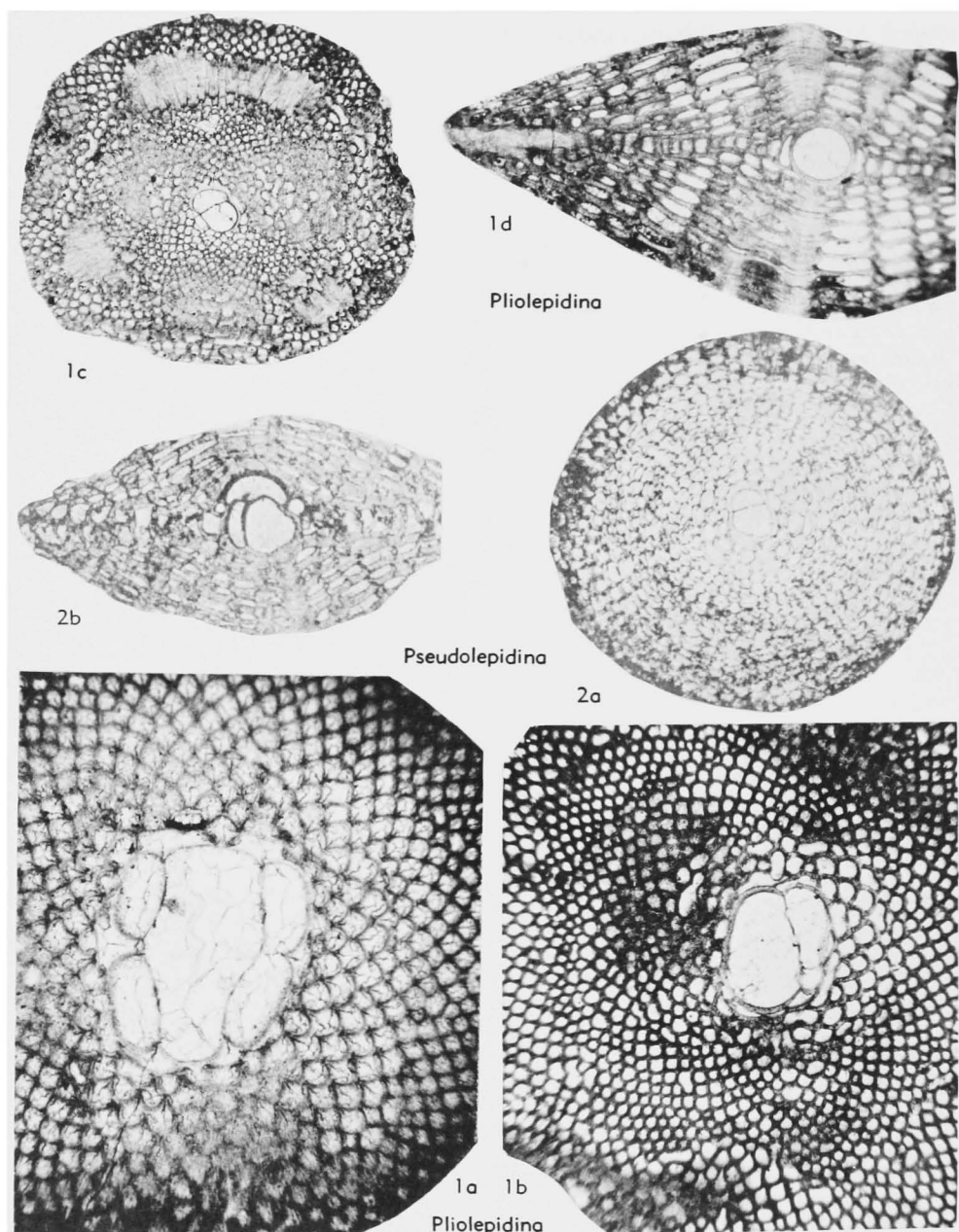


FIG. 591. Lepidocyclinidae (Lepidocyclininae; 1, *Lepidocyclina* (*Pliolepidina*); 2, *Pseudolepidina*) (p. C722-C724).

S.Am.-Eu.-Afr.-C.Pac., trop.—FIG. 590,2a. *L. (E.) tournoueri* LEMOINE & R. DOUVILLÉ, Oligo., Mex.; equat. sec., $\times 40$ (*366).—FIG. 590,2b. *L. (E.) ephippioides* JONES & CHAPMAN, L.Mio., Saipan Is.; equat. sec., $\times 40$ (*366).
L. (*Pliolepidina*) H. DOUVILLÉ, 1915, *622, p.

727 [**L. (P.) tobleri* H. DOUVILLÉ, 1917, *623, p. 844 (= *Isolepidina pustulosa* H. DOUVILLÉ, 1917, *623, p. 843); SD (SM)] [= *Multicyclina* CUSHMAN, 1918, *410, p. 96 (type, *Lepidocyclina (M.) duplicata*); *Orbitoina* VAN DE GEYN & VAN DER VLIERK, 1935, *786, p. 222, 227 (*nom. nud.*);

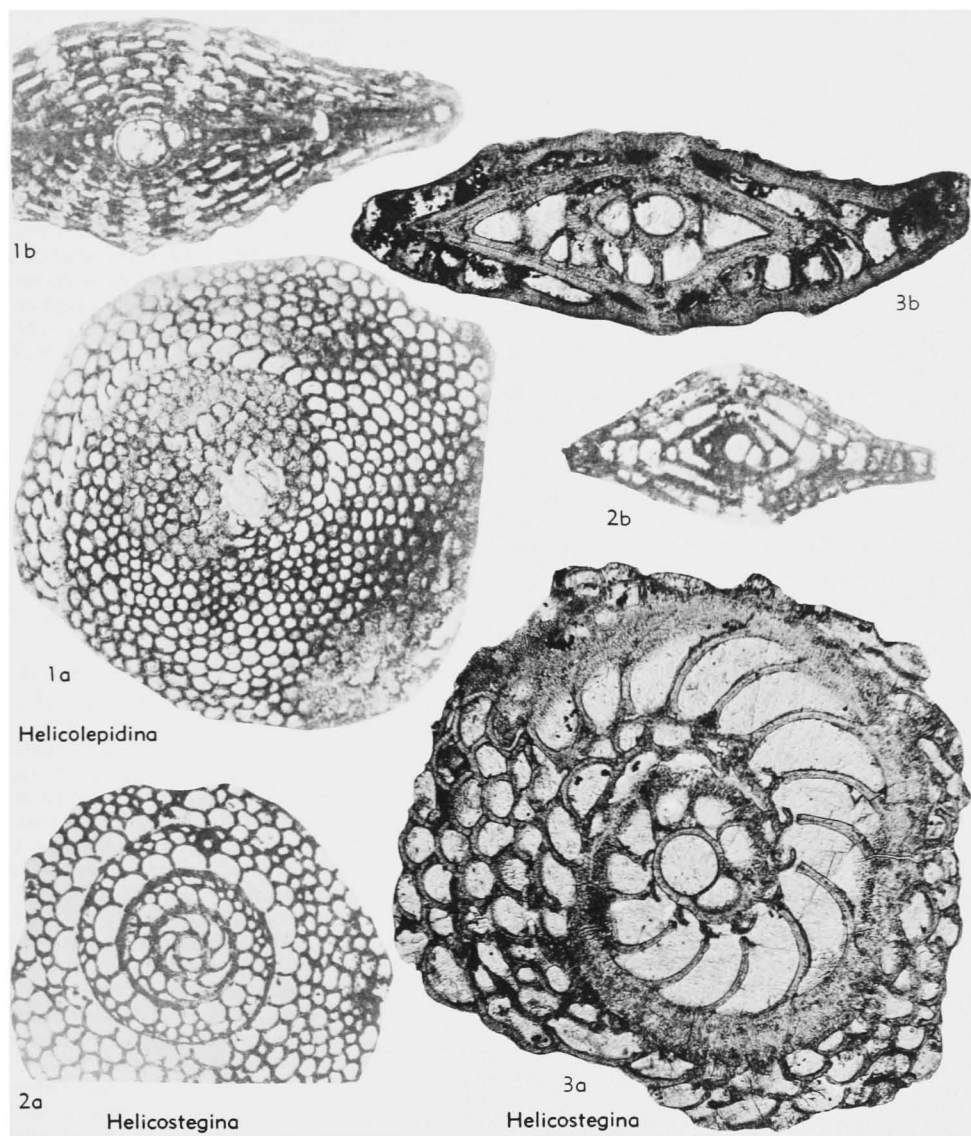


FIG. 592. Lepidocyclinidae (Helicolepidininae; 1, *Helicolepidina*; 2,3, *Helicostegina*) (p. C724).

Isorbitoina VAN DE GEYN & VAN DER VLK, 1935, *786, p.222, 227, 255 (*nom. nud.*); *Pliorbitoina* VAN DE GEYN & VAN DER VLK, 1935, *786, p. 222, 227, 255 (type, *Lepidocyclina* (*Pliolepidina*) *tobleri* H. DOUVILLÉ); *Polyorbitoina* VAN DE GEYN & VAN DER VLK, 1935, *786, p. 227 (type, *Lepidocyclina* (*Polylepidina*) *proteiformis* VAUGHAN, 1924, *1988, p. 810); *Multilepidina* A. SILVESTRI, 1937, *1787, p. 160 (*non* HANZAWA, 1932) (type, *Pliolepidina* *tobleri* H. DOUVILLÉ, 1917); *Isorbitoina* THALMANN, 1938, *1897c, p. 202 (type, *Lepidocyclina* *trinitatis* H.

DOUVILLÉ, 1924, *627, p. 374); *Triplepidina* VAUGHAN & COLE, 1938, *1997, p. 167 (type, *T. veracruziana*); *Neolepidina* BRÖNNIMANN, 1947, *219, p. 378 (type, *Isolepidina* *pustulosa* H. DOUVILLÉ, 1917, *623, p. 843)]. Embryonic chambers bilocular, initial chamber usually slightly larger than second chamber, with variable number of relatively large, distinct periembrionic chambers, or teratologically with one large chamber, on periphery of which are numerous smaller chambers, equatorial chambers rhombic to ogival with 4-stolon system. *M.Eoc.-U.Eoc.*, N.

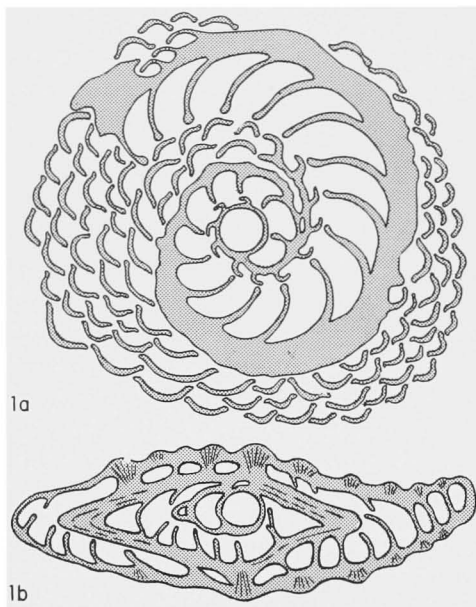


FIG. 592A. *Lepidocyclinidae* (Helicolepidininae; 1, *Helicostegina*) (p. C724).

Am.-S.Am.-Afr.[Trop.].—FIG. 591,1a,b. **L. (P.) pustulosa* (H. DOUVILLÉ), U.Eoc., (1a, Panama; 1b, Trinidad); 1a, teratologic embryonic chambers; 1b, normal embryonic chambers; both $\times 40$ (*359).—FIG. 591,1c,d. *L. (P.) veracruziana* (VAUGHAN & COLE), U.Eoc., Mex.; equat. sec., vert. sec., $\times 20$, $\times 40$ (*2113c).

[H. DOUVILLÉ (1915, *622, p. 727) introduced the nominal subgenus named *Pliolepidina* without originally assigning species to it, but in 1917 (*623, p. 843) he described and illustrated a single species named *P. tobleri*, which thus was established as the type-species by subsequent monotypy. Also in 1917 DOUVILLÉ (*623, p. 844) described and figured a species named *Isolepidina pustulosa* and then in 1924 (*627, p. 43) expressed the opinion that *P. tobleri* "résulte seulement d'un accident tératologique." VAUGHAN & COLE (1941, *1998, p. 67) from a survey of extensive topotype materials concluded that DOUVILLÉ's surmise as to the teratological nature of his *P. tobleri* was undoubtedly correct. Therefore, they cited *Isolepidina pustulosa*, distinguished as the normal lepidocyclinid corresponding to teratological *P. tobleri*, as the correct designation of the type-species of *Pliolepidina*. This procedure accords with stipulations in zoological nomenclature, but in recognizing "*Lepidocyclina* (*Pliolepidina*) *pustulosa* forma *tobleri* (H. DOUVILLÉ) forma *teratologica*" (*1998, p. 66, pl. 24) they did not conform to the Zoological Code (1961), which specifies (Art. 1) that "names given to . . . teratological specimens . . . are excluded [from zoological nomenclature]." The name *Pliolepidina tobleri* is here rejected entirely, since it has the status of a *nomen nudum*.]

L. (Polylepidina) VAUGHAN, 1924, *1988, p. 794, 807 [**L. (P.) chiapasensis*, =**L. antillea* CUSHMAN, 1919, *414, p. 63; OD] [= *Eulinderina* BARKER & GRIMSDALE, 1936, *84, p. 237 (type, *Planorbulina* (*Planorbulinella*) *guayabalensis* NUTTALL, 1930, *1371, p. 276); *Eolepidina* TAN, 1939 (type, *Eulinderina semiradiata* BARKER & GRIMSDALE, 1936, *84, p. 238)]. Embryonic

chambers bilocular, initial chamber usually slightly larger than second chamber, followed by partial but distinct coil of 4 to 9 large periembryonic chambers which gradually decrease in size; equatorial chambers arcuate, with 4-stolon system. *M.Eoc.*, N.Am.-S.Am.—FIG. 590,3. **L. (P.) antillea* CUSHMAN, W.Indies(St. Bartholomew); 3a,b, equat. secs. of microspheric and megalospheric specimens, $\times 40$ (*366).

Pseudolepidina BARKER & GRIMSDALE, 1937, *85, p. 169 [**P. trimera*; OD]. Embryonic chambers bilocular in equatorial sections, trilocular in vertical sections; equatorial layer double in peripheral zone. *M.Eoc.*, Carib.-N.Am.—FIG. 591,2. **P. trimera*, Mex.; 2a,b, equat. sec., vert. sec., $\times 25$, $\times 36$ (*85).

Subfamily HELICOLEPIDININAE Tan, 1936

[Helicolepidininae TAN, 1936, p. 277] [=Helicolepidinae VAUGHAN & COLE in CUSHMAN, 1940, p. 325 (nom. van.)]

Equatorial layer characterized by well-defined sequence of chambers arranged in open spiral which persists beyond initial periembryonic spire with chamberlets intercalated between whorls of chambers of spiral. *M.Eoc.-U.Eoc.*

Helicolepidina TOBLER, 1922, *1937, p. 380 [**H. spiralis*; OD] [= *Helicocyclina* TAN, 1936, *1868, p. 995 (type, *Helicolepidina paucispira* BARKER & GRIMSDALE, 1936, *84, p. 243)]. Megalospheric embryonic chambers bilocular, subequal, followed by open spiral of chambers which are bounded on their proximal side by perforate spiral band forming 1 or 2 volutions, and in some extending to periphery of test; equatorial chambers arcuate to rudely hexagonal; lateral chambers well developed. *U.Eoc.*, N.Am.-S.Am.—FIG. 592,1. **H. spiralis*, W.Indies(Trinidad); 1a,b, equat. and vert. secs., $\times 27$ (*2122).

Helicostegina BARKER & GRIMSDALE, 1936, *84, p. 233 [**H. dimorpha*; OD] [= *Helicolepidinoides* TAN, 1936, *1868, p. 992 (type, *Helicostegina gyralis* BARKER & GRIMSDALE, 1936, *84, p. 236)]. Test lenticular, pustulose to papillose; earliest chambers coiled in involute trochoid spire, later ones subdividing ventrally into subsidiary chamberlets, in adult stage of some species forming distinct peripheral flange similar to other members of *Lepidocyclinidae*; aperture comprising narrow slit near inner margin of ventral face of last chamber, with backward projecting lip, as in *Tremastegina*; flange (if present) and chamberlets of ventral layer connected by paired foramina. *M.Eoc.-U.Eoc.*, Carib.-N.Am.(Mex.).—FIG. 592,2. *H. polygyralis* (BARKER), U.Eoc., W.Indies(Trinidad); 2a,b, equat. and vert. secs., $\times 40$ (*366).—FIG. 592,3; 592A,1. **H. dimorpha*, M.Eoc., Mex.; 592,3a,b, equat. and vert. secs., $\times 56$ (*84); 592A, 1a,b, sketches of equat. and vert. secs. showing structure, $\times 43$ (*2110).

PSEUDORBITOIDIDAE

By W. STORRS COLE

Family PSEUDORBITOIDIDAE

M. G. Rutten, 1935

[*nom. transl.* BRÖNNIMANN, 1958, p. 167 (*ex* Pseudoorbitoididae M. G. RUTTEN, 1935, p. 544)]

Test lenticular, composed of equatorial layer covered on each side by zones of lateral chambers; embryonic chambers bilocular, followed by long or short rotaliid spire of nepionic chambers; equatorial layer beyond embryonic apparatus composed of radial vertical plates variously arranged except in microspheric specimens which have arcuate equatorial chambers in zone between embryonic apparatus and peripheral zone of radial plates; annular walls present in equatorial layer of some genera; protoplasmic communication by stolons and fine pores; canal system present. *U.Cret.*

The genera of this family are characterized by vertical radial plates which occur in the equatorial layer. The pseudorbitoidids are mutants of *Sulcoperculina* in which lateral chambers have developed and the radial vertical plates present in the sulcus of *Sulcoperculina* have become elongated.

Pseudorbitoides H. DOUVILLÉ, 1922, *624, p. 204 [**P. trechmanni*; OD] [= *Historbitoides* BRÖNNIMANN, 1956, *231d, p. 61 (type, *H. kozaryi*); *Aktinorbitoides* BRÖNNIMANN, 1958, *232, p. 167 (type, *A. browni*)]. Embryonic chambers of microspheric generation forming distinct spire followed by arcuate equatorial chambers which are succeeded by radial plates; embryonic chambers of megalospheric form bilocular, with 2 or more perieembryonic chambers forming irregular spire succeeded by radial plates which extend to periphery; lateral chambers well developed, resting directly on radial plates. *U.Cret.*, Carib.(Jamaica)-New Guinea-N.Am.—FIG. 593,1a,b. **P. trechmanni*, Jamaica; 1a,b, equat. and vert. secs. of microspheric specimens, $\times 40$ (*2123).—FIG. 593,1c,d. *P. israelshkyi* VAUGHAN & COLE, USA (La.); 1c,d, equat. and vert. secs. of megalospheric specimens, $\times 40$ (*2123).

Sulcorbitoides BRÖNNIMANN, 1954, *231a, p. 55 [**S. pardoi*; OD] [= *Conorbitoides* BRÖNNIMANN, 1958, *232, p. 173 (type, *C. cristallensis*)]. Nepionic coil long, rotaliid, followed by 2 alternating systems of vertical radial plates without annular walls; lateral chambers rest directly on radial rods of equatorial layer. *U.Cret.*, Carib.(Cuba)-USA (Texas).—FIG. 593,2. **S. pardoi*, Cuba; 2a,b, equat. sec., vert. sec., $\times 28$, $\times 40$ (*231).

Vaughanina D. K. PALMER, 1934, *1408, p. 240 [**V. cubensis*; OD] [= *Rhabdorbitoides* BRÖNNI-

MANN, 1955, *231c, p. 97 (type, *R. hedbergi*); *Ctenorbitoides* BRÖNNIMANN, 1958, *232, p. 171 (type, *C. cardwelli*)]. Nepionic coil short, followed by 2 alternating systems of radial plates; annular walls present; lateral chambers and radial plates separated by roof and floor of equatorial layer. *U.Cret.*, Carib.(Cuba)-Mex.-USA (Fla.).—FIG. 593,3. **V. cubensis*, Cuba; 3a, ext. view, $\times 20$; 3b,c, equat. and vert. secs., $\times 37.5$ (*2123).

Superfamily CASSIDULINACEA
d'Orbigny, 1839

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 313 (*ex* family Cassidulinidae d'ORBIGNY, 1839).]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹superfamily, ²family group); dagger(†) indicates *parim*]—[=*Enclinosstegia* EIMER & FICKERT, 1899, p. 682 (*nom. nud.*); =¹Orthoklinostegia EIMER & FICKERT, 1899, p. 685 (*nom. nud.*); =²Textulinidia RHUMBLER in KÜKENTHAL & KRUMBACH, 1923, p. 88; =²Rotaliformest BROTZEN, 1942, p. 9 (*nom. neg.*); =¹Monolamellidae REISS, 1957, p. 128 (*nom. nud.*); =¹Bilamellidae REISS, 1957, p. 127 (*nom. nud.*); =¹Nonionidea SUBBOTINA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 282]

Test enrolled, planispiral, or low or high trochospiral; wall of perforate granular calcite; aperture slitlike, loop-shaped or multiple. *U.Trias-Rec.*

Family PLEUOSTOMELLIDAE
Reuss, 1860

[Pleurostomellidae REUSS, 1860, p. 151, 203] [=Pleurostomellidae GÜMBEL, 1870, p. 52; =Ellipsoidinidae A. SILVESTRI, 1923, p. 808; =Pleurostomellida COPELAND, 1956, p. 188 (*nom. van.*)]

Early stage triserial or biserial, later uniserial, or uniserial throughout; aperture a curved narrow slit, lateral or terminal, with internal siphon between those of adjacent chambers. ?*Jur.*, *L.Cret.-Rec.*

Subfamily PLEUOSTOMELLINAE Reuss, 1860

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 315 (*pro* subfamily Pleurostomellidae REUSS, 1860, p. 368).]—[All names cited are of subfamily rank]—[=*Cryptostegia* BÜTSCHLI in BRÖNN, 1880, p. 203 (*nom. nud.*); =Ellipsodonsariinae A. SILVESTRI, 1901, p. 109; =Ellipsolageninae A. SILVESTRI, 1923, p. 265; =Ellipsoidininae PETTERS, 1954, p. 39]

Early stage biserial, later uniserial, or uniserial throughout. ?*Jur.*, *L.Cret.-Rec.*

Pleurostomella REUSS, 1860, *1548, p. 203 [**Dentalina subnodosa* REUSS, 1851, *1542, p. 24, =*Dentalina nodosa* d'ORBIGNY, REUSS, 1846, *1538, p. 28; SD CUSHMAN, 1911, *404b, p. 49] [=Pleurostomellina SCHUBERT, 1911, *1689b, p. 58 (type, *Pleurostomella barroisi* BERTHELIN, 1880, *133, p. 30); *Ellipsodonsaria* (*Ellipsodentalina*) FRANK, 1928, *740, p. 54 (type, *Dentalina subnodosa* REUSS, 1851, *1542, p. 24; SD LOEBLICH & TAPPAN, herein) (obj.)]. Test small, elongate, chambers in early stage biserially arranged, or cuneate and alternating in position, later uniserial; sutures in early stage oblique, later becoming more nearly straight and horizontal, wall

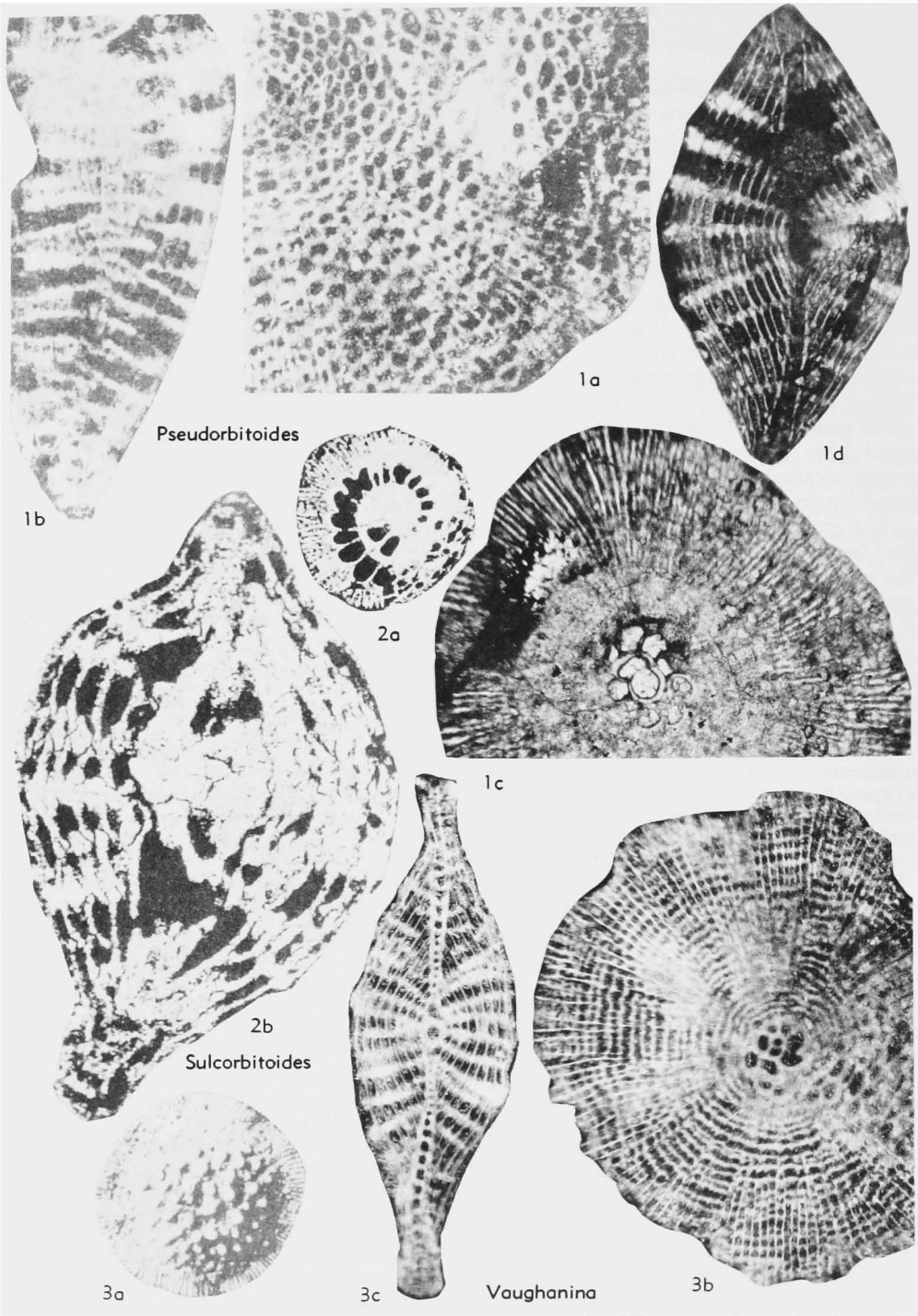


FIG. 593. *Pseudorbitoididae*; 1, *Pseudorbitoides*; 2, *Sulcorbitoides*; 3, *Vaughanina* (p. C725).

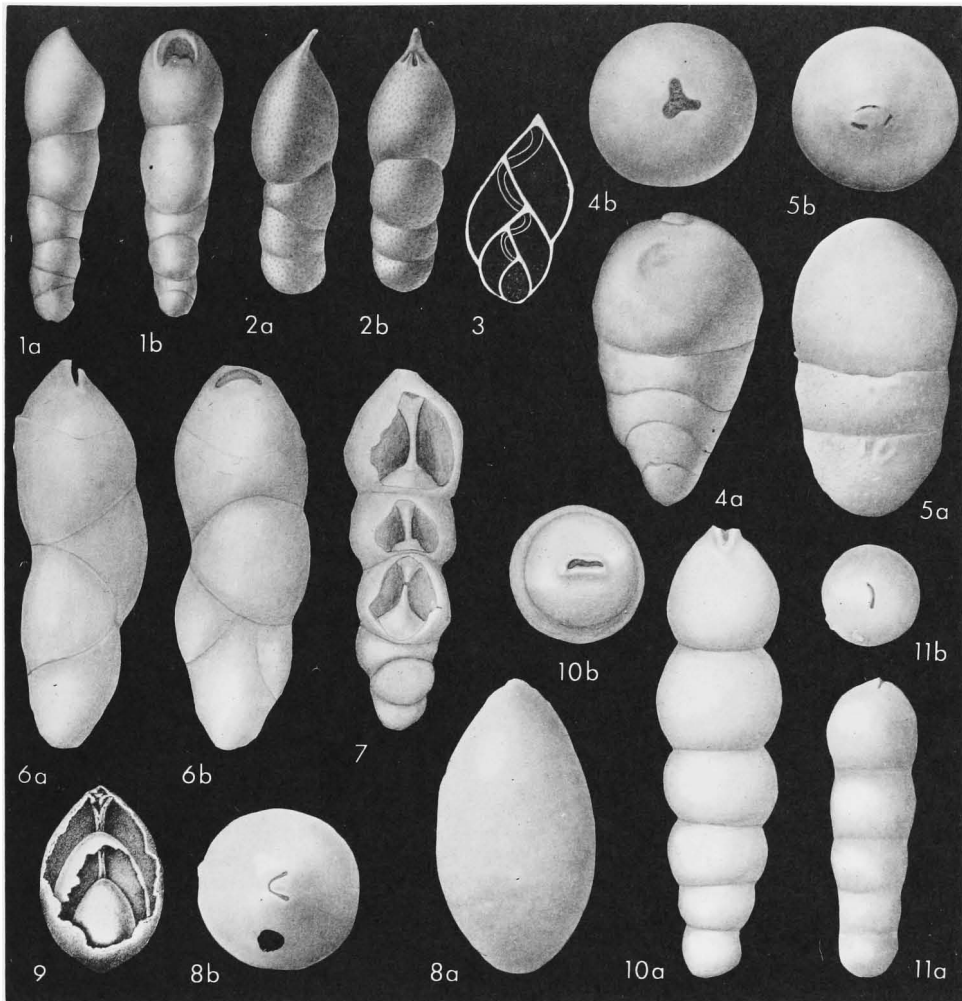


FIG. 594. Pleurostomellidae (Pleurostomellinae; 1-3, *Pleurostomella*; 4, *Daucina*; 5, *Pinaria*; 6,7, *Ellipsoidella*; 8,9, *Ellipsoidina*; 10,11, *Nodosarella*) (p. C725-C728, C730).

calcareous, finely perforate, granular in structure; aperture terminal, with projecting hood at one side, 2 small teeth on opposite side, and internal tube. [*Pleurostomellina* was originally separated as being uniserial, but both type-species show considerable variation in the length and development of the biserial stage, or its indication by means of the alternating cuneate chambers.] *L. Cret.-Rec.*, cosmop.—FIG. 594,1. **P. subnodosa* (REUSS), U.Cret.(Campan.), Ger.(Bav.); 1a,b, side and edge views, $\times 48$ (*2117).—FIG. 594, 2. *P. barroisi* BERTHELIN, L.Cret.(Alb.), Eng.; 2a,b, side and edge views, $\times 74$ (*2117).—FIG. 594,3. *P. brevis* SCHWAGER, Mio., Eu.(Italy); long. sec. showing internal tube extending between successive apertures, $\times 30$ (*1757).

Daucina G. BORNEMANN in ERMAN, 1855, *710, p. 153 [**D. ermaniana*; OD (M)]. Test free, elongate,

uniserial, with slowly enlarging and strongly overlapping chambers; wall calcareous, smooth, microstructure not described; aperture terminal, trilobate, apparent modification of bifid toothed aperture of *Pleurostomella*. *Tert.*, S.Am.(Brazil). —FIG. 594,4. **D. ermaniana*; 4a,b, side and apert. view of lectotype, here designated (Cushman Coll. 14223), $\times 33$ (*2117).

Ellipsobulimina A. SILVESTRI, 1903, *1757, p. 210 [**E. seguenzai*; OD (M)]. Test free, ovate or rounded with early biserial stage and later uniserial, each pair of biserial chambers completely overlapping all preceding ones, and uniserial chambers completely enveloping earlier test so that externally it resembles *Ellipsoidina*; wall calcareous; aperture terminal, semilunate, with internal tube connecting successive apertures. [Differs from *Ellipsoidina* in having an early biserial

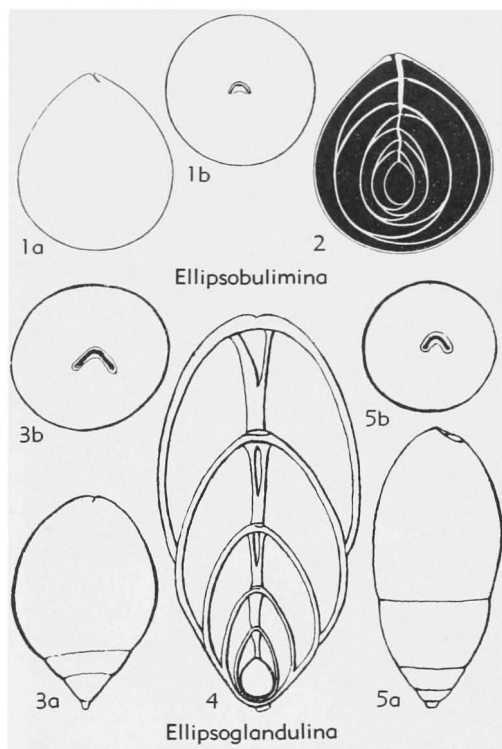


FIG. 595. Pleurostomellidae (Pleurostomellinae; 1,2, *Ellipsobulimina*; 3-5, *Ellipsoglandulina*) (p. C727-C728).

stage.] *Mio.*, Eu.—FIG. 595,1,2. **E. seguenzai*, Italy; 1a,b, side, apert. views, $\times 33$; 2, long. sec. showing biserial early stage, enveloping chambers and internal tube, $\times 38$ (*1758).

Ellipsodimorphina A. SILVESTRI, 1901, *1752, p. 16, 18 [**E. subcompacta* LIEBUS, 1922, *1136, p. 57; SD (SM) LIEBUS, 1922, *1136, p. 57]. Test elongate, biserial in early stage, later chambers cuneate and finally completely uniserial, rounded in section; sutures distinct, depressed; aperture an elongate arched slit. *U.Cret.-Eoc.*, Eu.—FIG. 596,1. **E. subcompacta* LIEBUS, *Eoc.*, Czech. (Moravia); 1a,b, side, apert. views, $\times 53$ (*1136).

Ellipsoglandulina A. SILVESTRI, 1900, *1751, p. 12 [**E. laevigata*; OD (M)]. Test free, elongate, uniserial with strongly overlapping chambers and tapering base; wall calcareous; aperture terminal, semilunate, internally provided with entosolenian tube extending between successive apertures. [Differs from *Ellipsoidina* in not being completely involute.] ?*Jur.*, ?*Cret.*, *Eoc.-Rec.*, Eu.-Carib.-N.Z.-N.Am.—FIG. 595,3-5. **E. laevigata*, *Plio.*, Eu. (Sicily); 3a,b, side, apert. views, megalospheric form, $\times 44$; 4, long. sec. showing tube, $\times 44$; 5a,b, side, apert. view of microspheric form, $\times 30$ (*1751).

Ellipsoidella HERON-ALLEN & EARLAND, 1910, *907,

p. 410, 414 [**E. pleurostomelloides*; OD (M)]. Test free, elongate, chambers cuneate and biserially arranged in early portion, later becoming less closely appressed and uniserial, but wedge-shaped and alternating, and may finally become completely rectilinear; sutures depressed, oblique; wall calcareous, perforate, granular in structure, surface smooth; aperture subterminal, an arched slit, with overhanging lip and internal tube extending downward from just beneath aperture where it is expanded, to attach to apertural region of preceding chamber. *U.Cret.*, Eu.—FIG. 594,6,7. **E. pleurostomelloides*, Brit.I.(Eng.); 6a,b, side, edge views of lectotype, $\times 109$; 7, dissected paratype showing internal tube, $\times 79$ (*2117).

[*Ellipsoidella* differs from *Nodosarella* in having an early biserial stage and later alternating chambers, whereas *Nodosarella* is uniserial throughout, with horizontal sutures. CUSHMAN (1948, *486, p. 278) placed the biserial forms in *Nodosarella* and considered *Ellipsoidella* a synonym, but the type-species of *Nodosarella* is uniserial throughout, hence *Ellipsodimorphina* A. SILVESTRI, 1900, is a synonym of *Nodosarella*, and *Ellipsoidella* is a valid genus. A lectotype for *E. pleurostomelloides* is here designated and refigured (BMNH P41662, specimen figured by HERON-ALLEN & EARLAND, 1910, *907, pl. 10, fig. 4) and paratypes (BMNH-P41663, P41664), all from the Cretaceous chalk at Selsey Bill, Sussex, England.]

Ellipsoidina SEGUENZA, 1859, *1711, p. 12 [**E. ellipsoides*; SD BRADY, 1868, *187, p. 338]. Test free, ovate, with completely enveloping uniserial chambers each attached to preceding ones at base of test; wall calcareous, finely perforate, granular in structure, white and opaque in appearance; aperture terminal, semilunate to chevron-shaped, provided with apertural tube which extends back internally to preceding aperture. *Eoc.-Plio.*, Eu.-Carib.—FIG. 594,8,9. **E. ellipsoides*, *Mio.*, Eu. (Sicily); 8a,b, side, apert. views, $\times 31$ (*2117); 9, partially dissected specimen, showing apertural entosolenian tube of final 2 chambers, $\times 12$ (*187).

Ellipsolingulina A. SILVESTRI, 1907, *1765, p. 69 [**Lingulina impressa* TERQUEM, 1882, *1890, p.

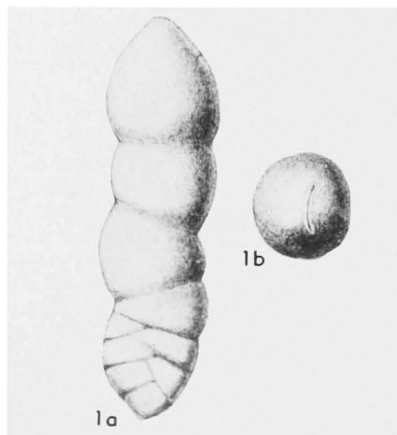


FIG. 596. Pleurostomellidae (Pleurostomellinae; 1, *Ellipsodimorphina*) (p. C728).

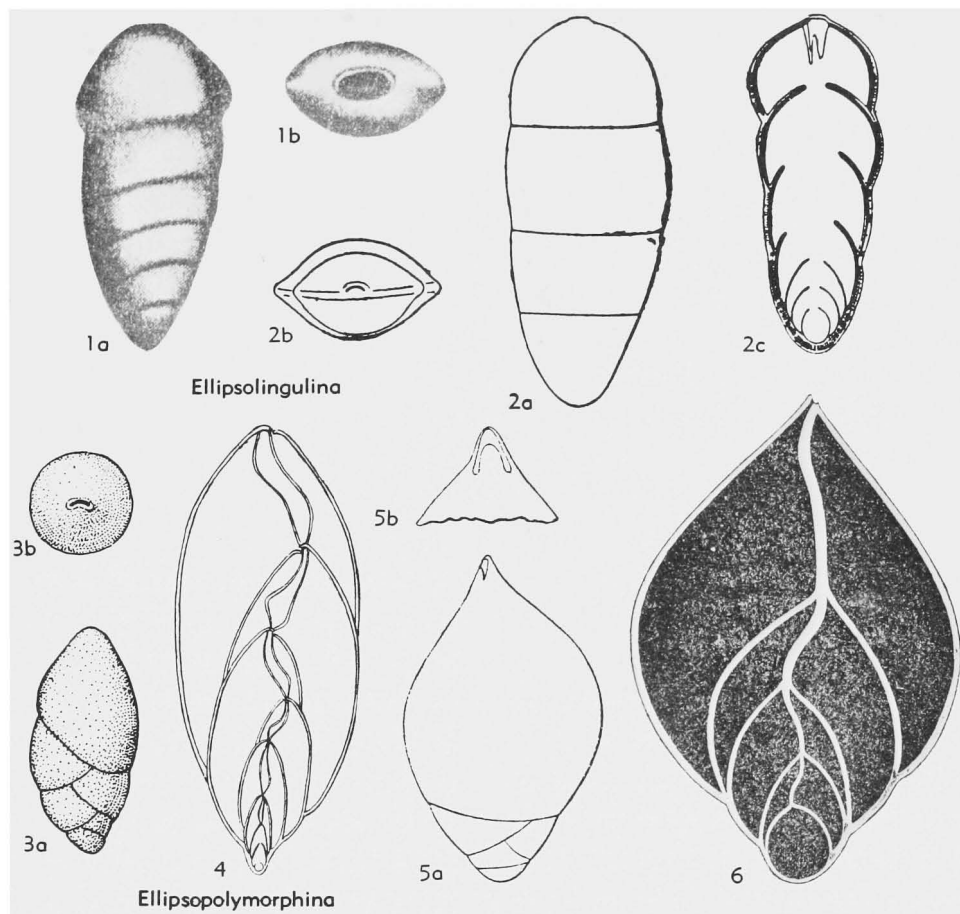


FIG. 597. Pleurostomellidae (Pleurostomellinae; 1,2, *Ellipsolingulina*; 3-6, *Ellipsopolymorphina*) (p. C728-C730).

38; OD]. Test free, elongate, compressed, chambers uniserial and overlapping; sutures horizontal; wall calcareous, microstructure not known; aperture terminal, arcuate, with internal tube projecting inward from final chamber. *Eoc.-Oligo.*, Eu.—FIG. 597,1. **E. impressa* (TERQUEM), M. Eoc.(Lutet.), Fr.; 1a,b, side, top views, $\times 140$ (*700).—FIG. 597,2. *E. silvestrii* GALLOWAY, Oligo., Italy; 2a-c, side, apert. view and long. sec., enlarged (*1765).

[The present genus is tentatively placed in the Pleurostomellinae because of its arcuate terminal aperture and internal tube. Whether the wall is granular or radial in microstructure and whether the internal tube is like that of the Pleurostomellinae or Glandulinidae requires study of topotypes. LE CALVEZ (1952, *1114, p. 35) stated that TERQUEM's type-specimen was not preserved in the Paris collections.]

Ellipsopolymorphina A. SILVESTRI, 1901, *1752, p. 14 [**Dimorphina deformis* (COSTA) FORNASINI, 1890, *730, p. 471 (non *Glandulina deformis* COSTA, 1853) = **Ellipsopolymorphina fornasinii* GALLOWAY, 1933, *762, p. 382; OD (M)]

[= *Ellipsopleurostomella* A. SILVESTRI, 1903, *1757, p. 209, 216 (type, *E. schlichti*)]. Test free, elongate, ovate, early stage biserial, later uniserial, with strongly overlapping chambers; sutures slightly depressed; wall calcareous; aperture terminal, semilunate or chevron-shaped slit, with internal tube connecting apertures of adjacent chambers. *Mio.-Plio.*, Eu.—FIG. 597,3,4. **E. fornasinii* GALLOWAY, Plio., Italy (3), Mio., Sicily (4); 3a,b, side, apert. views, approx. $\times 35$ (*762); 4, long. sec., $\times 65$ (*1752).—FIG. 597,5,6. *E. schlichti* (SILVESTRI), Mio., Italy; 5a, side view, $\times 50$; 5b, apert. end to show aperture, $\times 50$; 6, long. sec. showing connecting apertural tube, $\times 80$ (*1758).

[*Ellipsopleurostomella* was proposed by A. SILVESTRI (1903, *1757) to include the forms previously placed in *Ellipsopolymorphina*, as he then regarded a number of earlier species as dimorphic variations of *Polymorphina labiata* SCHWAGER. The new name supposedly better indicated the relationship of the genus, and he stated that he then "repudiated" the earlier name, which obviously cannot be done under the Rules of Nomenclature. In 1903 SILVESTRI

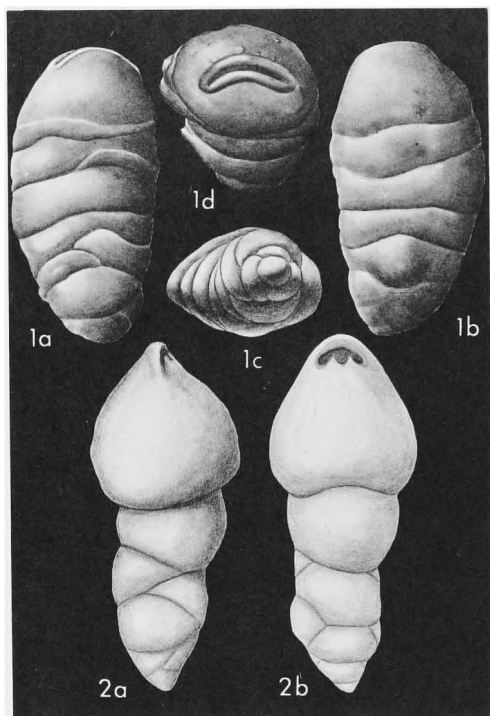


FIG. 598. Pleurostomellidae (Wheelerellinae; 1, *Wheelerella*; 2, *Bandyella*) (p. C730).

included two species in *Ellipsopleurostomella*, *E. labiata* (SCHWAGER) and *E. schlichti*, n.sp. The latter was selected as type by CUSHMAN (1933, *461) but was stated by ELLIS & MESSINA (*700) to be a *nomen nudum* in 1903. Although poorly described, the discussion of *E. schlichti* by SILVESTRI (1903, *1757, p. 216) appears sufficient to validate the species, and the type of *Ellipsopleurostomella* is here considered to be *E. schlichti*. The generic name is nevertheless a junior synonym of *Ellipsopolymorphina*.]

Nodosarella RZEHA, 1895, *1605, p. 219 [*Lingulina tuberosa* GÜMBEL, 1870, *840, p. 629; SD CUSHMAN, 1928, *439, p. 261] [= *Ellipsonodosaria* A. SILVESTRI, 1900, *1751, p. 4 (type, *Lingulina rotundata* D'ORBIGNY, 1846, *1395, p. 61)]. Test free, uniserial; chambers inflated; sutures horizontal and constricted; wall calcareous, very finely perforate; aperture terminal, slitlike or faintly arcuate, bordered on each side by faint lip, or slightly overlapping hood on one side. *Paleoc.-Rec.*, cosmop.—FIG. 594,10. *N. rotundata* (D'ORBIGNY), Mio., Eu.(Aus.); 10a,b, side, top views of lectotype, here designated (D'ORBIGNY Collection, MNHN, Paris), $\times 36$ (*2117).—FIG. 594,11. **N. tuberosa* (GÜMBEL), Up.M.Eoc. or Low.U. Eoc., Ger.(Bav.); 11a,b, side, apert. views, $\times 25$ (*2117).

[CUSHMAN, 1948, *486, p. 278] included biserial species in *Nodosarella* and uniserial ones in *Ellipsonodosaria*. As the type-species of *Nodosarella* is uniserial, with horizontal sutures, *Ellipsonodosaria* A. SILVESTRI, 1900, is thus a junior synonym, as was noted by STAINFORTH (1952, *1833, p. 7). Biserial forms are placed in *Ellipsoidella*.]

Pinaria BERMÚDEZ, 1937, *119, p. 242 [*P. heterosculpta*; OD]. Test free, robust, elongate, uni-

serial, sutures depressed, horizontal; wall calcareous, microstructure not known; aperture terminal, consisting of small slits, possibly due to fusion across opening of apertural teeth such as those of *Pleurostomella*, with internal tube. *Eoc.*, Carib.(Cuba).—FIG. 594,5. **P. heterosculpta*; 5a,b, side, apert. view of holotype, $\times 18$ (*2117).

Subfamily WHEELERELLINAE Petters, 1954

[Wheelerellinae PETTERS, 1954, p. 39]

Early stage triserial, later uniserial. *U. Cret.*

Wheelerella PETTERS, 1954, *1448, p. 38 [**W. magdalenaensis*; OD]. Test elongate, ovate in section, early portion with triserially arranged chambers, later uniserial, chambers low, broad, closely appressed, strongly overlapping; wall calcareous, finely perforate; aperture an elongate curved slit with bordering lip, which is slightly higher on outer curve, with internal siphon projecting inward from aperture. *U.Cret.(Coniac.)*, S.Am. (Colom.).—FIG. 598,1. **W. magdalenaensis*; 1a-d, opp. sides, basal, and apert. views of holotype, $\times 98$ (*2117).

Bandyella LOEBLICH & TAPPAN, 1962, *1185, p. 111 [**Pleurostomella greatvalleyensis* TRUJILLO, 1960, *1954, p. 345; OD]. Test free, short, robust; chambers triserially arranged in early stage, later biserial, and final chambers cuneate, uniserial; wall calcareous, perforate-granular in structure; aperture subterminal, slightly eccentric, with a T-shaped opening consisting of crescentic slit just below hooded terminus, with short perpendicular slit extending down face. [Differs from *Wheelerella* in having a T-shaped eccentric or hooded aperture, instead of a straight terminal slitlike aperture. *Ellipsopolymorphina* resembles *Bandyella* in apertural form but has only a biserial early stage before the later uniserial development.] *U.Cret.(Coniac.-Campan.)*, USA(Calif.).—FIG. 598,2. **B. greatvalleyensis* (TRUJILLO), Campan.; 2a,b, side, face views of holotype, $\times 79$ (*2117).

Family ANNULOPATELLINIDAE

Loeblich & Tappan, n.fam.

Test conical, proloculus followed by reniform second chamber, then uniserial, with annular chambers as seen from apex, overlapping on flattened side, chambers subdivided by many radial tubules opening as pores at surface; wall calcareous, perforate-granular in structure; no visible aperture other than surface pores. *Mio.-Rec.*

Annulopatellina PARR & COLLINS, 1930, *1430, p. 92 [**Orbitolina annularis* PARKER & JONES, 1860, *1417d, p. 31; OD (M)] [= *Anulopatellina* A. SILVESTRI, 1931, *1784, p. 65 (*nom. null.*)]. Test free, depressed uniserial, conical, concavo-convex, pairs of tests commonly found joined by their umbilical surfaces; proloculus followed by reni-

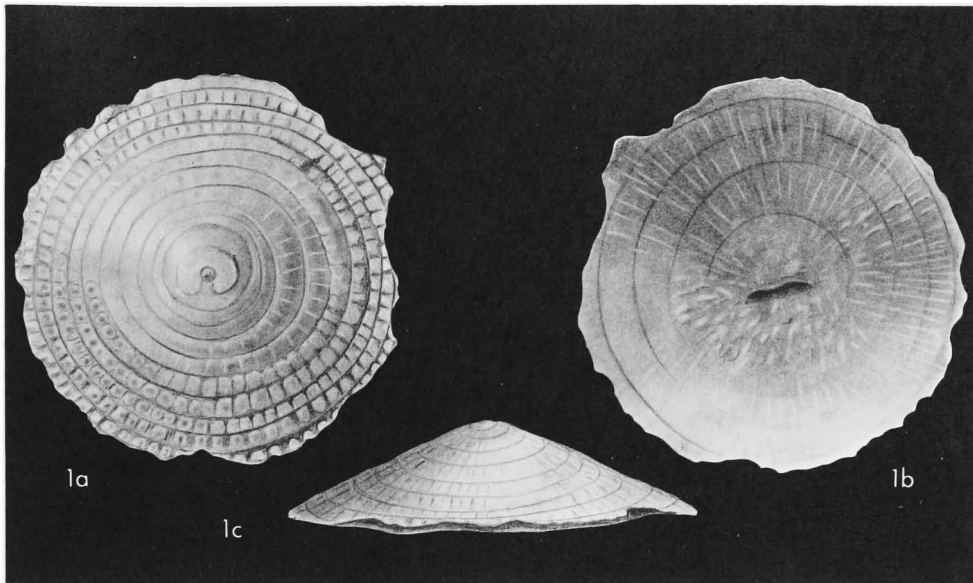


FIG. 599. Annulopatellinidae; 1, *Annulopatellina* (p. C730-C731).

form second chamber, then by annular chambers, all visible from conical elevated side but completely overlapping previous chambers on concave umbilical side, chambers subdivided by many tiny radial tubules (which superficially resemble secondary septa of *Patellina*), being hollow and opening at surface as pores, curving and anastomosing to form area of many tiny vesicular pustules in center of umbilical side; wall calcareous, perforate granular in structure, not radial and composed of single crystal as *Spirillinidae*; no aperture visible. *Mio.-Rec.*, Australia-W.Indies (Trinidad).—FIG. 599, 1. **A. annularis* (PARKER & JONES), *Rec.*, S. Australia; 1a-c, opposite sides and edge view, $\times 128$ (*2117).

[Differs from *Patellina* in having a crescentic second chamber and in lacking an undivided spiraling chamber following the proloculus. It also differs in having uniserial depressed later chambers, instead of a biserial series, and in having the concave terminal face filled with vesicular tissue rather than the S-shaped columella typical of *Patellina* and *Patellinoides*. The test is composed of granular calcite, rather than formed of a single crystal as in *Patellina*. The types of *Orbitolina annularis* PARKER & JONES, 1860, the type-species of *Annulopatellina*, were isolated by us from the original material in the British Museum (Natural History). The lectotype, here designated (BMNH-ZF3597), and paratypes (BMNH-ZF3596) are from shore sand, Melbourne, Australia.]

Family CAUCASINIDAE N. K. Bykova, 1959

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 314 (ex subfamily Caucasininae N. K. BYKOVA, 1959)] [=Virgulinidae HOFKER, 1951, p. 236; =Enallostegues D'ORBIGNY, 1826, p. 260 (partim) (*nom. neg.*, *nom. nud.*); =?Silicotextulinidae SIGAL in PIVETEAU, 1952, p. 163]

Test elongate, early stage spiral about elongate axis, later may become uniserial; aperture loop-shaped, with internal tooth plate connecting those of adjacent chambers. *U.Cret.-Rec.*

Subfamily FURSENKOININAE Loeblich & Tappan, 1961

[Fursenkoininae LOEBLICH & TAPPAN, 1961, p. 314 (*nom. subst. pro subfamily Virgulininae CUSHMAN*, 1927, p. 68)]

Test basically biserial, but distinctly twisted, later may become uniserial; aperture loop-shaped in biserial stage, becoming terminal in uniserial stage. *U.Cret.-Rec.*

Fursenkoina LOEBLICH & TAPPAN, 1961, *1177, p. 314 [*pro Virgulina* D'ORBIGNY, 1826, *1391, p. 267 (non BORY DE ST. VINCENT, 1823)]. [**Virgulina squamosa* D'ORBIGNY, 1826, *1391, p. 267; OD]. Test free, narrow, elongate, rounded to ovate in section; chambers inflated, greater in height than breadth, early portion in highly twisted biserial arrangement, later becoming less sigmoid and more typically biserial, sutures distinct, depressed-oblique, wall calcareous, very finely perforate, granular in structure, surface smooth; aperture narrow, elongate, extending up face of final chamber, lower part may be closed, leaving only suture toward base of chamber, upper part open, resulting in comma-shaped opening, tooth plate attached to closed suture of aperture, with free folded part extending through apertural opening as slight denticulated tooth, opposite end of tooth plate attached to previous apertural foramen. [Numerous references have erroneously stated that *Virgulina* (=Fursenkoina) has a triserial base. Topotypes of the type-species, *V. squamosa* D'ORBIGNY, from the Pliocene of Italy, when examined from the base, show only the highly twisted biserial development of the test found in *Sigmavirgulina*.] *U.Cret.-Rec.*, cosmop. —FIG. 600, 1-4. **F. squamosa* (D'ORBIGNY), Plio., Italy (1-3), *Rec.*, Indon. (4); 1a-c, opposite

sides and edge view, $\times 44$ (*2117); 2*a,b*, optical sec. of microspheric form showing tooth plates and edge view of aperture of same specimen, $\times 108$ (*928c); 3, megalospheric specimen with last chamber broken away to show tooth plates,

$\times 108$ (*928c); 4, diagram. sketch of isolated tooth plate showing form and denticulate margin, enlarged (*928c).

Cassidella HOFKER, 1951, *928c, p. 264 [*Virgulina tegulata* REUSS, 1846, *1538, p. 40; OD]

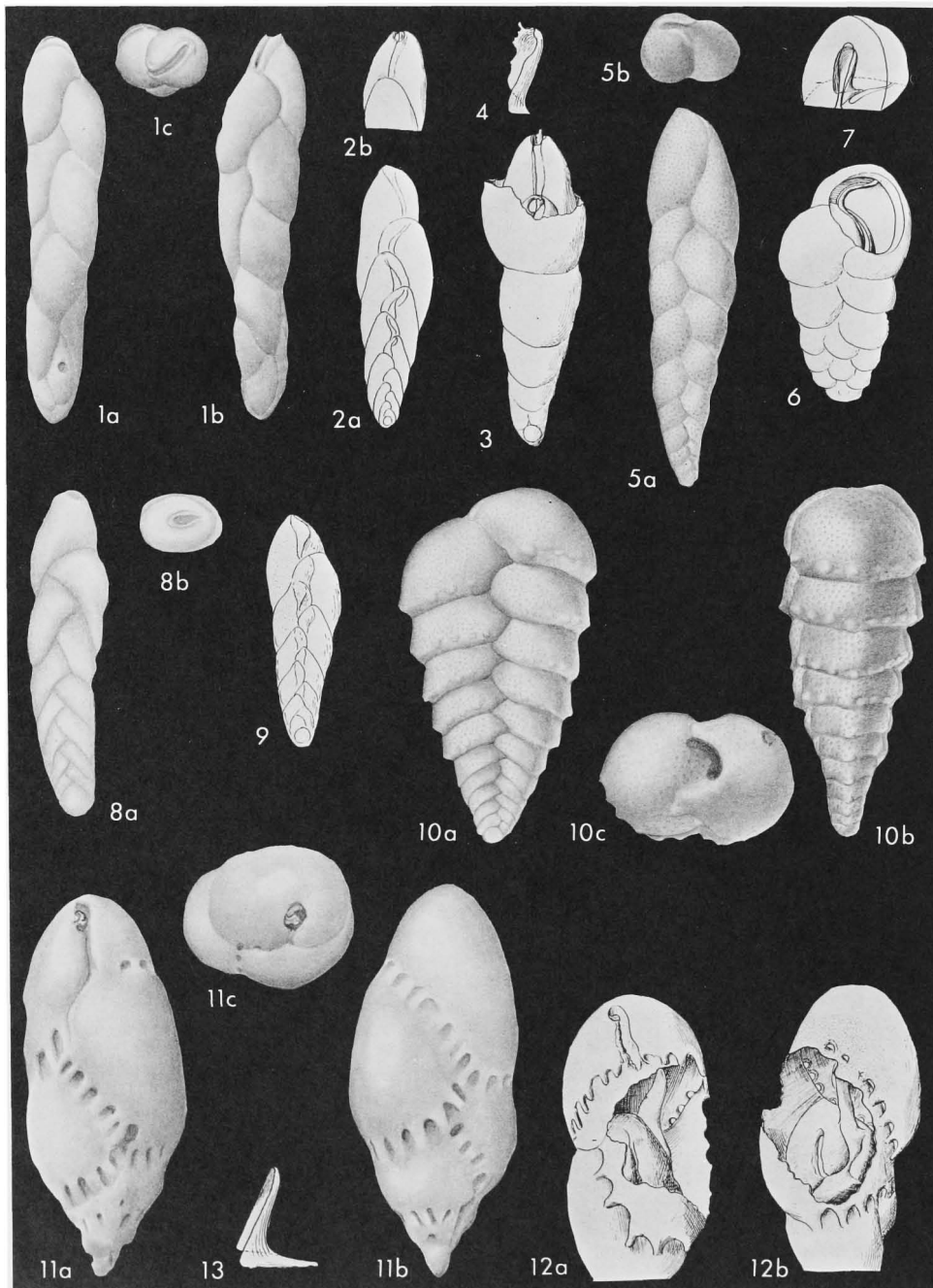


FIG. 600. Caucasinidae (Fursenkoininae; 1-4, *Fursenkoina*; 5-7, *Cassidella*; 8,9, *Coryphostoma*; 10, *Suggrunda*; 11-13, *Virgulinella*) (p. C731-C734).

[=*Praevirgulina* HOFKER, 1951, *935, p. 1 (nom. nud.)]. Test free, narrow, elongate, triserial in early stage, later biserial, very slightly twisted, chambers broad, low; sutures distinct, depressed; wall calcareous, finely perforate, granular in structure, surface smooth; aperture a long narrow slit, extending up face from base of final chamber, tooth plate simple, with folded or U-shaped section, arising at upper border of penultimate foramen, extending along basal wall of chamber to aperture where it becomes attached along lower apertural border. *U.Cret.-Rec.*, cosmop.—FIG. 600, 5-7. **C. tegulata* (REUSS), *U.Cret.*, USA (Ark.) (5), *Neth.* (6,7); 5*a,b*, side, apert. views, $\times 93$ (*2117); 6, final chamber dissected to show tooth plate, $\times 103$ (*928c); 7, diagram showing tooth plate in relation to penultimate foramen below and at right, aperture in foreground, $\times 103$ (*928c).

[The original type designation is somewhat ambiguous. HOFKER (*928c, p. 264) stated, "Genus *Cassidella*, nov. genus. Genotype, *Virgulina* (*Bolivina*) *tegulata* (Reuss)," and following the description, on p. 265 reported, "The type of the genus is *Cassidella oligocenica* Hofker." THALMANN (1952, *1897j, p. 971) in his bibliography and index cited *Virgulina tegulata* as type-species, recording the correct page number but incorrectly referring to it as published in a different paper by HOFKER, which did not describe the genus. As the first mentioned reference of HOFKER definitely stated "genotype, *V. tegulata*," this is regarded as original fixation of the type and therefore validation of the genus. Later workers have considered *Cassidella* a synonym of *Virgulina*, since *V. squamosa* was placed in *Cassidella* by HOFKER. As the Cretaceous type-species (*V. tegulata*) is a simple form, with less twisted test and simpler (nondenticulate) tooth plate than *V. squamosa* (= *Fursenkoina*), it is not here regarded as congeneric with the latter, and *Cassidella* is recognized as a valid and distinct genus. *Praevirgulina* was merely listed in combination with the specific name, as *P. tegulata*, but was not described. *Cassidella* differs from *Fursenkoina* in the less twisted test, broader and lower chambers, and simple, non-denticulate tooth plate with broader base and more U-shaped section.]

Coryphostoma LOEBLICH & TAPPAN, 1962, *1185, p. 111 [**Bolivina plaita* CARSEY, 1926, *282, p. 26; OD]. Test free, elongate, narrow, early chambers biserially arranged, later chambers becoming cuneiform with tendency to become uniserial; wall calcareous, finely perforate, granular in structure; aperture loop-shaped in early stage, extending from base of final chamber, becoming terminal in adult, with internal tooth plate. *U.Cret. (Campan.)-Rec.*, cosmop.—FIG. 600, 8, 9. **C. plaita* (CARSEY), *U.Cret.*, USA (Tex.) (8), *Mex.* (9); 8*a,b*, side, apert. views, $\times 64$ (*2117); 9, optical sec. showing internal tooth plates, $\times 104$ (*948).

[Differs from *Loxostomum* in having an internal tooth plate, being rounded in section, and in the absence of sharply keeled margins. It differs from *Rectobolivina* in having a granular, rather than radially built, wall, and in the later chambers being cuneate, without an elongate uniserial and rectilinear stage. *Loxostomoides* differs in having a radially built wall and retral processes with reentrants and lobes or crenulations of the chamber margins along the sutures.]

Sigmavirgulina LOEBLICH & TAPPAN, 1957, *1172, p. 227 [**Bolivina tortuosa* BRADY, 1881, *196c, p. 57; OD]. Test free, biserial, with chambers added slightly more than 180° apart, with sigmoidine arrangement of 2 series of chambers that at first form tight low spire, later become high-spined

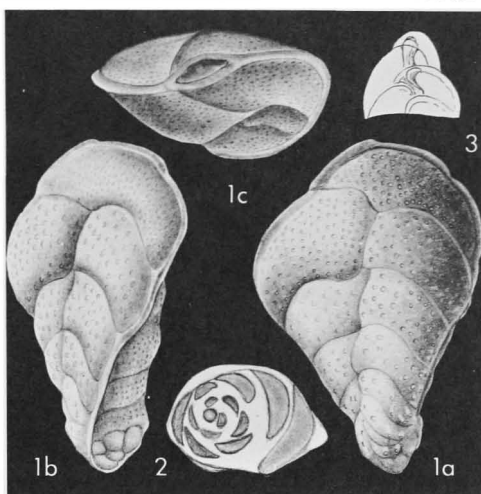


FIG. 601. Caucasinidae (Fursenkoininae; 1-3, *Sigmavirgulina*) (p. C733).

and almost regularly biserial, though somewhat twisted throughout; periphery angled or with distinct keel, chambers numerous, increasing regularly in height as added, increasing more rapidly in breadth so that test flares; sutures distinct, thickened, depressed; wall calcareous, of calcite by X-ray determination, coarsely perforate, granular in structure, surface smooth or with short spines in early portion; aperture an elongate oval at inner margin of final chamber, surrounded by lip which passes gradually into peripheral keel, provided internally with simple flaring tooth plate which is also twisted; in some specimens aperture may tend to become terminal, and is situated a short distance above the base of the chamber. *Mio.-Rec.*, cosmop.—FIG. 601, 1-3. **S. tortuosa* (BRADY), *Rec.*, Fiji (1,2), *Indon.* (3); 1*a-c*, side, edge, and apert. views, $\times 105$ (*1172); 2, basal view of partially etched specimen showing twisted biserial early chamber arrangement, $\times 105$ (*1172); 3, view in transmitted light showing twisted tooth plate, enlarged (*928c).

[Differs from *Bolivina* in having a granular wall structure, instead of radial, in the early sigmoidine type of development, the twisted adult test resulting from this process. *Sigmavirgulina* differs from *Fursenkoina* in having a compressed, rather than rounded, test, broad low chambers, rather than very high and elongate ones, and a coarsely perforate test.]

Suggrunda HOFFMEISTER & BERRY, 1937, *925, p. 29 [**S. porosa*; OD] [= ?*Silicotextulina* DEFLENDRE, 1934, *574, p. 1447 (type, *S. diatomitarum*)]. Test small, tapering, biserial throughout, chambers broad and low, with lower margin commonly nodose or spinose; sutures nearly horizontal, straight, depressed; wall calcareous; finely perforate, granular in structure, may have larger pores near basal margin of chambers; aperture a hook-shaped opening in basal depression of final chamber, presence or absence of tooth plate not reported. *Mio.*, S.Am. (Venez.)-W. Indies (Trini-

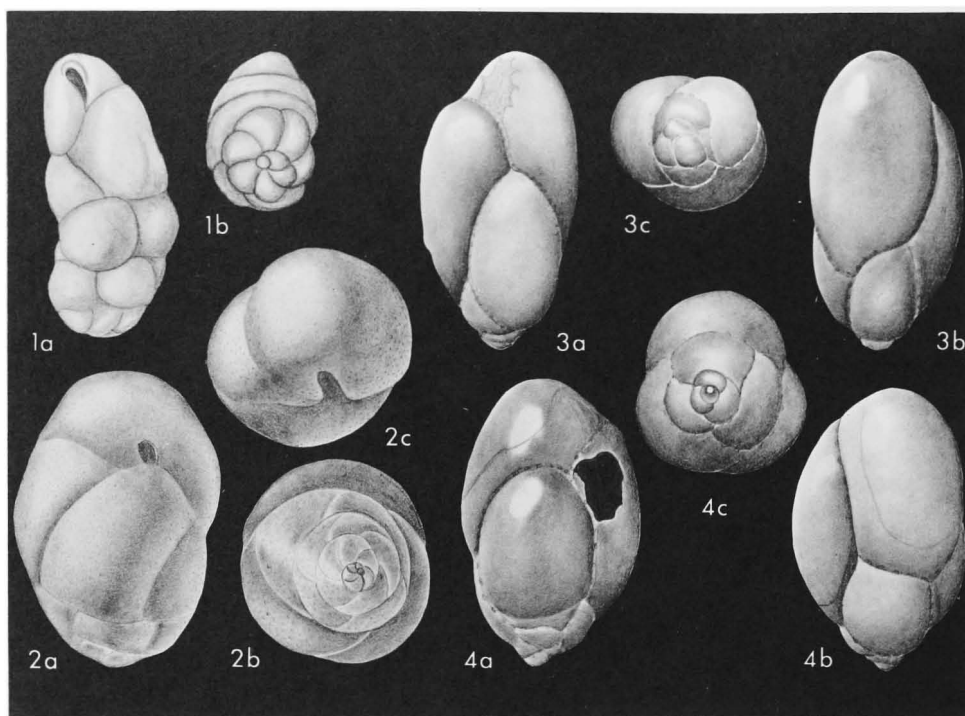


FIG. 602. Caucasinidae (Caucasininae; 1,2, *Caucasina*); Delosinidae; 3,4, *Delosina* (p. C734-C736).

dad)-USA(Calif.).—FIG. 600,10. **S. porosa*, M.Mio., Venez.; 10a-c, side, edge, and apert. views of holotype, $\times 174$ (*2117).

[The aperture of *Suggrunda* was originally described as a low basal arch, but the holotype of the type-species has a hook-shaped aperture, like that of *Grimsdaleinella* and *Gabonella*, though difficult to see because of its small size. *Silicotextulina* was described from isolated chambers and proclia which appeared siliceous or chitino-siliceous; they were found in Miocene diatomites of California. Apparently all forms referred to *Silicotextulina* consist either of internal casts or the silicified pseudochitinous inner membrane of an originally calcareous test. The small size, presence of pores near the basal margin of the chambers, and mode of occurrence strongly suggest that *Silicotextulina diatomitarum* DEFLANDRE might well be conspecific with *Suggrunda kleinpelli* BRAMLETTE, also described from California Miocene diatomites. Recent species referred to *Silicotextulina* appear to be internal casts of *Brizalina*.]

Virgulinella CUSHMAN, 1932, *453, p. 9 [**Virgulinella pertusa* REUSS, 1861, *1550, p. 362; OD] [= *Virgulinella* (*Virgulinella*) CUSHMAN, 1932, *453, p. 9 (obj.)]. Test free, elongate, rounded in section, early stage triserial, later biserial, chambers inflated, similar to *Fursenkoina* but with numerous small arched sutural openings, partially covered by bridges of basal chamber wall; wall calcareous, finely perforate, opaque, granular in structure; aperture an oblique loop-shaped opening in terminal face, with reduced tooth plate which begins near previous apertural foramen and attaches to lower part of chamber wall, then to lower border of aperture, supplementary sutural openings also present. [HOFKER (1956, *946, p. 98) regards *Candeina* as a descendant of *Virgulinella*, but *Candeina* has a radially built wall, and *Virgulinella*

a granular one.] *Mio.-Plio.*, Eu.-N.Am.-Asia (Indon.).—FIG. 600,11-13. **V. pertusa* (REUSS), Mio., Ger. (11), Neth. (12,13); 11a-c, opposite sides and apert. view, $\times 64$ (*2117); 12a,b,13, dissected specimen showing tooth plate and isolated tooth plate, enlarged (*946).

Subfamily CAUCASININAE N. K. Bykova, 1959

[Caucasininae N. K. BYKOVA in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 328]

Early stage trochospiral, later biserial; aperture a loop in apertural face. *U.Cret.-Mio.*

[Although no information is available as to the microstructure of the wall of the type-species of *Caucasina*, the genus *Aeolostreptis* LOEBLICH and TAPPAN, 1957 (which on the basis of descriptions and illustrations appears to be a junior synonym of *Caucasina* KHALILOV, 1951), has a distinctly granular wall. Hence the subfamily and family are placed in the Cassidulinacea and removed from the Buliminacea.]

Caucasina KHALILOV, 1951, *1036, p. 58 [**C. oligocenica*; OD] [= *Aeolostreptis* LOEBLICH & TAPPAN, 1957, *1172, p. 227 (type, *Buliminella vitrea* CUSHMAN & PARKER, 1936, *515, p. 7)]. Test free, elongate, base bluntly rounded, early portion in low discorbin coil with up to 8 chambers per whorl, later whorls becoming high-spired and reduced in number of chambers to 3 per whorl, early chambers low, later about equal in breadth and height and may be inflated, but not extremely high and elongate; sutures distinct, depressed; wall calcareous, finely perforate, granular in structure, surface smooth; aperture an

elongate loop at inner margin of final chamber, at right angles to sutures, with narrow lip at forward margin. *U.Cret.-Mio.*, Eu.-N.Am.-Asia.

—FIG. 602,1. **C. schischkinskayae* (SAMOYLOVA), Oligo., USSR (Caucasus); 1a,b, side and basal views, $\times 106$ (*1509).—FIG. 602,2. *C. vitrea* (CUSHMAN & PARKER), U.Cret., USA (Miss.); 2a-c, side, basal, and apert. views, $\times 200$ (*1172). [**C. oligocenica* = *Bulimina schischkinskye* SAMOYLOVA, 1947, *1623, p. 82, 100 (recte *B. schischkinskayae*).]

[*Caucasina* was originally described from the Oligocene of the Caucasus, and later reported to occur from Eocene to Miocene. *Aeolostreptis* was defined for Upper Cretaceous species. As no morphologic distinction between these "genera" was observed and species referable to the genus have been described from the Upper Cretaceous, Paleocene, Eocene, Oligocene and Miocene, *Aeolostreptis* was later regarded by us as a synonym of *Caucasina* (*1177).]

Family DELOSINIDAE Parr, 1950

[*Delosinidae* PARR, 1950, p. 345]

Test triserial; no primary aperture, but

large sutural pores open into subsutural canal. *Rec.*

Delosina WIESNER, 1931, *2063, p. 123 [**Polymorphina*(?) *complexa* SIDEBOTTOM, 1907, *1740, p. 16; OD (M)]. Test free, elongate, somewhat tapered at base, rounded in sections; chambers elongate, trochospirally arranged, with 3 strongly overlapping chambers per whorl, final whorl occupying much of entire length; sutures depressed; wall calcareous, finely perforate, granular in structure, surface smooth; distinct large sutural pores opening into subsutural canals which apparently terminate in spongy area of final chamber but do not open to exterior; apertural development consisting of perforations in somewhat restricted terminal area, in type-species forming somewhat loop-shaped arch upward from suture-contact with penultimate chamber at its apex. *Rec.*, *Medit.-Antarctic-Pac.O.*—FIG. 602, 3,4. **D. complexa* (SIDEBOTTOM), *Medit.*(*Delos*

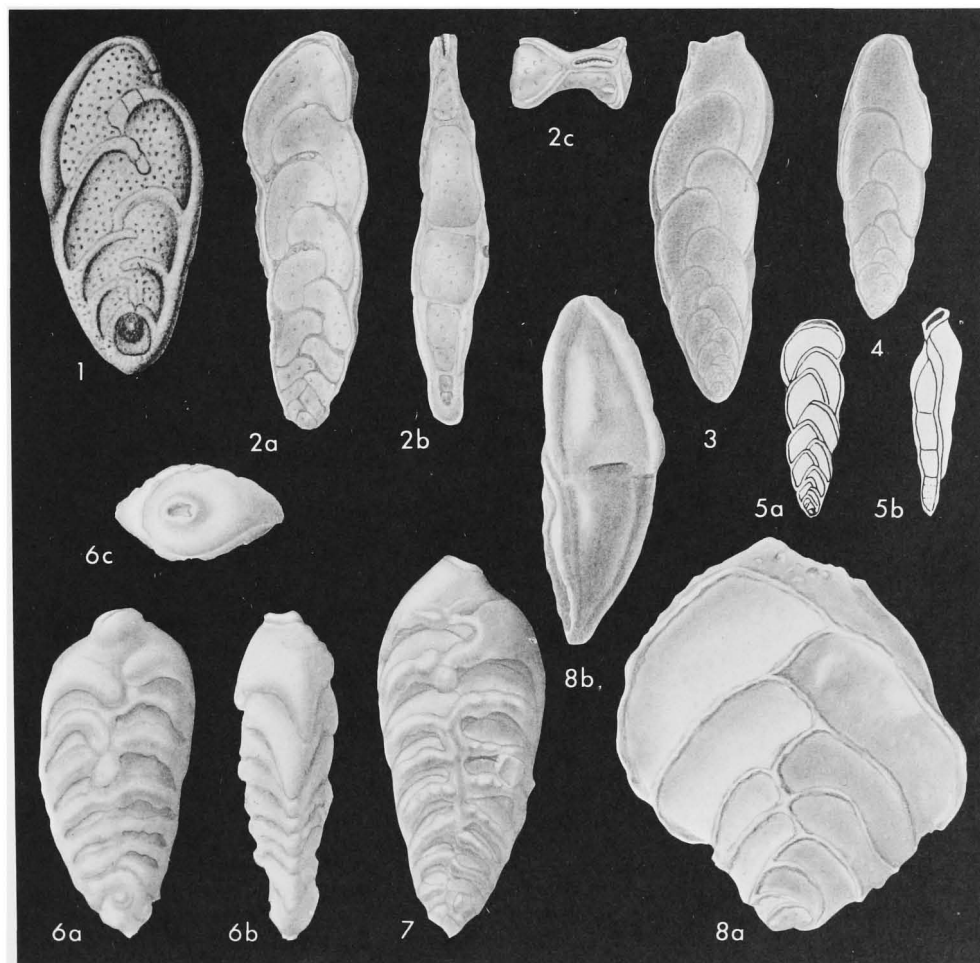


FIG. 603. Loxostomidae; 1-5, *Loxostomum*; 6,7, *Trachelinella*; 8, *Aragonia* (p. C736).

Is.); 3a-c, 4a-c, opposite sides and basal views of topotypes showing sutural pores opening into subsutural canals, $\times 87$ (*2117).

[Originally regarded as *Polymorphina*, in the Polymorphinidae, this genus was later placed in the Buliminidae, Bulimininae, by EARLAND (1934, *653, p. 125), who stated that sections showed a loop-shaped aperture in one specimen of a megalospheric proloculus, suggesting a bulimine aperture. It was placed in the subfamily Uvigerininae by CUSHMAN (1948, *486) and in the newly proposed family Delosinidae by PARR (1950, *1429). The perforate-granular wall structure would eliminate this genus from the families Polymorphinidae, Buliminidae, and Uvigerinidae, and even from their superfamilies, showing that it belongs to the Cassidulinacea and suggesting its close relationship to the Fursenkoininae (the sutural pores of *Delosina* are reminiscent of those in *Virgulinitella*). The internal tube of the Fursenkoininae has not yet been demonstrated in *Delosina*, however, and the absence of a distinct aperture allows retention of the monotypic family Delosinidae.]

Family LOXOSTOMIDAE

Loeblich & Tappan, 1962

[Loxostomidae LOEBLICH & TAPPAN, 1962, p. 110]

Test free, biserial, or may become uniserial in later stage, commonly with flattened sides and carinate margins; wall calcareous, perforate-granular in structure; aperture interiomarginal in simpler forms, later may become terminal, no tooth plate or internal siphon. *U.Cret. (Senon.)-Eoc.*

Loxostomum EHRENBURG, 1854, *680, p. 22 [**L. subrostratum*; SD CUSHMAN, 1927, *434, p. 490] [= *Loxostoma* HOWE, 1930, *969, p. 329 (*nom. van.*) (non BIVONA-BERNARDI, 1838); *Bolivinitella* MARIE, 1941, *1215, p. 189 (type, *Bolivinita eleyi* CUSHMAN, 1927, *429, p. 91)]. Test elongate, compressed, quadrate in section, with flat or concave sides; chambers biserially arranged throughout, strongly overlapping and arched in adult with tendency to become uniserial; sutures limbate, arched, sutural thickening merging laterally into longitudinal carinae at 4 margins; wall calcareous, finely perforate; aperture terminal, slitlike to ovate, commonly with lip which may be very finely tuberculate but lacking any internal tooth plate. [The synonymy of *Loxostomum* and *Bolivinitella* was noted by HOFKER (1951, *928c, p. 44) and discussed by LOEBLICH & TAPPAN (1962, *1185, p. 110), who therefore emended the generic description.] *U.Cret. (Senon.)-Paleoc.*, Eu.-N.Am.—FIG. 603,1-5. **L. subrostratum*, U. Cret. (Senon.), Eu. (Fr.); 1, side view of specimen mounted in balsam and viewed in transmitted light, copy of Ehrenberg's original figure (*472); 2a-c, side, edge, and top views of holotype of *Bolivinita eleyi*, U.Cret., USA (Ark.), $\times 104$ (*1303); 3,4, side views of topotype of *B. eleyi*, $\times 100$ (*1303); 5a,b, side and edge views of specimen from U.Cret., Fr., figured originally as *Bolivinitella eleyi* (CUSHMAN) by MARIE; $\times 38$ (*1215).

Aragonia FINLAY, 1939, *717c, p. 318 [**A. zelandica*; OD]. Test free, rhomboidal, compressed to fusiform in section, sides flat; chambers biserially arranged; sutures oblique, commonly limbate; wall

calcareous, granular, not perforate, surface ornamented by limbate and elevated sutures and marginal keel, and may also have longitudinal and diagonally placed costae that form irregular network; aperture small, low opening at base of final chamber, no internal tooth plate. [Originally *Aragonia* was placed in the Heterohellicidae (*717c) as related to *Bolivinoidea*, but because of the absence of a tooth plate and the character of the wall (lacking perforations, and resembling agglutinated calcareous grains) it was later regarded by REYMENT as related neither to the Heterohellicidae nor to the Boliviniinae (*1558) but to be an agglutinated form.] *Paleoc.-Eoc.*, N.Z.-N.Am.-Carib.-Eu.—FIG. 603,8. **A. zelandica*, M.Eoc., N.Z.; 8a,b, side, top views of paratype, $\times 192$ (*2117).

Trachelinella MONTANARO GALLITELLI, 1956, *1302, p. 38 [**Bolivina watersi* CUSHMAN, 1927, *429, p. 88] [= *Trachelina* MONTANARO GALLITELLI, 1955, *1300, p. 215 (*nom. nud.*)]. Test elongate, somewhat compressed, flaring gradually, chamber arrangement biserial, test commonly twisted as much as 90° with growth, periphery subacute, commonly carinate; sutures arched, incised; wall calcareous, finely perforate, surface with prominent ribs aligned along major inflation of chambers and consequently strongly arched, commonly fusing laterally into marginal carinae; aperture terminal, rounded to ovate with short neck and lip, no apertural tooth observed. [Differs from *Bolivina* in lacking an internal tooth plate, and in having a well-developed terminal neck and terminal aperture. The oblique axis, short neck, biserial chamber arrangement and absence of a tooth plate suggest a relationship with *Loxostomum*.] *U.Cret. (Maastricht.)*, USA (Tex.).—FIG. 603,6,7. **T. watersi* (CUSHMAN); 6a-c, side, edge, and apert. views showing heavy ornamentation and terminal aperture; 7, side view of holotype showing biserial chamber arrangement; all $\times 123$ (*1302).

Family CASSIDULINIDAE d'Orbigny, 1839

[Cassidulinidae d'ORBIGNY in DE LA SAGRA, 1839, p. xxxix, 123]—[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (¹family, ²subfamily); dagger (†) indicates *partim*]—[=²Cassidulinida SCHULTZE, 1854, p. 52; =¹Cassidulinidea REUSS, 1862, p. 373; =²Cassidulinae BRADY, 1881, p. 44; =²Cassidulininae BRADY, 1884, p. 69; =¹Cassidulina LANKESTER, 1885, p. 847; =¹Cassiduline DELAGE & HÉROUARD, 1896, p. 140; =²Cassidulininae CALKINS, 1901, p. 108; =¹Cassidulinida COPELAND, 1956, p. 188 (*nom. van.*)—[=¹Turbinoidat SCHULTZE, 1854, p. 52 (*nom. nud.*); =²Ehrenbergininae CUSHMAN, 1927, p. 84]

Test lenticular, subglobular or elongate; chambers biserially arranged, alternating chambers also planispirally enrolled at least in early stage, later may be uncoiled; aperture elongate, comma-shaped, slit extending from basal suture into apertural face. *Eoc.-Rec.*

Cassidulina D'ORBIGNY, 1826, *1391, p. 282 [*C. laevigata*; OD (M)] [= *Entrochus* EHRENBURG, 1843, *672, p. 408 (type, *E. septatus*); *Seleno-*

stomum EHRENBURG, 1858, *683, p. 12]. Test free, lenticular, commonly biumbonate, with clear central bosses; chambers biserially arranged in

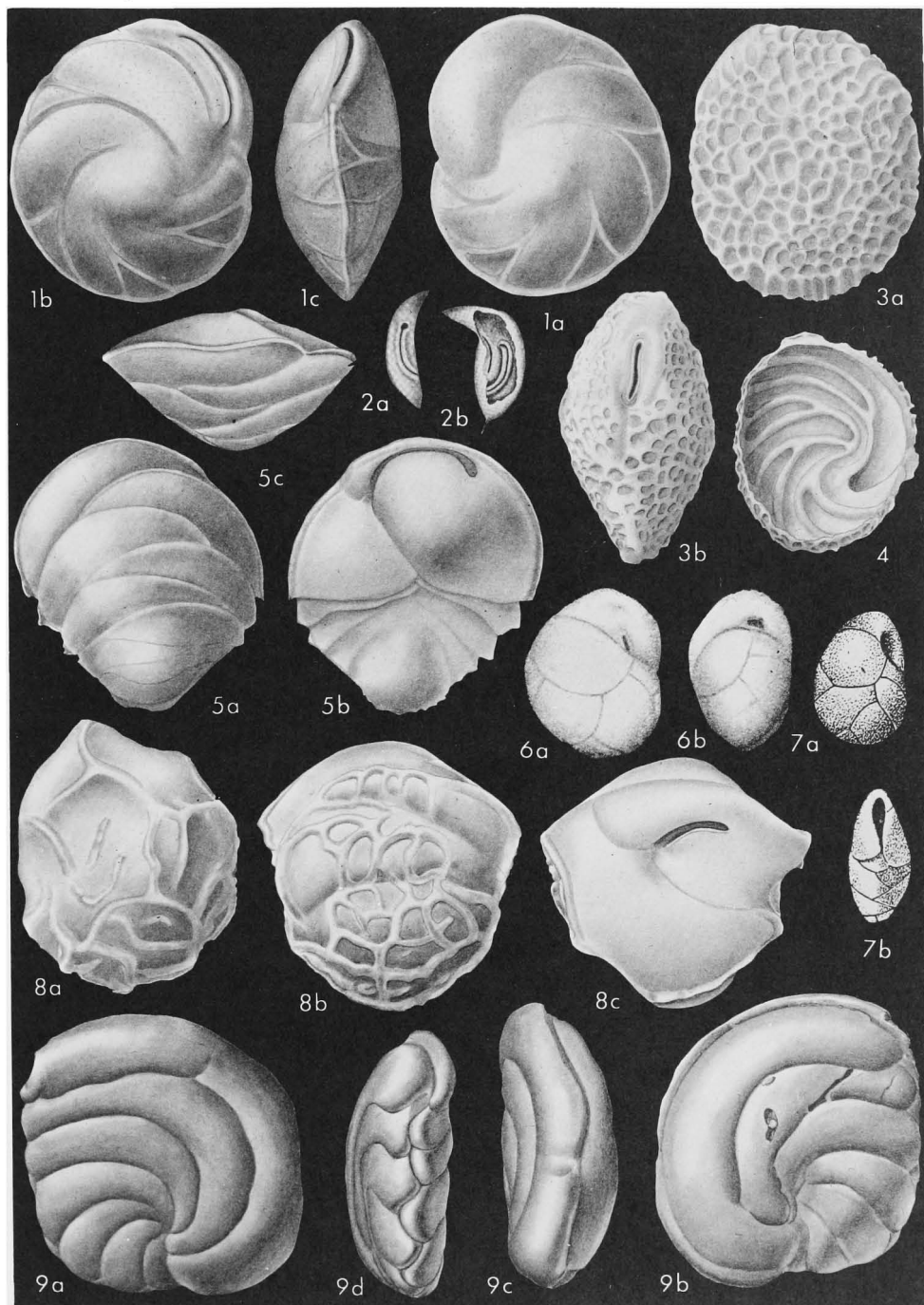


FIG. 604. Cassidulinidae; 1, 2, *Cassidulina*; 3, 4, *Favocassidulina*; 5, *Ehrenbergina*; 6, 7, *Globocassidulina*; 8, *Burseolina*; 9, *Cassidulinella* (p. C737-C738).

coil, chambers alternating on each side of periphery, each reaching boss on one side and only extending part way to boss of opposite side; succeeding chamber extending to center on alternate sides; wall calcareous, hyaline, perforate, granular in structure, surface generally smooth; aperture an elongate slit, extending from base of final chamber upward in curve paralleling anterior margin of chamber with narrow bordering lip on lower margin but lacking internal tooth. [*Cassidulina*, as here recognized, excludes the radial-walled species, now placed in *Islandiella*, as well as those with globular, nonkeeled tests and tripartite aperture, now placed in *Globocassidulina*. *Cassidulina laevigata* was originally described from ballast sand of unknown provenance.] *Eoc.-Rec.*, cosmop.—FIG. 604,1,2. **C. laevigata*, Rec., Eu. (Italy) (1), Atl.O. (2); 1*a-c*, opposite sides and edge view, $\times 78$ (*2117); 2*a,b*, final chamber showing apert. on exterior and partially dissected chamber showing apert. inside with inward bent apert. margin, $\times 40$ (*1361).

Burseolina SEGUENZA, 1880, *1713, p. 138 [*B. calabra*; OD (M)]. Test free, subglobular, tiny, periphery broadly rounded; chambers biserially enrolled; wall calcareous, perforate, surface ornamented with striae, or with coarse ridges and reticulations which obscure sutures, as in *Favocassidulina*, apertural face smooth; aperture a narrow, elongate, arched slit, extending up face of final chamber, with narrow bordering lip. [*Burseolina* is similar to *Globocassidulina* in having a rounded, rather than angular to carinate, periphery, may resemble *Favocassidulina* in surface ornamentation, and has the apertural characters of *Cassidulina*, with elongate arched aperture extending up the face with narrow bordering lip.] *Mio.*, Eu.(Italy)-Carib.—FIG. 604,8. **B. calabra*, Torton., Italy; 8*a-c*, side, dorsal, and face views, showing biserially arranged chambers, obscure ridges, and apert., $\times 111$ (*2117).

Cassidulinella NATLAND, 1940, *1347, p. 568, 570 (non SUZIN in VOLOSHINOVA & DAIN, 1952) [**C. pliocenica*; OD]. Test free, flattened, chambers biserially enrolled as in *Cassidulina*, with later chambers much elongated and overlapping at periphery, tending to encircle much of peripheral margin, zigzag suture between biserially arranged chambers almost peripheral in position; wall calcareous, thin, finely perforate, microstructure not determined, as specimens available are pyritic casts; aperture a much elongated slit extending up face, near to and paralleling outer margin of final chamber. [Differs from *Cassidulina* in the encircling tendency of its later chambers. Whether it is to be finally placed with the Cassidulinidae or Islandiellidae depends on additional information as to wall structure and presence or absence of an internal tooth.] *U.Mio.-U.Plio.*, USA(Calif.). —FIG. 604,9. **C. pliocenica*, Plio.; 9*a-d*, opposite sides, apert. and back peripheral views to show

chamber alternation, holotype, $\times 56$ (*2117).

Ehrenbergina REUSS, 1850, *1540, p. 377 [**E. serrata*; OD (M)]. Test flattened, compressed perpendicular to plane of coiling, periphery carinate; chambers broad, low, biserially arranged and enrolled, as in *Cassidulina*, but somewhat uncoiled; wall calcareous, finely perforate, granular in structure, surface smooth or with pustules or ridges; aperture an elongate curved slit, perpendicular to base of apertural face and paralleling peripheral keel. [The wall character and aperture of *Ehrenbergina* are similar to *Cassidulina*, but the test is uncoiled.] *Eoc.-Rec.*, cosmop.—FIG. 604,5. **E. serrata*, Mio., Eu.(Aus.); 5*a-c*, opp. sides and edge view, $\times 78$ (*2117).

Favocassidulina LOEBLICH & TAPPAN, 1957, *1172, p. 230 [**Pulvinulina favus* BRADY, 1877, *194, p. 535; OD]. Test free, lenticular, periphery acute; chambers biserially arranged and enrolled as in *Cassidulina*, each chamber extending to umbilicus on one side with only small triangular portion extending to opposite side; sutures not visible externally, obscured by coarse surface ornamentation; wall calcareous, finely perforate, granular in structure, ornamented by honeycomb-like secondary growth, with relatively wide hexagonal open areas separated by narrow, elevated ridges; aperture elongate, a slightly curved slit bordered by very narrow lip, and extending upward from base of final chamber, near to and paralleling anterior margin of chamber, opening toward side opposite that on which final chamber lies, each successive aperture appearing on alternate sides of test, region immediately surrounding aperture relatively smooth. *Rec.*, Pac.O.—FIG. 604,3,4. **F. favus* (BRADY), Chile (3), Caroline Is. (4); 3*a,b*, side and edge views of toptype, $\times 44$ (*1172); 4, half-sectioned hypotype, $\times 48$ (*1172).

Globocassidulina VOLOSHINOVA, 1960, *2020, p. 58 [**Cassidulina globosa* HANTKEN, 1875, *863, p. 64; OD] [= *Cassilongina* VOLOSHINOVA, 1960, *2020, p. 58 (type, *Cassidulina oblonga* REUSS, 1850, *1540, p. 376)]. Test free, subglobular, peripheral margin rounded, umbilicus closed; chambers biserially arranged and enrolled; wall calcareous, finely perforate, granular in structure, surface commonly smooth; aperture a narrow slit extending up face of final chamber, may have narrow infolded rim, but no apertural tooth plate. [*Cassilongina* was defined as having a tendency to elongate, but no true uncoiling occurs. *Cassilongina* was also stated to have a thin single-layered wall, and *Globocassidulina* a many-layered wall. Both are lamellar in character, and relative thickness of the wall varies in different species. *Cassilongina* is here regarded as synonymous with *Globocassidulina*.] *Eoc.-Rec.*, cosmop.—FIG. 604, 6. **G. globosa* (HANTKEN), U.Eoc., USA(S.Car.); 6*a,b*, side, edge views, $\times 90$ (*467). —FIG. 604, 7. *G. oblonga* (REUSS), Tert., Spain(Galicia); 7*a,b*, side, edge views, approx. $\times 93$ (*2022).

**Family INVOLUTINIDAE Bütschli,
1880**

[*nom. transl.* SIGAL in PIVETEAU, 1952, p. 159 (ex subfamily Involutininae BÜTSCHLI in BRONN, 1880, p. 209; Involutininae

THALMANN, 1935, p. 715)]—[=Problematicinae RHUMBLER, 1913, p. 389; =Aproblematica RHUMBLER, 1913, p. 389 (*nom. van.*); =Ventrolamininae WEYNSCHENK, 1950, p. 17; =Ventrolamininae LOEBLICH & TAPPAN, 1961, p. 292]
Test tubular and enrolled, with secondary

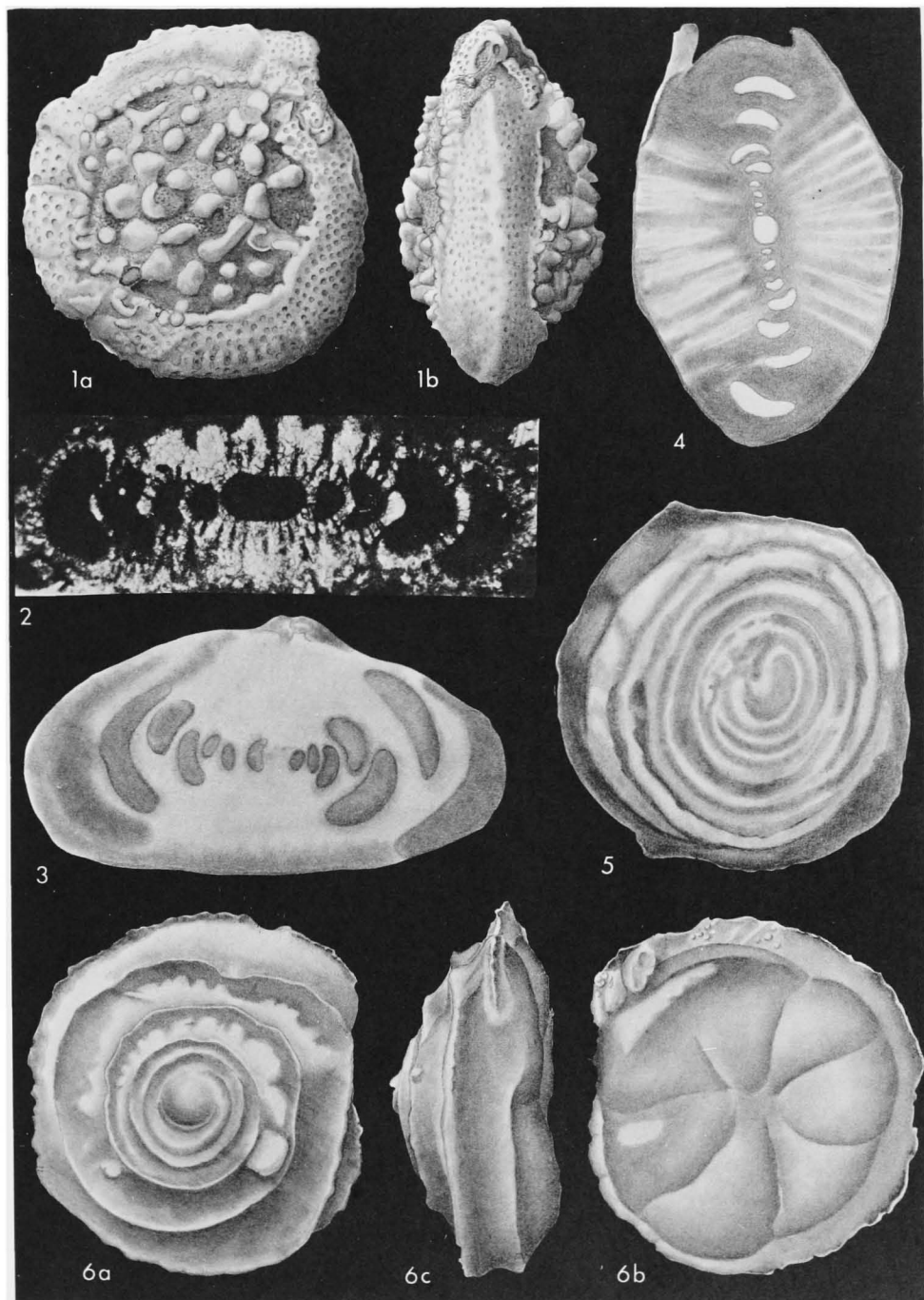


FIG. 605. Involutinidae; 1,2, *Involutina*; 3-5, *Aulotortus*; 6, *Paalzowella* (p. C740-C741).

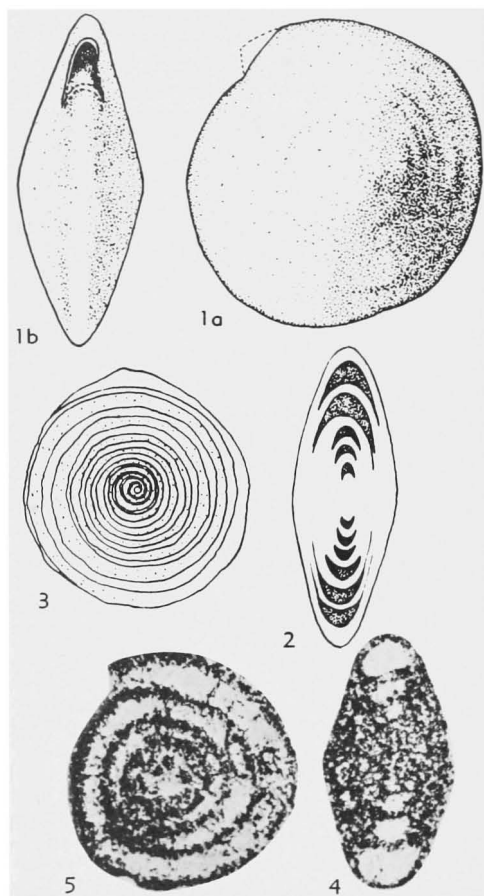


FIG. 606. Involutinidae: 1-5, *Aulotortus* (p. C740-C741).

deposits in umbilical region on one or both sides; wall calcareous perforate, lamellar, microgranular. *U.Trias.-U.Cret.(Cenoman.-Turon.)*.

Involutina TERQUEM, 1862, *1883, p. 450 [*I. jonesi* TERQUEM & PIETTE in TERQUEM, 1862, *1883, p. 461, =*Nummulites? liassicus* JONES in BRODIE, 1853, *208, p. 275; SD BORNEMANN, 1874, *174, p. 711] [= *Problematina* BORNEMANN, 1874, *174, p. 733 (type, *Involutina deslongchampsii* TERQUEM, 1864, *1885, p. 432); *Arinvolutum* RHUMBLER, 1913, *1572b, p. 390 (*nom. van.*); *Arproblemataum* RHUMBLER, 1913, *1572b, p. 390 (*nom. van.*)]. Test free, lenticular, consisting of proloculus followed by planispirally coiled, nonseptate tubular second chamber, umbilical region on both sides filled with numerous secondarily deposited pillars or plugs; surface may be pitted; aperture at open end of tube. [The complex taxonomy and confusion as to the type-species has

been recently reviewed in detail by LOEBLICH & TAPPAN (1961, *1176).] *U.Trias.-L.Jur.(Lias.)*, Eu.—FIG. 605, 1, 2. **I. liassica* (JONES), Lias., Eng.(1), Switz. (2); 1a, b, side, edge views of hypotype, $\times 35$ (*2117); 2, axial sec., $\times 27$ (*1525).

Aulotortus WEYNSCHENK, 1956, *2052, p. 26 [*A. sinuosus*; OD] [= *Trocholina* (*Paratrocholina*) OBERHAUSER, 1957, *1383, p. 196 (type, *T. (P.) oscillans*); *Angulodiscus* KRISTAN, 1957, *1057, p. 278 (type, *A. communis*); *Arenovidalina* HO, 1959, *923, p. 414 (type, *A. chialingchiangensis*)]. Test free, lenticular, compressed to nearly globular; small spherical proloculus followed by planispirally to slightly streptospirally enrolled and undivided tubular chamber, umbilical area of both sides of test filled with secondary deposit of crystalline calcite, so that only final whorl is visible at peripheral margin, earlier whorls and spiral suture obscured by secondary filling; wall calcareous, central area may be variously ornamented with irregular or radial ridges, ventral side in some species appearing granular and suggesting termination of umbilical pillars, which merge outward into radial ridges; aperture at open end of tubular chamber, slightly asymmetrical in position. *Trias.-U.Cret. (?Turon.)*, Eu.-Asia (China-Turkey).—FIG. 605, 3. **A. sinuosus*, M.Jur., Eu.(Aus.); $\times 37$ (*2052).

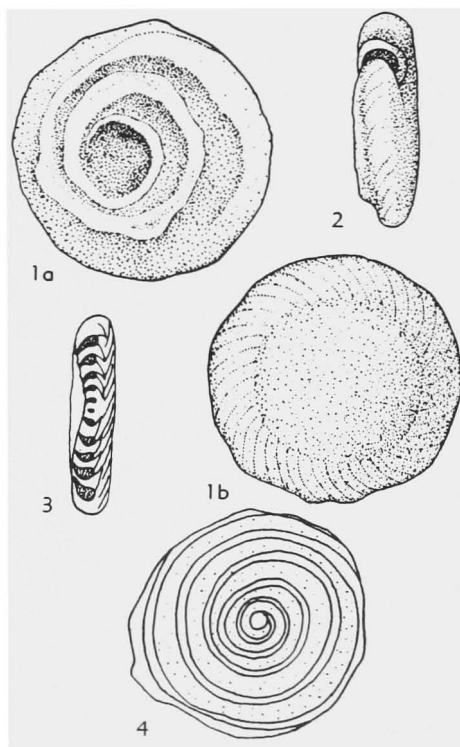


FIG. 607. Involutinidae: 1-4, *Paalzowella* (p. C741).

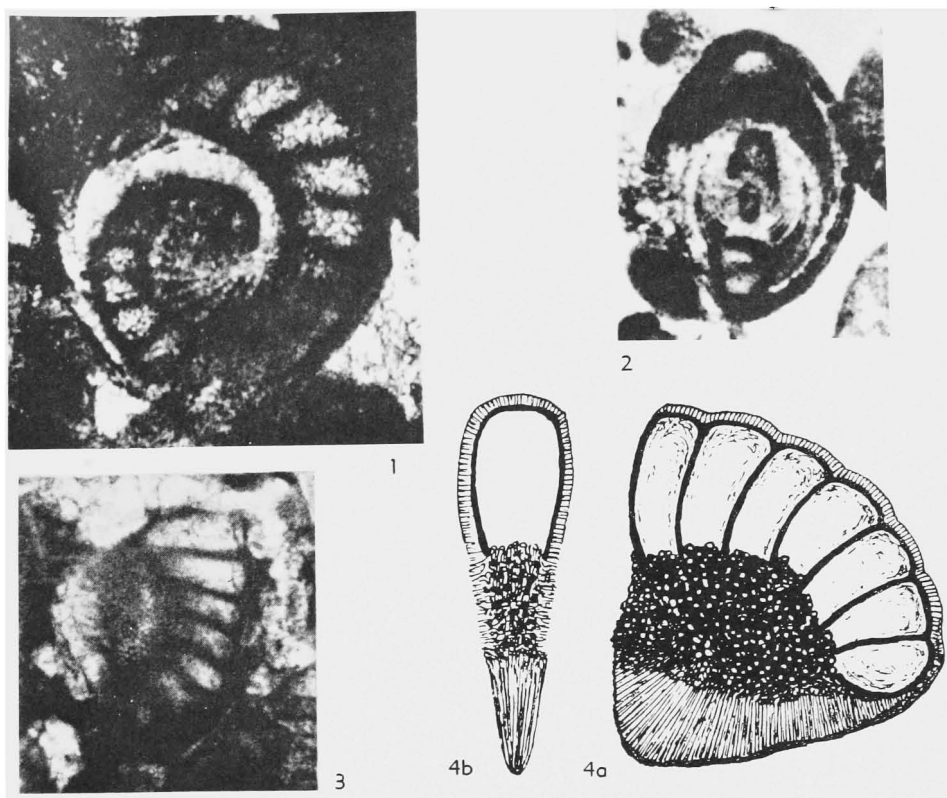


FIG. 608. Involutinidae; 1-4, *Protopeneroplis* (p. C741-C742).

—FIG. 605,4,5. *A. oscillans* (OBERHAUSER), U. Cret.(?Turon.), Turkey; 4, axial sec. of holotype, $\times 27$ (*1383); 5, equat. sec., $\times 27$ (*1383).—FIG. 606,1-3. *A. communis* (KRISTAN), U.Trias. (Rhaet.), Eu.(Aus.); 1a,b, side, apert. views of holotype; 2, axial sec.; 3, equat. sec.; all $\times 35$ (*1057).—FIG. 606,4,5. *A. chialingchiangensis* (Ho), Trias., China; 4, axial sec. of holotype, $\times 200$ (*923); 5, equat. sec., $\times 200$ (*923).

[*Aulotortus* differs from *Involutina* in its slightly streptospiral coiling, and in its less well-differentiated umbilical pillars. It was originally described as calcareous and imperforate and was placed in the Ophthalmitidae. A very nearly identical species was described by OBERHAUSER (1957, *1383) as *Paratrocholina*. Well-preserved specimens clearly show the perforate nature of the test. The synonymies of the type-species of both genera include reference to an earlier figure and description by WEYNSCHENK (1950, *2050) indicated as "Genus?, species?." In an appendix to his article, OBERHAUSER noted the probability that *Paratrocholina* and *Aulotortus* are synonymous, the apparently imperforate wall of *Aulotortus* possibly being due to later recrystallization. This is suggested also by the original figures of *Aulotortus*.]

Paalzowella CUSHMAN, 1933, *461, p. 234 [*Discorbina scalariformis* PAALZOW, 1917, *1403, p. 247; OD] [= *Coronella* KRISTAN, 1957, *1057, p. 280 (type, *C. austriaca*) (non *Coronella* LAURENTI, 1768; nec GOLDFUSS, 1828); *Coronipora* KRISTAN, 1958, *1058, p. 114 (nom. subst. pro *Coronella*

KRISTAN, 1957) (obj.)]. Test free, conical, consisting of single tubular chamber, spirally enrolled, nearly completely involute on umbilical side, evolute on spiral side, periphery keeled; spiral suture may be thickened and elevated, showing remnant of earlier peripheral keel, radial markings giving ventral surface lobate appearance but do not reflect true septa; aperture at open end of tube. [Differs from *Trocholina* in being more completely involute on the umbilical side and lacking umbilical plugs and pillars, and in having radial ornamentation.] U.Trias.(Rhaet.)-U.Jur., Eu.—FIG. 605,6. **P. scalariformis* (PAALZOW), U.Jur., Ger.; 6a-c, opposite sides and edge view of topotype, $\times 116$ (*2117).—FIG. 607,1-4. *P. austriaca* (KRISTAN), U.Trias.(Rhaet.), Aus.; 1a,b, opposite sides of holotype; 2, edge view of paratype; 3, axial sec.; 4, equat. section; all $\times 35$ (*1057).

Protopeneroplis WEYNSCHENK, 1950, *2050, p. 13 (non HOFKER, 1950, *933a, p. 393) [**P. striata*; OD] [= *?Ventrolamina* WEYNSCHENK, 1950, *2050, p. 17 (type, *V. cribrans*)]. Test planispirally enrolled, bilaterally symmetrical and involute, not close-coiled, successive whorls not touching in equatorial section; septa thickened,

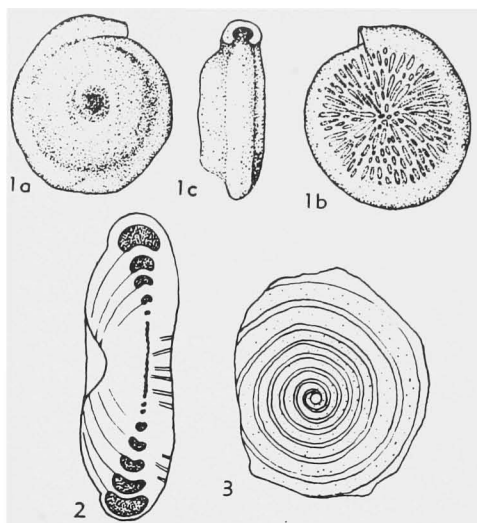


FIG. 609. Involutinidae; 1-3, *Semiinvoluta* (p. C742).

slightly oblique; wall calcareous, granular, fibrous, finely perforate, lamellar, surface with regularly arranged spiraling costae; aperture areal. *M. Jur.-U. Jur.*, Eu. (Aus., Tirol)-Asia (Israel).—FIG. 608, 1, 2. **P. striata*, *M. Jur.*, Aus.; 1, equat. sec., $\times 110$ (*2050); 2, axial sec., $\times 130$ (*2050).—FIG. 608, 3, 4. *P. cribrans* (WEYNSCHENK), *U. Jur.*, Aus.; 3, equat. or oblique sec., so-called sieve plate in lower part may be an oblique cut through fibrous wall, $\times 77$ (*2050); 4a, b, diagram, interpretation of equat. and axial secs., approx. $\times 120$ (*2050).

[*Protopeneroplis* and *Ventrolamina* were both described from thin sections, hence are only partially known. It seems probable that the 2 nominal genera and possibly their type-species are synonymous, as they are from the same samples, show very similar chamber size, arrangement, and septal angle. *Ventrolamina* sections possibly represent oblique sections of *Protopeneroplis*. Additional study of free specimens and oriented sections is needful for better determining the relationships.]

***Semiinvoluta* KRISTAN, 1957, *1057, p. 276** [*S. clari*; OD]. Intermediate in character between *Trocholina* and *Involutina*; test similar to *Trocholina* in having umbilical pillars on one side only but with coiling nearly planispiral, as in *Involutina*, and with secondary thickening also on spiral side; aperture at open end of tube. *U. Trias. (Rhaet.)*, Aus.—FIG. 609, 1-3. **S. clari*; 1a-c, opposite sides and edge views of holotype; 2, axial sec.; 3, equat. sec., all $\times 35$ (*1057).

***Trocholina* PAALZOW, 1922, *1404, p. 10** [*Involutina conica* SCHLUMBERGER, 1898, *1659, p. 151; SD CUSHMAN, 1933, *461, p. 234] [= *Neotrocholina* REICHEL, 1956, *1525, p. 404 (type, *N. valdensis*); *Trocholina (Trochonella)* KRISTAN, 1957, *1057, p. 285 (type, *T. (T.) crassa*)]. Test free, conical, consisting of globular proloculus and spirally enrolled tubular second chamber, which is dorsally evolute with all whorls visible, ventral

umbilical region completely filled with coarse calcite crystals, appearing as irregularly arranged pillars, nodes or beads on surface; wall calcareous, dorsally coarsely perforate, ventrally more finely perforate, granular in structure, surface smooth or with elevated spiral suture, ventral surface of final whorl may show somewhat curved faint growth striae, which end in pustules at umbilical margin; aperture at open end of tube. *U. Trias. (Rhaet.)-U. Cret. (Cenoman.)*, Eu.-USA-Carib.-Afr.-M. East.—FIG. 610, 1, 2. **T. conica* (SCHLUMBERGER), *M. Jur.*, Ger. (1), *M. Jur. (Bathon.)*, Fr. (2); 1a-c, spiral, umbilical, and edge views, $\times 66$ (*2117); 2, axial sec. of holotype, $\times 113$ (*1525).—FIG. 610, 3, 4. *T. valdensis* (REICHEL), *L. Cret. (Valangin.)*, Switz.; 3a, b, umbilical and edge views, $\times 64$ (*1525); 4, axial sec. showing umbilical pillars, $\times 66$ (*1525).—FIG. 610, 5-7. *T. crassa* KRISTAN, *U. Trias. (Rhaet.)*, Eu. (Aus.); 5, umbilical view; 6, edge view of different specimen; 7, axial sec.; all $\times 24$ (*1057).

[WICHER (1952, *2058, p. 275) showed a stratigraphic change in ornamentation in *Trocholina* with oldest forms possessing fewer and larger ventral pillars or nodes, and progressively younger species showing more numerous but smaller nodes. *Coscinoconus* LEUPOLD & BIGLER (1936, *1130, p. 618), regarded as a synonym of *Trocholina* by HENSON (1948, *900, p. 449) and WICHER (1952, *2058, p. 273) was shown by MASLOV (1958, *1232, p. 546) to belong to the Dasycladaceae (algae). HENSON and WICHER placed *Trocholina* in the subfamily Cornuspirinae (=Cyclogyrinae) and CUSHMAN (1948, *486, p. 284) placed it in the subfamily Turrispirillinae, family Rotaliidae. BERMÚDEZ assigned it to the Spirillinae, family Spirillinae, though stating (*127, p. 29), "Probablemente el género *Trocholina* estaría mejor situado en la subfamilia Rotaliinae de la familia Rotaliidae." *Trocholina* has a microgranular wall, and therefore cannot be placed with *Spirillina*, which has walls composed of a single crystal or several crystals of calcite, or with *Rotalia*, which has a radial and canalliculate wall structure.]

Family NONIONIDAE Schultze, 1854

[*nom. correct.* CUSHMAN, 1927, p. 49 (pro family Nonionida SCHMARDT, 1871, p. 165)].—[All names cited are of family rank; dagger(†) indicates *partim*].—[=Polythalamat LATREILLE, 1825, p. 161 (*nom. nud.*); =Hélicosteguest D'ORIGNY, 1826, p. 268 (*nom. neg., nom. nud.*); =Nautiloidat SCHULTZE, 1854, p. 53 (*nom. nud.*); =Cryptostegia REUSS, 1862, p. 320, 372 (*nom. nud.*); =Nautiloidat REUSS, 1860, p. 151 (*nom. nud.*)]—[=Nonioninidae REUSS, 1860, p. 151; =Nonioninidae REUSS, 1860, p. 221; =Nonionidea COPELAND, 1956, p. 187 (*nom. van.*)]—[=Chilostomellidae BRADY, 1881, p. 42, 44; =Chilostomellidae HAECKEL, 1894, p. 185; =Quilostomellidos GADEA BUISÁN, 1947, p. 18 (*nom. neg.*)]

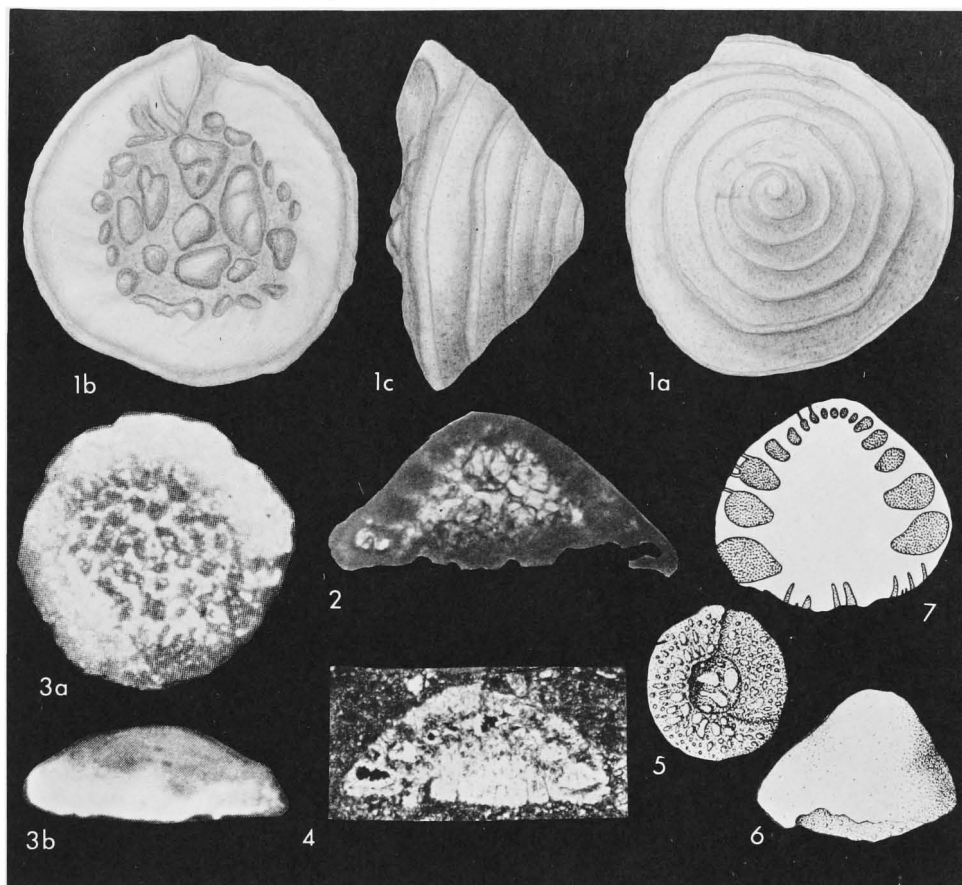
Test planispiral or trochospiral; finely perforate; aperture interiomarginal or areal. *Jur.-Rec.*

Subfamily CHILOSTOMELLINAE Brady, 1881

[*nom. transl.* A. SILVESTRI, 1906, p. 12 (23) (ex family Chilostomellidae BRADY, 1881)]—[All names cited are of subfamily rank; dagger(†) indicates *partim*].—[=Cryptostegia BÜTSCHLI in BRONN, 1880, p. 203 (*nom. nud.*); =Allomorphininae CUSHMAN, 1927, p. 85; =Allomorphinellinae CUSHMAN, 1927, p. 86]

Test trochospiral, with few chambers to whorl, planispiral and involute; aperture interiomarginal on umbilical side. *Jur.-Rec.*

***Chilostomella* REUSS in ČZJŽEK, 1849, *546, p. 50** [*C. ovoidea* REUSS, 1850, *1540, p. 380; SD CUSHMAN, 1914, *404d, p. 2]. Test free, ovate,

FIG. 610. Involutinidae; 1-7, *Trocholina* (p. C742).

planispiral and involute, with 2 chambers to whorl, chambers embracing; wall calcareous, perforate, granular in structure; aperture a narrow interior-marginal equatorial slit, which may have slight lip. *U.Cret.-Rec.*, cosmop.—FIG. 611,1. **C. ovoidea*, Mio., Eu.(Aus.); 1a,b, side, apert. views, $\times 63$ (*2117).

Allomorphina REUSS in ČŽŽEK, 1849, *546, p. 50 [**A. trigona* REUSS, 1850, *1540, p. 380; SD (SM)]. Test trochospiral, commonly 3 chambers to whorl, involute, only final whorl visible externally; wall calcareous, perforate, granular in structure; aperture an elongate slit, paralleling suture and bordered with slight lip. [As here restricted, *Allomorphina* includes involutely coiled species and *Quadriformina* trochospiral species with early coil visible at one side of the test. The number of chambers to a whorl is regarded as a specific character only.] *Jur.-Rec.*, cosmop.—FIG. 611,3. **A. trigona*, Mio., Eu.(Aus.); 3a-c, side, edge, and apert. views, $\times 78$ (*2117).

Allomorphinella CUSHMAN, 1927, *431, p. 86 [**Allomorphina contraria* REUSS, 1851, *1542, p. 43; OD]. Test free, planispiral, periphery rounded;

chambers few to whorl, involute, increasing rapidly in size; wall calcareous, perforate, aperture an elongate, narrow interior-marginal equatorial slit. [Differs from *Allomorphina* in being planispiral, rather than trochospiral and involute.] *U. Cret.*, Eu.—FIG. 611,2. **A. contraria* (REUSS), *U.Cret.*, Pol.; 2a-c, side, edge, and top views, approx. $\times 60$ (*700).

Chilostomelloides CUSHMAN, 1926, *427, p. 77 [**Lagena (Obliquina) oviformis* SHERBORN & CHAPMAN, 1886, *1732, p. 745; OD]. Test free, ovate in outline, adult with 2 chambers visible, latest formed almost completely embracing former; sutures oblique; wall calcareous, finely perforate; aperture offset from general contour of test, situated near suture line, circular, with slight bordering rim or lip. *Paleoc.-Mio.*, Eu.-N.Am.-Carib.-Afr.—FIG. 611,4. **C. oviformis* (SHERBORN & CHAPMAN), Eoc., Eng.; 4a,b, side, edge views of lectotype, $\times 48$ (*2117).

[Differs from *Chilostomella* in having a small, rounded, protruding aperture instead of a long, narrow slit. Wall structure and internal characters are unknown. A lectotype is here designated (BMNH-P41673) and paratypes (BMNH-P3648) from the London clay, in drainage works, Pic-

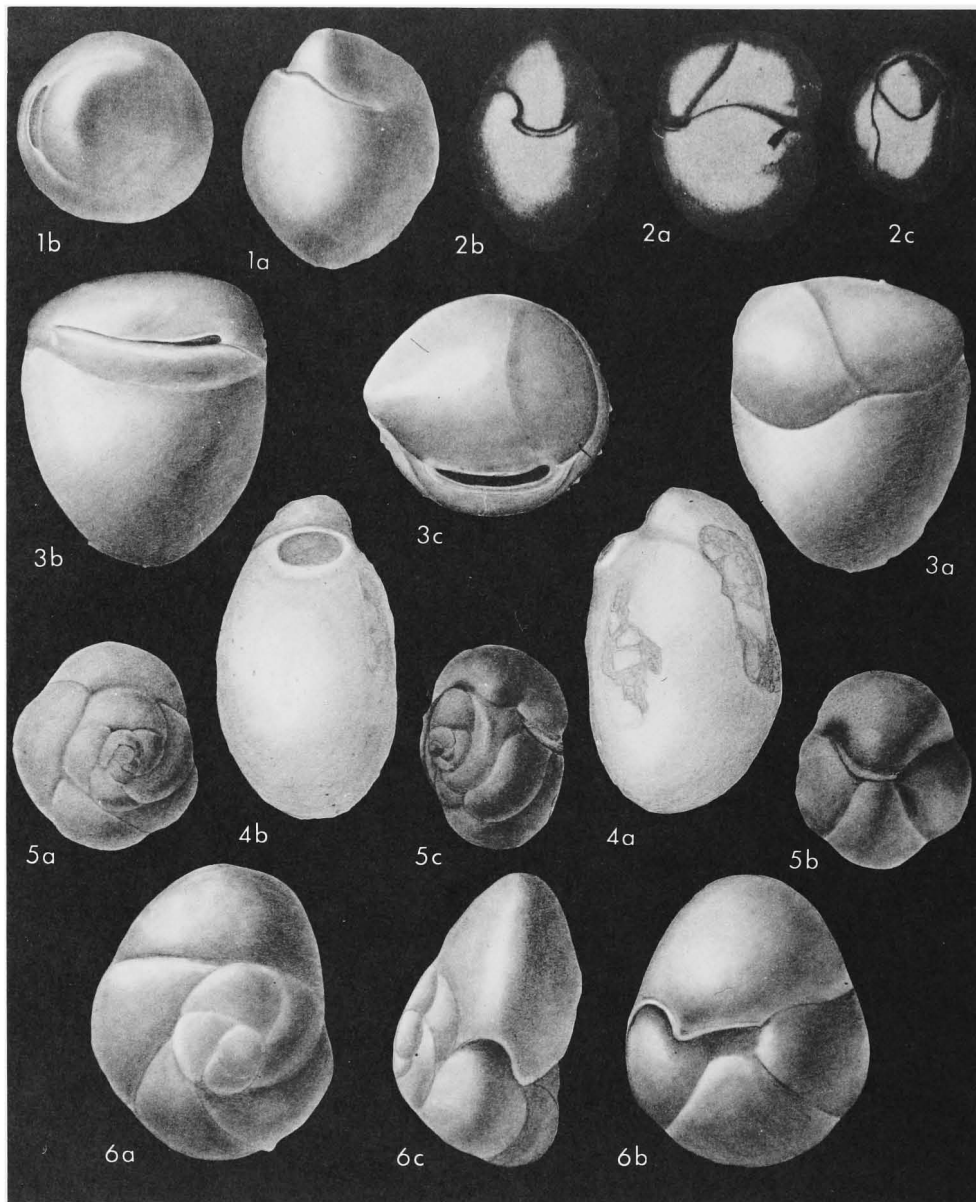


FIG. 611. Nonionidae (Chilostomellinae; 1, *Chilostomella*; 2, *Allomorphinella*; 3, *Allomorphina*; 4, *Chilostomelloides*; 5, 6, *Quadrिमorphina*) (p. C742-C745).

cadilly, London, England. The lectotype is that originally figured by SHERBORN & CHAPMAN (*1732, pl. 14, fig. 19b).]

Quadrिमorphina FINLAY, 1939, *717c, p. 325 [*Valvulina allomorphinoides* REUSS, 1860, *1548, p. 223; OD] [= *Gyromorphina* MARIE, 1941, *1215, p. 230, 256 (obj.); *Pallaimorphina* TAPPAN, 1957, *1875, p. 220 (type, *P. ruckerae*)]. Test trochospiral, periphery rounded, all chambers visible on spiral side, commonly 3 or 4 chambers in final whorl; wall calcareous, finely perforate, granular in structure, surface smooth; aperture interioma-

ginal, umbilical or extraumbilical in position and partially covered by projecting umbilical flap. *L. Cret.(Alb.)-Rec.*, Eu.-N.Am.-N.Z.—FIG. 611, 5. *Q. ruckerae* (TAPPAN), *L.Cret.(Alb.)*, Alaska; 5a-c, opposite sides and edge view of paratype, ×75 (*1875).—FIG. 611, 6. **Q. allomorphinoides* (REUSS), *U.Cret.*, USA(Tenn.); 6a-c, opposite sides and edge view, ×176 (*2117).

[*Pallaimorphina* was defined originally for a primitive species which does not show rapid chamber enlargement and had a narrower umbilical flap. As these features are

only of degree, the genera are regarded as synonymous. As here defined, *Quadriformina* also includes trochospiral species with evolute spiral side that had previously been placed in *Allomorphina*. *Allomorphina* is restricted to involute species, where only the final whorl of chambers is visible externally.]

Subfamily NONIONINAE Schultze, 1854

[*nom. correct.* CHAPMAN & PARR, 1936, p. 145 (*pro* subfamily Nonionida SCHULTZE, 1854, p. 53)]—[All names cited are of subfamily rank]—[=Pullenidae SCHWAGER, 1877, p. 18; =Pulleninae BÜTSCHLI in BRONN, 1880, p. 210; =Nonionininae A. SILVESTRI, 1950, p. 52; =Nonionellinae VOLOSHINOVA, 1958, p. 141]

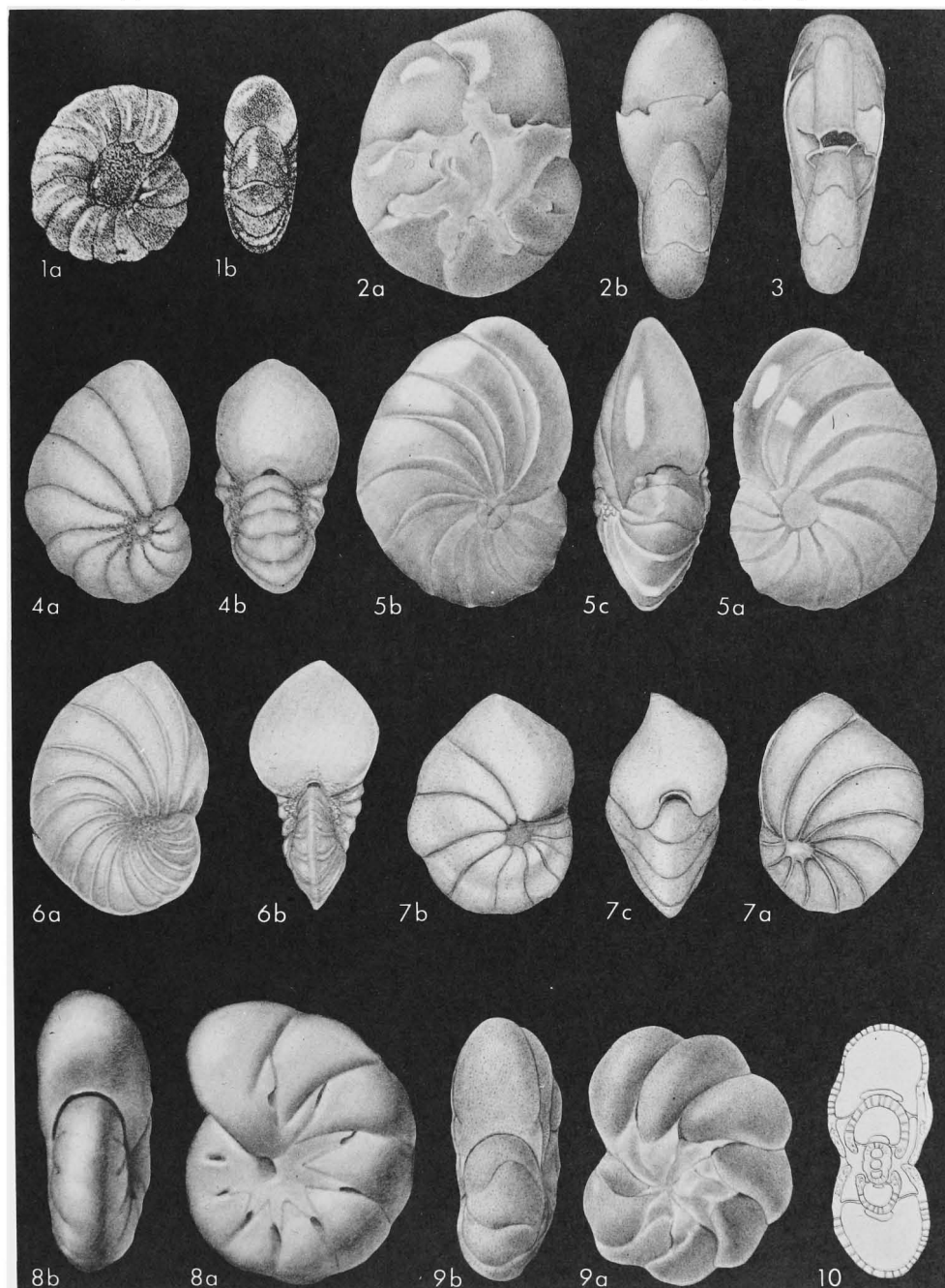


FIG. 612. Nonionidae (Nonioninae; 1, *Nonion*; 2,3, *Bisaccium*; 4-7, *Florilus*; 8-10, *Astrononion*) (p. C745-C748).

Test planispiral and involute to slightly trochospiral; aperture interiomarginal and equatorial, or areal and multiple. *U.Cret.-Rec.*

Nonion DE MONTFORT, 1808, *1305, p. 210 [**Nautilus incrassatus* FICHTEL & MOLL, 1798, *716, p. 38; OD] [= *Nonionia* RISSO, 1826, *1579a, p. 22 (type, *Nautilus incrassatus* FICHTEL & MOLL, 1798, herein designated, obj.)] Test free, planispiral and involute, slightly compressed, biumbonate, periphery rounded, peripheral outline lobulate; chambers numerous, increasing gradually in size as added; sutures distinct, depressed, radial, slightly curved; wall calcareous, finely perforate, granular in structure, surface smooth, umbonal region filled with secondarily deposited calcite, either as granules or solid boss; aperture an arched, equatorial, interiomarginal slit. [Differs from *Melonis* in having a filled, rather than open, umbilicus, thinner and more finely perforate and monolamellar walls (*1530). Many species previously included in *Nonion* should be referred to *Melonis* or *Florilus*.] ?*U.Cret.*, *Paleoc.-Rec.*, cosmop.—FIG. 612.1. **N. incrassatus* (FICHTEL & MOLL), Mio., Albania; 1a,b, side, edge views, $\times 100$ (*2019).

Astrononion CUSHMAN & EDWARDS, 1937, *503, p. 30 [**Nonionina stelligera* D'ORBIGNY in BARKER-WEBB & BERTHELOT, 1839, *86, p. 128; OD]. Test free, planispiral and involute, umbilical region slightly excavated, peripheral margin rounded; chambers increasing gradually in size, each with backward-projecting, nonporous, umbilical flap which partially covers preceding suture and umbilical region but leaves small cavity open beneath it, giving appearance of secondary chamberlets; sutures radial, depressed, slightly curved; wall calcareous, finely perforate, granular in structure, monolamellar, surface smooth; aperture a low, interiomarginal, equatorial slit, with openings at outer edge of umbilical fillings along their sutural extension. [Differs from *Nonion* and *Florilus* in its more highly developed umbilical and sutural filling, with included cavities suggesting "chamberlets," although these nonporous fillings are not comparable to true chamberlets.] *Eoc.-Rec.*, cosmop.—FIG. 612.8. **A. stelligera* (D'ORBIGNY), Rec., E.Atl.O.(Canary Is.); 8a,b, side, edge views, $\times 125$ (*2117).—FIG. 612.9. *A. gallowayi* LOEBLICH & TAPPAN, Rec., N.Am. (Alaska); 9a,b, side and edge views showing finely perforate walls and nonporous umbilical flaps, $\times 75$ (*1162).—FIG. 612.10. *A. sidebottomi* CUSHMAN & EDWARDS, Rec., Medit.; axial sec. showing cavities below nonperforate chamber flaps, enlarged (*946).

Bisaccium ANDERSEN, 1951, *15, p. 32 [**B. imbricatum*; OD]. Test planispiral, bilaterally symmetrical, periphery rounded; chambers gradually enlarging, umbilical region and sutures of both

sides covered by chamber extensions as in *Astrononion*, but more extensive, extending also across base of terminal chamber face to obscure aperture; sutures radial, slightly curved, depressed; wall calcareous, very thin, finely perforate, surface smooth and unornamented except for umbilical-sutural chamber extensions; apertural foramen an interiomarginal equatorial arch, but obscured in final chamber by secondary chamber flaps, communication of chamber cavities to exterior by means of openings along upper, lower, and peripheral sutural margins of secondary chamber flaps. *Rec.*, USA (La.).—FIG. 612.2,3. **B. imbricatum*; 2a, side view of holotype, $\times 78$ (*2117); 2b, edge view, $\times 78$ (*15); 3, edge view of paratype with secondary covering removed to show equat. apert. foramen, $\times 78$ (*15).

Chilostomellina CUSHMAN, 1926, *427, p. 78 [**C. fimbriata*; OD]. Test free, inflated to subglobular, planispiral throughout, and involute; chambers increasing rapidly in size, final one almost completely enveloping test and overlapping umbilical region on each side, with fimbriate margin at sides and base of apertural face; sutures slightly curved; wall calcareous, finely perforate, granular in structure; aperture a low, interiomarginal arch, with additional supplementary apertures at reentrants between finger-like projections of final chamber. [Differs from *Chilostomella* in being planispiral throughout development, and in the final chamber having a fimbriate margin with supplementary apertures. It differs from *Nonion* in its multiple aperture and fimbriate final chamber margin, and in its inflated, subglobular test.] *Rec.*, Bering Sea-Pac.O.—FIG. 613.11. **C. fimbriata*, Pac.; 11a-d, side, apert., peripheral and basal views, $\times 48$ (*1162).

Cribropullenia THALMANN, 1937, *1898, p. 351 [**Nonion? marielensis* PALMER, 1936, *1409, p. 127; OD] [= *Antillesina* GALLOWAY & HEMINWAY, 1941, *764, p. 366 (obj.)]. Test free, planispiral and involute, close-coiled, periphery broadly rounded; chambers few to whorl, inflated; sutures radial, depressed; wall calcareous, finely perforate, wall structure and lamellar character not described, surface with low spiraling costae; aperture consisting of small openings near base of apertural face. [Although the surface ornamentation is not characteristic of the Nonionidae, the genus is retained here until information as to wall structure and lamellar character is available.] *Eoc.-Oligo.*, Carib.-Afr.(Egypt).—FIG. 613.7. **C. marielensis* (PALMER), Oligo., Cuba; 7a,b, side, edge views of lectotype (here designated, USNM-498778), $\times 119$ (*2117).

Florilus DE MONTFORT, 1808, *1305, p. 134 [**F. stellatus* (nom. subst. pro *Nautilus asterizans* FICHTEL & MOLL, 1798, *716, p. 37; OD] [= *Nonionina* D'ORBIGNY, 1826, *1391, p. 293 (type, *Nautilus asterizans* FICHTEL & MOLL, 1798, *716, p. 37, SD PARKER & JONES, 1863, *1417f,

p. 433); *Pseudononion* ASANO, 1936, *47, p. 347 (type, *P. japonicum*); *Azera* KHALILOV, 1958, *1038, p. 6 (type, *A. transversa*)]. Test free,

planispiral, but may be asymmetrical, involute, but with broad, low chambers increasing rapidly in breadth and thickness resulting in flaring test,

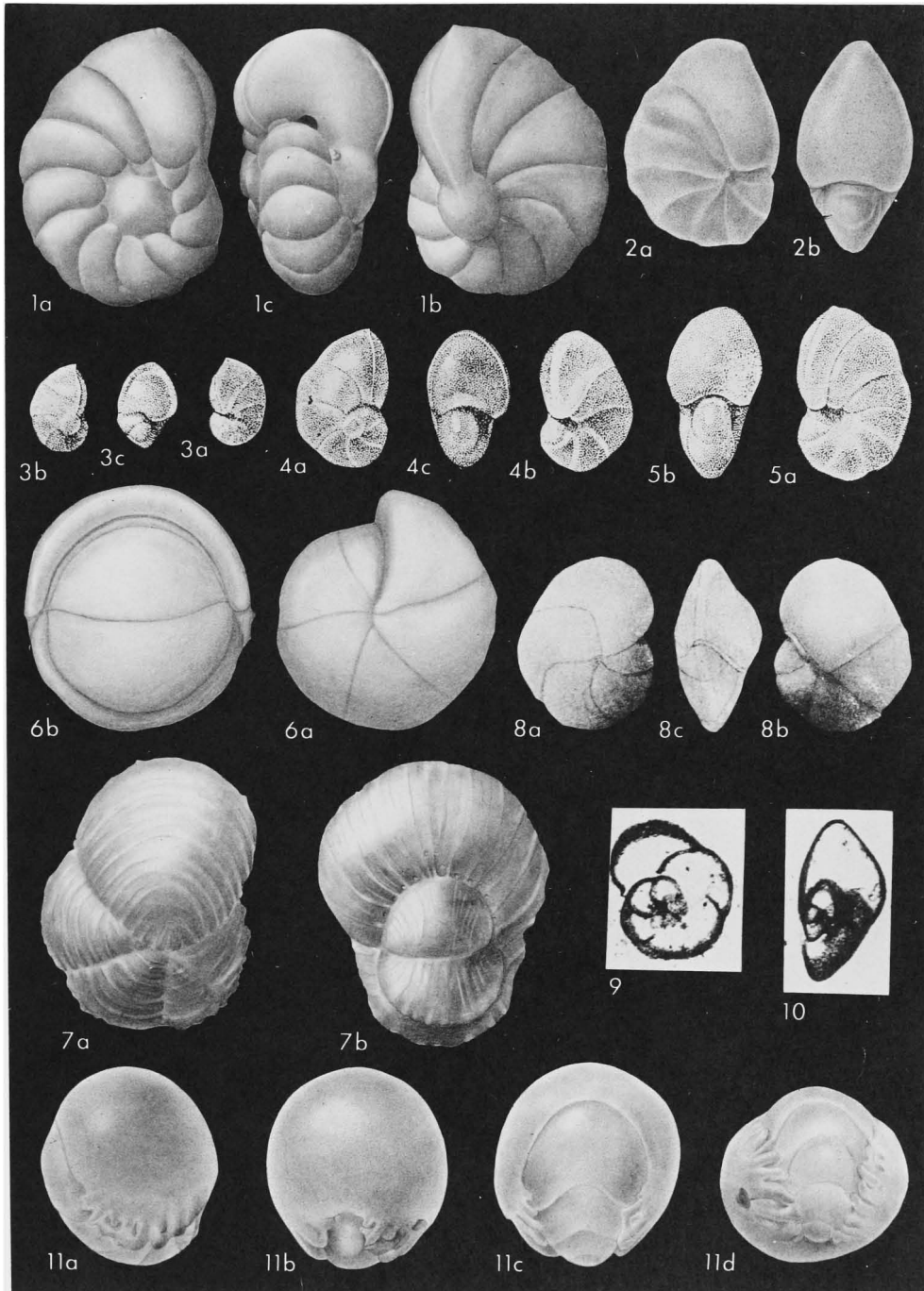


FIG. 613. Nonionidae (Nonioninae; 1, *Nonionella*; 2-5, *Nonionellina*; 6, *Pullenia*; 7, *Cribrpullenia*; 8-10, *Spiropecta*; 11, *Chilostomellina*) (p. C746, C748).

peripheral margin rounded to angled, umbilical region slightly depressed, filled with granular skeletal material which may extend slightly along sutures; wall calcareous, finely perforate, granular in structure, single-layered; aperture a narrow, interiomarginal, equatorial opening. [Differs from *Nonion* in the flaring test, due to the numerous broad low chambers, and from *Nonionella* in lacking the single umbilical chamber extension.] *Paleoc.-Rec.*, cosmop.—FIG. 612.4. **F. asterizans* (FICHTEL & MOLL), Rec., Eu.(Italy); 4*a,b*, side, edge views, $\times 48$ (*2117).—FIG. 612.5. *F. japonicus* (ASANO), Plio., Japan; 5*a-c*, opp. sides and edge view, $\times 71$ (*2117).—FIG. 612.6. *F. costiferus* (CUSHMAN), Mio., USA(Calif.); 6*a,b*, side, edge views, $\times 48$ (*2117).—FIG. 612.7. *F. transversus* (KHALILOV), U.Eoc., USSR(Azerbaijan); 7*a-c*, opp. sides and edge view of holotype, $\times 30$ (*1038).

Nonionella CUSHMAN, 1926, *426, p. 64 [**N. miocenica*; OD] [= *Nonionella* RHUMBLER in ANONYMOUS, 1949, *22, p. 40 (type, *N. aberrans*) (*nom. nud.*)]. Test free, trochospiral, slightly compressed, periphery rounded, spiral side partially evolute with umbonal boss, opposite side involute with final chamber overhanging umbilical region and may appear to form distinct umbilical flap; chambers relatively numerous, broad, low; wall calcareous, perforate, granular in structure; aperture interiomarginal, a low arch near periphery extending somewhat onto umbilical side. [Differs from *Nonion* in being asymmetrical and trochospiral, and in possessing an asymmetrically developed final chamber.] *U.Cret.-Rec.*, cosmop.—FIG. 613.1. **N. miocenica*, Mio., USA(Calif.); 1*a-c*, opp. sides and edge view, $\times 101$ (*2117).

Nonionellina VOLOSHINOVA, 1958, *2019, p. 142 [**Nonionina labradorica* J. W. DAWSON, 1860, *566, p. 191; OD]. Test free, trochospiral in early coiling, later becoming planispiral and involute; chambers enlarging rapidly around deep umbilicus; wall calcareous, finely perforate, granular in structure; aperture a low slit at base of apertural face. [*Nonionellina* is like *Nonionella* in the juvenile stages and like *Nonion* in the adult.] *Mio.-Rec.*, Eu.-N.Am.-Atl. O.-Japan-Pac. O.—FIG. 613.2-5. **N. labradorica* (J. W. DAWSON), Rec., Alaska (2), Sea of Okhotsk (3-5); 2*a,b*, side, edge views, $\times 36$ (*1162); 3*a-c*, opp. sides and edge view of juvenile specimen showing asymmetry; 4*a-c*, somewhat older, more symmetrical specimen; 5*a,b*, nearly adult specimen; 3-5, $\times 50$ (*2019).

Pullenia PARKER & JONES in CARPENTER, PARKER & JONES, 1862, *281, p. 184 [**Nonionina bulloides* D'ORBIGNY, 1846, *1395, p. 107, = *Nonionina sphaeroides* D'ORBIGNY, 1826, *1391, p. 293 (*nom. nud.*); OD (M)]. Test free, spheroidal to compressed, planispiral and involute; chambers few, 3 to 6 in final whorl; sutures radial; wall calcareous, finely perforate, granular in structure; aperture a narrow crescentic interiomarginal slit

extending nearly from umbilicus on one side to that opposite. *U.Cret.-Rec.*, cosmop.—FIG. 613.6. **P. bulloides* (D'ORBIGNY), Mio., Eu.(Aus.); 6*a,b*, side, edge views of lectotype, $\times 79$ (*2117).

[PARKER & JONES in CARPENTER, PARKER & JONES (1862, *281) described *Pullenia* as including the "form which has been represented by M. D'Orbigny (Modèles, No. 43) under the name of *Nonionina sphaeroides*, and has been subsequently described by him under the name of *N. bulloides*." Both here and in later publications, PARKER & JONES considered the two specific names synonymous. The plate in CARPENTER, PARKER & JONES (*281) cited the species under the name *Pullenia bulloides*, but nowhere in this original reference is *sphaeroides* cited in combination with *Pullenia*. This would therefore appear to be original designation of *bulloides* as type-species. Most later workers have also regarded *N. bulloides* as the type-species of *Pullenia* by original designation, although CUSHMAN (1948, *486, p. 320) stated the type to be "*Nonionina sphaeroides* D'Orbigny, but, as that species is indeterminate, it seems better to use *Nonionina bulloides* D'Orbigny." Both specific names were cited by D'ORBIGNY in 1826 without description or illustration. *Nonionina sphaeroides* was included in the Modèles (No. 43) in 1826, but no description was ever given by D'ORBIGNY. The specimens came from ship ballast sand and the type locality and horizon are unknown. This species is not only unrecognizable but was a *nomen nudum*; hence *N. bulloides* must be the type by monotypy (only valid species originally included). *Nonionina bulloides* was well figured and described by D'ORBIGNY from the Vienna Basin (*1395). A lectotype from the Miocene of Nussdorf, Vienna Basin, is here designated and refigured; it is in the D'ORBIGNY collection in the Muséum National d'Histoire Naturelle, Paris.]

Spirotecta BELFORD, 1961, *111, p. 81 [**S. pellicula*; OD]. Test free, inequally biconvex, trochospiral but completely involute throughout, with closed umbilicus on both sides, periphery narrowly rounded; chambers few, increasing gradually in size; sutures curved on less convex side, nearly straight and radial on more convex side; wall calcareous, finely perforate, granular in structure, septa single, monolamellar; aperture an interiomarginal equatorial arch with lower extension to umbilicus of more convex side, bordered with thin lip. [Originally placed questionably in the Chilostomellidae, *Spirotecta* is here transferred to the Nonionidae.] *U.Cret.(Campan.-Maastricht.)*, W.Australia.—FIG. 613.8-10. **S. pellicula*, Maastricht. (8,9), Campan. (10); 8*a-c*, opp. sides and edge view of holotype; 9, horiz. sec. showing single septal walls; 10, axial sec. showing completely involute but slightly trochospiral coiling; all $\times 48$ (*111).

Family ALABAMINIDAE Hofker, 1951

[Alabaminidae HOFKER, 1951, p. 389]—[In synonymic citations dagger(†) indicates *partim*]—[=Turbinoidae† D'ORBIGNY in DE LA SAGRA, 1839, p. xxxviii, 71 (*nom. nud.*)]

Test lenticular, trochospiral; wall calcareous, perforate, granular, septa single-layered (monolamellar); aperture basal, or a slit extending up apertural face, or both. *U.Cret.-Rec.*

Alabamina TOULMIN, 1941, *1944, p. 602 [**A. wilcoxensis*; OD] [= *Eponidoides* BROTZEN, 1942, *240, p. 38 (type, *Eponides dorsoplana* BROTZEN, 1940, *239, p. 31)]. Test free, lenticular, trochospiral, periphery subangular, with nonporous margin, all chambers visible on spiral side where

curved sutures are strongly oblique, only final whorl visible on opposite side where sutures are

nearly radial around umbilical depression, chambers somewhat prolonged into projection at

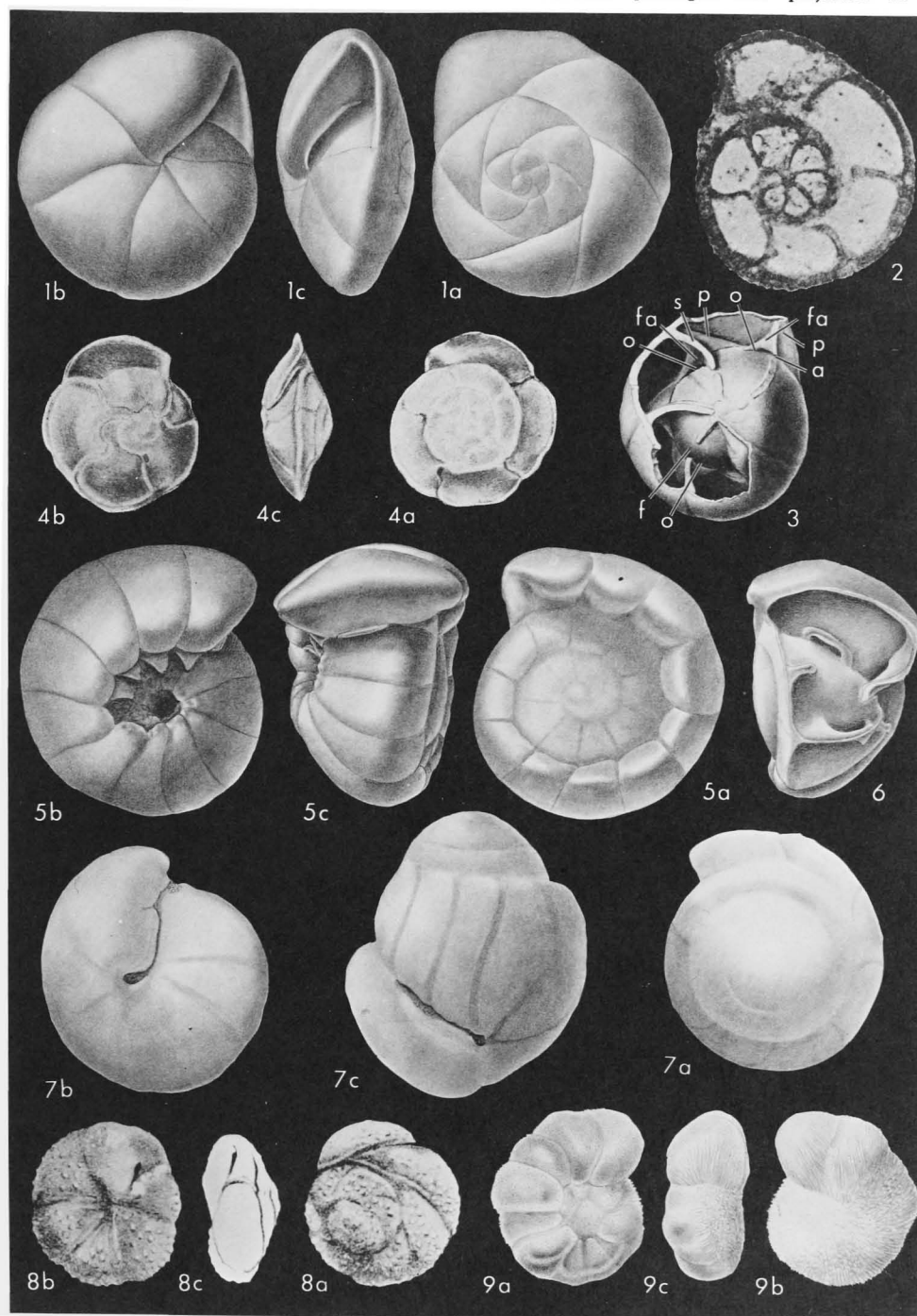


FIG. 614. Alabaminidae; 1-3, *Alabamina*; 4, *Oridorsalis*; 5, 6, *Gyroidina*; 7, *Rotaliatina*; 8, *Svatkina*; 9, *Trichohyalus* (p. C748-C751).

periphery on spiral side, apertural face sharply infolded below this projection; wall calcareous, finely perforate, granular in structure, with simple monolamellar septa; aperture an interiomarginal slit extending from near periphery almost to umbilicus, with narrow bordering lip. [HOFKER (1959, *951) regarded *Alabamina* as a synonym of *Eponides*, but *Alabamina* has a granular monolamellar wall, whereas that of *Eponides* is radial and bilamellar. The aperture of *Alabamina* is in an infolded area of the apertural face, unlike that of *Eponides*.] *U.Cret.(Santon.)-Rec.*, cosmop. —FIG. 614,1,2. **A. wilcoxensis*, L.Eoc., USA (Ala.); 1a-c, opposite sides and edge view, $\times 140$ (*2117); 2, horiz. sec. showing monolamellar septa, $\times 100$ (*1533). —FIG. 614,3. *A. sp.*, Paleoc.(Dan.), Sweden; dissected specimen from umbilical side showing indentation of septal face (*ja*) and opening beneath it (*o*), peripheral projection of chambers (*p*), aperture (*a*), septum (*s*), and septal foramina (*f*), enlarged (*241).

Gyroidina D'ORBIGNY, 1826, *1391, p. 278 [*G. orbicularis*; SD CUSHMAN, 1927, *433, p. 190]. Test free, trochospiral, periphery rounded to subtruncate, spiral side flattened with all chambers visible, opposite side elevated and umbilicate with only chambers of final whorl visible; chambers rhomboidal in section, with angled umbilical shoulder; sutures radial to oblique, flush to depressed; wall calcareous, perforate, granular in structure, lamellar character unknown; primary aperture a low interiomarginal slit restricted to mid-portion of apertural face, bordered by narrow lip, small secondary apertures umbilical in position, against previous chamber wall with projecting umbilical flap extending backward over it, so that it is not evident except when test is viewed obliquely, or when final chamber is dissected so that secondary aperture may be seen. *Eoc.-Rec.*, cosmop. —FIG. 614,5,6. **G. orbicularis*, Rec., Eu.(Italy); 5a-c, opp. sides and edge view; 6, edge view of dissected specimen showing foramen; all $\times 74$ (*2117).

[*Gyroidina* has never been completely described or well illustrated. The type-species was originally represented by one of D'ORBIGNY's models (figured later by other workers) but this model does not show details of the umbilical region. The umbilical flaps have been figured in some species of *Gyroidina* but not previously in the type-species. Their true character as lips over secondary umbilical apertures has not been noted. The presence of umbilical flaps was used by BROZZEN (1942, *240, p. 19) as a basis for distinguishing *Gyroidinoides* from *Gyroidina*, as the latter genus was erroneously said not to possess these structures. Although this basis is not valid, the genera are otherwise separable on apertural features. *Gyroidina* has a short, slidlike, primary interiomarginal aperture near the midline of the apertural face, and a secondary aperture opening from the chamber into the umbilicus, partially covered by an arched umbilical flap. *Gyroidinoides* has a single, more extensive interiomarginal aperture, extending from the periphery along the entire margin of the chamber to the umbilicus. It is partly covered by an umbilical chamber extension, but the umbilical flaps do not attach below, and the apertural opening is continuous beneath the flap.]

Oridorsalis ANDERSEN, 1961, *18, p. 107 [*O. westi*; OD]. Test free, lenticular, periphery carinate; chambers arranged in low trochospiral coil, chambers broad, low, all visible on spiral side but only

those of final whorl visible on opposite side; sutures radial, slightly curved on spiral side, strongly sinuate on umbilical side; wall calcareous, very finely perforate, granular in structure; primary aperture interiomarginal, extending from periphery nearly to closed umbilicus of umbilical side; small secondary sutural openings on spiral side near junction of spiral and septal sutures, with similar small sutural openings at mid-point of sutures at sinuate curve on umbilical side. *Oligo.-Rec.*, N.Am.-Eu.-Japan-Carib. —FIG. 614, 4. **O. westi*, Rec., USA (La.); 4a-c, opp. sides and edge view of holotype, $\times 60$ (*18).

[The genus was originally placed in the Discorbidae but is here transferred to the Alabaminidae because of its granular wall structure. Although the secondary sutural openings on the umbilical side were not reported in the original description, they are present in specimens obtained by us from the Miocene of Jamaica, and also appear to be indicated in the figures of the holotype. Some species previously placed in *Pseudoeponides* probably should be referred to *Oridorsalis*.]

Rotaliatina CUSHMAN, 1925, *421, p. 4 [**R. mexicana*; OD]. Test free, high trochospiral, with rounded periphery; all chambers visible on elevated spiral side, only those of final whorl visible around small, deep umbilicus on opposite side; sutures radial, nearly straight; wall calcareous, finely perforate, surface smooth, lamellar character and microstructure not described; aperture an elongate interiomarginal slit, extending from near periphery to open umbilicus, with narrow bordering lip. *Eoc.-Oligo.*, N.Am. —FIG. 614,7. **R. mexicana*, U.Eoc., Mex.; 7a-c, opp. sides and edge view, $\times 65$ (*2117).

Svratkina POKORNÝ, 1956, *1477, p. 257 [**Discorbis tuberculata* (BALKWILL & WRIGHT) var. *australiensis* CHAPMAN, PARR, & COLLINS, 1934, *326, p. 563; OD]. Test free, trochospiral, bi-convex, periphery rounded, all chambers visible and sutures oblique and curved on spiral side, only final whorl visible and sutures radial on opposite side, umbilicus closed; wall calcareous, coarsely perforate, with large pores opening at ends of tubercles, lamellar character and wall structure not described; aperture an elongate opening extending from near umbilicus up face of chamber in slight depression, nearly to periphery. [Similar to *Alabamina* in apertural character, but characterized by large pores opening into tubercles at the surface.] *?U.Cret.*, *U.Eoc.-Rec.*, Australia-Eu.-N.Am. —FIG. 614,8. **S. australiensis* (CHAPMAN, PARR, & COLLINS), *Oligo.*, Australia; 8a-c, opp. sides and edge view, $\times 139$ (*326).

Trichohyalus LOEBLICH & TAPPAN, 1953, *1162, p. 116 [**Discorbis bartletti* CUSHMAN, 1933, *457, p. 6; OD]. Test free, trochoid, plano-convex, all whorls visible on spiral side, umbilical side obscured by secondary growth of shell material, forming vesicular plate extending nearly to the periphery, perforations through this vesicular tissue opening into cavity beneath, exterior of plate variously ornamented; wall calcareous, coarsely perforate-granular in structure; no visible aperture

on final chamber, but interiomarginal intercameral openings occur on umbilical side near outer margin of chambers, which may be seen by dissection.

Rec., Arctic.—FIG. 614,9. **T. bartletti* (CUSHMAN), Can.(Fox Basin); 9a-c, opp. sides and edge view, $\times 17$ (*1162).

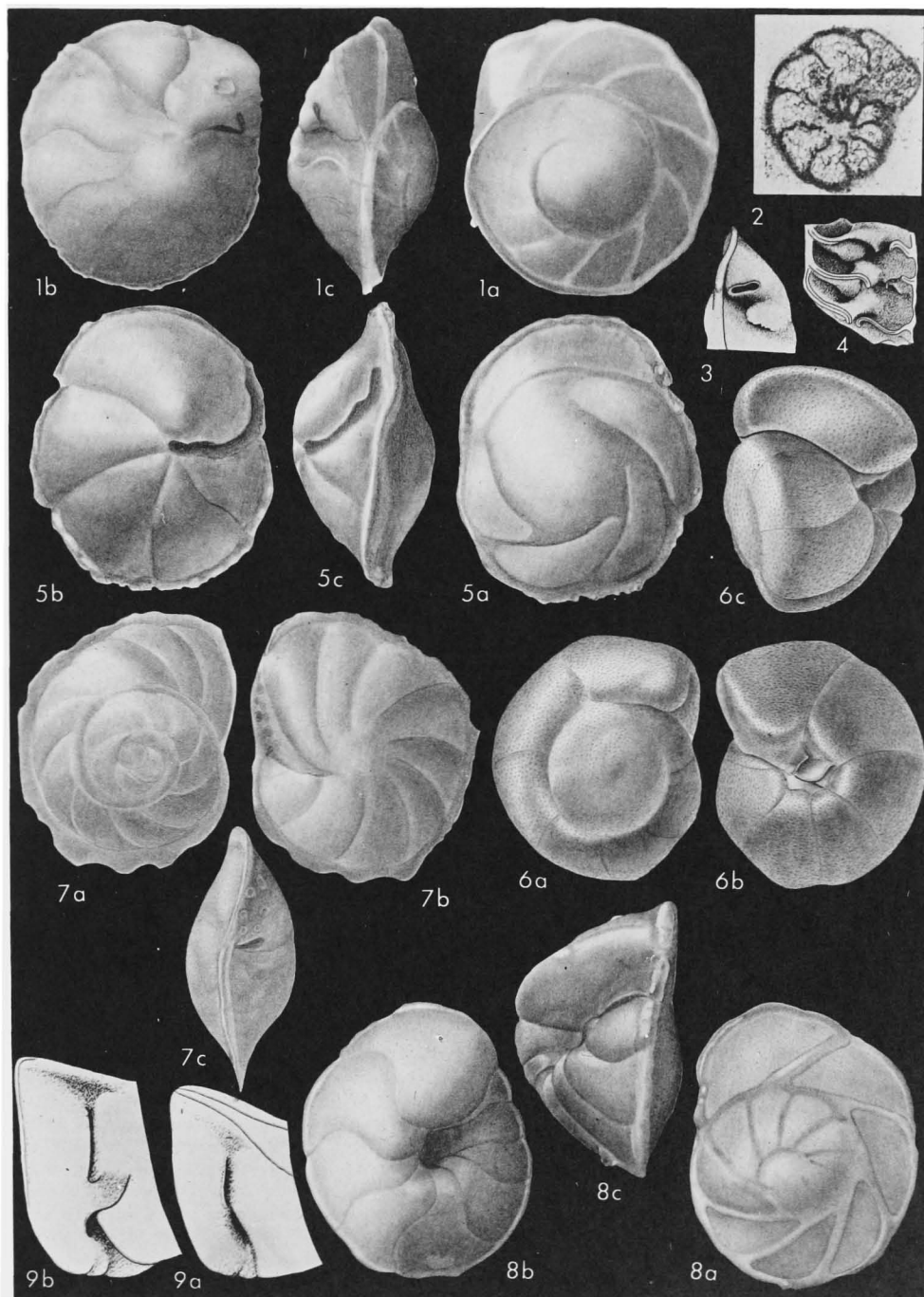


FIG. 615. Osangulariidae; 1-4, *Osangularia*; 5, *Charltonina*; 6, *Gyroidinoides*; 7, *Cribraparrella*; 8,9, *Globorotalites* (p. C752-C753).

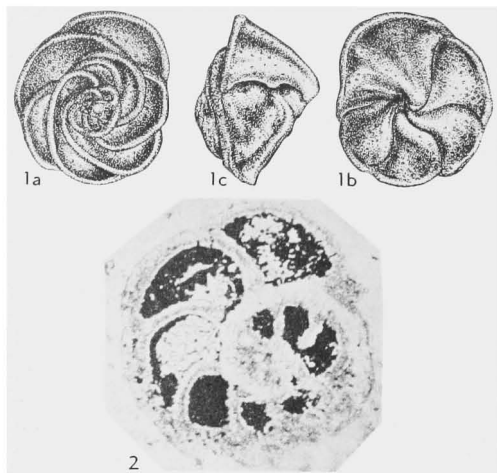


FIG. 616. Osangulariidae; 1,2, *Conorotalites* (p. C752).

Family OSANGULARIIDAE
Loeblich & Tappan, n.fam.

Test trochospiral; wall calcareous, perforate granular in structure, bilamellar; aperture with interiomarginal portion and vertical or oblique portion extending up apertural face, 2 parts may be joined, or distinct, separate openings, and areal opening may be multiple. *L.Cret.-Rec.*

Osangularia BROTZEN, 1940, *239, p. 30 [*O. lens*; OD] [= *Parrella* FINLAY, 1939, *717a, p. 523 (type, *Anomalina bengalensis* SCHWAGER, 1866, *1703, p. 259) (non *Parrella* GINSBURG, 1938)]. Test free, trochospiral, lenticular, biumbonate, periphery carinate; all whorls visible on spiral side, only final whorl visible on opposite side, chambers increasing gradually in size, sutures curved and oblique on spiral side, radial and sinuate on umbilical side; wall calcareous, finely perforate, granular in structure, bilamellar; aperture a bent opening, lying along base of final chamber on umbilical side and bending at oblique angle up apertural face, or 2 angles may be separated openings, one interiomarginal and one areal. *L.Cret.-Rec.*, cosmop.—FIG. 615,1,2. **O. lens*, Paleoc.(Dan.), Sweden; 1a-c, opp. sides and edge view, $\times 111$ (*2117); 2, horiz. sec., areal apert. openings visible in septa at lower left of figure, $\times 55$ (*1530). —FIG. 615,3,4. *O. bengalensis* (SCHWAGER), Mio., Asia (Israel); 3, apert. view showing areal opening; 4, interior, from umbilical side with wall removed, showing bulging chamber ends, areal aperture and lip, and apert. face indentation extending to previous septum; all $\times 45$ (*1533).

Charltonina BERMÚDEZ, 1952, *127, p. 69 [*Pseudoparrella madrugensis* CUSHMAN & BERMÚDEZ, 1948, *496, p. 73; OD]. Test trochospiral, lenticular to inequally biconvex, periphery carinate;

all chambers visible and sutures strongly oblique on spiral side, only final whorl visible and sutures radial on opposite side, umbilicus closed; wall calcareous, perforate, lamellar character and wall structure not described; aperture an elongate slit extending from umbilicus to periphery and bending up apertural face, parallel to peripheral keel. *U.Cret.-Paleoc.*, Carib.(Cuba).—FIG. 615,5. **P. madrugensis* (CUSHMAN & BERMÚDEZ), Paleoc.; 5a-c, opp. sides and edge view of holotype, $\times 108$ (*2117).

Conorotalites KAEVER, 1958, *1007, p. 435 [*Globorotalites bartensteini aptiensis* BETTENSTAEDT, 1952, *137, p. 282; OD]. Test plano-convex or inequally biconvex with much elevated umbilical side, periphery acute and carinate; sutures distinct, may be limbate, curved and oblique on spiral side, nearly radial, curved to sinuate, flush or depressed on umbilical side around pseudoumbilicus, umbilical shoulder angular; wall calcareous, coarsely perforate, granular in structure, bilamellar; aperture similar to *Globorotalites* with narrow interiomarginal aperture, and deeply indented murus reflectus which gives appearance of second opening. [*Conorotalites* differs from *Globorotalites* in its coarsely perforate wall.] *L.Cret.(Barrem.-Alb.)*, Eu.—FIG. 616,1,2. **C. aptiensis* (BETTENSTAEDT), L.Apt., Ger.; 1a-c, opp. sides and edge view of holotype, $\times 50$ (*137); 2, equat. sec., $\times 78$ (*1533).

Cribroparrella TEN DAM, 1948, *556, p. 487 [*nom. imperf.*, *nom. correct.* THALMANN, 1949, *1897h, p. 653] [**C. regadana*; OD] [= *Cribroparrella*, *Dribroparrella* TEN DAM, 1948, *556, p. 486, pl. expl. (*nom. null.*)]. Test free, trochospiral, biconvex, periphery carinate; chambers numerous, broad, low, with oblique, curved septa and all chambers visible on spiral side, only final whorl with radial curved septa visible on umbilical side, umbilicus closed and umbonate; wall calcareous, finely perforate, granular in structure, bilamellar; aperture a narrow oblique slit near base of apertural face, with projecting lip and smaller supplementary circular areal openings occur over entire apertural face. *Mio.* N.Afr.(Algeria) - W.Indies (Jamaica). —FIG. 615,7. **C. regadana*, Mio., Algeria; 7a-c, opposite sides and edge view of paratype, $\times 51$ (*2117).

Globorotalites BROTZEN, 1942, *240, p. 31 [*Globorotalia multisepta* BROTZEN, 1936, *237, p. 161; OD]. Test free, trochospiral, plano-convex, spiral side flat or slightly concave or convex, umbilical side strongly convex, periphery carinate, with poreless keel; chambers increasing gradually in size, sutures oblique, thickened on spiral side, radial and curved or sinuate, depressed on umbilical side, which has broad pseudoumbilicus and angular umbilical shoulder, deep indentation of base of apertural face below aperture (muris reflectus) attached to previous septum and externally resembles aperture although it does not communicate with chamber interior; wall calcareous, finely

perforate, granular in structure, bilamellar; aperture interiomarginal, on umbilical side, midway between umbilicus and periphery, deeply indented murus reflectus below aperture falsely appears to form second opening. *Cret.(Alb.-Maastricht.)*, Eu. —FIG. 615,8. **G. multisepta* (BROTZEN), U. Cret.(Coniac.), Sweden; 8a-c, opp. sides and edge view of syntype, $\times 93$ (*2117). —FIG. 615,9. *G. micheliniana* (D'ORBIGNY), U.Cret.(Campan.), Fr.; 9a, apert. view showing aperture and indentation forming murus reflectus below it; 9b, chamber interior showing broken murus reflectus; both $\times 90$ (*1533).

Goupillaudina MARIE, 1958, *1222b, p. 861 [**G. daguini*; OD] [= *Goupillaudina* MARIE, 1957, *1222a, p. 247 (*nom. nud.*)]. Test free, lenticular to operculine, slightly trochospiral, early stage involute, later partially evolute on both sides, compressed, periphery acute; chambers numerous, broad, low, strongly arched; sutures strongly curved and oblique; wall calcareous, finely perforate, microstructure and lamellar character unknown; aperture interiomarginal, connecting with deep spiroumbilical suture and extending from umbilical region to periphery, then bending to extend up apertural face as in *Charltonina*. U.Cret.(Coniac.-Maastricht.), Eu. —FIG. 617,1,2. **G. daguini*, U.Campan., Fr.; 1a-c, opp. sides and edge view of paratype, $\times 20$; 2a-c, opp. sides and edge view of holotype, $\times 20$; 2d, apert. detail, $\times 72$ (*1222b).

Gyroidinoides BROTZEN, 1942, *240, p. 19 [**Rotalina nitida* REUSS, 1844, *1537, p. 214; OD]. Test free, trochospiral, spiral side flattened, umbilical side elevated, periphery rounded; chambers rhomboidal in section, sutures radial to curved, flush to depressed; wall calcareous, perforate, bilamellar, granular in structure; aperture a continuous, low, interiomarginal slit extending from periphery to umbilicus, umbilical portion partially obscured by umbilical flap from each chamber. *Cret.-Rec.*, cosmop. —FIG. 615,6. **G. nitida* (REUSS), U. Cret.(Turon.), Sweden; 6a-c, opp. sides and edge view, $\times 74$ (*2117).

[Because of general misconception as to the characters of *Gyroidina*, forms with an open umbilicus and apertural lips were separated as *Gyroidinoides*. However, both of these morphological features occur in the type-species of *Gyroidina*, hence do not afford a valid distinction. The present genus was separated from *Gavelinella* as having a narrow umbilicus, high umbilical side, and reduced umbilical aperture. As here redefined on the basis of the type-species, *Gyroidinoides* differs from *Gyroidina* in having a single, continuous apertural opening from the periphery to the umbilicus, whereas *Gyroidina* has a restricted primary aperture at the mid-portion of the apertural face, and a secondary apertural opening into the umbilicus lying against the preceding chamber wall. The umbilical flap in *Gyroidinoides* is an extension of the chamber but does not divide the apertural opening. In *Gyroidina* it consists of an arched lip over the secondary aperture of each chamber. *Gyroidinoides* differs from *Pseudovalvulinaria* in being plano-convex, rather than biconvex, and in having the final aperture as the only opening to the exterior, rather than having the umbilical portion of earlier apertures remaining open.]

Family ANOMALINIDAE Cushman, 1927

[Anomalinidae CUSHMAN, 1927, p. 92]—[In synonymy

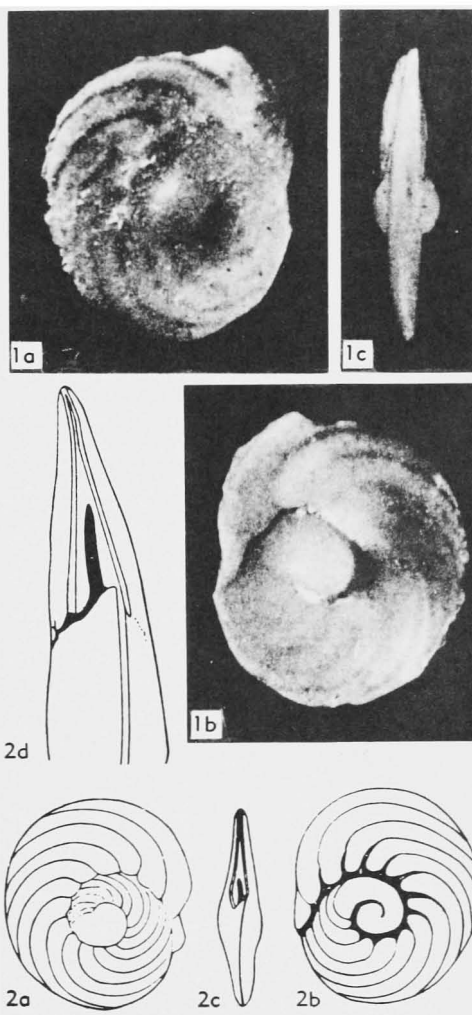


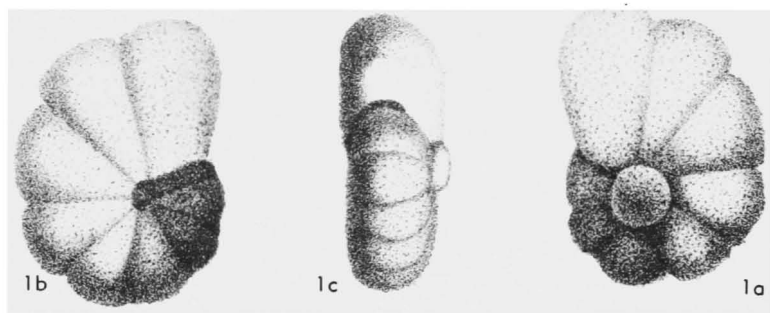
FIG. 617. Osangulariidae; 1,2, *Goupillaudina* (p. C753).

citations dagger(†) indicates *partim*—[=Hélicosteguest D'ORBIGNY, 1826, p. 268 (*nom. neg.*; *nom. nud.*); =Melonidae CHAPMAN, PARR & COLLINS 1934, p. 556; =Parrelloidae HOFKER, 1956, p. 936; =Gavelinellidae HOFKER, 1956, p. 946]

Test trochospiral to nearly planispiral, evolute on one or both sides; chambers simple; wall calcareous, coarsely perforate, granular in structure, bilamellar; primary aperture interiomarginal equatorial or somewhat extending onto spiral or umbilical sides, and may also have additional peripheral apertures. U.Trias.-Rec.

Subfamily ANOMALININAE Cushman, 1927

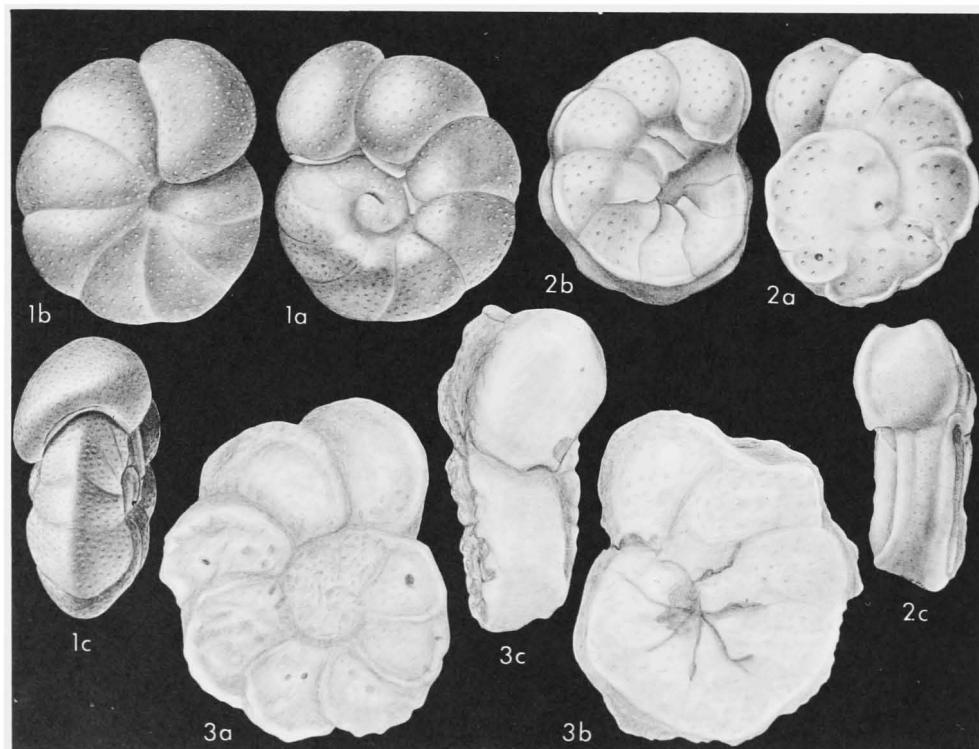
[Anomalininae CUSHMAN, 1927, p. 92] [=Pracrotalininae HOFKER, 1933, p. 125 (*partim*) (*nom. nud.*); =Melonisininae VOLOSHINOVA, 1958, p. 147; =Gavelinellinae LOEBLICH & TAPPAN, 1961, p. 316]

FIG. 618. Anomalinidae (Anomaliniinae; 1, *Anomalina*) (p. C754-C755).

Single primary aperture, interiomarginal and equatorial or extending onto spiral or umbilical sides, may have apertural flaps on umbilical side beneath which aperture opens into chambers, and may also have secondary sutural openings on periphery. *U.Trias.-Rec.*

Anomalina D'ORBIGNY, 1826, *1391, p. 282 [*A. punctulata*; SD CUSHMAN, 1915, *404e, p. 44] [= *Porospira* EHRENBERG, 1844, *673, p. 75 (type, *P. comes*)]. Test free, low trochospiral or nearly planispiral, spiral side with umbonal boss, opposite side with depressed umbilicus, periphery rounded; chambers few, sutures radiate; aperture

an interiomarginal equatorial opening, extending slightly to umbilical side. [The status of *Anomalina* is somewhat in question, inasmuch as the type-species has not been recognized since its description. We searched for the original type in the D'ORBIGNY collection in Paris, but it is apparently not preserved. A search in the type locality, Recent, Mauritius Is. (Île de France) for this species would clarify the generic status, and determine whether or not *Anomalinoides* is distinct from *Anomalina*. Both are here tentatively recognized, *Anomalina* as based on the original figure and description.] *Rec.*, Ind.O.—FIG. 618, 1. **A. punctulata*, *Rec.*, Mauritius Is.; 1a-c, opp.

FIG. 619. Anomalinidae (Anomaliniinae; 1, *Anomalinoides*; 2,3, *Boldia*) (p. C755-C757).

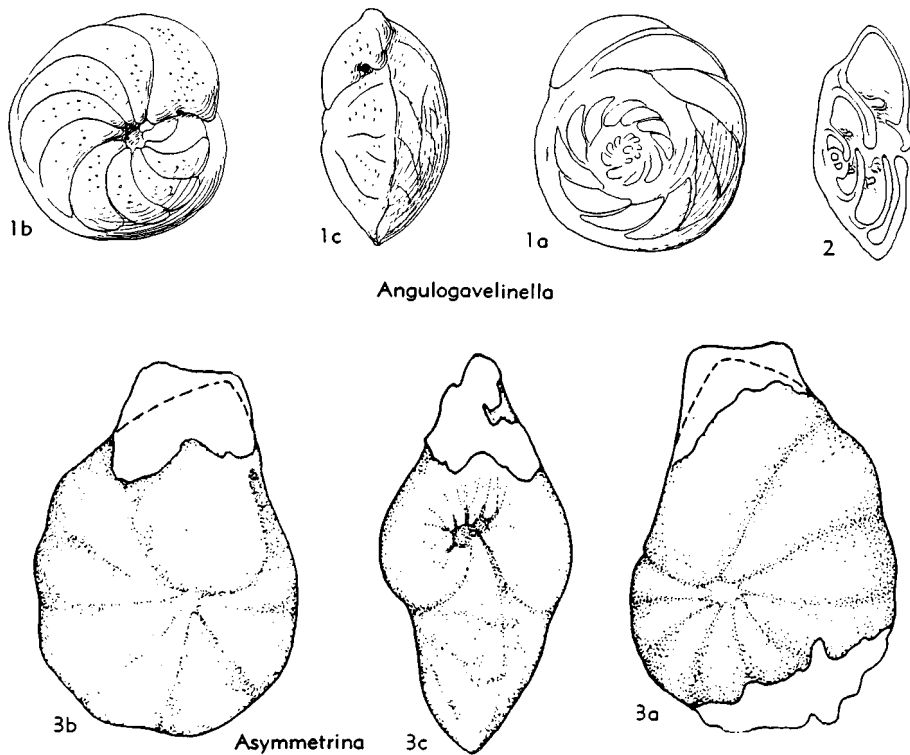


FIG. 620. Anomalinidae (Anomalininae; 1,2, *Angulogavelinella*; 3, *Asymmetrina*) (p. C755).

sides and edge view of holotype, enlarged (*1391). **Anomalinoides** BROTZEN, 1942, *240, p. 23 [*A. plummerae*, = *Anomalina pinguis* JENNINGS, 1936, *989, p. 195; OD]. Test free, nearly planispiral, but asymmetrical, periphery broadly rounded, spiral side partially evolute with umbonal boss, opposite side involute and umbilicate; wall calcareous, coarsely perforate, granular in structure; aperture a low interiomarginal equatorial slit with narrow bordering lip, extending along spiral suture on evolute side under umbilical margin of later chambers. [*Anomalinoides* differs from *Anomalina* in that its aperture continues onto the spiral side instead of being entirely peripheral.] *U.Cret.-Rec.*, cosmop.—FIG. 619,1. *A. pinguis* (JENNINGS), *U.Cret.* (Maastricht.), USA (Tex.); 1a-c, opp. sides and edge view, $\times 68$ (*2117). **Angulogavelinella** HOFKER, 1957, *948, p. 365 [*Discorbina gracilis* MARSSON, 1878, *1228, p. 166; OD]. Test trochospiral, lenticular, inequally biconvex, periphery with nonporous keel, small and deep umbilicus present; chambers numerous, low, arched; septa double (bilamellar), sutures curved, oblique; wall calcareous, coarsely perforate on umbilical side, nonperforate on spiral side, sutures and peripheral keel nonporous; aperture a somewhat oblique, high interiomarginal

arch midway between periphery and umbilicus. *U.Cret.*, Eu.—FIG. 620,1,2. *A. gracilis* (MARSSON), Maastricht., Ger.; 1a-c, opp. sides and edge view; 2, axial sec. showing deep umbilicus, double septum (at right of figure), and apert. openings, $\times 60$ (*948).

Asymmetrina KRISTAN-TOLLMANN, 1960, *1059, p. 74 [*A. biomphalica*; OD]. Test free, lenticular, planispiral, involute, but slightly asymmetrical, bi-umbilicate; wall calcareous, perforate, lamellar character and microstructure unknown; aperture an interiomarginal, equatorial arch with radiate margin. [The genus is known from a single specimen of the type-species and needs additional study for correct placement. It was originally included in the Anomalinidae.] *U.Trias.* (Rhaet.), Eu. (Aus.).—FIG. 620,3. *A. biomphalica*; 3a-c, opp. sides and edge view of holotype, $\times 80$ (*1059).

Boldia VAN BELLEN in VAN DEN BOLD, 1946, *155, p. 124, VAN BELLEN, 1946, *114, p. 122 [*nom. subst. pro Terquemia* VAN BELLEN (non TATE, 1868; nec VAN VEEN, 1932)] [*Rotalina lobata* TERQUEM, 1882, *1890, p. 63; OD] [= *Terquemia* VAN BELLEN, 1946, *113, p. 86 (obj.)]. Test free, trochospiral, plano-concave or biconcave, periphery broadly truncate; all chambers visible on slightly

concave, nearly flat spiral side, only chambers of final whorl visible on concave, slightly umbilicate opposite side; sutures thickened and raised spirally,

strongly incised on umbilical side; wall calcareous, perforate; aperture a low interiomarginal arch at umbilical edge of truncate periphery and extend-

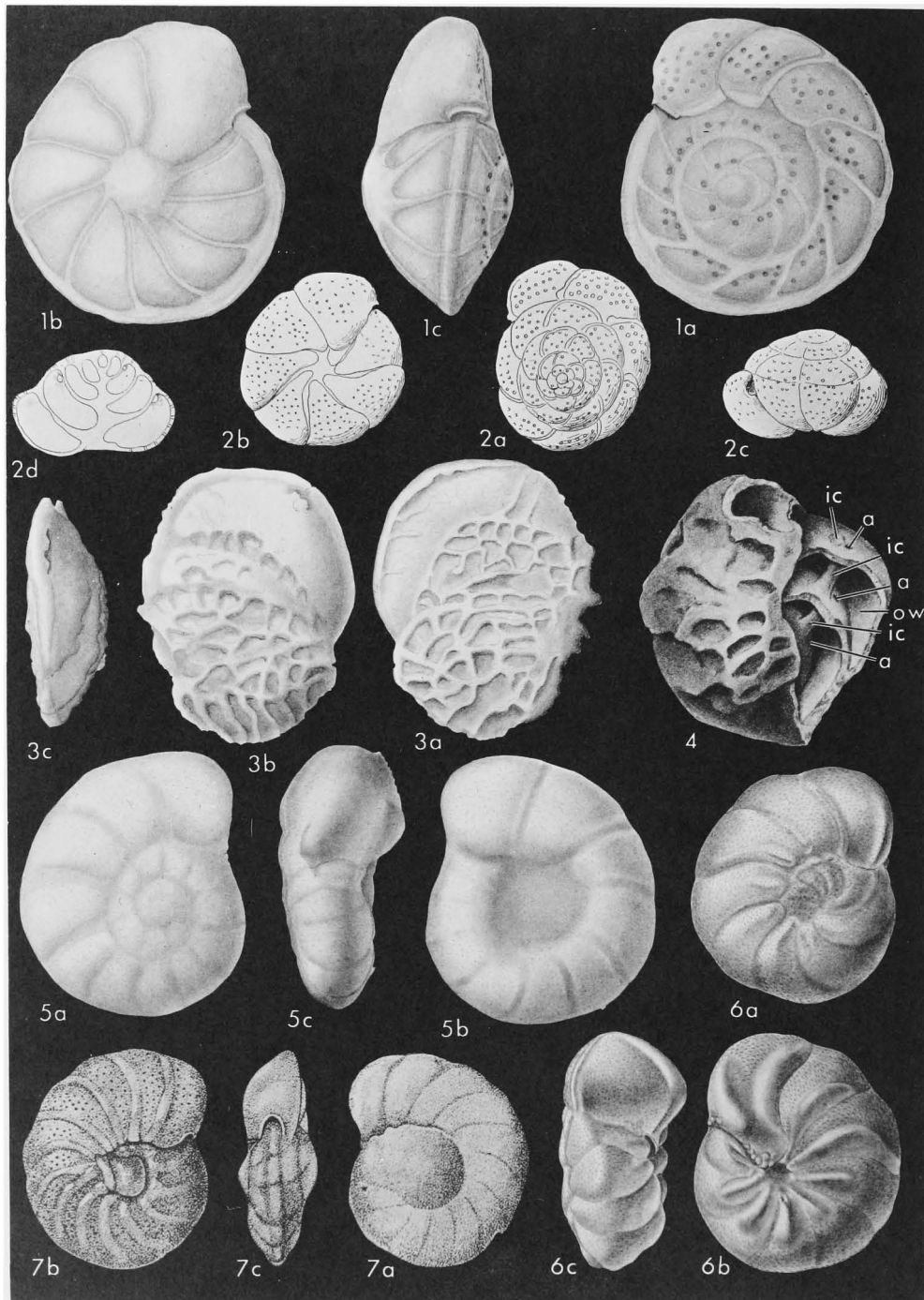
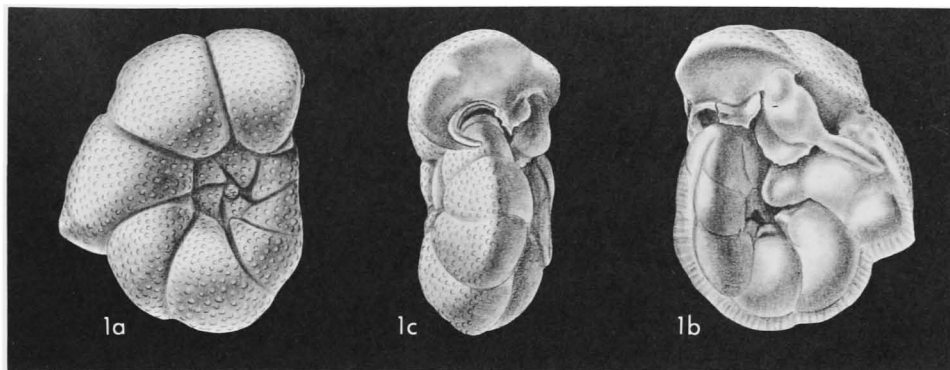


FIG. 621. Anomaliniidae (Anomaliniinae; 1,2, *Cibicidoides*; 3,4, *Coleites*; 5-7, *Gavelinella*) (p. C757, C759).

FIG. 622. Anomalinidae (Anomalininae; 1, *Discanomalina*) (p. C757-C758).

ing onto umbilical side beneath flaplike margin of final chamber, earlier apertures also remaining open as sutural slits beneath imbricating flaps of previous chambers. *Paleoc.-M.Eoc.*, Eu.-W.Indies (Cuba)-C.Am.(Guat.).—FIG. 619,2,3. **B. lobata* (TERQUEM), *M.Eoc.*, Fr.; 2a-c, opp. sides and edge view of hypotype; 3a-c, opp. sides and edge view of holotype; all $\times 109$ (*2117).

[In the original generic description, VAN BELLEN (*113, p. 86) cited *Rotalina lobata* TERQUEM as the type-species but on the plate explanation (pl. 13, figs. 13-15) he referred to *Terquemina lobata* (TERQUEM), nov. gen., nov. sp., stating that the illustrations are of the holotype. As he did not describe a new species, only a new genus, the holotype of *lobata* is the specimen of TERQUEM, which is in the collections of the Muséum National d'Histoire Naturelle, Paris (here refigured). Comparison of the illustrations suggests the possibility that VAN BELLEN's specimen belongs to a species distinct from TERQUEM's type, as it has an entire, rather than lobulate, periphery and numerous radiating grooves on the umbilical side, apparently covering the surface of the chambers. *Rotalina lobata* TERQUEM is the type-species of *Boldia* by original designation, regardless of the specific name eventually applied to the specimen of VAN BELLEN.—*Boldia* differs from *Anomalina* in its very truncate periphery and biconcave or plano-concave test with the aperture extending onto the umbilical side. It differs from *Pipervia* in having deeply incised umbilical sutures, and in lacking the extremely inflated and angular chambers of that genus. The genus was originally described without definite family assignment, although in the chart arranging phylogenetically, it is grouped with *Cibicides*. CUSHMAN (1948, *486, p. 333) apparently followed this in placing the genus in the Anomalinidae. Y. LE CALVEZ (1949, *1112, p. 8) stated that *Rotalina lobata* TERQUEM should be classified as *Anomalina lobata*, but apparently had not then noted VAN BELLEN's description of *Boldia*. BERMÚDEZ (1952, *127, p. 41) placed the genus in the Discorbininae (=Discorbininae), considering that extension of the aperture onto the umbilical side was analogous to that of *Discorbin*.]

Cibicidoides THALMANN, 1939, *1897d, p. 448 [**Truncatulina mundula* BRADY, PARKER, & JONES, 1888, *203, p. 228; OD] [=Cibicidoides BROTZEN, 1936, *237, p. 186, 194 (nom. nud.); *Parrelloides* HOFKER, 1956, *945, p. 936 (type, *Cibicides hyalinus* HOFKER, 1951, *928c, p. 359)]. Test free, trochospiral, biconvex and biumbonate, all chambers visible on spiral side, only those of final whorl visible on umbilical side; wall calcareous, hyaline, with series of coarse perforations on spiral side, appearing only near previous spiral suture in early portion of test, but covering large portion of spiral side of later chambers; aperture a low interioromarginal equatorial arch with slight projecting lip. [Although specimens were not avail-

able for determining the wall structure of the type-species, *C. proprius* is very similar to this species in other features and is of granular wall structure. The so-called radially built species listed by WOOD & HAYNES (1957, *2076) belong elsewhere (*Cibicidina*, etc.).] *Rec.*, Ind.O.-Atl.O.—FIG. 621,1. **C. mundula* (BRADY, PARKER, & JONES); 1a-c, opp. sides and edge view of lectotype (here designated and refigured), BMNH-ZF3585, from Plummer Station 4, 260 fathoms, lat. $22^{\circ}54'S$, long., $40^{\circ}37'W$, over Abroholos Bank, off coast of Brazil, S.Am., $\times 109$ (*1166).—FIG. 621,2. *C. hyalinus* (HOFKER), *Rec.*, Sumatra; 2a-c, opp. sides and edge view; 2d, axial sec., $\times 105$ (*928c).

Coleites PLUMMER, 1934, *1466, p. 605 [**Pulvinulina reticulosa* PLUMMER, 1927, *1461, p. 152; OD]. Test with early stage trochospirally coiled, later uncoiling, periphery carinate; chambers low and broad; wall calcareous, hyaline, coarsely perforate, granular in structure, lamellar character not known, surface coarsely reticulate; aperture in early stage an irregular ovate areal opening near periphery on umbilical side, elongate and terminal in adult, with tooth on umbilical side of test, interior with solid column extending from inner margin of aperture to previous foramen. *Paleoc.-L.Eoc.*, N.Am.-Eu.-C.Am.—FIG. 621,3,4. **C. reticulosa* (PLUMMER), *Paleoc.*(Midway.), USA (Ark.) (3), *Paleoc.*(Dan.), Sweden (4); 3a-c, opp. sides and top view, $\times 57$ (*2117); 4, dissected specimen showing aperture (a), intercameral column (ic), outer wall (ow), enlarged (*241).

Discanomalina ASANO, 1951, *52c, p. 13 [**D. japonica*; OD]. Test free, thick, planispiral, both sides excavated centrally, spiral side partially evolute, opposite side involute, periphery broadly rounded; chambers inflated, with backward-projecting flap on umbilical side, may have spinelike projections on periphery from one or more chambers; sutures radial; wall calcareous, granular in structure, coarsely perforate on spiral side, umbilical side and apertural face of clear, nonperforate shell material; aperture a low broad equatorial slit, interioromarginal, bordered by slight lip, slitlike supplementary openings may appear be-

neath umbilical chamber flaps. *Mio.-Rec.*, Japan-Pac.O.-Atl.O.-Carib.—FIG. 622, 1. **D. japonica*,

Rec., Pac.; 1a-c, opp. sides and edge view, $\times 44$ (*2117).

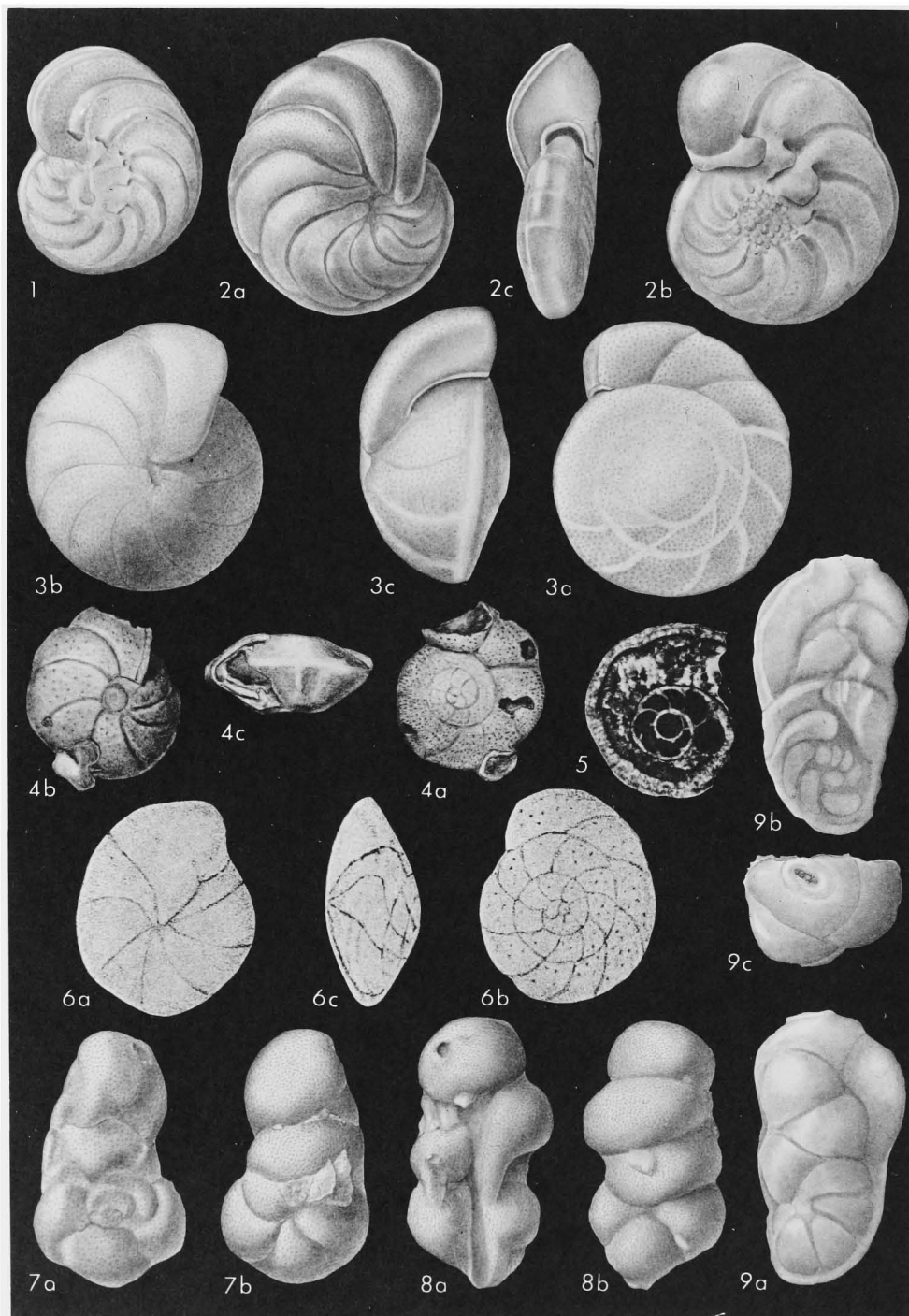


FIG. 623. Anomaliniidae (Anomaliniinae; 1, 2, *Hanzawaia*; 3-6, *Heterolepa*; 7-9, *Karrerria*) (p. C759-C761).

Gavelinella BROTZEN, 1942, *240, p. 7 [**Discorbina pertusa* MARSSON, 1878, *1228, p. 166; OD] [= *Pseudovalvulineria* BROTZEN, 1942, *240, p. 20 (type, *Rosalina lornciana* D'ORBIGNY, 1840, *1394, p. 36); *Anomalina* (Brotzenella) VASILENKO in N. K. BYKOVA *et al.*, 1958, *265, p. 52 (type, *Anomalina monterelensis* MARIE, 1941, *1215, p. 243)]. Test free, trochospiral, biconvex, sides flattened, periphery rounded; all whorls visible on spiral side, on opposite side only chambers of final whorl visible around umbilicus, which is partially closed by subtriangular flaps projecting from umbilical margins of each chamber; small umbilical boss may also be present; wall calcareous, perforate, granular in structure with double septal walls (bilamellar); aperture a low interiomarginal slit extending from near periphery to umbilicus, bordered above by narrow lip which broadens out into triangular flap at umbilical chamber margin, aperture continuous beneath flap with those of earlier chambers. *Cret.-Mio.*, Eu.-N. Am.-S. Am.-Australia-N. Z.—FIG. 621.5. **G. pertusa* (MARSSON), U.Cret.(Maastricht.), Eu. (Denm.); *5a-c*, opp. sides and edge view, $\times 98$ (*2117).—FIG. 621.6. *G. lornciana* (D'ORBIGNY), U.Cret.(Senon.), Eu.(Fr.); *6a-c*, opp. sides and edge view of lectotype, $\times 61$ (*2117).—FIG. 621.7. *G. monterelensis* (MARIE), U.Cret. (Campan.), USSR; *7a-c*, opp. sides and edge view, $\times 38$ (*265).

[*Pseudovalvulineria* was originally said to differ from *Gavelinella* in having a less open umbilicus, and an umbilical knob. The type-species of both genera lack an umbilical knob, and in other similar species this character is not constant, and the relative proportions of the umbilicus also vary considerably. Furthermore, the apertural features are identical; hence *Pseudovalvulineria* is regarded as a synonym as it was by HOFKER (*948). A lectotype is here designated and refigured for *Rosalina lornciana* D'ORBIGNY.]

Hanzawaia ASANO, 1944, *50, p. 98 [**H. nipponica*; OD]. Test free, trochoid, plano-convex, periphery moderately angled with keel, flattened side partially involute with elevated flaps on lower margin of chamber partially or completely overlapping chambers of previous whorl and commonly coalescing over entire central area, opposite side involute but without open umbilicus, central area with clear boss; sutures strongly curved, thickened; wall calcareous, granular in microstructure, rather coarsely perforate except for clear area above aperture, central flaps of spiral side and thickened sutures and keel, all of which are of clear, apparently solid, calcite; aperture an arch on periphery, extending somewhat onto convex involute side but also laterally continuous with opening on flattened side, under central flap of final chamber, with supplementary openings under umbilical flaps, both on their outer and inner margins. *Mio.-Rec.*, cosmop.—FIG. 623.1,2. **H. nipponica*, Plio., Japan; *1*, evolute side of topotype; *2a-c*, opp. sides and edge view of hypotype, $\times 41$ (*2117).

[*Hanzawaia* differs from *Cibicides* in possessing central chamber lobes on the evolute side, and in being more

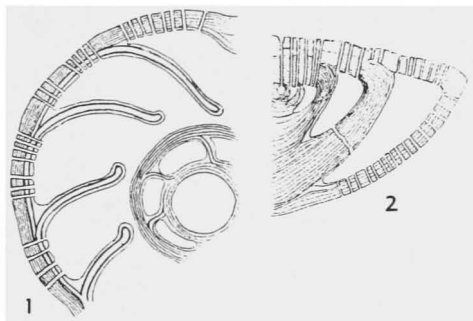


FIG. 624. Anomalinidae (Anomaliniinae; 1,2, *Heterolepa*) (p. C759-C760).

coarsely perforate. *Cibicides* differs in lacking chamber flaps, having a radial wall structure, and a more elevated umbilical side. REISS (1958, *1530, p. 65) mentioned *Hanzawaia* as belonging to the "Pulvinulinidae," and stated that all had radiate walls. *Hanzawaia* has a granular wall, however, and is not related to the other genera discussed by REISS.]

Heterolepa FRANZENAU, 1884, *742, p. 214 [**H. simplex*=**Rotalina dutemplei* D'ORBIGNY, 1846, *1395, p. 157; SD LOEBLICH & TAPPAN, 1962, *1187, p. 72] [= *Pseudotruncatulina* ANDREAE, 1884, *19, p. 122 (type, *Rotalina dutemplei* D'ORBIGNY, 1846, *1395, p. 157); *Dendrina* COSTA MS in FORNASINI, 1898, *732, p. 206 (type, *D. succinea*) (non QUENSTEDT, 1848); *Pninaella* BROTZEN, 1948, *241, p. 119 (type, *P. scanica*); *Cibicides* (*Gemellides*) VASILENKO, 1954, *1986, p. 186 (type, *C. (G.) orcinus*); *Hollandina* HAYNES, 1956, *887, p. 94 (type, *H. pegwellensis*)]. Test free, trochospiral, inequally biconvex or plano-convex, periphery bluntly angled, may have nonperforate keel, flat to slightly convex evolute spiral side, with relatively numerous chambers in slowly enlarging whorls, more convex umbilical side involute, with radial sutures; wall calcareous, thick and lamellar, coarsely and regularly perforate, granular in structure, septa double (bilamellar); aperture slit-like, interiomarginal, extending about half of distance to umbilicus on umbilical side and extending across periphery on spiral side, may also extend for some distance along spiral suture. *U. Cret.(Maastricht.)-Rec.*, cosmop.—FIG. 623.3. **H. dutemplei* (D'ORBIGNY), Mio., Eu.(Aus.); *3a-c*, opp. sides and edge view, $\times 37$ (*2117).—FIG. 624.1. *H. praecincta* FRANZENAU, Mio., Eu. (Hung.); horiz. sec. showing bilamellar wall character and coarse perforations, enlarged (*742).—FIG. 624.2. *H. bullata* FRANZENAU, Mio., Eu. (Hung.); vert. sec., enlarged (*742).—FIG. 623.4,5. *H. scanica* (BROTZEN), Paleoc., Eu. (Sweden); *4a-c*, opp. sides and edge view of holotype; *5*, horiz. sec., with secondarily resorbed septa, probably due to preservation, $\times 38$ (*241).—FIG. 623.6. *H. pegwellensis* (HAYNES), Paleoc., Brit.I.(Eng.); *6a-c*, opp. sides and edge view of holotype, $\times 90$ (*887).

[FRANZENAU originally included four species in *Heterolepa*, without designating a type-species, *H. simplex*, n. sp., *H.*

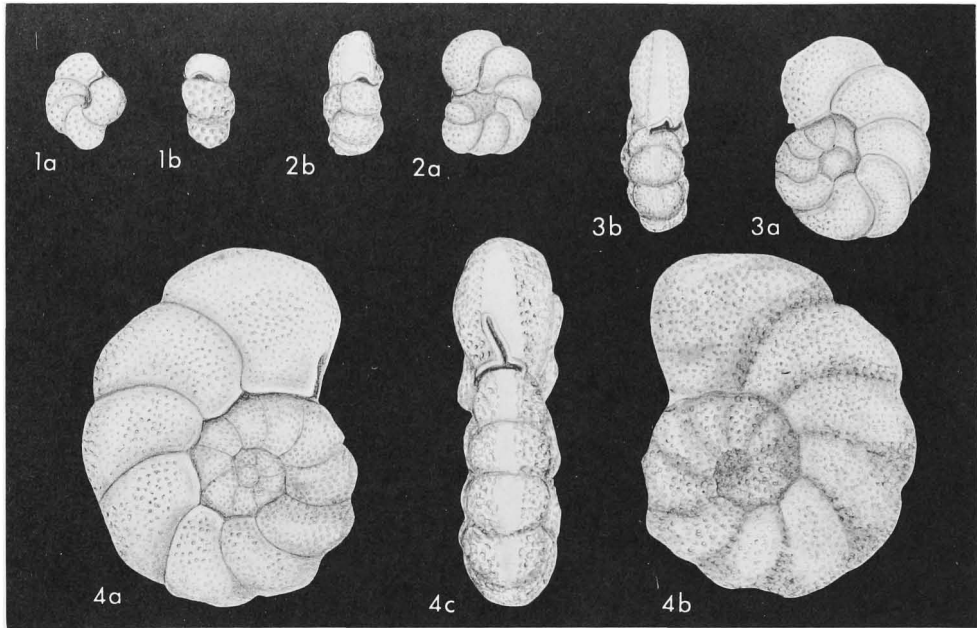


FIG. 625. Anomaliniidae (Anomaliniinae; 1-4, *Holmanella*) (p. C760).

costata, n. sp., *H. praecincta*, n. sp. and *H. bullata*, n. sp. ELLIS & MESSINA (*700) stated that FRANZENAU designated *Rotalina dutemplei* as the type in 1885, but this was not in the original list of species, hence was ineligible for selection as the type-species. In 1885 FRANZENAU (*743, p. 152) stated that *H. simplex* was a synonym of *Rotalina dutemplei* D'ORBIGNY. As the type must be one of the species originally included by FRANZENAU, we (*1187) so designated *H. simplex*.—During the same year (1884) *Pseudotruncatulina* was described on the basis of its bilamellar walls, also with *Rotalina dutemplei* as type-species. *Gemellides* (proposed as a subgenus of *Cibicides*) also originally included this species, but was separated on the basis of its apertural characters. Regardless of the basis for separation, both *Pseudotruncatulina* and *Gemellides*, including the same species, are junior synonyms of *Heterolepa*. *Prinaella* was regarded as having secondarily much enlarged foramina, but the figured section shows well-preserved septa in the early portion; hence it seems probable that the remaining septa were probably destroyed during preservation. *Prinaella scanica* seems otherwise much like *H. dutemplei* and certainly congeneric. The other species included by BROTZEN (*Pulvinulina nitidula*) is probably not congeneric, as it is a very thin-walled form. Although previously regarded as closely related to *Cibicides* (some species having been referred to it erroneously), *Heterolepa* has a granular wall structure and is free, not attached by the spiral side, thus related to the Anomaliniidae, as here restricted, rather than to the Cibicididae.]

Holmanella LOEBLICH & TAPPAN, 1962, *1187, p. 72 [**Discorbinella valmonteensis* KLEINPELL, 1938, *1046, p. 350; OD]. Test free, large, compressed, enrolled, bievolute, nearly planispiral but somewhat asymmetrical, with nonporous, broadly rounded peripheral margin; chambers gradually enlarging; sutures distinct, depressed, curved backward at periphery; wall calcareous, thin, very coarsely perforate, granular in microstructure, bilamellar; aperture in young stage a low interior-marginal opening at one side of periphery, in later stages with low opening continuing along spiral suture to connect with previous apertures and with perpendicular slit extending obliquely up nonporous apertural face, all apertures bor-

dered by narrow lip. *Mio.*, USA (Calif.).—FIG. 625, 1-4. **H. valmonteensis* (KLEINPELL); 1a,b, side and edge views of juvenile specimen showing slightly trochospiral development and low asymmetrical arched aperture; 2a,b, side and edge views of somewhat older specimen with higher asymmetrical arch; 3a,b, side and edge views of larger specimen with beginning of vertical slit shown as notch, imperforate area visible on periphery and along sutures of spiral side; 4a-c, spiral, umbilical, and edge views, with well-developed oblique slit-like aperture extending up face and connecting with spiral suture on spiral side; all $\times 48$ (*2117).

Involvinia KRISTAN-TOLLMANN, 1960, *1059, p. 76 [**I. obliqua*; OD]. Test free, lenticular, trochospiral or with tendency to become planispiral, umbilical region closed or umbonate; wall calcareous perforate but coarse granular, with calcareous cement and some included sand grains; aperture a large oval equatorial opening that extends slightly to umbilical side, margin radiate. [The wall characters need clarification. The above description is from the original, and leaves doubt as to whether the wall is lamellar, hyaline perforate, and radial or granular in structure, or non-lamellar agglutinated calcareous, or granular. The genus was originally placed in the Anomaliniinae.] *U.Trias. (Rhaet.)*, Eu. (Aus.).—FIG. 626, I. **I. obliqua*; 1a-c, opp. sides and edge view of holotype, $\times 125$ (*1059).

Karrerria RZEHA, 1891, *1604, p. 4, 6 [**K. fallax*; OD] [= *Vagocibicides* FINLAY, 1939, *717c, p. 326 (type, *V. maoria*)]. Test attached, early portion trochospirally coiled with one or more volutions, attached by spiral side, free convex side

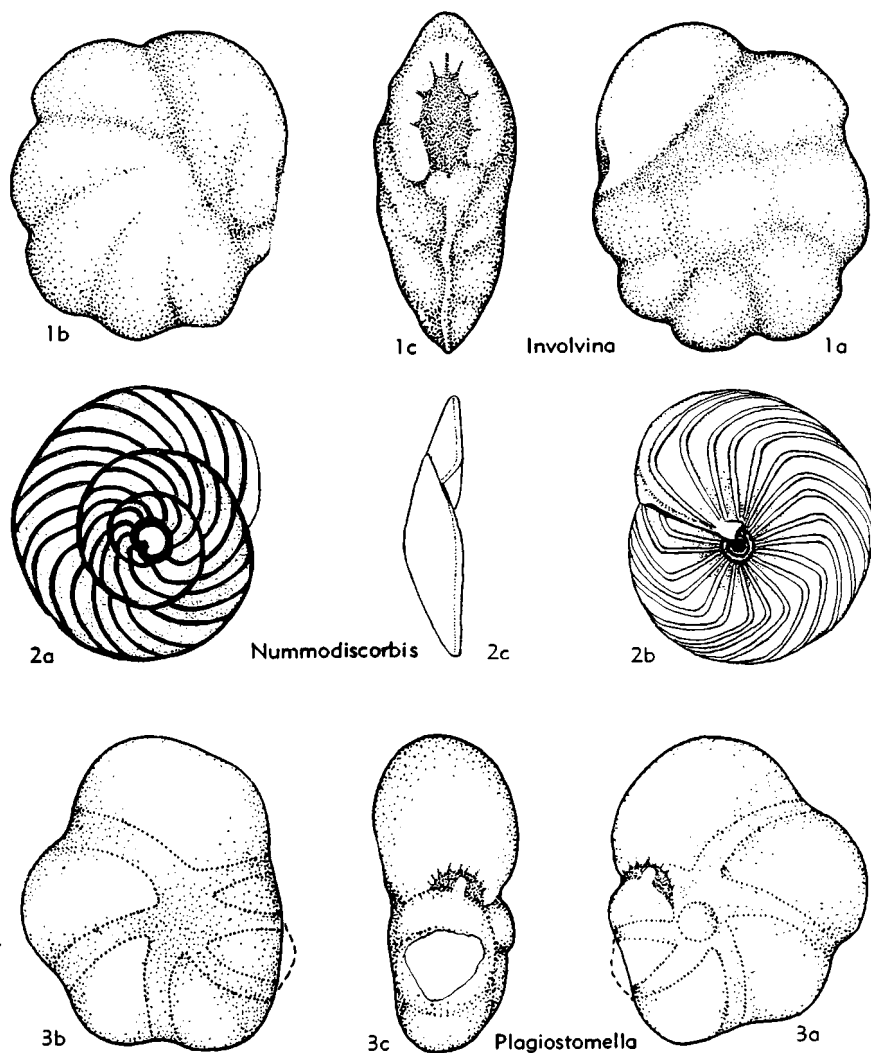


FIG. 626. Anomalinidae (Anomaliniinae; 1, *Involvina*; 2, *Nummodiscorbis*; 3, *Plagiostomella*) (p. C760, C763).

involute, later portion uncoiling and rectilinear; sutures depressed, nearly straight; wall calcareous, thick, finely perforate, granular in structure, surface smooth; aperture terminal or subterminal, rounded. [*Stichocibicides* was regarded as a synonym by BROTZEN (*241), TEN DAM (*554), and BERMÚDEZ (*127), but it has a coarsely perforate wall and nonporous peripheral keel.] *L.Cret. (Alb.)-Rec.*, Eu.-N.Afr.-USA (Calif.)-N.Z.—FIG. 623,7,8. **K. fallax*, Paleoc., Eu.(Denm.); 7a,b, 8a,b, opp. sides of two specimens, $\times 40$ (*2117). —FIG. 623,9. *K. maoria* (FINLAY), M.Oligo., N.Z.; 9a-c, opp. sides and apert. view, $\times 51$ (*2117).

Melonis DE MONTFORT, 1808, *1305, p. 66 [**M. etruscus* = *Nautilus pompilioides* FICHTEL & MOLL,

1798, *716, p. 31; OD] [= *Melossis* PALLAS in OKEN, 1815, *1385, p. 333 (type, *Nautilus pompilioides* FICHTEL & MOLL, 1798, *716, p. 31; SD GALLOWAY, 1933, *762, p. 266); *Melonia* BRONN, 1849, *211, p. 720 (non LAMARCK, 1822; nec SCHINZ, 1825, pro *Melania* LAMARCK, 1799, nom. van.); *Gavelinonion* HOFKER, 1951, *935, p. 17 (nom. nud.); *Gavelinonion* THALMANN, 1953, *1897k, p. 876 (nom. nud.) (erroneously cited *Rotalia tuberculifera* REUSS, 1862, as type of *Gavelinonion* HOFKER, 1951); *Gavelinonion* HOFKER, 1956, *946, p. 116 (nom. nud.); *Gavelinonion* HOFKER, 1957, *948, p. 368 (type, *Nautilus umbilicatus* WALKER & JACOB in KANMACHER, 1798, *1011, p. 641)]. Test free, early stage slightly trochospiral, adult planispiral, symmetrical and involute, deep-

ly biumbilicate, with umbilicus commonly bordered by rim of nonperforate skeletal material, periphery broadly rounded; about 9 to 12 cham-

bers per whorl; sutures flush to slightly depressed, radiate, straight to slightly curved, septa double, bilamellar (*946); wall calcareous, coarsely per-

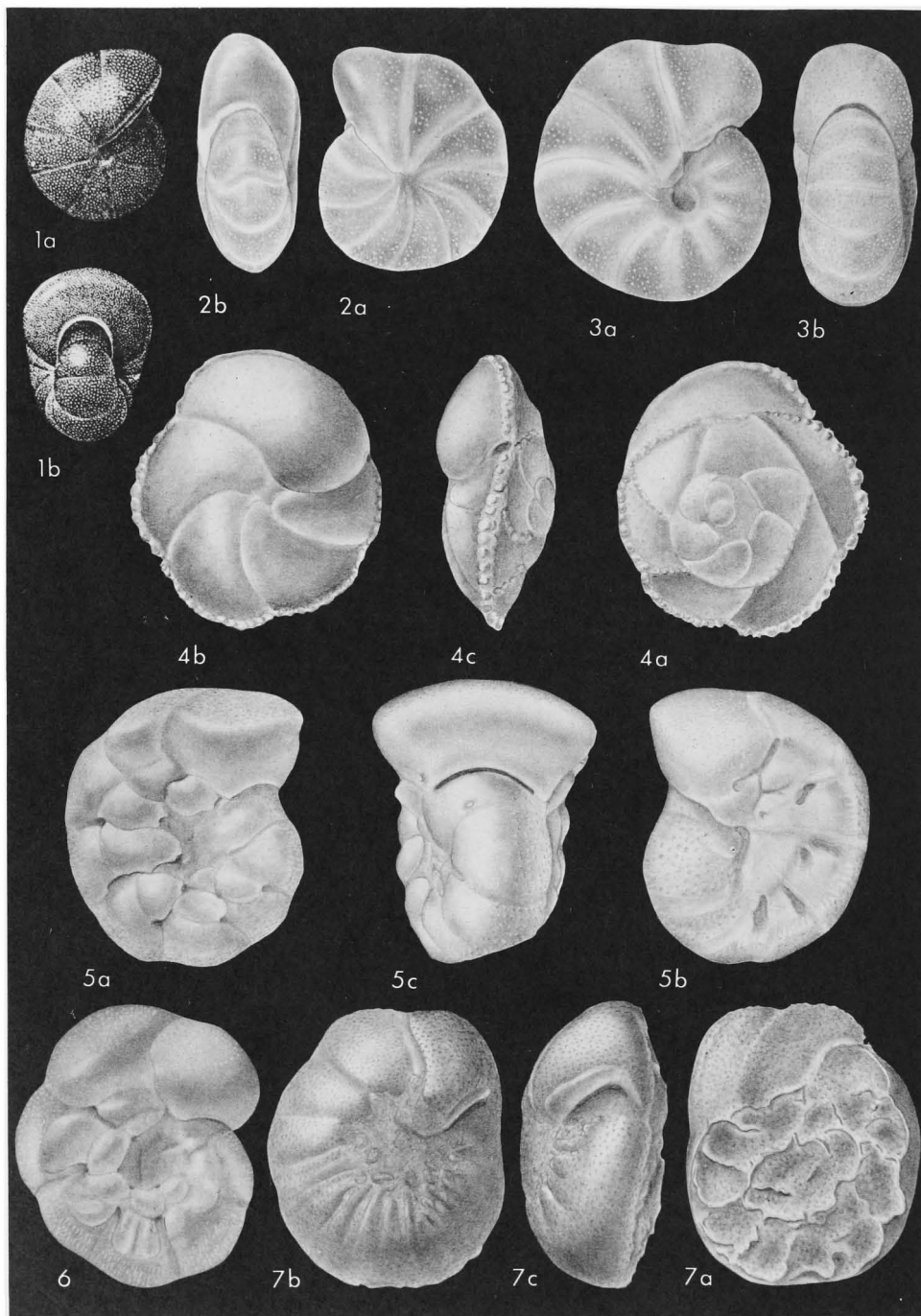


FIG. 627. Anomaliniidae (Anomaliniinae; 1-3, *Melonis*; 4, *Pulsiphonina*; 5, 6, *Paromalina*; 7, *Stensioina*) (p. C761-C763).

forate, granular in structure, apertural face, septa, and umbilical thickened rim imperforate, surface smooth; aperture an elongate interiomarginal, equatorial slit, extending laterally to umbilicus on both sides of test. ?*U.Cret.*(*Maastricht.*), *Paleoc.-Rec.*, cosmop.—FIG. 627,1. **M. pompilioides* (FICHTEL & MOLL), Plio., Eu.(Albania); 1*a,b*, side, edge views, $\times 100$ (*2019).—FIG. 627,2,3. *M. zaandami* (VAN VOORTHUYSEN), Rec., Greenl.; 2*a,b*, 3*a,b*, side and apert. views, $\times 75$ (*1162).

Nummodiscorbis HORNIBROOK, 1961, *959, p. 106 [**N. novozealandica*; OD]. Test low and conical, plano-convex to concavo-convex, with angular periphery; low and numerous chambers trochospirally arranged, in numerous slowly enlarging whorls; sutures curved and oblique on evolute spiral side, sharply angled centrally on involute umbilicate opposite side; wall calcareous, finely perforate, lamellar character and microstructure not known; aperture an elongate interiomarginal slit, extending from near periphery to umbilicus, with small apertural flap projecting into umbilicus. *L.Mio.*, N.Z.—FIG. 626,2. **N. novozealandica*; 2*a-c*, opp. sides and edge view of holotype, $\times 100$ (*959).

[This genus was originally placed in the Discorbinae, as was *Gavelinella*, but no information was given (*959) as to whether or not *Nummodiscorbis* has the radially built monolamellar wall of this group. Since it appears closer in other characters to *Gavelinella*, it is here tentatively placed in the Anomalinidae, pending further study of its wall character.]

Paromalina LOEBLICH & TAPPAN, 1957, *1172, p. 230 [**P. bilateralis*; OD]. Test free, planispiral, biumbilicate, both sides somewhat excavated centrally, periphery truncate; chambers laterally inflated, with their umbilical margins extending backward in flap covering part of previous suture and chamber, flaps more rarely coalescing to obscure otherwise open umbilicus; sutures radial, depressed; wall calcareous, granular in structure, with clear imperforate wall on sides and apertural face, coarsely perforate truncate periphery; aperture a broad low slit on periphery, bordered above by narrow lip, at base of final chamber and against preceding whorl, with supplementary openings beneath umbilical chamber flaps on each side of test. [Differs from *Discanomalina* in having the clear imperforate-appearing shell wall on both sides of the test, and is coarsely perforate only on the truncate periphery.] *Rec.*, Atl.O.—FIG. 627, 5,6. **P. bilateralis*; 5*a-c*, opp. sides and edge view, $\times 53$ (*1172); 6, side view of paratype, $\times 48$ (*1172).

Plagiostomella KRISTAN-TOLLMANN, 1960, *1059, p. 73 [**P. inflata*; OD]. Test biconvex, slightly trochospiral, tending to become planispiral, umbilicus closed, periphery rounded; wall calcareous, perforate, lamellar character and microstructure unknown; aperture an interiomarginal, equatorial arch, extending slightly onto umbilical side, upper apertural margin fimbriate, lower margin with tooth, or possibly double aperture. [This genus is imperfectly known, as it is represented by a single

specimen of the type-species; hence its placement is questionable. It was originally placed in the Anomalininae.] *U.Trias.*(*Rhaet.*), Eu.(Aus.).—FIG. 626,3. **P. inflata*; 3*a-c*, opp. sides and edge view of holotype, $\times 125$ (*1059).

Pulsiphonina BROTZEN, 1948, *241, p. 106 [**Siphonina prima* PLUMMER, 1927, *1461, p. 148; OD] [= *Siphonina* (*Pulsiphonina*) BROTZEN, 1948, *241, p. 106 (obj.)]. Test free trochospiral, biconvex, periphery angular and with carinate, limbate, or beaded margin; all whorls visible from spiral side, where chambers are broad, low, and semilunate in appearance, only final whorl visible on umbilical side, where sutures are curved but nearly radial; wall calcareous, coarsely perforate, granular in structure; aperture a low narrow opening at periphery on umbilical side, and lying against peripheral keel, with narrow bordering lip. [*Pulsiphonina* differs from the superficially similar *Siphonina* in having a granular, rather than radially, built wall and in lacking a distinct apertural neck]. *U.Cret.*(*Maastricht.*)-*L.Eoc.*, N.Am.-Eu.—FIG. 627,4. **P. prima* (PLUMMER), *Paleoc.* (Midway.), USA(Ark.); 4*a-c*, opp. sides and edge view, $\times 185$ (*2117).

Stensioina BROTZEN, 1936, *237, p. 315 [**Rotalia exsculpta* REUSS, 1860, *1548, p. 222; OD]. Test trochospiral, unequally biconvex to plano-convex, with flattened spiral side and elevated umbilical side; chambers enlarging gradually; sutures oblique and strongly elevated on spiral side, radial and depressed on umbilical side, septa double (bilamellar); wall calcareous, coarsely perforate, granular in structure, spiral side with characteristic ornamentation, with sutures forming elevated ridges resulting in irregularly reticulate pattern on spiral side, with chamber wall more finely reticulate and pitted; aperture a low interiomarginal opening between umbilicus and periphery. *U.Cret.*, cosmop.—FIG. 627,7. **S. exsculpta* (REUSS), Eu.(Ger.); 7*a-c*, opp. sides and edge view of topotype, $\times 74$ (*2117).

Subfamily ALMAENINAE Myatlyuk, 1959

[Almaeninae MYATLYUK in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 272]

Primary aperture interiomarginal, equatorial or slightly umbilical, with lip; secondary slitlike aperture at peripheral margin, in plane of coiling. *Eoc.-Rec.*

Almaena SAMOYLOVA, 1940, *1622, p. 377 [**A. taurica*; OD (M)] [= *Kelyphistoma* KEIJZER, 1945, *1030, p. 207 (type, *K. ampulloculata*); *Planulinella* SIGAL, 1949, *1744, p. 158 (type, *P. escornebovensis*); *Almaena* (*Pseudoplanulinella*) SIGAL, 1950, *1745, p. 63, 68 (type, *A. (P.) hieroglyphica*)]. Test enrolled, compressed, planispiral, evolute on both sides, periphery carinate; wall calcareous, coarsely perforate, peripheral keel, apertural face and septa nonperforate; primary aperture ovate to slitlike, interiomarginal and equatorial to slightly asymmetrically equatorial in

position, with distinct bordering lip, elongate slit-like secondary subperipheral aperture paralleling peripheral keel on one side of test, as in *Anomalinella*, those of earlier chambers secondarily filled. *U.Eoc.-Mio.*, Eu.-Afr.-N.Am.—FIG. 628,1. **A. taurica*, *U.Eoc.*, USSR (Crimea); 1a-c, opp. sides and edge view of holotype, $\times 25$ (*1332).—FIG. 628,2. *A. hieroglyphica* (SIGAL), *Mio.* (Aquitain.), Fr.; 2a,b, side and edge views, $\times 71$ (*2117).—FIG. 628,3. *A. escornebovensis* (SIGAL), *Mio.* (Aquitain.), Eu. (Fr.); 3a,b, side and edge views, $\times 44$ (*2117).

Anomalinella CUSHMAN, 1927, *431, p. 93 [*Truncatulina rostrata* BRADY, 1881, *196c, p. 65; OD]. Test free, lenticular, slightly trochoid to nearly planispiral in adult, involute, biumbonate; chambers relatively numerous, increasing gradually in size; sutures distinct, thickened, gently curved; wall calcareous, hyaline, coarsely perforate, granular in structure with clear and nonperforate peripheral keel and sutures; aperture consisting of low, rounded interiomarginal arch, against peripheral margin of previous whorl, bordered above by lip, supplementary aperture consisting of elongate slit just to one side of periphery, bordering and paralleling peripheral keel. *Mio.-Rec.*, Pac.O.—FIG. 628,4. **A. rostrata* (BRADY), *Rec.*, New Guinea (Papua); 4a,b, side and edge views of lectotype, $\times 48$ (*2117).

[Differs from *Almaena* in being completely involute, rather than partially evolute. It differs from *Queraltina* in being planispiral rather than trochoid. A lectotype is here designated and refigured for *Anomalinella rostrata* (BRADY) from the syntypes in the British Museum (Natural History), BMNH-ZF2549, from *Challenger* station 217A, Humboldt Bay, Papua (New Guinea), at a depth of 37 fathoms. HOFKER (1960, *953, p. 49) regarded *Anomalinella*, *Almaena*, *Planulinella*, *Pseudoplanulinella* and *Kelyphistoma* all as synonyms of *Planulina*. However, typical *Planulina* has a radially built wall, is perforate only on one side of the test, and does not have supplementary peripheral apertures (species not agreeing in all these characters should not be referred to *Planulina*), whereas *Anomalinella* is granular in wall structure, both sides of the test are perforate, and the supplementary peripheral apertures are characteristic. The genera do not even belong to the same superfamily.]

Ganella AUROUZE & BOULANGER, 1954, *57, p. 187 [**G. neumannae*; OD]. Test free, lenticular, trochospiral in the early stage, becoming nearly planispiral and evolute on both sides in adult, although slightly asymmetrical, periphery carinate; chambers gradually enlarging; sutures curved backward at periphery, slightly depressed, those of earlier chambers thickened and elevated; wall calcareous, coarsely perforate, granular in structure, with nonporous, beaded and elevated sutures, and peripheral keel; aperture an elongate vertical slit, in young forms extending up from base of somewhat obliquely situated, flat to concave apertural face and migrating up face to become areal opening in median position in face of adult test, bordered by elevated rim. *Eoc.* (*Ypres.*), Eu. (Fr.).—FIG. 628,5. **G. neumannae*; 5a-c, opp. sides and edge view, $\times 72$ (*2117). **Queraltina** MARIE, 1950, *1218, p. 73 [**Q. epistominoides*; OD]. Test similar to *Almaena* but

distinctly trochospiral, asymmetrical and inequally biconvex, with chambers distinctly inflated on umbilical side and nearly flat on spiral side; wall granular in structure; peripheral apertures on spiral side of test, paralleling peripheral keel. [*Queraltina* is probably ancestral to *Almaena*, with more pronounced trochospiral development, and inflated umbilical side, whereas *Almaena* is more nearly bilaterally symmetrical, and is strongly compressed.] *Eoc.* (*U.Lutet.-Barton.*), Eu.—FIG. 628,6,7. **Q. epistominoides*, *Eoc.* (Barton.), Fr.; 6a,b, opp. sides of holotype, $\times 52$ (*2117); 6c, edge view, showing inflated chambers at left side, $\times 56$ (*1218); 7a, inflated umbilical side of paratype, $\times 52$ (*2117); 7b, edge view of more asymmetrical paratype, $\times 56$ (*1218).

Superfamily CARTERINACEA Loeblich & Tappan, 1955

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 317 (ex family Carterinidae LOEBLICH & TAPPAN, 1955)]

Test composed of secreted fusiform calcareous spicules, commonly oriented parallel to periphery and embedded in calcareous ground mass. *Rec.*

Family CARTERINIDAE Loeblich & Tappan, 1955

[Carterinidae LOEBLICH & TAPPAN, 1955, p. 27]

Test trochospiral, free or attached; later chambers subdivided by secondary septa. *Rec.*

Carterina BRADY, 1884, *200, p. 66, 345 [**Rotalia spiculotesta* CARTER, 1877, *294, p. 470; OD (M)]. Test free, trochospiral and umbilicate in early stages, attached and spreading irregularly in later stages, with wide, flangelike, undivided attachment spreading over surface of substratum; 3 to 5 crescentic chambers to whorl of approximately equal height throughout, becoming much more irregular and broader in later whorls, beginning in third whorl chambers subdivided by partial secondary septa projecting inward from lower and peripheral walls, in early stages only minor projections present, but in later ones almost complete partitions, true septa oblique and depressed on spiral side, secondary septa perpendicular to periphery, depressed on umbilical side but not visible on spiral side except when specimen is dampened, earlier chambers having only 2 or 3 of these secondary septa, but after third whorl increasing in number up to 15 to chamber as latter increase in relative length, leaving chamberlets all of approximately equal size; wall thin, composed of calcareous spicules (secreted by protoplasm) each forming single crystal with c-axis parallel to length of spicule, commonly aligned parallel to periphery of test, embedded in calcareous areolated ground mass; aperture not observed in attached specimens, ventral in free specimens. *Rec.*, Philip. Is. - India (Ceylon) - Gulf Suez-

Medit.-Japan.—FIG. 629,1,2. **C. spiculotesta* (CARTER), Philip. (1), Ceylon (2); 1a-c, opp. sides and edge view of free hypotype which may

have broken from small attachment, $\times 60$; 2a, complete, attached specimen with surrounding noncamerate flange also composed of secreted

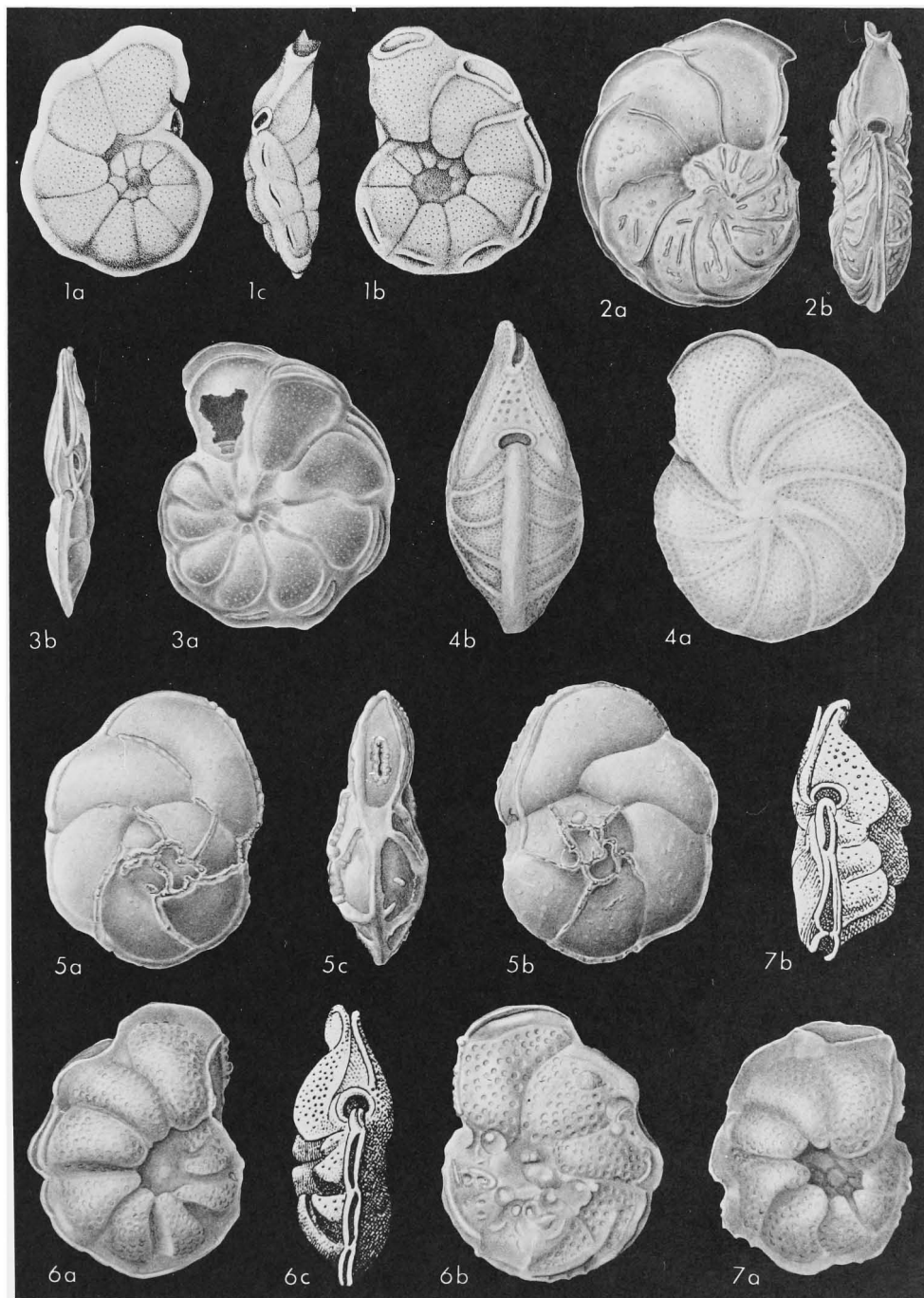


FIG. 628. Anomalinidae (Almaeninae; 1-3, *Almaena*; 4, *Anomalinella*; 5, *Ganella*; 6,7, *Queralina*) (p. C763-C764).

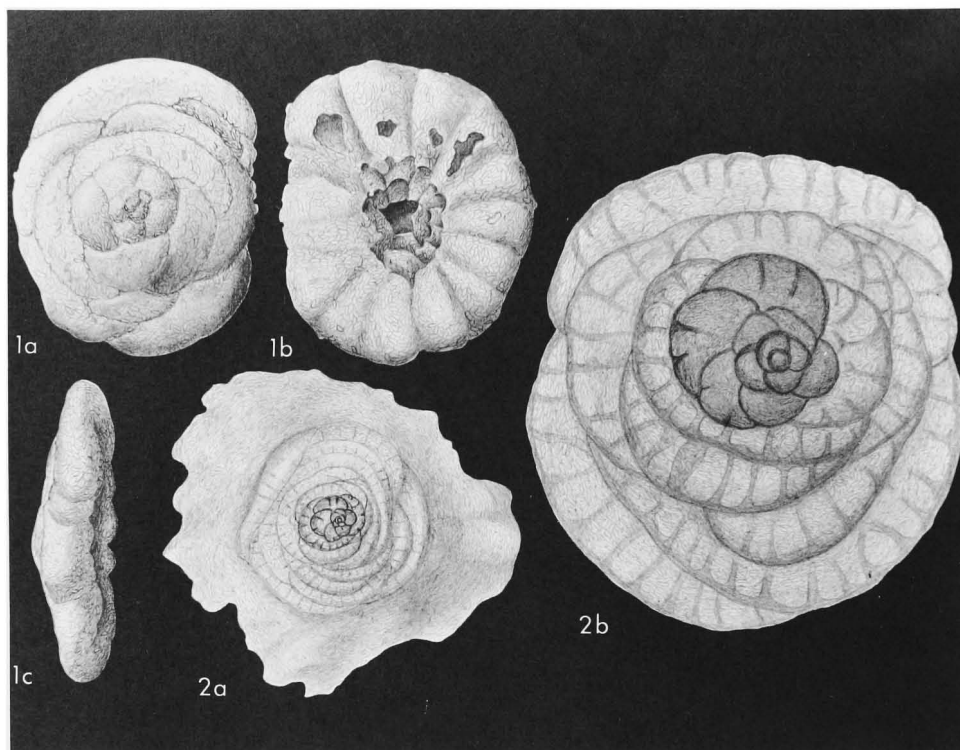


FIG. 629. Carterinidae; 1, 2, *Carterina* (p. C764-C766).

spicules, $\times 21$; 2b, central area of same specimen dampened to show secondary septa in later whorls and undivided early chambers, $\times 79$ (*1166).

Superfamily ROBERTINACEA Reuss, 1850

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 317 (ex family Robertinidae REUSS, 1850)] [=superfamily Ceratobuliminidae MYATLYUK in RAUZER-CHERNOUSOVA & FURSENKO, 1959, p. 273]

Test trochospiral, chambers divided internally by partitions which become more important in advanced forms; wall perforate-radial in structure, of aragonite; aperture a low slit in chamber face, with secondary aperture in each septum above partition. ?*Trias.*, *Jur.-Rec.*

Family CERATOBULIMINIDAE Cushman, 1927

[*nom. transl.* GLAESSNER, 1937, p. 27 (ex subfamily Ceratobuliminidae CUSHMAN, 1927)] [=Epistominidae WEDEKIND, 1937, p. 115; =Conorbidae HOFKER, 1951, p. 414 (*pro Conorbis* HOFKER, 1951, *non* SWAINSON, 1840); =Conorboididae THALMANN, 1952, p. 984; =Ceratobuliminidae HOFKER, 1956, p. 103 (*nom. null.*)]

Test trochospiral; wall calcareous, perforate, of aragonite; primary aperture closed when new chambers added and new foramen opened by resorption above internal partition. ?*Trias.*, *Jur.-Rec.*

Subfamily CERATOBULIMININAE Cushman, 1927

[Ceratobulimininae CUSHMAN, 1927, p. 84]

Primary aperture interiomarginal; coiling predominantly dextral. *Jur.-Rec.*

Ceratobulimina TOULA, 1915, *1943, p. 654 [**Rotalina contraria* REUSS, 1851, *1541, p. 76; OD (M)] [=Fissistomella CLODIUS, 1922, *350, p. 141 (type, *Rotalina contraria* REUSS, 1851; SD LOEBLICH & TAPPAN, herein); *Ceratobuliminoides* PARR, 1950, *1429, p. 358 (type, *C. bassensis*)]. Test trochospiral, deeply umbilicate, chambers enlarging rapidly, whorls few, coiling dextral; wall laminated, surface smooth, polished; aperture umbilical, consisting of elongate slit extending in groove up face of final chamber on umbilical side; internally incomplete, marginally serrate partition attached to posterior side of vertical apertural slit at interior of umbilical side, bends around aperture and extends across to be attached to spiral wall for short distance. [*Ceratobuliminoides* was said not to have internal septa but notches on the spiral side seem indicative of an internal partition similar to that of *Ceratobulimina*, and they are here regarded as synonymous.] *U.Cret.-Rec.*, cosmop.—FIG. 630, 1, 2. **C. contraria* (REUSS), M.Oligo., Ger. (1), Denm. (2); 1a-c, opp. sides and edge view of topotype, $\times 90$ (*2117); 2, dissected specimen showing external aperture (a),

septal foramen opening into penultimate chamber (*sf*), and internal serrate partition (*p*), $\times 92$ (*1950).—FIG. 630, 3. *C. bassensis* (PARR), Rec.,

Tasm.; 3*a-c*, opp. sides and edge view, $\times 100$ (*1429).

Cassidulinita SUZIN in VOLOSHINOVA & DAIN, 1952,

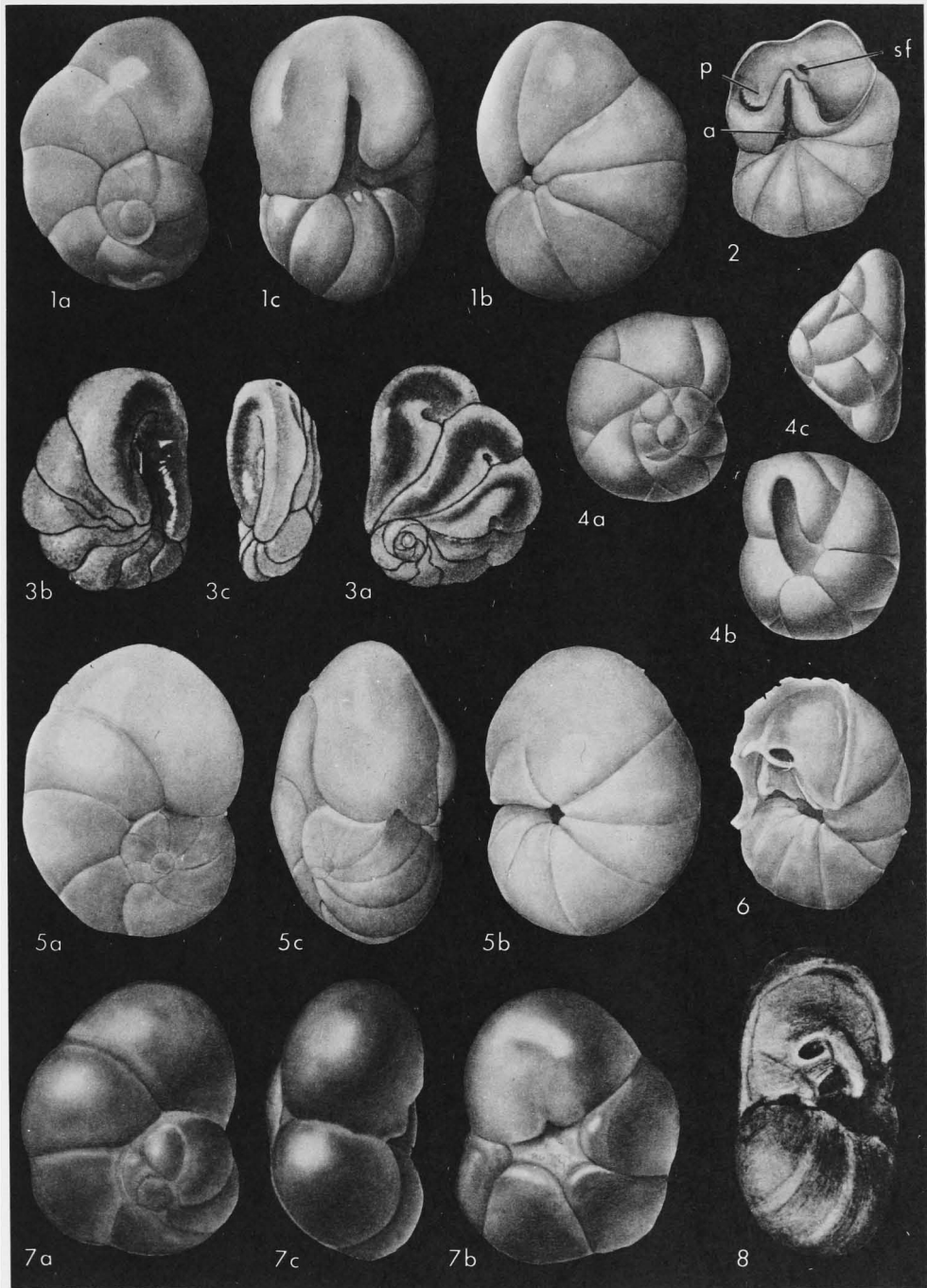


FIG. 630. Ceratobuliminidae (Ceratobulimininae; 1-3, *Ceratobulimina*; 4, *Cassidulinita*; 5*♂*, *Ceratocancris*; 7,8, *Ceratolamarckina*) (p. C766-C769).

*2022, p. 102 [**C. prima*; OD] [= *Cassidulinella* SUZIN, 1937, in VOLOSHINOVA & DAIN, 1952, *2022, p. 102 (non NATLAND, 1940)]. Test free, ex-

tremely small, from 0.08-0.15 mm. diam., plano-convex; chambers biserially arranged and trocho-spirally enrolled, alternate chambers extending to

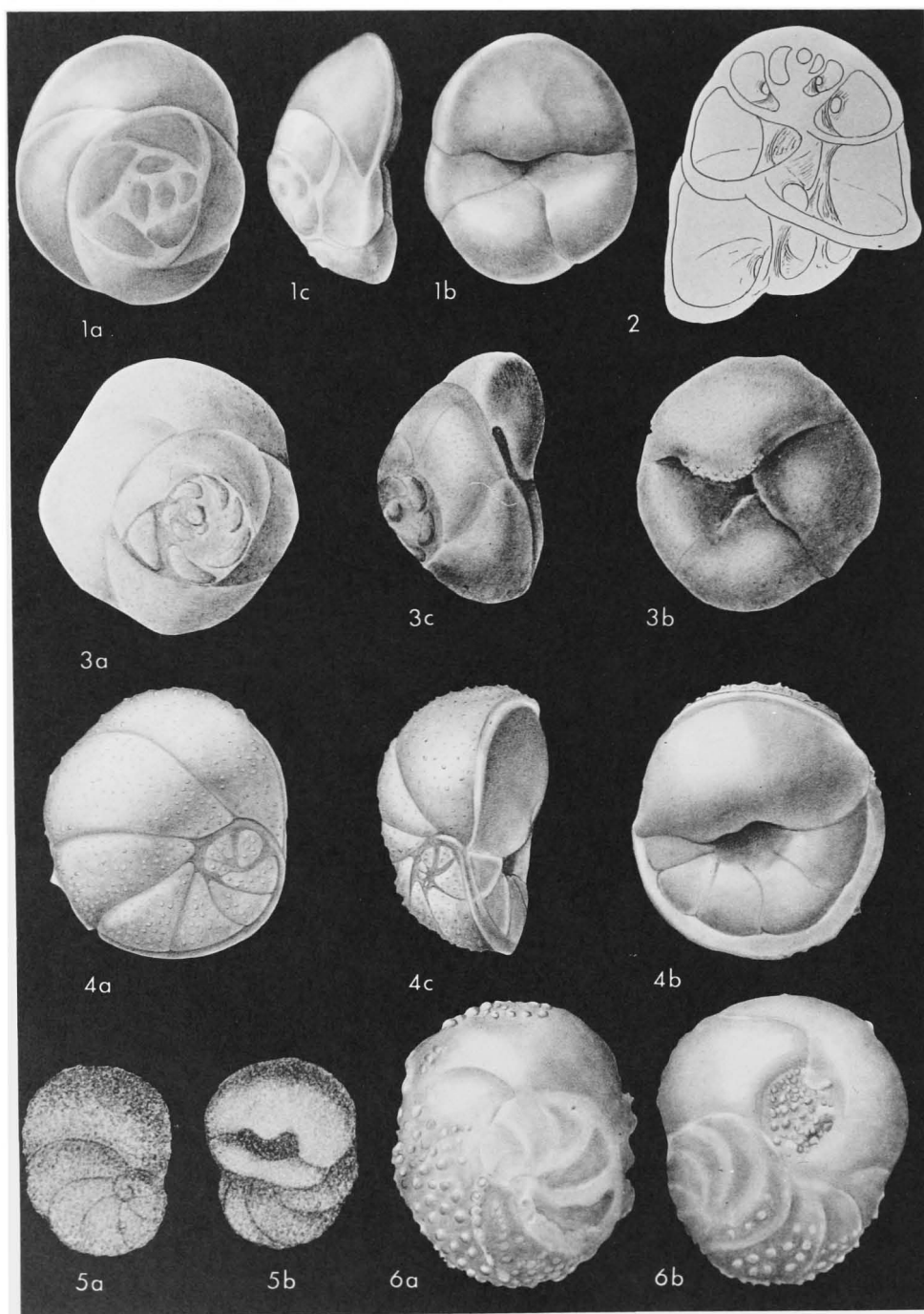


FIG. 631. Ceratobuliminidae (Ceratobulimininae; 1-3, *Conorboides*; 4,5, *Lamarckina*; 6, *Roglicia*) (p. C769-C770).

umbilicus on flattened umbilical side, with only small triangular portions of other chambers visible as wedges between other chambers at peripheral margin, but these extend entirely to spiral suture on convex opposite side, with only triangular marginal portion of main series of umbilical chambers present on this side; wall calcareous, very finely perforate, smooth; aperture an elongate, crescentiform slit, in shallow depression paralleling outer margin of final chamber, but approximately at mid-line of chamber on umbilical side. *Phio.*, USSR (Caucasus).—FIG. 630, 4. **C. prima*; 4a-c, opp. sides and edge view of holotype, $\times 260$ (*2022).

[*Cassidulinia* resembles *Cassidulina* in having an enrolled biserial chamber arrangement but differs in being trochospiral. It resembles *Ceratobulimina* in apertural characters but differs in having a biserial chamber arrangement. Whether the wall is of calcite or aragonite is unknown, as is the microstructure (radial or granular). The large aperture and trochospiral coiling suggest placement of this genus with the *Ceratobuliminidae*, but assignment is tentative pending clarification of wall features. *Rubratella* may be synonymous, as noted under that genus.]

Ceratocancris FINLAY, 1939, *717b, p. 117 [**Ceratobulimina* (*Ceratocancris*) *clifdenensis*; OD] [= *Ceratobulimina* (*Ceratocancris*) FINLAY, 1939, *717b, p. 117 (obj.)]. Similar to *Ceratobulimina* but with low slitlike basal aperture, extraumbilical-umbilical in position, ending at small notch near periphery and at similar notch in umbilical margin; internal partition not attached to spiral wall, and with low accessory internal partition attached to surface of previous whorl just inside aperture. *Mio.*, Eu.-N.Z.—FIG. 630, 5, 6. **C. clifdenensis*, L.Mio., N.Z.; 5a-c, opp. sides and edge of topotype, showing low aperture with small notch at its umbilical and peripheral extremities; 6, final chamber of topotype removed to show septal foramen, bordered below by main internal partition and small accessory partition just above primary apertural opening, $\times 69$ (*2117).

Ceratolamarckina TROELSEN, 1954, *1950, p. 452 [**Ceratobulimina tuberculata* BROTZEN, 1948, *241, p. 124; OD] [= *Ceratobulimina* (*Ceratolamarckina*) TROELSEN, 1954, *1950, p. 452 (obj.)]. Test similar to *Ceratobulimina* but with short, wide umbilical aperture, with only small notch at posterior end, and internal partition not attached to interior of chamber on spiral side. *L.Cret.-Paleoc.*, Eu.-N.Am.—FIG. 630, 7, 8. **C. tuberculata* (BROTZEN), Paleoc., Eu. (Denm.); 7a-c, opp. sides and edge view of topotype, $\times 115$ (*2117); 8, specimen figured as *C. perplexa*, Paleoc., Eu. (Sweden), final chamber removed, showing internal partition and intercameral foramen, $\times 100$ (*241).

Conorboides HOFKER in THALMANN, 1952, *1903, p. 14 [*pro Conorbis* HOFKER, 1951, *936, p. 357 (type, *C. mitra*) (*non Conorbis* SWAINSON, 1840)] [**Conorbis mitra* HOFKER, 1951, *936, p. 357; OD] [= *Conorbis* HOFKER, 1950, *932, p. 68, 76 (*nom. nud.*); *Nanushukella* TAPPAN, 1957, *1875, p. 218 (type, *N. umiatensis*)]. Test free, low

trochospiral, plano-convex, umbilicate, periphery subacute to rounded; few chambers to whorl; sutures oblique on spiral side, radiate on umbilical side; wall calcareous, of aragonite, by X-ray analysis; aperture a low interiomarginal umbilical arch with short, broad flap that may have fimbriate margin, apertures of earlier chambers of final whorl may remain open along suture beneath flaps, internal pillar extending from aperture parallel to axis of coiling to opposite chamber wall.

[*Conorboides* differs from *Conorbina* in having an aragonitic wall (in the type-species of both *Conorboides* and *Nanushukella*), an open umbilicus, and a more extensive umbilical aperture.] *Jur.* (*Lias.*)—*L.Cret.* (*Alb.*), Eu.-N.Am.—FIG. 631, 1, 2. **C. mitra* (HOFKER), Alb., Neth.; 1a-c, opp. sides and edge view, $\times 87$ (*2117); 2, vert. sec. showing internal pillars, $\times 120$ (*928c).—FIG. 631, 3. *C. umiatensis* (TAPPAN), Alb., Alaska; 3a-c, opp. sides and edge view, $\times 112$ (*1875).

Lamarckina BERTHELIN, 1881, *134, p. 555 [**Pulvinulina erinacea* KARRER, 1868, *1022, p. 187; OD] [= *Megalostomina* RZEHA, 1891, *1604, p. 6 (type, *M. fuchsii* RZEHA, 1895, *1605, p. 228, = *Discorbina fuchsii* RZEHA, 1888, *1602, p. 228, *nom. nud.*)]. Test free, trochospiral, coiling dextral, plano-convex, spiral side may be pustulose, with chambers increasing rapidly in size, becoming relatively broad and low, periphery carinate, opposite side smooth and polished, deeply umbilicate, final chamber occupying nearly half of area; wall finely perforate, lamellar; aperture an umbilical interiomarginal arch, closed by a thin plate when new chamber is added, septal foramen not homologous to primary aperture; internal partition similar to that of *Ceratobulimina*. *U. Cret.-Rec.*, cosmop.—FIG. 631, 4. **L. erinacea* (KARRER), Mio., Eu. (Hung.); 4a-c, opp. sides and edge of topotype, $\times 70$ (*2117).—FIG. 631, 5. *L. fuchsii* (RZEHA), Eoc. (Barton.), Eu. (Aus.); 5a,b, opp. sides, enlarged (*1605).

Praclamarckina KAPTARENKO-CHERNOUSOVA, 1956, *1016, p. 54; 1959, *1018, p. 86 [**P. humilis*; OD]. Test similar to *Lamarckina* but with closed umbilicus, may have umbonal boss on spiral side; aperture interiomarginal. [Nothing is known as to the presence or absence of an internal partition in this genus, nor has the wall composition been described. The original figures are reproduced, but are somewhat generalized.] *L.Jur.* (*Aalen.*)—*M.Jur.* (*Callov.*), USSR.—FIG. 632, 2. **P. humilis*, L.Aalen.; 2a-c, opp. sides and edge view, $\times 108$ (*1018).

Pseudolamarckina MYATLYUK in RAUZER-CHERNOUSOVA & FURSENKO, 1959, *1509, p. 278 [**Pulvinulina rjasanensis* UHLIG, 1883, *1962, p. 772; OD]. Test trochospiral, plano-convex, umbilicus closed; sutures oblique and thickened on spiral side, depressed and radial on umbilical side; wall thin, finely perforate; aperture interiomarginal, with extension up face of final chamber, internal partition parallel to plane of coiling. [*Pseudolamarckina*

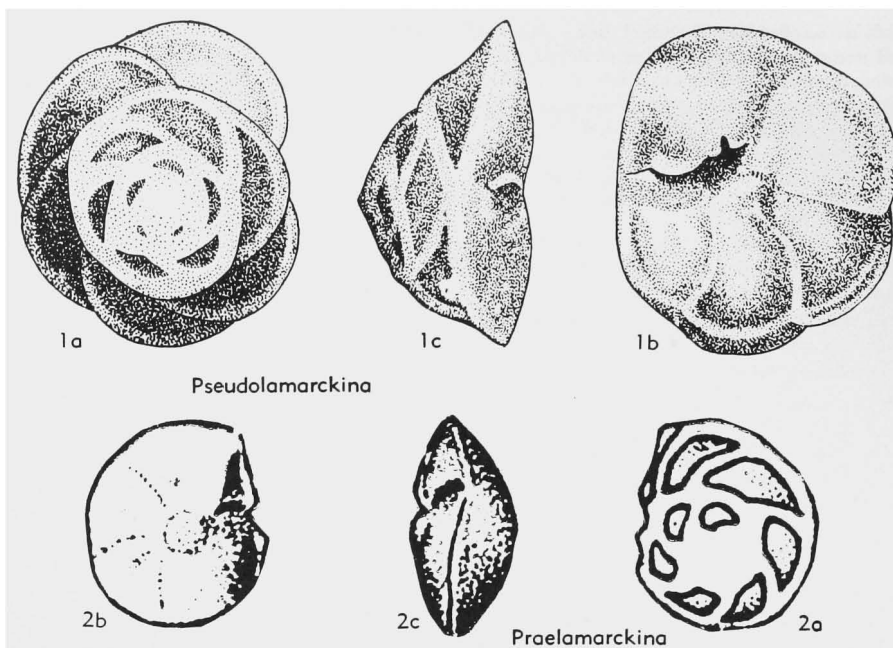


FIG. 632. Ceratobuliminidae (Ceratobulimininae; 1, *Pseudolamarckina*; 2, *Praelamarckina*) (p. C769-C770).

is tentatively included in the Ceratobulimininae, although no information is available as to whether the wall composition is of aragonite or calcite.] *M.Jur.-L.Cret.*, Eu.—FIG. 632, 1. **P. rjasanensis* (UHLIG), U.Jur. (Kimmeridg.), USSR; 1a-c, opp. sides and edge view, $\times 80$ (*1332).

Roglicia VAN BELLEN, 1941, *112, p. 1000 [**R. sphaerica*; OD (M)]. Test free, subglobular, trochospiral, final chambers large, somewhat embracing; surface of test with numerous short spines or pustules except in apertural region, which is smooth; aperture circular, umbilical in position, surrounded by thickened ring covered with thin plate. [*Roglicia* differs from *Ceratobulimina* in having an apertural plate.] *Eoc.*, Eu.—FIG. 631, 6. **R. sphaerica*, Yugo.; 6a,b, opp. sides of holotype, $\times 93$ (*2117).

Rubratella GRELL, 1956, *819, p. 760 [**R. intermedia*; OD]. Test free, small, trochospiral, to 7 chambers in type-species (4 to 7 in adult agamont, and 1 to 5 in somewhat smaller adult gamont), direction of coiling random, umbilicus closed, chambers broad and semilunate, with strongly curved sutures as seen from spiral side, wedge-like, with straight and radial sutures as seen from umbilical side, each chamber divided by radial internal partition into anterior and posterior half with small interconnecting foramen, only small portion of posterior half visible as triangular wedge near peripheral margin on spiral side, whereas anterior half of chamber occupies most of central portion of spiral side and only that of final chamber is visible on umbilical side, anterior

half of previous chambers being covered by successive chambers, both halves formed simultaneously, not successively; lamellar structure not described, wall of anterior half of chamber non-perforate, that of posterior half distinctly perforate; aperture a large, open umbilical arch, occupying about half of diameter of final chamber; cytoplasm with numerous orange-red refringent inclusions (xanthosomes); agamont generation heterokaryotic, with one somatic or vegetative nucleus which disintegrates when reproduction occurs and 5 generative nuclei (in rare specimens, less than 10 per cent, total number of nuclei varying from usual 6 to 2-8), gamont generation with single nucleus, situated in proloculus; during reproduction inner chamber walls resorbed, sexual reproduction plastogamic, 2 individual gamonts joining by their umbilical surfaces to form amoeboid gametes and zygotes, in asexual reproduction entire protoplast escaping from test after nuclear division but before division of cytoplasm into individual young gamonts (*820b). *Rec.*, Eu. (Fr.). —FIG. 633, 1-3. **R. intermedia*; 1a,b, opp. sides, showing exterior; 2, decalcified protoplasmic body; 3, living specimen from spiral side, showing numerous xanthosomes, $\times 500$ (*820b).

[Test morphology strongly suggests that *Rubratella* is a synonym of *Cassidulinia*, but the genera have not been compared by us and neither original description gives information as to wall structure (radial or granular), or lamellar character. The imperforate anterior half of the chamber described for *Rubratella* was not noted in *Cassidulinia*, which was merely stated to be finely perforate. Both type-species are extremely small, hence difficult to study in detail, and the 2 genera are therefore tentatively regarded as distinct. *Rubratella* was originally regarded

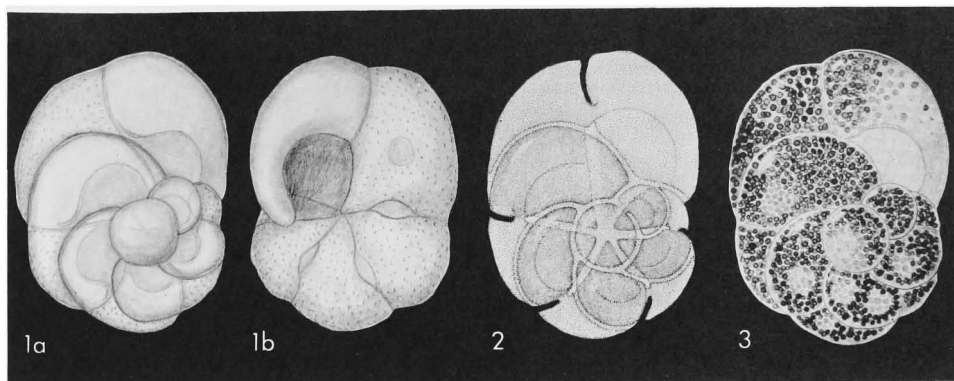


FIG. 633. Ceratobuliminidae (Ceratobulimininae; 1-3, *Rubratella*) (p. C770).

as belonging to the Rotaliidae, subfamily Discorbininae. Because of its secondary partitions and umbilical aperture, *Rubratella* is tentatively placed in the Ceratobuliminidae.]

Subfamily EPISTOMININAE Wedekind, 1937

[*nom. transl.* LOEBLICH & TAPPAN, 1961, p. 317 (ex family Epistominidae WEDEKIND, 1937) [=Praerotalininae HOFKER 1933, p. 125 (*partim*) (*nom. nud.*)]

Coiling predominantly sinistral; primary aperture on peripheral margin of chambers; internal partition joined to dorsal lip of aperture. ?*Trias.*, *Jur.-Rec.*

Epistomina TERQUEM, 1883, *1892, p. 37 [**E. regularis* TERQUEM, 1883, *1891, p. 379 (= *E. mosquensis* UHLIG, 1883, *1962, p. 766); SD GALLOWAY & WISSLER, 1927, *766, p. 60] [= *Brotzenia* HOFKER, 1954, *943, p. 169 (type, *Rotalia spinulifera* REUSS, 1863, *1554, p. 93); *Voorthuysenia* HOFKER, 1954, *943, p. 169 (type, *Epistomina tenuicostata* BARTENSTEIN & BRAND, 1951, *95, p. 327); *Sublamarcckella* ANTONOVA, 1958, *24, p. 68 (type, *S. terquemi*)]. Test lenticular, trochospiral, periphery angular to carinate, umbilical area closed; internal partition crossing chamber cavity from outer margin of lateromarginal apertural opening parallel to periphery on umbilical side, extending nearly or completely to wall against previous whorl; sutures thickened, may be elevated; oblique areal oval aperture on umbilical side, later remaining as interseptal foramen, and additional lateromarginal opening paralleling periphery on umbilical side, in earlier chambers secondarily closed by shell material. ?*Trias.*, *M. Jur.-L.Cret.*, *Eu.-N.Am.-Afr.*—FIG. 634,1,2. **E. regularis*, *M.Jur.*(Bajoc.), *Fr.* (1), *M.Jur.*(Dogger γ), *Eu.*(Aus.) (2); 1a-c, opp. sides and edge of holotype, ×40 (*700); 2a-c, opp. sides and edge of holotype of *E. mosquensis* UHLIG, ×72 (*1332).—FIG. 634,3-5. *E. spinulifera* (REUSS), *L.Cret.*(Alb.), *Eu.*(Neth.); 3a-c, opp. sides and edge, ×50 (*555); 4, horiz. sec. seen from umbilical side, showing internal partition, ×36; 5, axial sec. through chamber to show septal foramen (f), and internal partition (p), ×195 (*943).—FIG. 634,6. *E. terquemi* (ANTONOVA), *M.Jur.*(Bajoc.), *USSR*(Caucasus); 6a-c, opp. sides and

edge view, ×80 (*24).—FIG. 634,7. *E. tenuicostata* BARTENSTEIN & BRAND, *L.Cret.*(Valangin.), *N.Ger.*; 7a-c, opp. sides and edge view of holotype, ×65 (*95).

[*Epistomina* has been much divided recently and because of the poor illustrations and descriptions of the type-species, nearly all other species have been later assigned to one or another of these later genera. Many of TERQUEM's figures of other species are somewhat inaccurate, and the type of *E. regularis* was not located by us during an extensive search in the French museums in 1954, hence it is presumed to be lost. It is almost certainly identical to *E. mosquensis* UHLIG, 1883, however. Both species were described from equivalent strata, TERQUEM's species being from the Bajocian of Moselle, France, and that of UHLIG from the mid-Jurassic Dogger γ to basal upper Jurassic Malm a of Austria. UHLIG's species is commonly recognized and has been restudied both in Germany and the USSR. It was placed in *Brotzenia* by HOFKER (*943). *Brotzenia* is, therefore, here regarded as a synonym of *Epistomina*. *Voorthuysenia* was separated largely on relative size of the internal partition, which is here regarded as only of specific value. *Sublamarcckella* was separated on the basis of the semicircular or reniform areas bordered by elevated ridges which lie near the umbilical region, and which are covered by thin shell material and regarded as representing apertures. Many species of *Epistomina* (including the type-species) show similar umbilical ornamentation, not here regarded as homologous to the lateromarginal aperture of *Epistomina*, which is directly related to the internal partition. *Sublamarcckella* is also considered to be a junior synonym of *Epistomina*.]

Epistominita GRIGELIS, 1960, *825, p. 98 [**E. sudaviensis*; OD]. Test free, trochospiral, close-coiled, biconvex; chambers with internal secondary partition extending from spiral margin of peripheral aperture to attach obliquely to wall on umbilical side, as in *Epistominoides*, resulting in appearance of "supplementary chambers"; aperture a peripheral slit nearly in plane of coiling, with lip, apertures of earlier chambers closed by secondary skeletal material, but distinctly noticeable as peripheral grooves in these earlier chambers. [*Epistominita* has early apertural slits as in *Epistomina* and *Hoeglundina* and oblique supplementary sutures of the internal partition visible on the umbilical side of the test, as in *Epistominoides*.] *U.Jur.*(Oxford.), *Eu.*(Lith.).—FIG. 635, 1. **E. sudaviensis*; 1a-c, opp. sides and edge view of holotype, ×60 (*825).

Epistominoides PLUMMER, 1934, *1466, p. 602 [**Saracenaria wilcoxensis* CUSHMAN & PONTON, 1932, *521, p. 54; OD]. Test free, enrolled, slightly trochospiral, chambers triangular in sec-

tion, enlarging rapidly, internally divided by partition which extends inward from aperture on spiral side of test across chamber cavity to attach

at opposite wall where attachment forms supplementary suture; primary aperture a short peripheral slit at dorsal angle, lips merging gradually

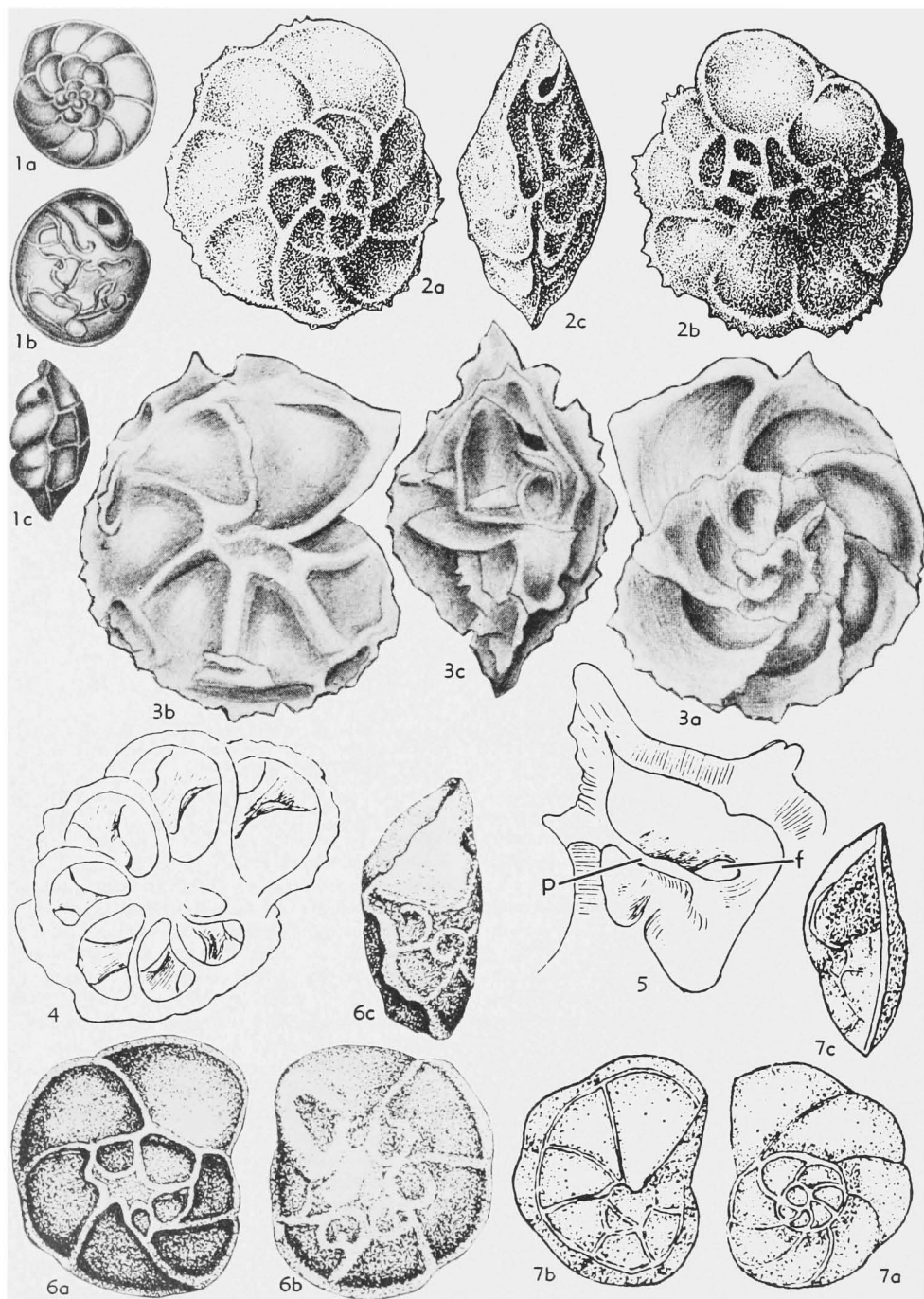


FIG. 634. Ceratobuliminidae (Epistomininae; 1-7, *Epistomina*) (p. C771).

into peripheral keel, aperture closed when new chambers are added, and intercameral foramen formed by resorption about midway in septal face. *U. Jur. (Oxford.)-L. Eoc., N. Am.-Eu.*—FIG. 636, 1, 2. **E. wilcoxensis* (CUSHMAN & PONTON),

Paleoc. (Dan.), USA (Tex.); 1*a*, side view showing primary and supplementary septa due to internal partition; 1*b*, apert. view showing position of attachment of internal partition and external lateromarginal aperture; 2, apert. view of specimen

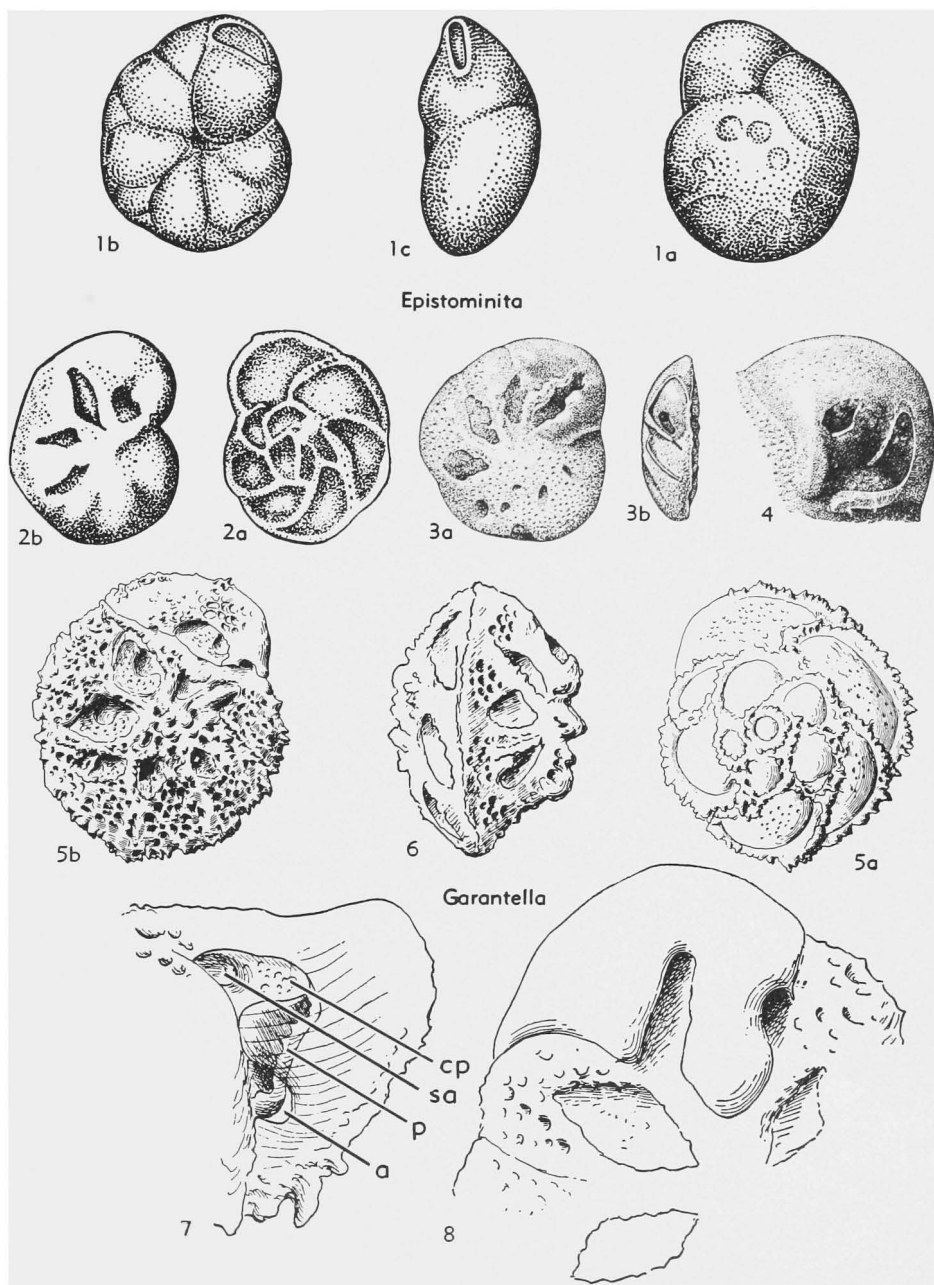


FIG. 635. Ceratobuliminidae (Epistomininae; 1, *Epistominita*; 2-8, *Garantella*) (p. C771, C774-C775).

with last chamber removed showing areal inter-cameral foramen and remnant of internal partition; all $\times 93$ (*2117).

Garantella KAPTARENKO-CHERNOUSOVA, 1956, *1016, p. 55; 1959, *1018, p. 102 [**G. rudia*; OD]. Similar to *Reinholdella* but differs in umbilical-

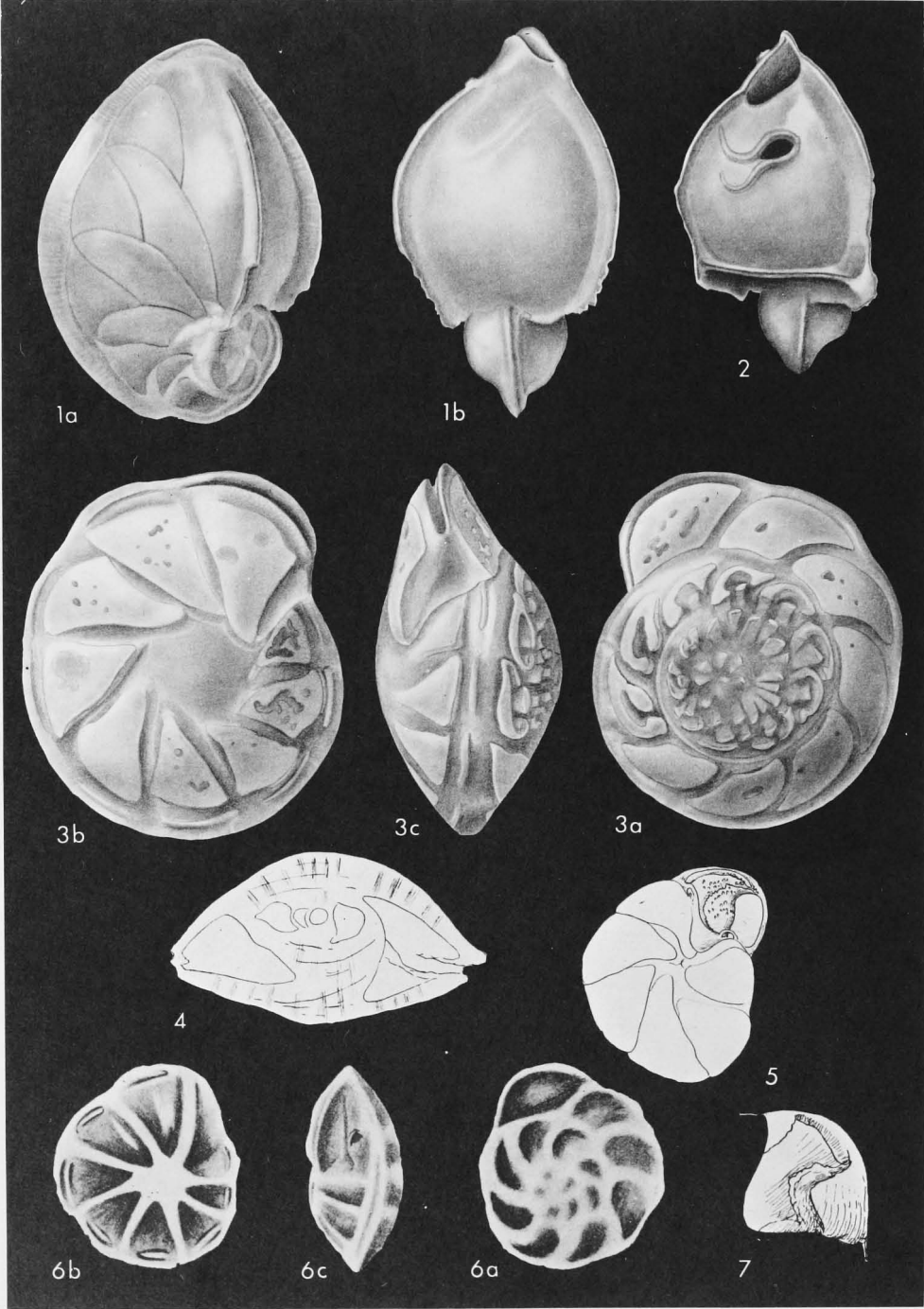


FIG. 636. Ceratobuliminidae (Epistomininae; 1,2, *Epistominoidea*; 3-7, *Hoeglundina*) (p. C771-C776).

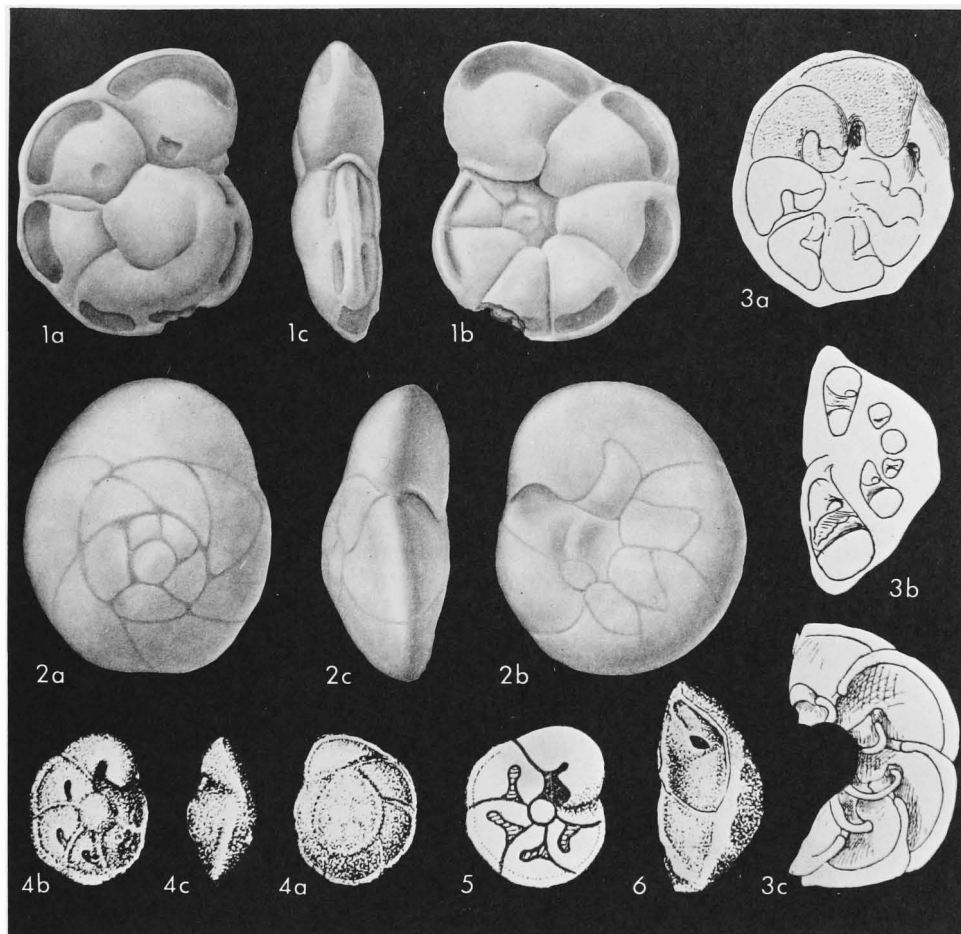


FIG. 637. Ceratobuliminidae (Epistomininae; 1, *Mississippina*; 2-6, *Reinholdella*) (p. C776-C777).

sutural position of apertures and covering plates, which are thus parallel to sutures, instead of perpendicular to them. [In addition to Upper Bajocian species recorded from the Ukraine, *Reinholdella ornata* HOFKER, from strata of the same age in Germany, belongs to *Garantella*. *G. floscula* KAPTARENKO-CHERNOUSOVA is apparently a synonym of *R. ornata*, and the species *G. ornata* (HOFKER) thus occurs in Germany and the Ukraine in Upper Bajocian strata (*Garantia garanti* zone, Dogger ϵ .] *M.Jur.(U.Bajoc.)*, USSR(Ukraine)-Eu.(Ger.).—FIG. 635,2-4. **G. rudia*, Ukraine; 2a,b, spiral and umbilical sides of holotype, $\times 55$; 3a,b, umbilical side and edge view of different specimens showing interseptal foramen, $\times 33$; 4, last chamber from umbilical side, enlarged to show aperture and septal foramen before addition of cover plate (*1509).—FIG. 635,5-8. *G. ornata* (HOFKER), Ger.; 5a,b, spiral and umbilical sides showing ornamented test, umbilical-sutural supplementary apertures, and covering plates, $\times 80$; 6, edge view, $\times 60$; 7, optical sec. of final

chamber (in clarifying oil) showing aperture (a), internal partition (p) with recurved margin, and porous cover plate (cp) over sutural aperture (sa); 8, ext. of final chamber with both apertures remaining open before addition of the cover plate, $\times 160$ (*937).

Hoeglundina BROTZEN, 1948, *241, p. 92 [*Rotalia elegans* D'ORBIGNY, 1826, *1391, p. 272; OD] [= *Hiltermannia* HOFKER, 1954, *943, p. 169 (type, *Epistomina chapmani* TEN DAM, 1948, *555, p. 166)]. Test similar to *Epistomina* with more highly developed internal partition extending from posterior wall of chambers and always secondarily resorbed from earlier chambers; latero-marginal aperture nearly peripheral in position extending breadth of chambers; those of earlier chambers may remain open or be secondarily closed. [*Hiltermannia* was separated on the basis of a smaller internal partition, relative size being a feature here regarded as of only specific importance.] *M.Jur.(Dogger)-Rec.*, cosmop.—FIG. 636,3-5. **H. elegans* (D'ORBIGNY), Rec., Carib.;

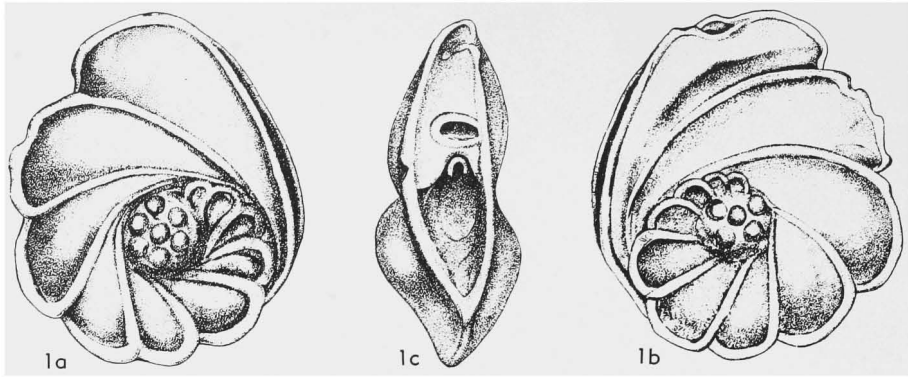


FIG. 638. Ceratobuliminidae (Epistomininae; 1, *Pseudoepistominella*) (p. C776).

3a-c, opp. sides and edge view, $\times 31$ (*2117); 4, axial sec. showing internal partition in final chamber only, $\times 20$ (*943); 5, umbilical view of small specimen with final chamber clarified to show internal partition and position of areal and lateromarginal apertures, enlarged (*928c).—FIG. 636,6,7. *H. chapmani* (TEN DAM), L.Cret., Eu.(Neth.); 6a-c, opp. sides and edge view of holotype, $\times 57$ (*555); 7, last chamber clarified to show internal partition, $\times 80$ (*943).

Mississippiina Howe, 1930, *969, p. 329 [*M. mon-souri*; OD]. Test free, coiled, trochoid in early stage, later becoming nearly planispiral, spiral side umbonate, umbilical side somewhat more involute; sutures nearly radial; wall calcareous, perforate, monolamellar; aperture interiomarginal on periphery and extending somewhat to umbilical side beneath slight flap of final chamber, supplementary apertures near peripheral keel and paralleling it on both sides, filled with bands of clear shell material. [Differs from *Stomatorbina* in being nearly planispiral, in having a peripheral aperture, and supplementary apertural shell bands on both sides of the peripheral keel.] *L.Oligo.-Rec.*, N.Am.-Pac.O.—FIG. 637,1. *M. mon-souri*, L.Oligo., USA(Miss.); 1a-c, opp. sides and edge view of holotype, $\times 65$ (*2117).

Pseudoepistominella KUZNETSOVA in N. K. BYKOVA *et al.*, 1958, *265, p. 48 [*P. mirusa*; OD]. Test free, lenticular, biumbonate, umbilical region pustulose, with thickened knobs or pustules on both sides of test, early stage may be slightly trochospiral, later planispiral and bivolute, periphery carinate; chambers numerous, low, broad and curved, similar in form on both sides of test, with small internal diagonal partition; sutures curved, oblique, thickened; wall calcareous, smooth, probably perforate and aragonitic; aperture of 2 types, primary aperture interiomarginal, equatorial arch and additional oval areal aperture about one-third of distance from base of apertural face, both openings with thickened lip. [The wall of *Pseudoepistominella* was originally stated to be porcelane-

ous, smooth and dull, without statement as to presence or absence of pores, but as the genus was inferred to belong to the Epistominidae, it is here regarded to be perforate of aragonitic composition, as many of the other early Epistominidae have a porcelaneous appearance, but they are not imperforate like the Miliolacea.] *L.Cret.(Barrem.)*, USSR(Caucasus).—FIG. 638,1. *P. mirusa*; 1a-c, opp. sides and edge view of holotype, showing 2 types of apertures and small transverse internal partition, near upper part of septal face, $\times 32$ (*265).

Rectoepistominoides GRIGELIS, 1960, *825, p. 102 [*R. scientis*; OD]. Test similar in early development to *Epistominoides* but later stage uncoiling and becoming rectilinear; elongate slitlike aperture at dorsal angle of chamber, bordered by lip. *U. Jur.(L.Oxford.)*, Eu.(Lith.).—FIG. 639,1. *R. scientis*; 1a-c, opp. sides and edge view of hypotype, $\times 60$ (*825).

Reinholdella BROTZEN, 1948, *241, p. 126 [*Discor-bis dreheri* BARTENSTEIN in BARTENSTEIN & BRAND, 1937, *92, p. 192; OD] [= *Lamarckella* KAPTARENKO-CHERNOUSOVA, 1956, *1016, p. 54, 1959, *1018, p. 91 (type, *L. media*)]. Test free, trochospiral, plano-convex to biconvex; supplementary cover plates surrounding umbilicus to cover sutural apertures, extending farthest toward periphery near mid-portion of primary chambers so that latter have saddle-shaped outline on umbilical side; sutures oblique dorsally, radiate ventrally; wall of aragonite (by X-ray powder diffraction film) finely perforate; aperture a low interiomarginal arch near periphery on umbilical side, with supplementary aperture in indentation at center of suture on umbilical side but secondarily closed in most specimens, internal pillar-like partition connected to this aperture extending from umbilical to spiral walls. *L.Jur.(U.Lias.)-M.Jur.(L. Dogger)*, Eu.—FIG. 637,2,3. *R. dreheri* (BARTENSTEIN), M.Jur.(Dogger), Ger.; 2a-c, opp. sides and edge view, $\times 185$ (*2117); 3a-c, diagrams to show apert. characters; 3a, last 2 cham-

bers shaded showing final chamber with open aperture and secondary covering plate over this in earlier chambers; 3b, transv. sec. showing pillar-like internal partitions and septal foramina; 3c, horiz. sec. seen from spiral side, showing position and form of internal partitions and septal foramina, approx. $\times 70$ (*937).—FIG. 637, 4-6. *R. media* (KAPTARENKO-CHERNOUSOVA), M.Jur. (Bajoc.), USSR; 4a-c, opp. sides and edge views; 5, umbilical side; 6, edge view showing intercameral foramen, $\times 54$ (*1018).

[Originally the type-species was described as *Discorbis*, later placed in *Asterigerina* and finally made the type-species of the new genus *Reinholdella* on the basis of the "umbilical and interiomarginal aperture and an inner partition in the chambers as in *Lamarckina*." BROTZEN considered that it approached closely "an ideal type of the primitive Ceratobulimininae," and that it was possibly ancestral to *Lamarckina*, *Ceratobulimina*, and *Asterigerina*. HOFKER (1952, *937, p. 20) described the 2 apertures in the type-species. The one near the periphery was designated by him as a deuterofoamen, formed by arching of the suture. The secondary aperture, in the chamber indentation, was the protofoamen of HOFKER and, as he stated (p. 22), "a well-developed tooth plate is connected with the proximal foramen, thus indicating that this foramen is a protofoamen." He also noted that the protofoamen is commonly "closed by a porous plate, which forms the so-called supplementary chamber. This closing of the protofoamen leads to the forming of a small chamberlet, mainly formed by the lumen of the protofoamen itself. It is connected with the normal chamber by the opening of the nearly vertical toothplate." HOFKER stated that *Reinholdella* had been derived from *Conorboides*, and on the basis of a new species, *R. epistominoides*, he concluded that it was closely related to *Epistomina*. Our examination shows that the type-species of *Reinholdella* is composed of aragonite, as proved by X ray with powder diffraction film, thus upholding the suggested relationship of *Reinholdella* to other aragonitic genera (e.g., *Lamarckina*, *Ceratobulimina*, *Epistomina*) which was proposed originally on the basis of apertural and internal features. *Lamarckella* was said to be characterized by supplementary sutural apertures on the umbilical side, which also occur in the type-species of *Reinholdella*, and it was regarded as synonymous with *Reinholdella*, in the family Ceratobuliminidae, by MYATLYUK in RAUZER-CHERNOUSOVA & FURSENKO (1959, *1509, p. 277).]

Schlosserina HAGN, 1954, *860, p. 18 [*Rosalina asterites* GÜMBEL, 1870, *840, p. 658; OD]. Test free, trochoid, biconvex, with peripheral keel, ventrally umbilicate; all chambers visible on spiral side and sutures limbate, curved, only chambers of last whorl visible on umbilicate opposite side, where sutures are depressed and straight; wall calcitic (by X-ray powder diffraction film; see below), perforate; aperture multiple, of 4 types, all on umbilical side; primary aperture low slit at base of final chamber, supplementary sutural slits between later chambers, large areal pores scattered over final chamber face and wide-spiraling slits near periphery which are filled with secondary shell material. *Eoc.*, Eu.—FIG. 640, 1. **S. asterites* (GÜMBEL); 1a-c, opp. sides and edge view of neotype, $\times 35$ (*2117).

[*Schlosserina* resembles *Stomatorbina* in being trochospiral with secondary spiraling slits only on the umbilical side but differs in possessing a multiple areal aperture. Since all of GÜMBEL's collection was destroyed during World War II, the types of *S. asterites* are lost. The specimen illustrated by HAGN (1954, *860, pl. 3, fig. 15) in describing the genus was referred to as a "genoholotype" (Coll. Munich Prot. 272) and is here designated as neotype of *Rosalina asterites*. It is from the "Stockletten" marls (Eocene) of the Rollgraben near Kressenberg, Bavaria, Germany. The X-ray diffraction film made for *Schlosserina* showed a dominantly calcite pattern, but portions of it

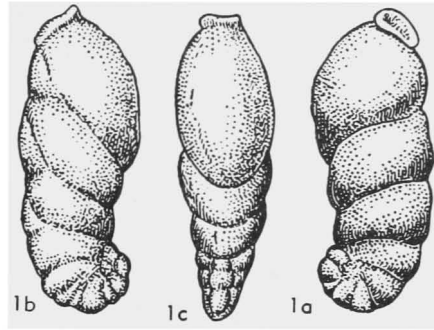


FIG. 639. Ceratobuliminidae (Epistomininae; 1, *Rectoepistominoides*) (p. C776).

also showed that traces of aragonite were present. It is difficult to determine whether the aragonite traces represent the original wall or adherent material on the exterior of the shell, and whether the calcite represents the wall of the shell or a filling in the interior. It will be necessary to obtain clean and unfilled specimens in order to determine the exact wall composition more exactly. *Schlosserina* is tentatively placed with the morphologically similar *Mississippina* and *Stomatorbina* in the aragonite-walled Epistominidae.]

Stomatorbina DORREEN, 1948, *610, p. 295 [*Lamarckina torrei* CUSHMAN & BERMÚDEZ, 1937, *491, p. 21; OD]. Test free, trochoid, all chambers visible on convex spiral side where sutures are limbate and curved, only chambers of final whorl visible on umbilicate opposite side where sutures are radial; wall calcareous, of aragonite (by X-ray analysis), perforate; aperture consisting of interiomarginal slit on umbilical side, not reaching periphery, supplementary apertures represented by bands of clear shell material, paralleling peripheral keel only on umbilical side in adult. *Eoc.*, W.Indies (Cuba)-N.Z.—FIG. 640, 2. **S. torrei* (CUSHMAN & BERMÚDEZ), Cuba; 2a-c, opp. sides and edge view of holotype, $\times 41$ (*2117).

[UCHIO (1952, *1958, p. 197) stated that young specimens of *Pulvinulina concentrica* PARKER & JONES are planispiral and show bands of shell material on both sides of the test in young stages but become trochoid in later development, with loss of the supplementary apertures on the spiral side, thus showing a change from the characters of *Mississippina* in the juvenile forms to the adult characters of *Stomatorbina*, differing only in the aperture which remains peripheral while typical *Stomatorbina* has an aperture restricted to the umbilical side. A close relationship is shown between the genera, but the distinct adult characters are considered to be sufficient basis for their separation.]

Family ROBERTINIDAE Reuss, 1850

[Robertinidae REUSS, 1850, p. 375] [=Robertininae SIGAL in PIVETEAU, 1952, p. 220]

Test high, trochospiral, coiling predominantly dextral; septal foramen homologous with part of primary aperture, not a secondary feature as in the Ceratobuliminidae. *U.Cret.-Rec.*

Robertina D'ORBIGNY, 1846, *1395, p. 202 [*R. arctica*; OD (M)]. Test elongate, high, trochospiral, with several chambers in each whorl, chambers divided by double transverse partition

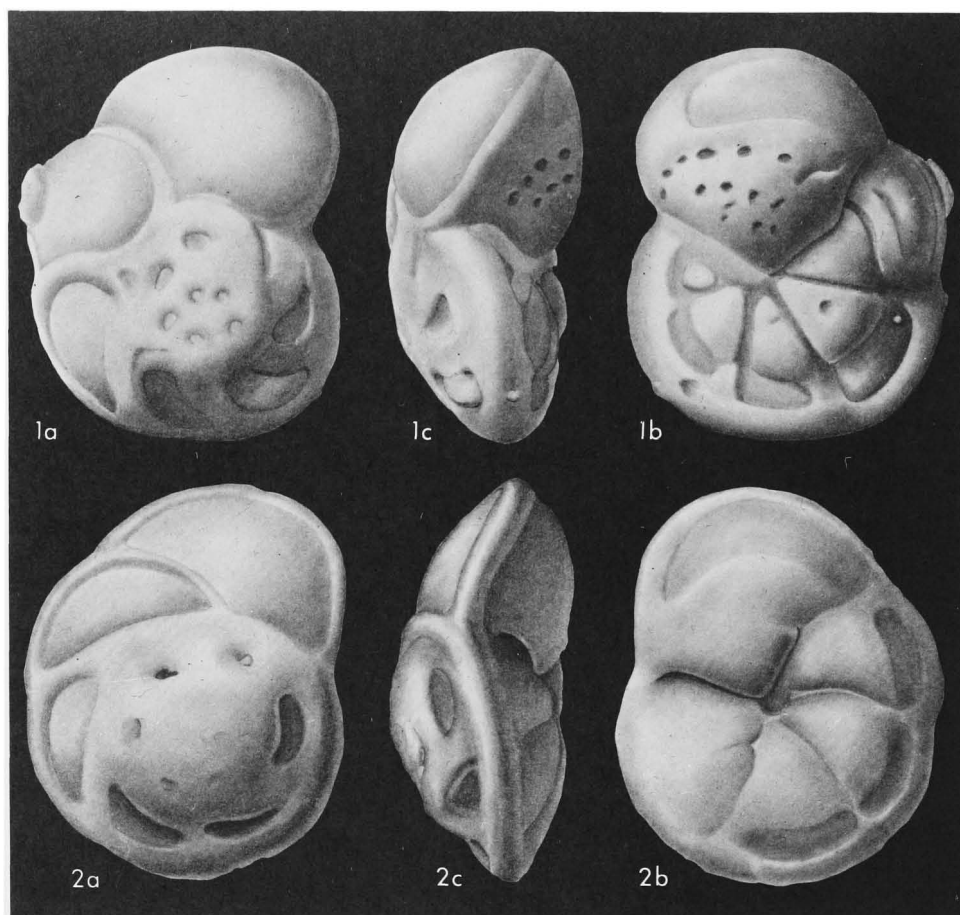


FIG. 640. Ceratobuliminidae (Epistomininae; 1, *Schlosserina*; 2, *Stomatorbina*) (p. C777).

formed by infoldings of outer wall, chamber halves interconnected by low opening against previous chambers; primary aperture an elongate, loop-shaped opening extending up face of final chamber, with small supplementary triangular aperture on opposite side of test, where transverse internal partition meets preceding chamber, supplementary openings of earlier chambers secondarily closed as new chambers are added. *L.Eoc.-Rec.*, Eu.-N.Am.-N.Z.-Tasm.-Atl.O.-Pac.O.-Arctic-Antarctic.—FIG. 641, 1. **R. arctica*, Rec., Spitz.; 1a-c, opp. sides and edge view showing single primary loop-shaped aperture and supplementary aperture at suture junctions on opposite side of test, $\times 55$ (*924); 1d, detached chamber oriented as in 1a, viewed from within, showing internal partition, primary aperture on far side, and small supplementary opening at the upper end of internal partition, $\times 105$ (*924).

Alliatina TROELSEN, 1954, *1950, p. 464 [**Cushmanella excentrica* DI NAPOLI ALLIATA, 1952, *1346, p. 105; OD]. Test similar to *Cushmanella* but simpler and asymmetrically developed, in-

ternal partition consisting of oblique inverted V-shaped projection extending inward from oblique areal aperture to attach below septal foramen of penultimate chamber. *Plio.-Rec.*, Eu.-N.Am.-Pac.O.-Malay Penin.-Kerimba Arch.—FIG. 641, 2, 3. **A. excentrica* (DI NAPOLI ALLIATA), Plio., Italy; 2a,b, side, edge views of metatype, $\times 119$ (*2117); 3a, oblique view of dissected specimen showing areal septal foramen of penultimate chamber (f), primary aperture (a), and angular internal partition (p) surrounding aperture; 3b, edge view, with final chamber partially dissected, showing angular asymmetrical internal partition, primary aperture at exterior lying within sharp upper angle, $\times 75$ (*1950).

Alliatinella D. J. CARTER, 1957, *284, p. 82 [**A. gedgravensis*; OD]. Test similar to *Alliatina* but distinctly trochospiral, accessory chambers developed only on umbilical side; internal partition asymmetrical and chevron-shaped in section, extending obliquely across chamber; areal aperture asymmetrically placed somewhat to umbilical side of test and may be closed by thin plate and there-

fore nonfunctional until plate is resorbed to form septal foramen after addition of another chamber, basal, equatorial aperture always open. *Plio.*,

Brit. I.(Eng.)-Eu.(Italy).—FIG. 641,4,5. **A. gedgravensis*, Eng.; 4a-c, holotype, opp. sides and edge view, $\times 92$ (*284); 5, apert. view of dissected



FIG. 641. Robertinidae; 1, *Robertina*; 2,3, *Alliatina*; 4,5, *Alliatinella*; 6,7, *Cushmanella*; 8, *Cerobertina*; 9, *Pseudobulimina* (p. C777-C782).

paratype showing septal foramen with internal partition visible on left side of figure and sutural

line showing position of partition on right side of chamber, $\times 92$ (*284).

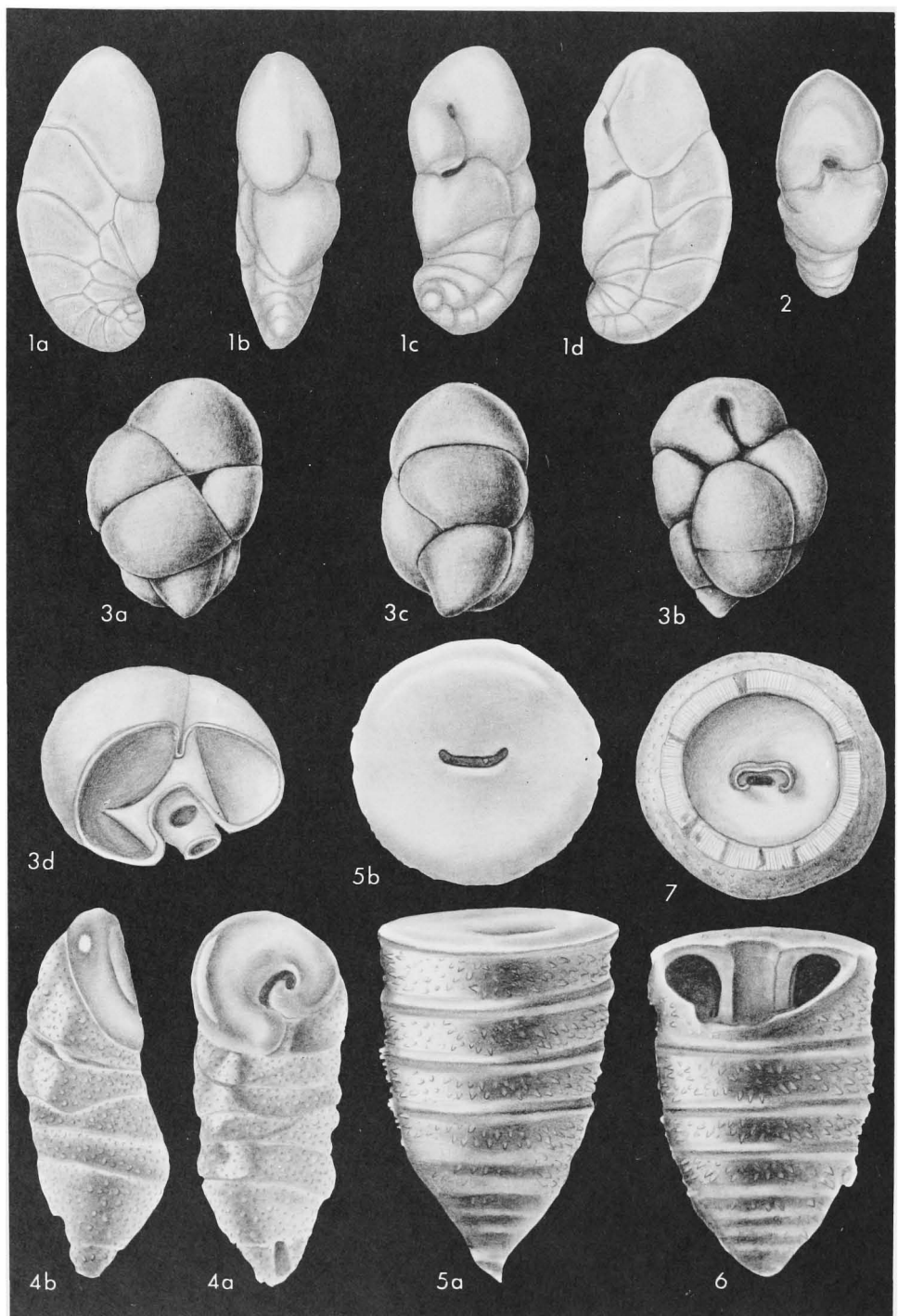


FIG. 642. Robertinidae; 1,2, *Geminospira*; 3, *Robertinoides*; 4, *Ungulatella*; 5-7, *Colomia* (p. C781-C782).

Cerobertina FINLAY, 1939, *717b, p. 118 [**C. bartrumi*; OD]. Test ovate to auriculate in outline, periphery rounded, chamber arrangement trochospiral in early stage, later uncoiling, internal secondary partition partially dividing chambers, sutures of these partitions visible on umbilical side where they appear to form supplementary chamberlets about equal in size to that of primary chamber on same side; wall of aragonite, perforate, surface smooth; aperture an interiomarginal slit, which extends in furrow-like depression of apertural face. *M.Eoc.-Rec.*, N.Z.-Antarctic-Malay Arch. —FIG. 641.8. **C. bartrumi*, L.Mio., N.Z.; 8a-c, opp. sides and edge view of paratype, $\times 92$ (*2117).

[*Cerobertina* differs from *Pseudobulimina* in having the smaller chamberlets and secondary partitions visible on the umbilical, rather than the spiral, side. In *Geminospira* the chamberlets can be seen from both sides and are peripheral in position. *Alliatinella* is similar to *Cerobertina*, but only the basal aperture is always open and the vertical slit is commonly closed, leaving only a small, rounded opening in the face.]

Colomia CUSHMAN & BERMÚDEZ, 1948, *495, p. 12 [**C. cretacea*; OD]. Test free, elongate, conical, early stage trochospiral, with 3 chambers in early microspheric whorl, followed by more or less well-developed biserial stage and finally uniserial, with low cylindrical chambers; sutures may be thickened and elevated; wall of aragonite, surface may be hispid or smooth; aperture a terminal crescentic slit, internal hemicylinder with thickened borders extending from inside of aperture to terminal wall of previous chamber, apertures of successive chambers and internal columella gradually changing in orientation at successive angles of about 80°. *U.Cret.-M.Eoc.(L.Lutet.)*, W. Indies (Cuba)-USA-Eu. —FIG. 642.5,6. **C. cretacea*, U.Cret., Cuba; 5a,b, side, top views of holotype; 6, paratype with final chamber dissected to show hemicylindrical columella; all $\times 133$ (*2117). —FIG. 642.7. *C. sp.*, U.Cret., USA (Calif.); interior of final chamber showing shape of hemicylindrical columella as seen in cross section, $\times 105$ (*2117).

Cushmanella PALMER & BERMÚDEZ, 1936, *1411, p. 252 [**Nonionina brownii* D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 45; OD]. Test free, in nearly planispiral coil, involute, chambers increasing rapidly in size, with one or more small supplementary chambers at umbilical area of each chamber on both sides of test; wall calcareous, finely perforate except for equatorial oval area just above primary aperture on final septal face; arcuate, slitlike primary areal aperture, secondary interiomarginal equatorial aperture, and small accessory apertures at sides of test at supplementary chambers, tubelike internal partition attached only at upper and lateral inner margins of primary aperture, having free edges somewhat infolded at each side of lower margin of aperture; lateral tubular branches from partition opening at lateral accessory apertures. *Rec.*, Carib. —FIG. 641.6,7. **C. brownii* (D'ORBIGNY), Cuba; 6a,b, side, edge

views of topotype, $\times 30$ (*117); 7a, optical sec. of last chamber in side view, showing internal tubular partition extending back from primary areal aperture to attach at outer wall of previous chamber and extending laterally to small accessory apertures, secondary equatorial interiomarginal aperture also visible; 7b, optical sec. of last chamber as seen from aperture, showing internal partition with free infolded basal margin, primary areal aperture, secondary basal aperture below and smaller accessory lateral apertures at ends of tubular extensions from partition, with oval nonperforate area of chamber wall above primary aperture; both $\times 120$ (*946).

[On the original type slide of *Nonionina brownii* in the D'ORBIGNY collections in the Museum National d'Histoire Naturelle, Paris, examined by us in 1954, 3 specimens are mounted. One of these is crushed beyond recognition; the other 2 are conspecific but neither agrees with the original figures or descriptions given by D'ORBIGNY nor do they represent *Cushmanella* as generally understood. It is possible that the original illustration and description were based on the specimen which was later destroyed and that more than one species was originally erroneously regarded as identical. However, these specimens appear much closer in all respects to D'ORBIGNY's figures of *Valvulina inaequalis* (*1393, pl. 7, fig. 10-12), being distinctly trochospiral, with an umbilical flap of the last chamber covering the umbilical area and a simple interiomarginal aperture. This strongly suggests another possibility as to disposition of the types of *N. brownii*. The D'ORBIGNY types are mounted on tiny glass plates inserted in vials, which in turn are glued to boards bearing the printed labels. During our examination of this collection, it was noted that in some instances the glue attaching the vials to the labeled boards was dried and cracked, and some of the vials had become detached. Some of them had obviously been later reglued to the boards, leaving open the possibility that the vial of *N. brownii* may have been so detached and perhaps erroneously later fastened to the wrong board. —[As the above-mentioned specimens show none of the diagnostic features mentioned by D'ORBIGNY in his original description (nor even the same number of chambers per whorl), do not have supplementary chambers, are not planispiral, have no areal aperture, and thus do not resemble the original figures, it is probable that the original type has been lost, misplaced, or destroyed. In the interests of nomenclatural stability, we here recognize the species *N. brownii* (and *Cushmanella*, the genus based on it) as figured and described by D'ORBIGNY and all later workers, rather than as represented by the above-mentioned questionable specimens in the D'ORBIGNY collection.]

Geminospira MAKIYAMA & NAKAGAWA, 1941, *1206, p. 243 [**G. simaensis*; OD]. Test elongate, early chambers in trochospiral arrangement, later uncoiling and arcuate but somewhat asymmetrical, secondary series of smaller chamberlets at inner periphery and visible from both sides of test, somewhat more extensive on umbilical side; sutures radiate, curved, slightly depressed; wall of aragonite, finely perforate, surface smooth; aperture an interiomarginal slit at base of final chamber and nearly equatorial in position, with elongate groove extending up face of final chamber and broadening into ovate opening at upper end, which remains as intercameral foramen when next supplementary chamber is added. [*Geminospira* was regarded as a synonym of *Pseudobulimina* by ASANO (1950, *52a, p. 2), but *Geminospira* differs in having the secondary chambers visible from both sides of the test, owing to their equatorial position. The aperture was originally described as a vertical slit, and the interiomarginal opening

was not previously noted.] *Plio-Pleist.*, Japan.—FIG. 642,1,2. **G. simaensis*, Pleist.; 1a-d, opp. sides, edge, and oblique views showing chamberlets and apertures; 2, specimen with opened final chamber to show intercameral foramen, $\times 105$ (*2117).

Pseudobulimina EARLAND, 1934, *653, p. 133 [**Bulimina chapmani* HERON-ALLEN & EARLAND, 1922, *911, p. 130; OD (M)]. Test ovate to elongate, with rapidly enlarging chambers in low trochospiral coil, chambers internally subdivided as in *Robertina*, suture formed by partial division visible on spiral side but not on umbilical side; aperture with 2 diverging slits as in *Robertinoides*, walls of vertical slit in face extending inward to connect with upper surface of preceding chamber, only sutural slit opening into larger chamber cavity, smaller chamber cavity without external opening, but connecting internally to larger chamber. *Eoc.-Rec.*, N.Am.-Eu.-Antarctic-Pac.O. — FIG. 641,9. **P. chapmani* (HERON-ALLEN & EARLAND), *Rec.*, Antarctic; 9a-d, spiral, umbilical, edge, and oblique umbilical views, $\times 56$ (*2117).

Robertinoides HÖGLUND, 1947, *924, p. 222 [**Bulimina normani* GOËS, 1894, *804, p. 47; OD]. Test elongate, in high trochospiral coil, chambers divided by transverse partition formed by infolding of wall, as in *Robertina*, chamber halves connecting by low opening under this partition against earlier chambers; tubular chamber extension occurring between 2 divergent slits of primary aperture, opening into proximal half of chamber within, and connecting with exterior by means of oval opening into main aperture where its divergent branches originate, primary aperture double, with elongate slit or loop extending up face of final chamber in position of internal partition, and similar elongate slit along suture against previous whorl at distal margin of chamber; accessory aperture also present on opposite side of test where suture of internal partition meets spiral suture, as in *Robertina*. *Rec.*, Eu.(Sweden).—FIG. 642,3. **R. normani* (Goës); 3a-c, opp. sides and edge of neotype, $\times 50$ (*924); 3d, detached final chamber viewed from within, showing 2 diverging slits of primary aperture, internal septum, accessory aperture, and tubular chamber extension with large rounded opening between primary apertural slits, $\times 140$ (*924).

Ungulatella CUSHMAN, 1931, *449, p. 81 [**U. pacifica*; OD]. Test elongate, trochospiral, with conical proloculus, later with sides nearly parallel, and ovate section, chambers as seen in clarifying oil (e.g., castor oil) each a full coil in length, suggesting uniserial appearance, but with one margin always overlapping other, and oblique sutures visible on side from which aperture may be seen; wall coarsely perforate, surface with tiny pustules but apertural face clear, smooth and polished, or may have faint radial striae; aperture umbilical, appearing as recurved loop extending up face from one side of final chamber. *Rec.*, Pac.

—FIG. 642,4. **U. pacifica*; 4a,b, side and edge views of paratype showing apert. character, $\times 192$ (*2117).

[Originally included in the Buliminidae, *Ungulatella* was regarded as an uniserial derivative from *Buliminella* and *Buliminoides*. Later (*464, p. 101) it was stated to have a high-spined, undivided coil and to be related to *Conicospirillina*. It is here transferred to the Robertinidae and regarded as more closely related to *Robertina* and *Colomia* than to the above-mentioned Buliminidae.]

NOMINA INQUIRENDA

Diplostoma EBENSBERGER, 1962, *654A, p. 54 [**D. siamesia*; OD] [non *Diplostoma* RAFINESQUE, 1817, nec DE FROMENTEL, 1860]. Genus based on 16 specimens of type-species from *U.Cret.* (*Maastricht.*), Ger.(Aachen). Placed in the Lagenidae (=Nodosariidae), it was said to occur as 1-, 2- or 4-chambered tests; chambers fusiform, with radiate apertures at both ends of proloculus; later chambers added simultaneously at each end, each with radiate terminal aperture. [As this form of growth is previously unknown in the Nodosariidae or Polymorphinidae, we believe it probable that these represent twinned specimens of a polymorphinid, perhaps one of the associated species of *Pyrulinoides* or *Pyrulina*. However, if additional evidence upholds the validity of this genus, it will have to be renamed, since the name here cited is a junior homonym.]

Pseudonovella KIREVA, 1949, *1040A bis?. *Pseudonovella* was stated by A. D. MIKLUKHO-MAKLAY, RAUZER-CHERNOUSOVA & ROZOVSKAYA in RAUZER-CHERNOUSOVA & FURSENKO (1959, *1509, p.208) to be a subgenus of *Novella* GROZDILOVA & LEBEDEVA. We have seen no citation for the original reference to the genus, but it is probably in the publication cited above, which we have been unable to locate in any U.S. library. The type-species and method of its fixation are also unknown to us. *Pseudonovella* differs from *Novella* (*Novella*) in the involute, rather than evolute, character of the final whorl.

GENERIC NOMINA NUDA APPLIED TO FORAMINIFERIDA

Acanthospira REINSCH, 1877, *1526, p. 177.

Amorphina PARKER in PARKER & JONES, 1857, *1416, p. 278.

Amphigramma REINSCH, 1877, *1526, p. 177.

Askopsis DE FOLIN, 1881, *724, p. 138.

Asterorbitoides A. SILVESTRI, 1907, *1768, p. 86 (*nom. nud.*, no species named). Seemingly proposed for radiate lepidocyclines.

Bigeneropolis MARIE, 1950, *1219, p. 50.

Calcidiscus GROZDILOVA, 1960, *830, p. 44.

Caspirella N. K. BYKOVA, 1960, *263, p. 324.

Caucasinella MYATLYUK, 1960, *1333, p. 208.

Chaetotrochus EHRENBERG, 1866, *686, p. 76, 81.

Cheiramina DE FOLIN, 1881, *724, p. 132.

Cheiropsis DE FOLIN, 1881, *724, p. 132.
Clavula DE FOLIN, 1881, *724, p. 132 (*non* WRIGHT, 1859).
Clyphogonium REINSCH, 1877, *1526, p. 177.
Cosinella EMBERGER, MAGNÉ, REYRE & SIGAL, 1955, *701, p. 113.
Cyclogypsinoidea A. SILVESTRI, 1937, *1787, p. 201.
Cylindrospira DE FOLIN, 1883, *725, p. 318.
Dendropela DE FOLIN, 1883, *725, p. 328; 1887, *726a, p. 113.
Dillina MUNIER-CHALMAS & SCHLUMBERGER, 1883, *1329, p. 862.
Diplomasta DE FOLIN, 1881, *724, p. 136.
Discolita RAFINESQUE, 1815, *1496, p. 140.
Discorbitoides A. SILVESTRI, 1907, *1768, p. 86. [No type-species named. Seemingly proposed for non-radiate discocyclinids.]
Dyoxeia DE FOLIN, 1881, *724, p. 141.
Eilemammina DE FOLIN, 1881, *724, p. 132.
Eocyclammina BERMÚDEZ, 1950, *125, p. 225.
Eofrondicularia K. V. MIKLUKHO-MAKLAY, 1954, *1277, p. 42.
Eolituonella BERMÚDEZ, 1950, *125, p. 225.
Exseroammodiscus POYARKOV, 1957, *1480, p. 34, 36.
Glaesneria BROTZEN & BERMÚDEZ in BERMÚDEZ, 1950, *125, p. 341.
Glandularia DAIN, 1960, *549, p. 197.
Globalternina IVANOVA in SUBBOTINA, GLUSHKO & PISHVANOV, 1955, *1848, p. 606.
Heterosteginella A. SILVESTRI, 1937, *1787, p. 117.
Ilyopegma DE FOLIN, 1881, *724, p. 139.
Ilyoperidia DE FOLIN, 1881, *724, p. 139.
Ilyosphaera DE FOLIN, 1883, *725, p. 328.
Ilyozotika DE FOLIN, 1881, *724, p. 139.
Julia DE FOLIN, 1881, *724, p. 141 (*non* GOULD, 1862).
Kikrammina DE FOLIN, 1881, *724, p. 132.
Limocaeum DE FOLIN, 1881, *724, p. 139.
Mallopela DE FOLIN, 1881, *724, p. 140; 1883, *725, p. 328.
Messina BROTZEN, 1960, *242, p. 13.
Neoarchaesphaera A. D. MIKLUKHO-MAKLAY, 1958, *1269, p. 131, fig. 1.
Nodulinella RHUMBLER in ANONYMOUS, 1949, *22, expl. pl. 8.
Nummularia WEDEKIND, 1937, *2041, p. 111 (*non* SOWERBY & SOWERBY, 1826).
Ophidionella DE FOLIN, 1881, *724, p. 140.
Ouladnailla EMBERGER, MAGNÉ, REYRE & SIGAL, 1955, *701, p. 113.
Ovulida DE FOLIN, 1887, *726a, p. 114.
Palaeocornuspira BOGDANOVICH, 1952, *152, p. 40, 41, 46, 57.
Pentasyderina NICOLUCCI, 1846, *1357, p. 205.
Praecosinella EMBERGER, MAGNÉ, REYRE & SIGAL, 1955, *701, p. 113.
Praerotalipora SALAJ & SAMUEL in SCHEIBNEROVA, 1962, *1643A, p. 215 [*Globotruncana ticinensis* GANDOLFI, 1942, *768, p. 113].
Premnammina DE FOLIN, 1881, *724, p. 136.

Psammecinus DE FOLIN, 1881, *724, p. 136 (*non* AGASSIZ, 1864).
Psammolychna DE FOLIN, 1881, *724, p. 136.
Psammoperidia DE FOLIN, 1881, *724, p. 135.
Psammozotika DE FOLIN, 1881, *724, p. 138.
Pseudocoscinoconus SPECK, 1953, *1824.
Pseudolituola MARIE, 1941, *1215, p. 21, 256.
Pseudosigmoilina BOGDANOVICH, 1952, *152, p. 41, 42, 158.
Pseudospiroloculina BOGDANOVICH, 1952, *152, p. 41, 42, 152.
Ptyka DE FOLIN, 1881, *724, p. 139.
Rectotrochaminoides FISCHER, 1954, *719, p. 9.
Rhizopela DE FOLIN, 1881, *724, p. 140.
Ropalozotika DE FOLIN, 1881, *724, p. 141.
Scarificatina MARIE, 1950, *1219, p. 50.
Sphaerophthalmidium POKORNÝ, 1954, *1474, p. 59.
Stephanopela DE FOLIN, 1881, *724, p. 140.
Toxinopsis DE FOLIN, 1881, *724, p. 138.

UNRECOGNIZABLE GENERIC NAMES APPLIED TO FORAMINIFERIDA

Adherentina SPANDEL, 1909, *1823, p. 212 [**A. rhenana*]. Placed by some authors as a synonym of *Cibicides*, but it possesses a terminal aperture and original description stated that it lacked pores. Possibly similar to *Karreria*, but impossible to determine from the inadequate figures and description.
Aeolides DE MONTFORT, 1808, *1305, p. 143 [**A. squammatulus*].
Annulina TERQUEM, 1862, *1883, p. 432 [**A. metensis*]. Siliceous discs with thickened rim, from L.Jur. (Lias.) of France and Germany, have been referred to echinoderms (*1348a) and regarded as spicules (*1890), or may possibly belong to Radiolaria.
Apiopterina ZBORZEWSKI, 1834, *2101, p. 311 [**A. orbignyi*]. A polymorphinid but unrecognizable generically from description and figures; regarded as synonym of *Pyrulina* D'ORBIGNY, 1839 (*762, p. 258). Should investigation prove this correct, it would take precedence over *Pyrulina*.
Arethusa DE MONTFORT, 1808, *1305, p. 303 [**A. corymbosa*]. Perhaps a member of the Polymorphinidae.
Aristeropora EHRENBERG, 1858, *683, p. 11. A turbinate rotaliid form.
Arthrocena MODEER, 1791, *1291, p. 91.
Aspidodexia EHRENBERG, 1872, *687, p. 276 [**A. lineolata*].
Aspidospira EHRENBERG, 1844, *673, p. 75.
Auriculina COSTA, 1856, *392, p. 259 [**A. crenata*] (*non* *Auriculina* GRATELOUP, 1838; *nec* GRAY, 1847).
Buliminopsis RZEHAK, 1895, *1605, p. 217 [**B. conulus*] (*non* *Buliminopsis* HEUDE, 1890).
Calatharia ZALESSKY, 1926, *2099, p. 87 [**C. perforata*]. Unrecognizable form in thin section.

- Cameroconus** MEUNIER, 1888, *1254, p. 234 [**C. marmoris*]. Apparently axial section of an enrolled foraminifer, unrecognizable.
- Canopus** DE MONTFORT, 1808, *1305, p. 291 [**C. fabeolatus*] (*non Canopus* FABRICIUS, 1803; *nec* RAFINESQUE, 1840; *nec* WALKER, 1855; *nec* FELLDER, 1861; *nec* WOLLASTON, 1864).
- Cantharus** DE MONTFORT, 1808, *1305, p. 295 [**C. calceolatus*] (*non Cantharus* BOLTEN, 1798; *nec* CUVIER, 1817; *nec* SCUDDER, 1882).
- Canthropes** DE MONTFORT, 1808, *1305, p. 47 [**Canthrope galet* (*nom. neg.*, = *Canthropes* sp.)] [= *Canthropus* PALLAS in OKEN, 1815, *1385, p. 335 (*nom. van.*); *Cantharipes* AGASSIZ, 1846, *6, p. 64 (*nom. van.*)].
- Cepinula** SCHAFFHÄUTL, 1851, *1637, p. 49.
- Cerataria** ZALESSKY, 1926, *2099, p. 92 [**C. pulchella*].
- Chelibs** DE MONTFORT, 1808, *1305, p. 307 [**C. gradatus*] [= *Celibs* SHERBORN, 1893, *1731a, p. 38 (*nom. van.*)].
- Cidarollus** DE MONTFORT, 1808, *1305, p. 111 [**C. plicatus*].
- Cimelidium** EHRENBURG, 1858, *683, p. 22 [**Gut-tulina? homeri* EHRENBURG, 1858].
- Clypeocyclus** A. SILVESTRI, 1908, *1771, p. 154 [type, no recognizable species named.]. "An invalid genus, defined theoretically, resembling *Linderina* and *Cycloclypeus*," *762, p. 456.
- Colpopleura** EHRENBURG, 1844, *673, p. 74 [**Rotalia ocellata* EHRENBURG, 1838].
- Cortalus** DE MONTFORT, 1808, *1305, p. 115 [**C. pagodus*].
- Craterularia** RHUMBLER, 1911, *1572a, p. 90, 100, 136. No species named in original paper and no valid species yet described; probably represents a *Trochammina* with boring organism.
- Crustula** ALLIX in LECOINTRE & ALLIX, 1913, *1117, p. 46 [**C. complanata*]. Type in Lecoindre collection, BRGG, Paris, mounted in balsam, cracked and unrecognizable.
- Cucurbitina** COSTA, 1856, *392, p. 363 [**C. cruciata*] (*non Cucurbitina* ALEXANDER, 1833).
- Cyclopavonina** SILVESTRI, 1937, *1787, p. 93 [**C. cyclica*].
- Cylindria** DE GREGORIO, 1930, *817, p. 48 [**C. minuta*] (*non Cylindria* ZETTERSTEDT, 1849, *err. pro Cylidria* DESVOIDY, 1830).
- Dexiopora** EHRENBURG, 1861, *685, p. 304 [**D.? megapora*].
- Dorbignya** DESHAYES, 1830, *590, p. 231.
- Dujardinia** GRAY, 1858, *812, p. 270 [**D. mediterranea*] (*non* QUATREFAGES, 1844; *nec* GEDOELST, 1916). Stated to be calcareous, with pores, and intermediate between Rhizopoda and Porifera.
- Elliptina** HARTING, 1852, *883, p. 116. Included *E. inflata* and *E. truncata*.
- Epistominites** ZALESSKY, 1926, *2099, p. 92 [**E. formosulus*].
- Fusulinella (Ozawaina)** LEE, 1927, *1119, p. 13 [**Nummulina antiquior* ROUILLIER & VOSINSKY, 1849, *1588A, p. 337; SD GALLOWAY, 1933, *762, p. 396].
- Glandiolus** DE MONTFORT, 1808, *1305, p. 315 [**G. gradatus*].
- Grammobotrys** EHRENBURG, 1844, *673, p. 95 [**Polymorphina? aculeata* EHRENBURG, 1844]. CUSHMAN, 1944, *480, stated the type from Loandra, South Africa, belongs to *Virgulina*, but he used *Virgulina* in a more inclusive sense than at present, and no information is available as to wall structure and other diagnostic features. Could be *Cassidella*, *Fursenkoina*, *Brizalina*, or *Bolivina*.
- Gyrammina** EIMER & FICKERT, 1899, *692, p. 669 [**Trochammina annularis* BRADY, 1876]. Unrecognizable as based on the types in the BRADY collection in the British Museum (Natural History).
- Hedbergina** BRÖNNIMANN & BROWN, 1956, *235, p. 529 [**Globigerina seminolensis* HARLTON, 1927, *879, p. 24]. Probably a Cretaceous form but described from Pennsylvanian; unrecognizable (*164, p. 39, 40).
- Hemistegina** KAUFMANN, 1867, *1026, p. 150 [**H. rotula*].
- Hemisterea** EHRENBURG, 1872, *687, p. 276 [**H. nautilus*].
- Hemisticta** EHRENBURG, 1872, *687, p. 276 [**H. amplificata*].
- Heterostomum** EHRENBURG, 1854, *680, p. 22 [**H. cyclostomum*] [*non* DIESING, 1850 (*pro Heterostoma* FILIPPI, 1837)].
- Lagenopsis** DE GREGORIO, 1930, *817, p. 48 [**L. maliarda*].
- Lekithiammina** DE FOLIN, 1887, *727Aa, p. 128 [**L. aculeata*] [= *Lekithiammina* DE FOLIN, 1881, *724, p. 136 (*nom. nud.*)].
- Lepista** ZALESSKY, 1926, *2099, p. 90 [**L. ornata*] (*non Lepista* WALLENGREN, 1863).
- Lobularia** COSTA, 1839, *390, p. 186 [**L. vesiculosa*] (*non Lobularia* LAMARCK, 1816).
- Lyrina** ZBORZEWSKI, 1834, *2101, p. 311 [**L. fischeri*].
- Mesopora** EHRENBURG, 1854, *679, p. 377 [**M. chloris*] (*non Mesopora* WESMAEL, 1852).
- Metarotaliella** GRELL, 1962, *822, p. 214 [**M. parva*]. Incompletely described (only reproductive characters), not illustrated and test character not mentioned, stated to be a small heterokaryotic rotaliid with asexual development as in *Rotaliella* (with 3 generative nuclei and one vegetative nucleus), the agamont commonly giving rise to 12 gamonts; sexual reproduction with association in pairs as in *Rubratella*, and resulting in a variable number of amoeboid gametes. Apparently it is to be more completely described later in the *Archiv für Protistenkunde*. Rec., Fr.
- Mirfa** DE GREGORIO, 1890, *816, p. 260 [**M. subte-traedra*].
- Mirga** DE GREGORIO, 1930, *817, p. 49 [**Orbulina (M.) permiana*].

- Misilus** DE MONTFORT, 1808, *1305, p. 295 [**M. aquatifer*].
- Molnaria** ZALESSKY, 1926, *2099, p. 89 [**M. spinulata*].
- Monocystis** EHRENBURG, 1854, *680, p. 22 [**Miliola (Monocystis) arcella*] (*non Monocystis* STEIN, 1848).
- Nummulitella** DORREN, 1948, *610, p. 291 [**N. polystylata*; OD]. Assigned by author to Nummulitidae; probably a rotaliid. *U.Eoc.*, N.Z.
- Oncobotrys** EHRENBURG, 1856, *682, p. 172 [**O. buccinum*].
- Orobias** EICHWALD, 1860, *691, p. 22, fig. 16 [**O. aequalis*].
- Orthocerina** D'ORBIGNY in DE LA SAGRA, 1839, *1611, p. 17 [**Nodosaria (O.) quadrilatera*; OD (M)] [= *Nodosaria (Orthocerina)* D'ORBIGNY, 1826, *1391, p. 255 (*nom. neg.*)].
- [The type cannot be *Nodosaria clavulus* LAMARCK, as stated by GALLOWAY, *762, as in 1826 D'ORBIGNY (*1391, p. 255) did not use a Latin name for the subgenus, only the French vernacular; hence it was invalid. In 1839 when the Latin designation was used by D'ORBIGNY (*1611, p. 17) only *O. quadrilatera* was mentioned by name, hence is the type-species by monotypy, although D'ORBIGNY stated that there were 2 species known to him, the other being fossil from the Tertiary of the Paris area. PARKER & JONES (*1417f, p. 433) stated that *Nodosaria (Orthocerina) clavulus* did not belong to the genus, restricting it to include only *O. quadrilatera* and 4 later described species by REUSS. They erroneously stated *O. murichisoni* (REUSS) to be the type, however. HERON-ALLEN & EARLAND (1930, *915, p. 172) correctly regarded *O. quadrilatera* as the type-species. Other forms included by PARKER & JONES have agglutinated tests, some of which are now placed in *Triplasia*. HERON-ALLEN & EARLAND included calcareous species now regarded as *Tristix*. Other species placed in *Orthocerina* by various authors are to be placed in *Nodosaria*, *Pseudonodosaria*, *Geinitzina*, and *Amphimorphina*, representing 4 or 5 families. The type-species is poorly known from the original brief description only, which does not state whether it is calcareous or agglutinated, and it has not since been recognized in the type area (Cuba, Jamaica), where it was stated to be rare. Thus it is regarded as unrecognizable.]
- Otostomum** EHRENBURG, 1872, *687, p. 276 [**O. strophoconus*].
- Ovolina** TERQUEM, 1864, *1884, p. 285 [**Ovolina fusiformis*, = *Oolina fusiformis* TERQUEM, 1863].
- Paronia** PREVER in CHELUSSI, 1903, *330A, p. 74 [*non DIAMARE*, 1900] [**Nummulites complanata* LAMARCK, 1804].
- Pectinaria** ZALESSKY, 1926, *2099, p. 94 [**P. costata*] (*non Pectinaria* LAMARCK, 1818).
- Phanerostomum** EHRENBURG, 1843, *672, p. 409 [**P. integerrimum*].
- Physomphalus** EHRENBURG, 1856, *682, p. 172 [**P. porosus*].
- Platyoeus** EHRENBURG, 1854, *680, p. 23 [**P. squama*].
- Pleurites** EHRENBURG, 1854, *680, p. 23 [**P. cretae*].
- Pleurostomina** A. COSTA, 1862, *389, p. 94 [**P. bimucronata*].
- Pleurotrema** EHRENBURG, 1840, *667, chart opposite p. 120 [**P. calcarina*].
- Pseudastrophizula** WETZEL, 1940, *2047, p. 122 [**P. eisenacki*]. Internal cast or "steinkern" of a foraminifer from an Upper Cretaceous glacial pebble in Denmark.
- Pteroptyx** EHRENBURG, 1873, *689, p. 151, 152 (*non OLIVIER*, 1902) [**P. vespertilio*].
- Ptygostomum** EHRENBURG, 1843, *672, p. 409 [**P. oligoporum*].
- Raphanulina** ZBORZEWSKI, 1834, *2101, p. 311 [**R. humboldtii*]. A polymorphinid regarded as equivalent to *Globulina* D'ORBIGNY (*762, p. 259) but unrecognizable generically from the description and figures.
- Renulina** BLAKE, 1876, *144, p. 262 (*non LAMARCK*, 1805; *nec* DE BLAINVILLE, 1825) [**R. sorbyana*].
- Rhabdella** D'ARCHIAC & HAIME, 1853, *38, p. 351 [**R. malcolmi*].
- Rhaphidodendron** MÖBIUS, 1876, *1292, p. 115 [**R. album*].
- Rhynchoplecta** EHRENBURG, 1854, *679, p. 405 [**R. punctata*].
- Rotalites** LAMARCK, 1801, *1084, p. 401 [**R. tuberculosa*]. Grignon, Fr.
- Semseyia** FRANZENAU, 1893, *745, p. 358 [**S. lamellata*].
- Septammina** MEUNIER, 1888, *1254, p. 235 [**S. renaulti*].
- Siderospira** EHRENBURG, 1845, *675, p. 376 [**Siderolina? indica* EHRENBURG, 1845].
- Spiroplectina** SCHUBERT, 1902, *1682, p. 84 (*non CUSHMAN*, 1927). No species named. Early stage as in *Spiroplecta*, later as in *Fronicularia*, but not stated whether calcareous or agglutinated.
- Spiropleurites** EHRENBURG, 1854, *678, p. 237.
- Strophoconus** EHRENBURG, 1843, *670, p. 166 [**S. cribosus*]. CUSHMAN (1927, *434) stated that one of the species, *S. auricula*, was a young *Virgulina*, but no information is available about the type-species.
- Synspira** EHRENBURG, 1854, *680, p. 24 [**S. triquetra*].
- Tinoporus** DE MONTFORT, 1808, *1305, p. 147 [**T. baculatus*]. See discussion by LOEBLICH & TAPPAN (1962, *1186).
- Trioxeia** DE FOLIN, 1888, *727, p. 110 [**T. edwardsi*] [= *Trioxeia* DE FOLIN, 1881, *724, p. 141 (*nom. nud.*)].
- Upsonella** W. L. MOORE, 1959, *1308A, p. 995 [**U. typus*; OD]. "Unilocular, subspherical, spinose foraminifer characterized by a distinctive furrow or attachment scar which is developed along the base of the test and which has a narrow flap or rim around its periphery. The multiple apertures of this form are probably associated with the spines (*1308A)." *L.Penn.*, USA(Tex.).
- [Whether the genus is agglutinated or granular calcareous in wall character it is not stated, hence it is uncertain whether it is close to *Parathurammmina*, *Astrorhiza*, *Thurammmina*, or *Archaeochitina*. Although nomenclatorially validated, the above genus is thus unrecognizable, without further published description and illustration. Although more complete description may be found in the unpublished dissertation, of which the above reference is an abstract, the dissertation is not a publication. Neither the sale of microfilm nor Xerox reproduction from the microfilm consists of publication, and (ICZN, 1961, Art. 8) "a work when first issued must (1) be reproduced in ink on paper by some method that assures numerous identical copies; and (4) not . . . reproduced or distributed by a forbidden method." According to Art. 9 (1) "distribution of microfilms, or microcards, or matter reproduced by similar methods" does not constitute publication.]
- Volutaria** ZALESSKY, 1926, *2099, p. 95 [**V. potonicei*].

Volvotextularia G. TERMIER & H. TERMIER, 1950, *1882, p. 33, 39 [**V. polymorpha*] [= *Volvotextularia* G. TERMIER & H. TERMIER, 1947, *1881, table p. 146, 147, 271 (*nom. nud.*)].

GENERIC NAMES ERRONEOUSLY APPLIED TO FORAMINIFERIDA

- Aguyayoina** BERMÚDEZ, 1938, *120, p. 386 [**A. asterostomata*]. Anthozoan.
- Ammosphaeroides** CUSHMAN, 1910, *404a, p. 51 [**A. distoma*] [= *Arammosphaerium* RHUMBLER, 1913, *1572b, p. 348 (*nom. van.*) (obj.)]. Inorganic, mineral coating on a sand grain.
- Archaealagena** HOWCHIN, 1888, *965, p. 539 [**Lagena howchiniana* BRADY, 1876] [= *Archealagena* HARLTON, 1927, *879, p. 24 (*nom. null.*) (obj.)]. A plant.
- Balanulina** RZEHAŁ, 1888, *1603, p. 265 [**B. kittlii*]. May be a barnacle, bryozoan, or coral, or a foraminifer. Unrecognizable.
- Birrarnoldia** HOVASSE & COUTURE, 1961, *964, p. 1054 [*pro Arnoldia* HOVASSE, 1956, *963, p. 2584 (*non* MAYER, 1887, *non* KIEFFER, 1895, *non* WLASSENKO, 1931)] [**Arnoldia antiqua* HOVASSE, 1956; OD]. Minute siliceous and iron oxide globules from Precambrian of Africa, probably inorganic.
- Cadosina** WANNER, 1941, *2038, p. 79 [**C. fusca*]. Member of family Cadosinidae of Tintinnina.
- Cadosinella** VÖGLER, 1941, *2015, p. 282 [**C. gracillimoides*]. Member of family Cadosinidae of Tintinnina.
- Capsulina** SEGUENZA, 1880, *1713, p. 375 [**C. loculicida*]. Originally described as a foraminifer, probably echinoderm pedicellaria.
- Cayeuxina** GALLOWAY, 1933, *762, p. 156 [**C. pre-cambrica*]. Probably inorganic.
- Cellulina** ZBORZEWSKI, 1834, *2101, p. 308. Alga.
- Cercidina** VÖGLER, 1941, *2015, p. 290 [**C. supracretacea*]. Probably member of Tintinnina.
- Cheilosporites** WÄHNER, 1903, *2029, p. 98 [**C. tirolensis*]. Problematica, described from non-oriented limestone sections, originally and here regarded as algal in nature, later variously referred to sponges and foraminifers. Consists of large branching colonies (to 5 cm.), of uniserial chambers up to 4 mm. diam., with axial siphon; wall of calcite grains. The chambers show very little increase in size as added and some apparent branches have series of chambers approximately half of normal size, without a gradual change in size as is common in foraminiferal ontogeny. Made the monotypic basis for the family Cheilosporitidae A. G. FISCHER (1962, *718, p. 123). *U.Trias.*, Bavaria.
- Chuarina** WALCOTT, 1899, *2032, p. 234 [**C. circularis*]. *Algonkian*, Chuar terrane, USA (Ariz.).
- Cochleatina** E. V. BYKOVA, 1956, *258, p. 12 [**C. plaviniensis*]. A bryozoan, probably *Corynotrypa* BASSLER, 1911.
- Coelotrochium** SCHLÜTER, 1879, *1670, p. 668. Alga.
- Coscinoconus** LEUPOLD in LEUPOLD & BIGLER, 1936, *1130, p. 618 [**C. alpinus*]. According to MASLOV (1958, *1232) this is an alga.
- Cystodictyina** CARTER, 1880, *296, p. 448 [**C. compressa*]. Placed by CARTER in a new group Testamoebiformia; probably calcareous alga.
- Dexiospira** EHRENBERG, 1859, *684, p. 309 (*non Dexiospira* CAULLERY & MESNIL, 1897). Inorganic concretionary masses.
- Discoidina** TERQUEM & BERTHELIN, 1875, *1893, p. 15 [**D. liasica*] (*non Discoidina* STEIN, 1850). *Incertae sedis*; not a foraminifer.
- Girvanella** NICHOLSON & ETHERIDGE, 1878, *1356, p. 23 [**G. problematica*] [= *Argirvanellum* RHUMBLER, 1913, *1572b, p. 386 (*nom. van.*)]. Alga.
- Goniolina** D'ORBIGNY, 1850, *1397b, p. 41 [**G. hexagona*]. A plant fossil.
- Holocladina** CARTER, 1880, *296, p. 447 [**H. pustulifera*]. Placed by CARTER in a new group Testamoebiformia; probably calcareous alga.
- Keramosphaerina** STACHE, 1913, *1829, p. 659, 666 [**Bradya tergestina* STACHE, 1889] [= *Bradya* STACHE, 1889, *1828, p. 35, 89 (obj.)] (*non Bradya* BOECK, 1873; *nec Bradya* CARTER, 1877). Probably a hydrocoralline.
- Ladinosphaera** OBERHAUSER, 1960, *1384, p. 44 [**L. geometrica*]. Questionably organic, probably small limonitic "concretions" in geometric arrangement.
- Matthewina** GALLOWAY, 1933, *762, p. 157 [**Globigerina cambrica* MATTHEW, 1895]. Probably inorganic.
- Millarella** CARTER, 1888, *298, p. 178 [**M. cantabrigiensis*]. Not a foraminifer.
- Nodoplanulus** HUSSEY, 1943, *975, p. 166 [**N. elongata*]. An isopod appendage (*1303, p. 151, 152).
- Polytrema** RISSO, 1826, *1579b, p. 340 (*non* RAFINESQUE, 1819, *non* FÉRUSAC, 1822, *non* D'ORBIGNY, 1850). A bryozoan.
- Protocyclina** PAALZOW, 1922, *1404, p. 35 [**P. liasina*]. Not a foraminifer, but echinoderm ossicle.
- Psammisiphon** VINE, 1882, *2006, p. 390 [**P. amplexus*] (*non Psammisiphon* RHUMBLER, 1913). Not a foraminifer; possibly Annelida.
- Pseudogypsina** TRAUTH, 1918, *1948, p. 243 [**P. multiformis*]. Probably a calcareous alga.
- Rhaphidoscene** JENNINGS, 1896, *988, p. 320 [**R. conica*] [= *Arrhaphoscenium* RHUMBLER, 1913, *1572b, p. 346 (obj.)] (*nom. van.*). Represents young of the sponge *Tentorium*.
- Siphonema** BORNEMANN, 1886, *175, p. 17. Alga.
- Spirocerium** EHRENBERG, 1858, *684, p. 310 [**S. priscum*]. Inorganic; globular mass of "glauconite."
- Spongina** DE GREGORIO, 1930, *817, p. 8, 48 [**Globigerina* (S.) *permica*]. Described as a subgenus of *Globigerina*; not a foraminifer.

Stoliczkiella CARTER, 1888, *298, p. 173 [**S. theobaldi*]. Probably an echinoid.

Stomiosphaera WANNER, 1940, *2038, p. 76 [**S. moluccana*]. Similar to *Cadosina*, but with perforate walls, probably related to Tintinnina.

Terquemina GALLOWAY, 1933, *762, p. 157 [**T. devonica*]. Not a foraminifer.

Wetheredella WOOD, 1948, *2072, p. 20 [**W. silurica*]. Composed of subcircular, radially layered calcite tubes, encrusting and irregularly branching in habit; doubtfully a foraminifer, probably algal.

Order REITLINGERELLIDA Vologdin, 1958

[Order Reitlingerellida VOLOGDIN, 1958, p. 405]

Shell free, consisting of narrow tubular chamber of constant diameter (0.016-0.017 mm.) coiled in expanding spire, cylindrical helical spire, or with early glomerate coil. [Genera here included were originally regarded as foraminifers, and some have since been considered as algae (e.g., *Obruchevella*, *Cavifera*, *Glomovertella*, *Syniella*) (ELIAS, 1954, *697, p. 52). Although their systematic position is doubtful, they are here listed and figured. No attempt is made to evaluate the validity of these similar-appearing forms.] *L.Cam.-U.Ord.*

Family REITLINGERELLIDAE

Loeblich & Tappan, n.fam.

Characters of order. *L.Cam.-U.Ord.*

Reitlingerella VOLOGDIN, 1958, *2018, p. 408 [**R. densa*; OD]. Test with system of tubular chambers, closely appressed, with curved loops of differing form and orientation. *L.Cam.*, USSR (Tuva). —FIG. 643, 1. **R. densa*, ×210 (*2018).

Bostrychosaria VOLOGDIN, 1958, *2018, p. 406 [**B. bistorta*; OD]. Closely spiraling tube, 0.017 mm.

diam., with elongate axis of spiraling, entire specimen being of equal diameter throughout and approximately cylindrical. *L.Cam.*, USSR (Tuva). —FIG. 643, 2. **B. bistorta*, holotype, ×210 (*2018).

Cavifera REYTLINGER, 1948, *1559, p. 80 [**C. concinna*; OD]. Tube coiling in single whorl, approx. 0.08-0.09 mm. diam., leaving broad central cavity; wall calcareous, microgranular; end of tube open. *Cam.*, USSR (Yakutiya). —FIG. 644, 1. **C. concinna*, ×215 (*1559).

Chabakovia VOLOGDIN, 1939, *2017, p. 221, 255 [**C. ramosa*, OD]. Small dendritic branches formed by series of bulbous chambers, with partitions convex in direction of growth; wall calcareous, nearly opaque. [Originally described as an alga, *Chabakovia* was regarded by ELIAS (*696) as a foraminifer belonging to the Ptychocladinae. The complex, chambered branching form is of a more advanced nature than would be expected in early Paleozoic foraminifers, and *Chabakovia* is tentatively here placed with the Reitlingerellida, although it may possibly belong to the algae.] *M.Cam.*, USSR (Ural Mts.). —FIG. 645, 1. **C. ramosa*, 1a-c, typical specimens, ×40 (*2017).

Flexurella VOLOGDIN, 1958, *2018, p. 407 [**F. obvoluta*; OD]. Shell tubular, flattened, more or

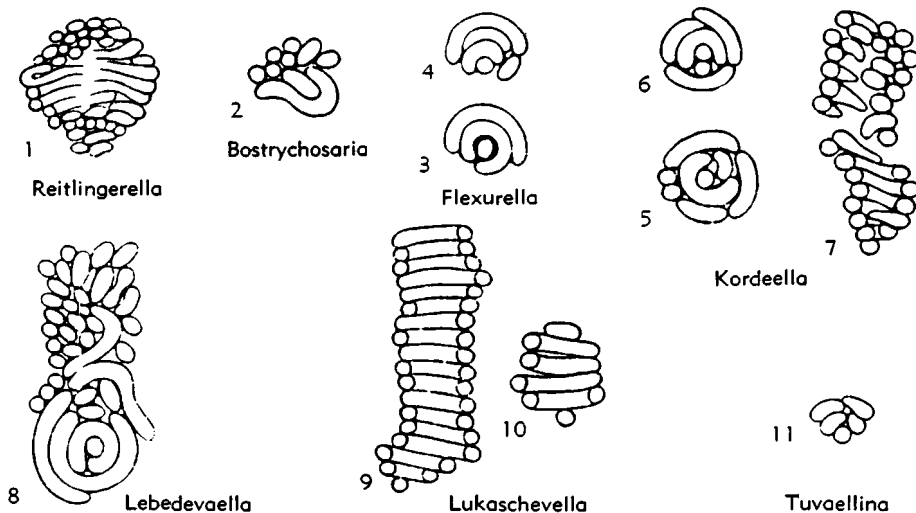


FIG. 643. Reitlingerellidae; 1, *Reitlingerella*; 2, *Bostrychosaria*; 3, 4, *Flexurella*; 5-7, *Kordeella*; 8, *Lebedevaella*; 9, 10, *Lukashevella*; 11, *Tuvaellina* (p. C787-C789).

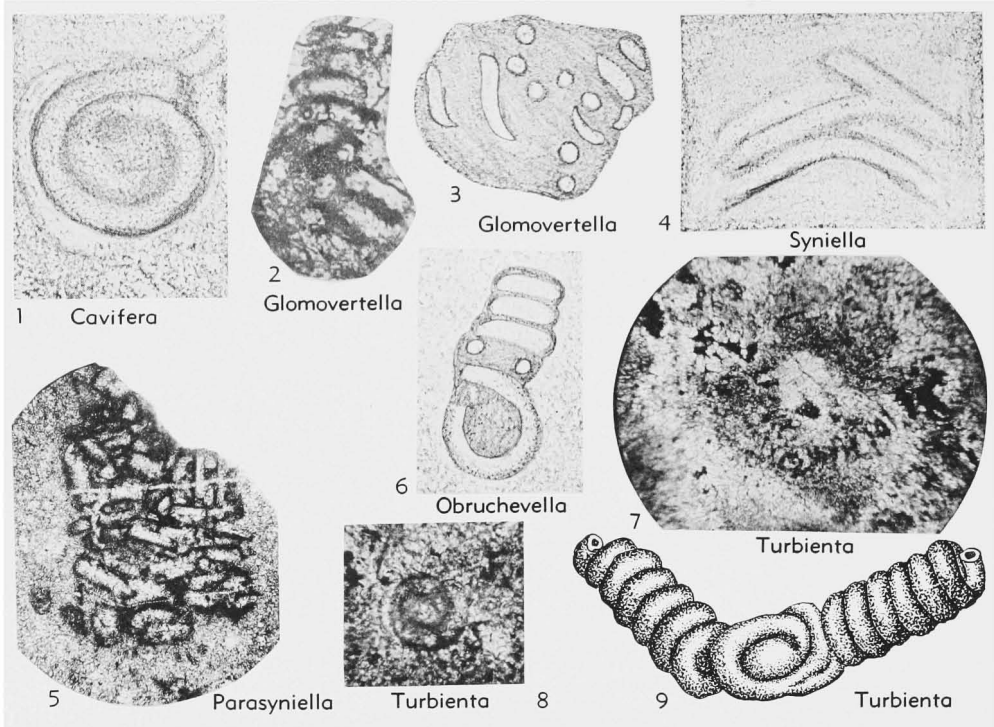


FIG. 644. Reitlingerellidae; 1, *Caviifera*; 2,3, *Glomovertella*; 4, *Syniella*; 5, *Parasyniella*; 6, *Obruchevela*; 7-9, *Turbienta* (p. C787-C789).

less discoidal, in early stage coiled in 2 or 3 whorls, later stage with arcuate loops. *L.Cam.*, USSR (Tuva).—FIG. 643,3,4. **F. obvolvata*; $\times 210$ (*2018).

Glomovertella REYTLINGER, 1948, *1559, p. 80 [**G. firma*; OD]. Test free or attached, with globular initial chamber followed by tubular chamber of 1 or 2 whorls and with later loops in changing planes of coiling; wall calcareous, finely granular; aperture at open end of tube. *Cam.*, USSR.—FIG. 644,2,3. **G. firma*; 2, paratype, $\times 240$ (*1565); 3, holotype, $\times 244$ (*1559).

Kordeella VOLOGDIN, 1958, *2018, p. 407 [**K. campylostroma*; OD]. Test consisting of compact closely looped tube of 0.017 mm. diam., somewhat produced in direction of growth. *L.Cam.*, USSR (Tuva).—FIG. 643,5-7. **K. campylostroma*; $\times 210$ (*2018).

Lebedevella VOLOGDIN, 1958, *2018, p. 408 [**L. involvensis*; OD]. Test to 0.28 mm. in length and 0.14 mm. in breadth, consisting of narrow tubular chamber 0.020 mm. diam., forming interwoven loops transverse to flat axis. *L.Cam.*, USSR (Tuva).—FIG. 643,8. **L. involvensis*, $\times 210$ (*2018).

Lukashevella VOLOGDIN, 1958, *2018, p. 408 [**L. spiralis*; OD]. Tubular chamber coiled in high spire, with slight variation in dimensions. *L.Cam.*, USSR (Tuva).—FIG. 643,9,10. **L. spiralis*; $\times 210$ (*2018).

Obruchevela REYTLINGER, 1948, *1559, p. 78 [**O. delicata*; OD]. Elongate cylindrical form, consisting of elongate tube of equal diameter coiled in tightly closed spire, not around central cavity; wall calcareous, finely granular; communication with exterior at open end of tube. *L.Cam.*, USSR (Yakutiya).—FIG. 644,6. **O. delicata*; holotype, $\times 244$ (*1559).

Parasyniella E. V. BYKOVA, 1961, *260, p. 67 [**P. geniculosa*; OD]. Test free, globular, consisting of numerous chambers of rectangular section or irregularly arranged tubes without visible orderly arrangement; wall calcareous, dark in thin section, fine-grained; aperture not observed, chambers interconnected by openings in walls or by open tubular branches. *U.Ord. (Caradoc.)*, USSR (N.Kazakh.).—FIG. 644,5. **P. geniculosa*; holotype, $\times 47$ (*2112).

Rectangulina ANTROPOV, 1959, *25A, p. 30 [**Syniella tortuosa* ANTROPOV, 1950, *25, p. 31; OD]. Test irregularly angular in form, consisting of groups of closely arranged, regular, prismatic, quadrate chambers in parallel rows, groups of parallel chambers variously oriented relative to each other and to test exterior; aperture unknown. [*Syniella* was regarded originally as of uncertain systematic position, and later placed in the Order Reitlingerellida, Subclass Foraminifera by VOLOGDIN, 1958 (*2018). ANTROPOV regarded *Rec-*

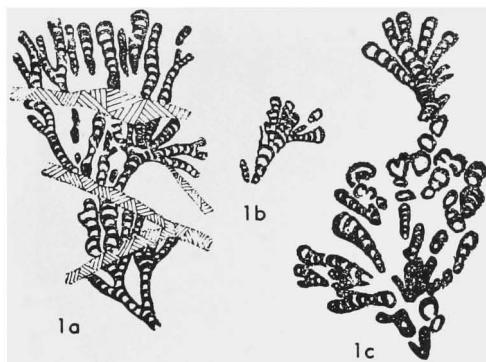


FIG. 645. Reitlingerellidae; 1, *Chabakovia* (p. C787).

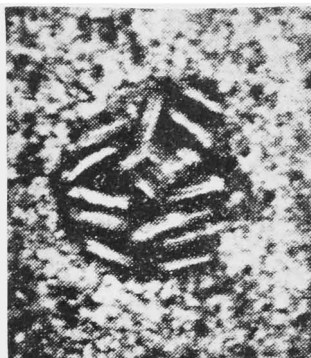


FIG. 645A. Reitlingerellidae; *Rectangulina* (p. C788-C789).

tangulina as of uncertain position, possibly algal. It undoubtedly is related correctly to the Reitlingerellida, although the true systematic position of the entire group is uncertain.] *U.Dev.* (*L. Frasn.*), USSR (Tatar - Bashkir - Kuybyshevsk - Udmurt).—FIG. 645A. **R. tortuosa* (ANTROPOV), N.Russian platform (Shugurian region); sec. of holotype, $\times 67$ (*25).

Syniella REYTLINGER, 1948, *1559, p. 81 [**S. invenusta*; OD]. Test appears to be elongate irregularly bending tube which may be bent double; wall calcareous, finely granular; aperture not observed. *L.Cam.*, USSR (Yakutsk).—FIG. 644,4. **S. invenusta*; long. sec. of holotype, $\times 244$ (*1559).

Turbienta E. V. BYKOVA, 1961, *260, p. 65 [**T. bifida*; OD]. Globular proloculus followed by tubelike undivided second chamber which at first coils in 1 or 2 flat whorls, then with 2 coils in opposite directions in high cylindrical open spires; wall calcareous, fine-grained; aperture at open end of tube. *U.Ord.* (*Caradoc.*), USSR (N.Kazakh.).—FIG. 644,7-9. **T. bifida*; 7, holotype, $\times 107$; 8, paratype, $\times 220$; 9, diagram, enlarged (*2112). *Tuvaellina* VOLOGIN, 1958, *2018, p. 406 [**T. prima*; OD]. Low spiraling tube of 0.016 mm. diam., with slight connections of one whorl to another. *L.Cam.*, USSR (Tuva).—FIG. 643,11. **T. prima*; $\times 260$ (*2018).

Order XENOPHYOPHORIDA Schulze, 1904

[*nom. correct.* LOEBLICH & TAPPAN, 1961, p. 318 (*pro order Xenophyophora* SCHULZE, 1912, p. 41, *nom. transl. ex group Xenophyophora* SCHULZE, 1904, p. 1387)]—[All synonymic citations refer to order status unless otherwise stated; dagger(†) indicates *partim*]—[=Domatocoelata HAECKEL, 1889, p. 8; =Xenophyophoren SCHULZE, 1905, p. 6 (*nom. neg.*); =suborder Arxenophyria RHUMBLER, 1913, p. 339 (*nom. van.*); =Xenophyophorae CHATTON, 1925, p. 76; =suborder Xenophyophora JIROVEC, 1953, p. 335 (*nom. transl.*)]—[=Myxozoa† SCHEPOTIEFF, 1912, p. 267; =Mycetozoida† SCHEPOTIEFF, 1912, p. 267; =Psamminidea POCHÉ, 1913, p. 202]

Multinucleate plasmodium containing numerous clear solid bodies (granellae), and forming pseudopodial network enclosed in system of hollow tubes (granellarium), some tubes (stercomarium) also containing dark bodies (stercomata), probably of fecal nature, and may contain xanthosomes, tiny red or yellow highly refractive spherical bodies; tube system composed of hyaline organic substance resembling spongin, and interspaces containing pseudoskeleton of foreign matter (xenophya), including sand grains, sponge spicules, tests of foraminifers, radiolarians or diatoms; reproduction probably by swarm spores. [Deep-water forms.] *Rec.*

These organisms have been described as sponges (*851), agglutinated foraminifers (*803), Labyrinthulida or Mycetozoa (*1647). There is no trace of cell differentiation, tissue or organ formation, such as is found in sponges. As living organisms have not been studied (only preserved material was used) the pseudopodial character is unknown. The presence of stercomata relates these to many rhizopods, as such bodies have been reported in the orders Gromida and Foraminiferida (*1701). The plasmodium in the granellarium, containing nuclei, may disintegrate into single isolated mononucleate cells. The plasma lumps at the ends of the granellarium branches are comparable to such lumps formed in other rhizopods, the pseudopodial complex of which retracts under unfavorable conditions.

The Xenophyophorida differ from the Labyrinthulida in having a skeleton of foreign particles, in the character of the tube

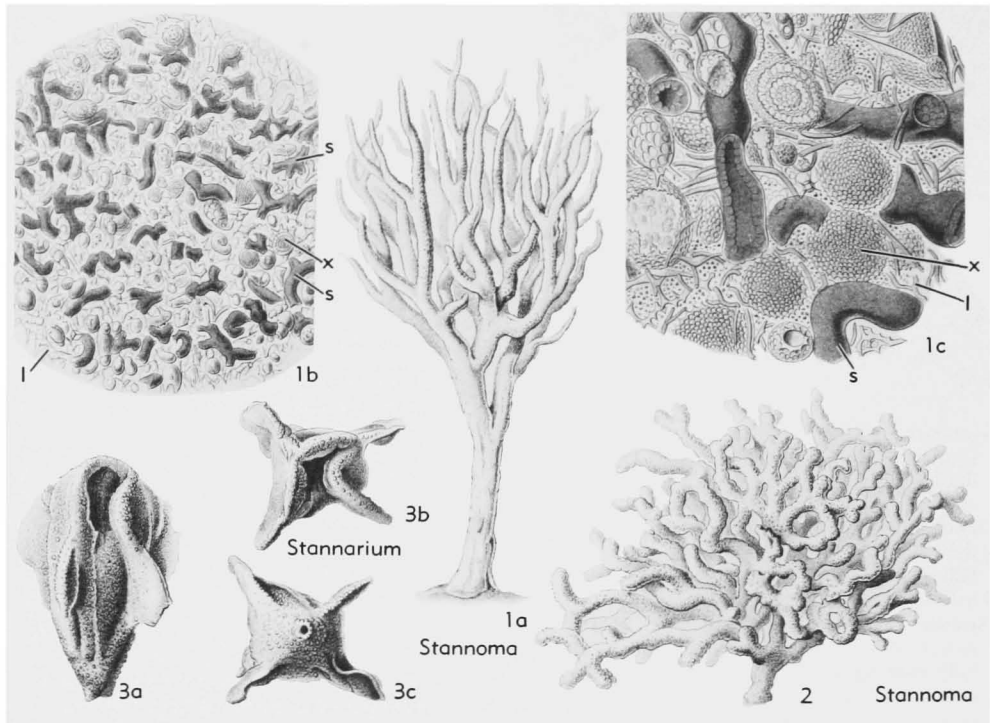


FIG. 646. Stannomidae; 1,2, *Stannoma*; 3, *Stannarium* (p. C790-C792).

systems, granellae and stercomarium, and the linellae of the Stannomidae. The linellae are similar in form and perhaps correspond to the capillitium of the Mycetozoida, but the capillitium is formed within the plasmodium fruiting body and the linellae lie outside of this. The Xenophyophorida differ from Foraminiferida in having the loose internal skeleton of xenophya in which the protoplasma-filled tubes are freely suspended, the test of agglutinated Foraminiferida enclosing the protoplasm. The linellae of the family Stannomidae are completely different from anything found in the Foraminiferida. The Xenophyophorida are regarded as belonging to a separate order intermediate between the Foraminiferida and Labyrinthulida (*1700).

Family STANNOMIDAE Haeckel, 1889

[Stannomidae HAECKEL, 1889, p. 7, 8, 54] [=subfamily Stannomida LANKESTER, 1909, p. 286 (nom. transl.); =†Xenophyophoridae LANKESTER, 1909, p. 286 (nom. nud.); =Neusiniinae CUSHMAN, 1910, p. 129; =Neusiniidae CUSHMAN, 1927, p. 29 (nom. transl.)]

Expanded flabelliform or branching body, flexible in life, with xenophya (foreign

bodies) held together by smooth, strongly refractive spongin-like threads, rounded in section, up to several mm. in length and 1 to 12 microns in diameter (linellae), expanding in size where they attach to the xenophya. *Rec.*

Stannoma HAECKEL, 1889, *851, p. 72 [**S. dendroides*; SD LOEBLICH & TAPPAN, herein] [=*Stannoplegma* HAECKEL, 1889, *851, p. 74 (type, *Stannoma coralloides* HAECKEL, 1889)]. Arborescent body (height to 8 cm.), with numerous free or anastomosing cylindrical branches, originating from nearly cylindrical pedicle (length 1-3 cm., diam. 2-5 cm.) terminating basally in a soft, finely fibrous mass; internal structure with abundant linellae (av. diam. 4 microns). [Originally described with two included species but no type designated, although *S. coralloides* was stated possibly to represent a distinct genus.] *Rec.*, C.Pac. (2,400-2,600 fathoms).—FIG. 646, 1. **S. dendroides*, trop. Pac.; 1a, exterior, $\times 1.3$; 1b, fragment of section, showing stercomarium (s), xenophya (x), linellae (l), $\times 26$; 1c, same, $\times 100$ (*851).—FIG. 646, 2. *S. coralloides* HAECKEL, trop. Pac.; $\times 2$ (*851).

Stannarium HAECKEL, 1889, *851, p. 69 [**S. concretum* HAECKEL, 1889, p. 71; SD LOEBLICH &

TAPPAN, herein]. Branched lamellar body, with 2 primary vertical leaves, which are either free or grown together, and secondary leaves budding

from these; xenophya consisting of Radiolaria or *Globigerina* tests, linellae regular, thin (diam. 2-8 μ) and elongate. *Rec.*, C.Pac. (2,600-2,900

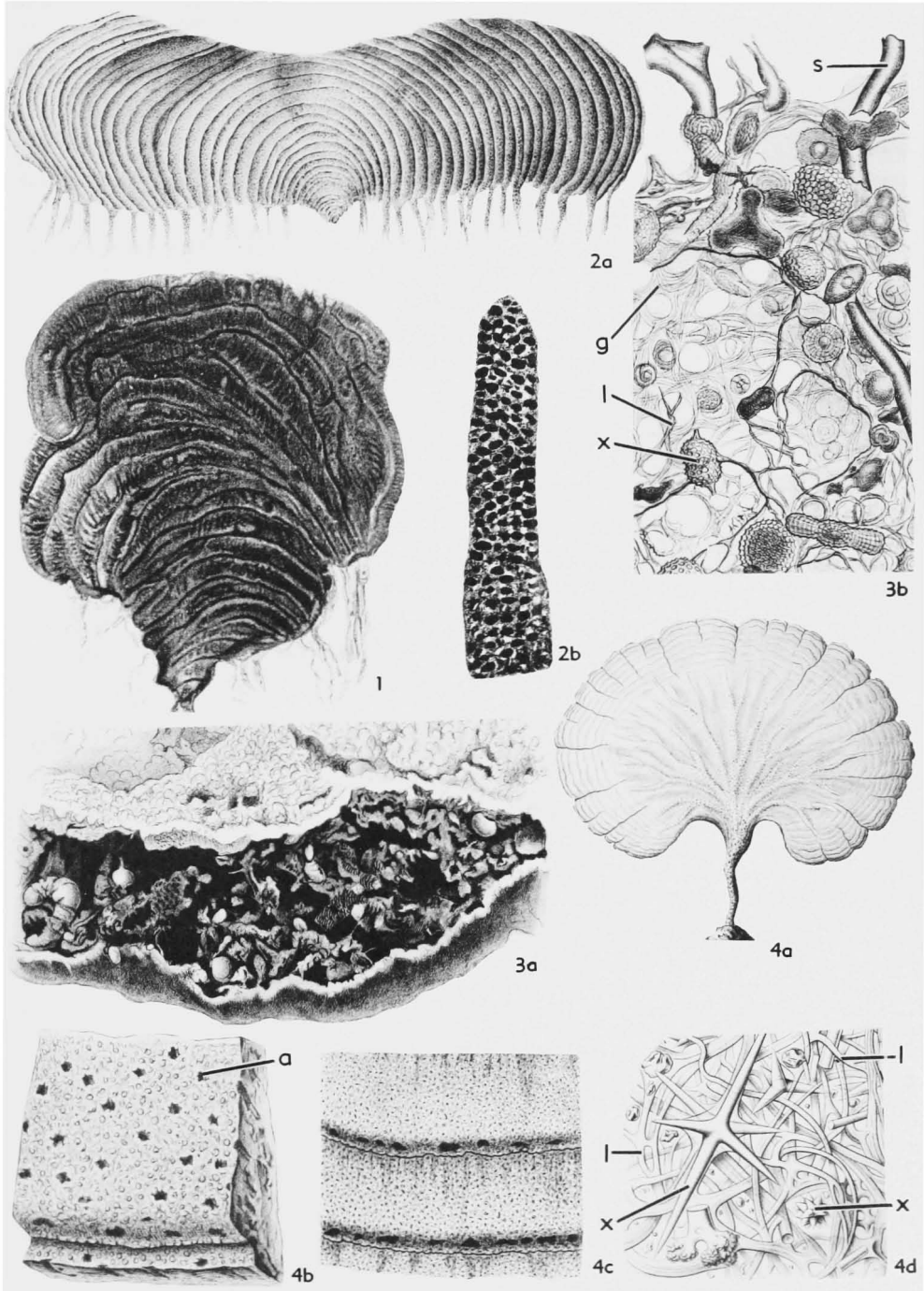


FIG. 647. Stannomidae; 1-4, *Stannophyllum* (p. C792).

fathoms).—FIG. 646,3. **S. concretum*; 3a-c, side, top, and base, $\times 1$ (*851).

Stannophyllum HAECKEL, 1889, *851, p. 60 [**S. zonarium* HAECKEL, 1889, p. 62; SD LOEBLICH & TAPPAN, herein (*=S. flabellum* HAECKEL, 1889, *=Neusina agassizi* GOËS, 1892)] [*=Psammophyllum* HAECKEL, 1889, p. 49 (type, *P. flustraceum* HAECKEL, 1889, p. 51; SD LOEBLICH & TAPPAN, herein); *Neusina* GOËS, 1892, p. 195 (type, *N. agassizi* GOËS, 1892, obj.)]. Thin foliaceous or flabelliform erect body (diam. 4-24 cm.) arising from simple short pedicle expanding basally; surface may be marked by concentric furrows, may have loosely bound free linellae (length to 2 cm.) near margins, linellae forming dense network on both surfaces, with numerous embedded xenophya; stercomarium dendritic, occupying considerable portion of body and containing numerous xanthosomes; granellarium filled with uniform plasma, containing granellae and evenly distributed nuclei (diam. 4μ) with some larger nuclei (diam. 6-8 μ) that have a distinct nuclear membrane, a dense network of chromatin, and 1 or 2 spherical homogeneous nucleoli. *Rec.*, E.Pac. (1,740-2,200 fathoms), trop. Pac.-N.Pac.-W.Ind.O. (2,100-2,900 fathoms).—FIG. 647,1-3. **S. zonarium*; 1, trop. Pac., $\times 1$ (*1700); 2a, E.Pac., $\times 0.5$; 2b, transv. sec. (transmitted light), $\times 11$ (*803); 3a, margin, $\times 30$; 3b, sec. showing granellarium (g), stercomarium (s), linellae (l), and xenophya (x), $\times 70$ (*851).—FIG. 647,4. *S. flustraceum* (HAECKEL), N.Pac.; 4a, $\times 0.5$; 4b, distal surface, showing apertural openings (a), $\times 12$; 4c, same, $\times 4$; 4d, section showing linellae (l) and xenophya (x), $\times 150$ (*851).

Family PSAMMINIDAE Haeckel, 1889

[*Psammidae* HAECKEL, 1889, p. 7, 8, 32] [*=Psammidae* LINDENFELD, 1886, p. 589 (nom. nud., pro *Psammella* LINDENFELD, ms.); *=subfamily* *Psammidae* LANKESTER, 1909, p. 286 (nom. transl.)] [*=Xenophyphoridae* LANKESTER, 1909, p. 286 (nom. nud.)]

Body discoidal or an irregular lump or crust; with xenophya cemented together and enclosed by transparent maltha; no linellae. *Rec.*

Psammina HAECKEL, 1889, *851, p. 34 [**P. globigerina* HAECKEL, 1889; SD LOEBLICH & TAPPAN, herein] [*=Psammoplakina* HAECKEL, 1889, *851, p. 35 (type, *P. discoidea* HAECKEL, 1889 *=Psammina plakina* HAECKEL, 1889)] Body discoidal (diam. 20-30 mm., thickness 1.5-3.5 mm.), with thin flat plates of cemented xenophya, commonly foraminiferal, rarely radiolarian tests; oriented arborescent stercomarium, branches (diam. 0.3-0.5 mm.), and dichotomously branching granellarium, with jelly-like mass predominant and granellae scattered; distinct and large pores on peripheral margin or upper surface. [*Psammina* originally included 3 species without type citation (*851). The description of *P. plakina* stated that it differed sufficiently from the 2 typical species to be the type of a new genus. *Psammoplakina dis-*

coidea is thus an objective synonym of *Psammina plakina*. *P. plakina* and *P. globigerina* are congeneric (*1700).] *Rec.*, S.Atl.-trop.Pac. (1,100 to 2,750 fathoms).—FIG. 648,1-3. **P. globigerina*, trop. Pac.; 1a,b, top and edge, $\times 10$; 2, section showing radiating stercomarium (s), anastomosing granellarium (g), $\times 10$; 3, decalcified fragment, as above, with few xenophya (x) remaining consisting of radiolaria, $\times 100$.—FIG. 648,4,5. *P. plakina* HAECKEL, S.Atl.; 4a,b, top and edge, $\times 5$; 5, vert. sec. showing platelike upper and lower layers of xenophya (x) and apertural pores (a), $\times 35$ (*851).

Cerelasma HAECKEL, 1889, *851, p. 45 [**C. gyrosphaera* HAECKEL, 1889; SD LOEBLICH & TAPPAN, herein]. Globular or tuberoso body; differing from *Psammina* in rich secretion of spongin-like organic matter (maltha) forming a thin lamellar framework for entire body, and also enclosing xenophya (usually Radiolaria) in small sacculi; numerous anastomosing tubes of stercomarium containing plasmodia, with some dark-colored grains or stercomata; granellarium containing nuclei and granellae. *Rec.*, trop.Pac. (2,000-2,425 fathoms).—FIG. 648,6. **C. gyrosphaera*; 6a, exterior, $\times 0.5$; 6b, part of transv. sec., showing maltha (m), surrounding xenophya (x), and anastomosing stercomarium (s), $\times 50$; 6c, same, without xenophya, $\times 150$ (*851).

Holopsamma CARTER, 1885, *297, p. 211 [**H. laevis* CARTER, 1885, p. 212; SD LOEBLICH & TAPPAN, herein]. Body massively tuberoso or lumpy, with groups of apertural pores at crest of prominent ridges or projecting lobes; differing internally from *Cerelasma* in absence of sacculi around xenophya, and from *Psammopemma* in restriction of apertures to ridges or lobes; internal structure similar to *Psammetta*, but with addition of dark clublike masses near granellarium (latter may form network enclosed in clear sheath, and may contain small bodies as does stercomarium). [Original description (*297) included 5 species, type not cited, of which 2 were removed to *Psammopemma* (*851), remaining species not since recognized, and never figured. *H. argillaceum* HAECKEL probably *=H. laevis* CARTER, as both are described as lobose, other species hemispherical, globular, massive.] *Rec.*, N.Atl.-S.Pac.-S.Australia (1,675-2,270 fathoms).—FIG. 649,1. *H. argillaceum* HAECKEL, S.Pac.; 1a, exterior, $\times 2$; 1b, vert. sec., $\times 2.5$ (*851).

Psammetta SCHULZE, 1905, *1700, p. 6 [**P. erythrocytomorpha* SCHULZE, 1905]. Biconcave circular discs (diam. 2-3 cm.), periphery rounded, thickness constant (5-12 mm. depending on test size); surface roughened, feltlike texture, olive or brownish green; xenophya consisting largely of dense network of radially oriented siliceous sponge spicules and less abundant foraminiferal tests; granellarium of dichotomously branched but not oriented, light yellow tubes, open at ends but with some short branches having viscous spheri-

cal terminations, filled with granellae (diam. $1-3\mu$) and with definite cell nuclei (diam. 3μ) at intervals of 10μ within the tubes; dark brown, nearly

straight strands of arborescent stercomarium (diam. $0.1-0.2$ mm.), arising at center of disc and enlarging and branching outward with irregu-

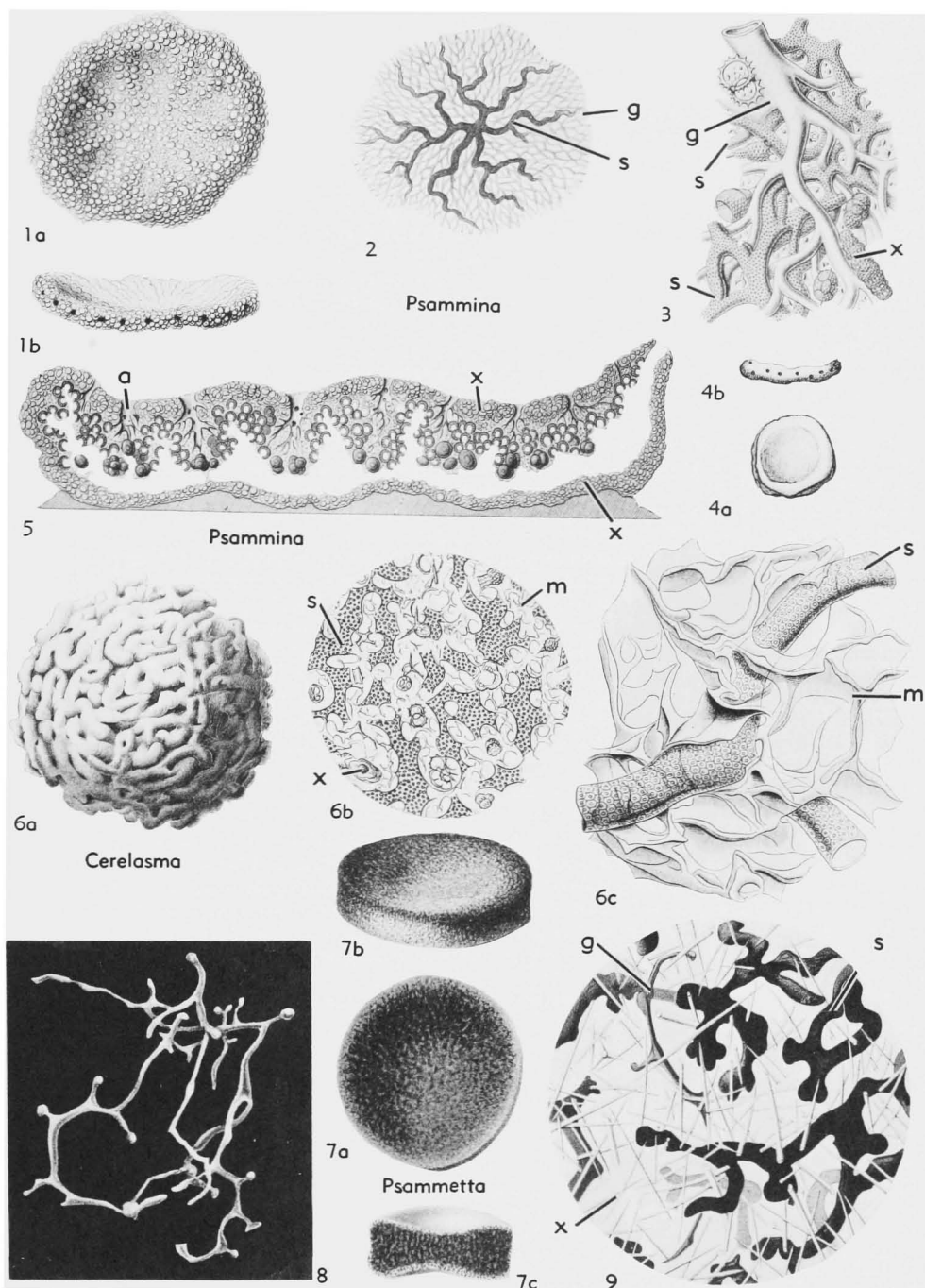


FIG. 648. Psamminidae; 1-5, *Psammina*; 6, *Cerelasma*; 7-9, *Psammetta* (p. C792-C794).

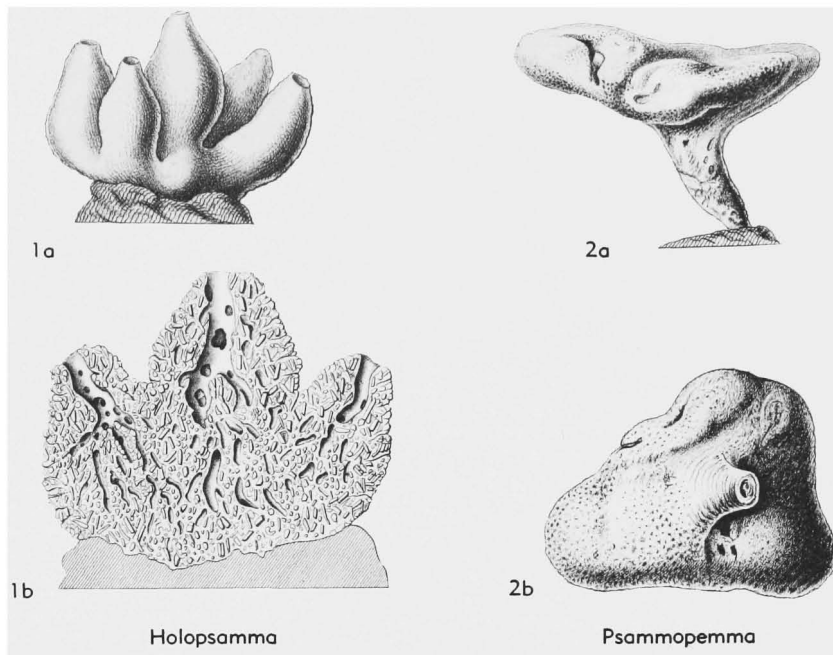


FIG. 649. Psamminidae; 1, *Holopsamma*; 2, *Psammopemma* (p. C792, C794).

larly spaced knotlike thickenings and containing yellowish to dark greenish brown globular stercomata (diam. 10-40 μ) which are acid- and dye-resistant; all structures surrounded by thin membranous spongin-like sheath or binding material, with expansions as putty-like mass at points of junction, sheath thin over xenophya, solid and firm over stercomarium, and dense over granellarium, except for spherical bulbous ends of branches; smooth, spherical xanthosomes (diam. 1-10 μ) occurring inside stercomarium and free between strands, are highly refractive and yellow-red (garnet) in color. *Rec.*, Ind.O.-E.Afr. (depth 1,668 m.).—FIG. 648,7-9. **P. erythrocytomorpha*, Ind.O.; 7a-c, top, edge and vert. sec., $\times 1$; 8, single complete portion of granellarium,

$\times 10$; 9, sec. showing stercomarium (s), granellarium (g) and xenophya (x) of sponge spicules, $\times 65$ (*1700).

Psammopemma MARSHALL, 1881, *1227, p. 113 [**P. densum* MARSHALL, 1881, OD (M)]. Irregular massive or lumpy body, entire surface with numerous small pores, no large openings as in *Psammina* and *Holopsamma*; xenophya of foraminifers or radiolarians, not enclosed in sacculi like those of *Cerelasma*; narrow branched tubes of granellarium interwoven with anastomosing tubes of stercomarium. *Rec.*, trop.Atl.-trop.Pac. (2,400-2,600 fathoms).—FIG. 649,2. *P. radiolarium* HAECKEL, trop.Pac.; 2a,b, side and basal views, $\times 2$ (*851).

Order LABYRINTHULIDA Lankester, 1877

[In synonymic citations superscript numbers indicate taxonomic rank assigned by authors (1series, 2section, 3suborder, 4order, 5subclass, 6class and a dagger(†) indicates *partim*)] —[=⁴Labyrinthulida LANKESTER, 1877, p. 442; =⁵Labyrinthulidae LANKESTER, 1885, p. 838; =³Labyrinthuleae ZOPF, 1892, p. 46; =⁴Labyrinthulids DELAGE & HÉROUARD, 1896, p. 79 (*nom. neg.*); =⁴Labyrinthuleae OLIVE, 1902, p. 453; =⁴Labyrinthulidea POCHÉ, 1913, p. 194; =Labyrinthuloidea VALKANOV, 1940, p. 245; =⁴Labyrinthulales MARTIN in AINSWORTH and BISBY, 1950, p. 411] —[=Monadinen (Monadineae)† ZOPF, 1885, p. 98; =Monadineae azoosporae ZOPF, 1885, p. 99] —[=⁶Proteomyxa LANKESTER, 1885, p. 839; =⁵Proteomyxēs (*nom. neg.*) and =⁵Proteomyxiae DELAGE & HÉROUARD, 1896, p. 66; =³Protomyxidea DOFLEIN, 1901, p. 40; =⁵Proteomyxa CALKINS, 1909, p. 38; =⁴Proteomyxæ CHATTON, 1925, p. 76; =⁴Proteomyxa KUDO, 1931, p. 177; =⁴Proteomyxida T. L. JAHN & F. F. JAHN, 1949, p. 108; =⁴Protomyxidea, Protomyxēs (*nom. neg.*) TRÉGOUBOFF in GRASSÉ, 1953, p. 466] —[=²Filosat, =²Proteana LANKESTER, 1885, p. 838; =⁴Filoplasmodiēs (*nom. neg.*), =⁴Filoplasmodida DELAGE & HÉROUARD, 1896, p. 79; =⁴Filoplasmodida CALKINS, 1909, p. 38; =³Filoplasmodinos (*nom. neg.*), =³Filoplasmodinae FERNÁNDEZ GALIANO, 1921, p. 40] —[=²Zoosporae†

BERLESE in SACCARDO, 1888, p. 453; =⁴Zoosporēs (*nom. neg.*), =⁴Zoosporida DELAGE & HÉROUARD, 1896, p. 72] —[=⁴Azoosporae† BERLESE in SACCARDO, 1888, p. 453; =⁴Azoosporēs (*nom. neg.*), =⁴Azoosporida DELAGE & HÉROUARD, 1896, p. 67] —[=⁴Acystosporēs† (*nom. neg.*), =⁴Acystosporidat DELAGE & HÉROUARD, 1896, p. 66] —[=⁴Athalamiat SCHMARD, 1871, p. 160; =⁴Oomycetēs VAN TIEGHEM, 1898, p. 22 (*nom. neg.*); =⁴Vampyrellida WEST, 1901, p. 308, 333; =⁴Vampyrellidea POCHÉ, 1913, p. 182; =⁴Myxoida HARTOG in HARMER & SHIPLEY, 1906, p. 89; =³Reticulosa (Proteomyxa) MINCHEN, 1912, p. 217; =⁴Myxozoot, Mycetozoot, Mycetozoidat SCHEPOTIEFF, 1912, p. 267 (*non*=Mycetozoa DE BARY, 1859; *non*=Mycetozoida CALKINS, 1901)] —[=¹Hydromyxalest E. JAHN in ENGLER & PRANTL, 1928, p. 311; =⁴Myxothallophytat FITZPATRICK, 1930, p. 5; =⁴Pseudo-Heliozoaires TRÉGOUBOFF in GRASSÉ, 1953, p. 466 (*nom. neg.*)]

Branching and anastomosing radiating filopodia or rhizopodia; no test or shell; majority parasitic on algae or higher plants in fresh or marine water; flagellate swarm-

ers and encystment occur in life cycle. No hard parts. *Rec.*

Family LABYRINTHULIDAE Cienkowski, 1867

[*nom. correct.* DOFLEIN, 1901, p. 47 (*pro* Labyrinthuleae CIENKOWSKI, 1867, p. 274).]—[=Labyrinthuleen ZOFF, 1892, p. 46 (*nom. neg.*); =Labyrinthulidos GADEA BUISÁN, 1947, p. 28 (*nom. neg.*); =Labyrinthulida COPELAND, 1956, p. 201, 203 (*nom. neg.*); =Filoplasmodiaceae HARTOG in HARMER and SHIPLEY, 1906, p. x, 90 (*nom. nud.*)]

Small fusiform bodies grouped in a network of filopodia, or pseudoplasmodium, individuals encyst independently, may have flagellate stage in life cycle. *Rec.*

Family PSEUDOSPORIDAE Berlese, 1888

[*nom. correct.* POCHÉ, 1913, p. 197 (*pro* Pseudosporae BERLESE in SACCARDO, 1888, p. 453).]—[=Monadineae Zoosporae CIENKOWSKI, 1865, p. 213 (*nom. nud.*); =Zoosporae HARTOG in HARMER and SHIPLEY, 1909, p. x, 89 (*nom. nud.*);

=Pseudosporae ZOFF, 1885, p. 115 (*nom. neg.*); =Pseudosporinae DELAGE and HÉROUARD, 1896, p. 74; =Pseudosporae COPELAND, 1956, p. 191 (*nom. van.*); =Ectobiellidae POCHÉ, 1913, p. 199]

Solitary and heliozoan-like, with flagellate swimmers. *Rec.*

Family VAMPYRELLIDAE Zopf, 1885

[*nom. correct.* KLEBS, 1892, p. 428 (*pro* Vampyrellaceae ZOFF, 1885, p. 99).]—[=Vampyrellae BERLESE in SACCARDO, 1888, p. 453; =Vampyrellacées VAN TIEGHEM, 1898, p. 22 (*nom. neg.*); =Vampyrellida CASH & HOPKINSON, 1905, p. 36; =Vampyrellacea COPELAND, 1956, p. 191 (*nom. van.*)]—[=Monadinae Tetraplastae CIENKOWSKI, 1865, p. 218 (*nom. nud.*); =Hydromyxaceae KLEIN, 1882, p. 254 (*nom. nud.*); =Bursullineae ZOFF, 1885, p. 111 (*nom. neg.*); =Bursullinae BERLESE in SACCARDO, 1888, p. 453; =Bursullidae POCHÉ, 1913, p. 183].—[=Azoosporidae DOFLEIN, 1901, p. 40 (*nom. nud.*); =Azoosporae† HARTOG in HARMER & SHIPLEY, 1906, p. x, 89 (*nom. nud.*); =Azoosporida VALKANOV, 1940, p. 240 (*nom. nud.*)]—[=Monobidiidae POCHÉ, 1913, p. 183; =Pseudo-Heliozoa SANDON, 1927, p. 146 (*nom. nud.*); =Plakopodaceae E. JAHN in ENGLER & PRANTL, 1928, p. 313]

Solitary and heliozoan-like, multinucleate; without flagellate swimmers. *Rec.*

ADDENDUM

The following genera were published after families to which they belong were submitted to the Editor.

Accordiella FARINACCI, 1962, *711A, p. 7, 9 [**A. conica*; OD]. Test large, 1.2 mm. in height, 0.6 to 1.0 mm. in diameter, conical, circular in section; chambers large, in high trochospiral coil of 3 or more chambers per whorl and 8 to 12 volutions, exterior region simple and undivided, axial part of test with numerous horizontal plates and vertical pillars, resulting in labyrinthic appearance, chambers communicating with inner labyrinthic region by means of evenly aligned perforations at inner edge of chamber roof; wall calcareous, imperforate, microgranular, with rare agglutinated grains, inner layer darker, possibly originally pseudochitinous, outer layer with hyaline calcite crystals; aperture cribrate, consisting of perforations between pillars, over convex terminal face. *U. Cret. (Coniac. - Santon.)*, Eu. (Italy-Fr.-Spain).—FIG. 651, 1. **A. conica*, Santon., Italy (S. Lazio); 1a, nearly axial sec. of holotype, 1b, transv. sec. of paratype, 1c, subtang. sec. of paratype showing undivided outer region of chambers, all $\times 35$ (*711A).

[Originally placed in the family Verneuilinidae, subfamily Eggerellinae, this genus is here transferred to the Pfenderinae (family Pavonitinae) because of wall character and composition, trochospiral coiling, and complex interior. It is similar to *Pfenderina*, differing in having fewer chambers per whorl, and broadly conical test.] (See p. C292.)

Dainella BRAZHNKOVA, 1962, *204A, p. 22 [*Endothyra*(?) *chomatica* DAIN in BRAZHNKOVA, 1962, *204A, p. 23; OD]. Subglobular test, slightly appressed along axis; numerous chambers per whorl, increasing slowly and regularly in size; streptospirally enrolled, involute; wall calcareous, single homogeneous layer, with massive chomata;

aperture simple, basal. [Differs from *Endothyra* in the homogeneous wall, numerous chambers per whorl and massive chomata, and from *Quasiendothyra* in the involute coiling and inflated test, simple wall, and strongly streptospiral coiling throughout.] *L. Carb. (L. Visean)*, USSR (Don Basin-Ukraine).—FIG. 650, 1. **D. chomatica* (DAIN); 1a, axial sec. of holotype, $\times 100$; 1b, c, horiz. and axial secs. of paratypes, $\times 90$, $\times 75$ (*204A). (See p. C346.)

Goatapitigba NARCHI, 1962, *1346A, p. 277 [**G. jurara*; OD]. Test attached; globular proloculus followed by few somewhat inflated pyriform cham-

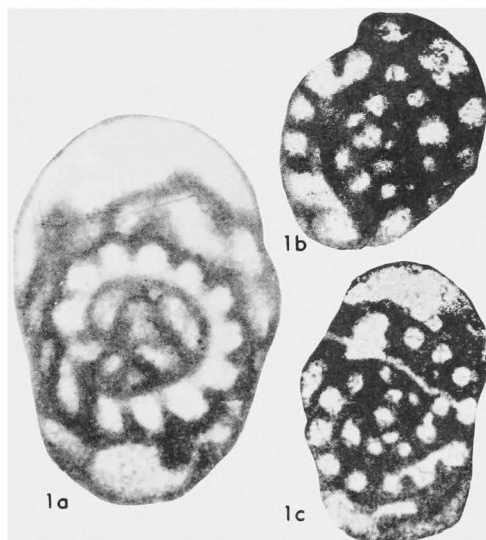
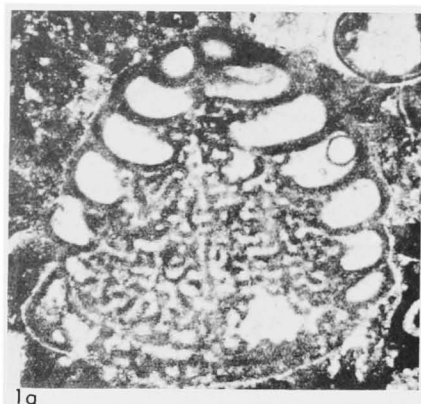
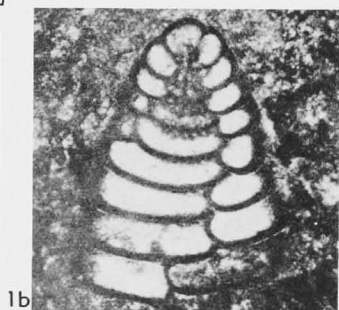


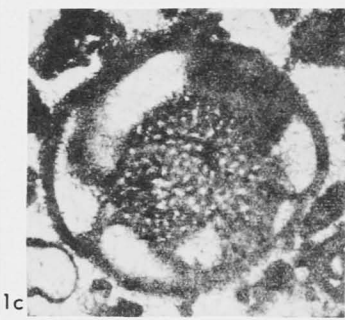
FIG. 650. Endothyridae (Endothyrinae; 1, *Dainella*) (p. C795).



1a



1b



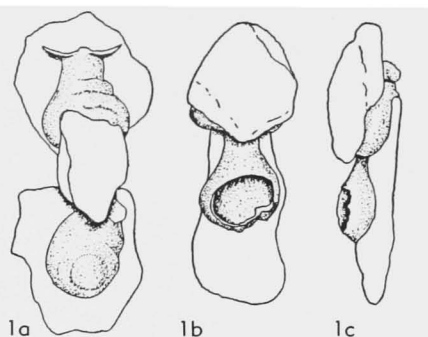
1c

FIG. 651. Pavnitininidae (Pfundnerinidae; 1, *Accordiella*) (p. C795).

bers; wall agglutinated, with considerable cement and pseudochitinous inner layer; aperture terminal, against attachment. *Rec.*, S.Am.(Brazil, Cabo Frio).—FIG. 652, 1. **G. jurara*; 1a, holotype, $\times 14$; 1b,c, top and edge views of paratype, $\times 14$ (*1346A).

[The chamber form is reminiscent of the porcelaneous Nubulariinae, some of which may also have surficial agglutinated material. As no information is available as to the amount or character of the cement, the present genus is retained tentatively in the Saccamminidae and because of its attached nature is placed in the Hemisphaeramminidae. It differs from *Saccamminis* in the regular and pyriform chambers, and finely agglutinated wall.] (See p. C204.)

Petchorina REYTLINGER in VARSANOFEVA & REYT-



1a

1b

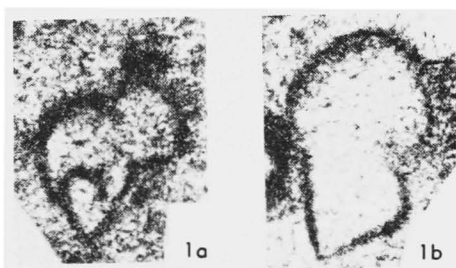
1c

FIG. 652. Saccamminidae (Hemisphaeramminidae; 1, *Goatapitigba*) (p. C795-C796).

LINGER, 1962, *1980A, p. 56 [**P. schezhimovensis*; OD]. Test oval to angularly irregular in outline, 0.31 to 0.45 mm. in diameter; interior partially subdivided by short pseudosepta into 2 or 3 successively larger pseudochambers; wall calcareous, microgranular, about 36μ in thickness; aperture not observed. [Originally placed in the Parathuramminidae, and stated to differ from *Bisphaera* by the presence of pseudosepta, and from *Baituganella* by the test form and minutely granular wall. Tentatively recognized herein, it is also similar in outline to *Uslonia*, which occurs in correlative strata in Kazan, but differs in the presence of partial chamber subdivisions.] *Dev.* (Frasn.), USSR (Pechora distr.).—FIG. 653, 1. **P. schezhimovensis*; 1a, holotype; 1b, paratype, $\times 70$ (*1980A). (See p. C315.)

Asterocyclina GÜMBEL, 1870 (see p. C714).

[The name *Asteriatites* was published by VON SCHLOTHEIM in 1813 (Taschenb. Mineralogie, v. 7, p. 68, 109) as designation of an asterozoan (p. 68) and of a foraminifer (p. 109). In 1820 the same author (Die Petrefactenkunde, p. 324) referred to the echinoderm as *Asteriacites*, interpreted by NEAVE as a lapsus (pro *Asteriatites* SCHLOTHEIM, 1813, p. 68). Then, in 1822 SCHLOTHEIM again published *Asteriacites* (Petrefactenkunde Nachtrag 1, p. 71) as the name for his (1813, p. 109) foraminifer. The ambiguous application of *Asteriatites* in 1813 is resolved by fixing it herein as the name for an ophiuroid (p. 68), with type-species by subsequent monotypy as *Asteriacites ophiurus* SCHLOTHEIM, 1820, p. 324. *Asteriacites* SCHLOTHEIM, 1822 (type, *A. patellaris*) is a junior homonym, cited properly as (*non Asteriacites* SCHLOTHEIM, 1820).]



1a

1b

FIG. 653. Parathuramminidae; 1, *Petchorina* (p. C796).

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