SCHISTOCERATOIDEA

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Superfamily SCHISTOCERATOIDEA Schmidt, 1929

[*nom. transl.* Kullmann, herein, *ex* Schistoceratidae Schmidt, 1929, p. 75]

Conch form discoidal to thickly discoidal; evolute and usually with wide umbilicus to moderately involute with narrow umbilicus. Triangular coiling of early whorls common in some groups. Shell surface smooth or reticulate; growth lines sinuous, with ventral sinus. Early whorls may exhibit riblike nodes on umbilical shoulder, extending to biconvex growth striae. Suture similar to Gastrioceratoidea, but with the following tendencies during the course of phylogeny: (1) median saddle becoming as high as entire ventral lobe; (2) ventral lobe becoming wide and in some forms giving rise to additional sutural elements or subelements (Welleritidae); (3) umbilical portion of suture expanded between L and U [German], U and I [Russian], in some genera giving rise to new sutural elements: $(E_1E_mE_1)AL{:}UI$ --> $(E_1E_mE_1)ALU_2{:}U_1I$ --> $E_1E_mE_1ALU_{2v}U_{2m}U_{2d}U_1I$ [German], $(V_1V_1)LU{:}ID$ --> $(V_1V_1)LU_1{:}U_2ID$ --> $(V_1V_1)LU_1U_{2.2}U_{2.1}{:}U_{2.2}ID$ [Russian] (Schistoceratidae, Welleritidae, Christioceratidae); (4) trifurcation of lobes (Schistoceratidae, Christioceratidae). *Pennsylvanian (upper Bashkirian)–Cisuralian (Sakmarian).*

Family SCHISTOCERATIDAE Schmidt, 1929

[Schistoceratidae Schmidt, 1929, p. 75] [=Bendoceratidae Plummer & Scott, 1937, p. 208, subj.]

Triangular or irregular coiling of early whorls common. Ornamentation of shell surface reticulate; at young stage with riblike nodes on umbilical shoulder. During the course of phylogeny, umbilical portion of suture expanding and giving rise to additional sutural elements by addition of a second umbilical lobe (U_2) and finally its trifurcation ($U_{2v}U_{2m}U_{2d}$) [German], $U_{2.2}U_{2.1}{:}U_{2.2}$ [Russian]. Sutural development $(E_1E_mE_1)AL{:}UI$ --> $E_1E_mE_1ALU_{2v}U_{2m}{:}U_{2d}U_1I$ [German], $(V_1V_1)LU{:}ID$ --> $(V_1V_1)LU_1U_{2.2}U_{2.1}{:}U_{2.2}ID$ [Russian]. *Pennsylvanian (upper Bashkirian)–Cisuralian (Sakmarian).*

Schistoceras Hyatt, 1884 in 1883–1884, p. 336 [**S. hyatti* Smith, 1903, p. 108; SD Smith, 1903, p. 104; =*Goniatites missouriensis* Miller & Faber, 1892, p. 164, subj., *fide* Miller & Furnish, 1940c, p. 538] [=*Metaschistoceras* Plummer & Scott, 1937, p. 255 (type, *M. heilprini* Plummer & Scott, 1937, p. 256, OD); for discussion, see Miller & Furnish, 1940c, p. 538]. Conch form moderately evolute to involute, with narrow umbilicus at maturity. Growth striae biconvex; longitudinal lirae present, but reticulate ornamentation inconspicuous. Shell surface smooth, without nodes. Median saddle almost as high as first lateral saddle; second umbilical lobe trifurcate, its portions being completely separate. Sutural formula $E_1E_mE_1ALU_{2v}U_{2m}{:}U_{2d}U_1I$ [German], $(V_1V_1)LU_1U_{2.2}U_{2.1}{:}U_{2.2}ID$ [Russian]. Seven species. *Pennsylvanian (Kasimovian)–Cisuralian (Sakmarian):* Russia and Kazakhstan (South Urals), Slovenia (?Karawanken Mountains), Russia (Siberia), China (Ningxia), USA (Illinois, Iowa, Missouri, Ohio, Oklahoma, Pennsylvania, Texas). ——Fig. 65,*1a–c.* **S. missouriense* (Miller & Faber); *a–b,* Kansas City, Missouri, USA, Winterset Limestone, middle part of Missourian, ×1; *c,* suture, Jack County, Texas, USA, Graham Formation, Virgilian, SUI 14000, ×1 (Miller & Furnish, 1940c).——Fig. 65,*1d. S. diversecostatum* Böse, cross section, upper part of Gaptank Formation, Virgilian, Texas, ×4 (Ruzhentsev, 1950).

Branneroceras Plummer & Scott, 1937, p. 218 [**Gastrioceras branneri* Smith, 1896, p. 257; OD] [=*Tschungkuoceras* Gerth, 1950, p. 264 (type, *Gastrioceras peronatum* Yin, 1935, p. 25, OD), for discussion, see McCaleb, 1968, p. 64]. Conch form evolute, with wide or moderately wide umbilicus. Coiling of inner whorls in some forms irregular to tetragonal. Ribs transversely elongate, fasciculating into several weak ribs, or dichotomizing on flanks or ventrolateral shoulder, with ventrolateral salient and deep ventral sinus. Growth striae biconvex, crossed by fine longitudinal lirae, producing crenulate appearance. Branches of ventral lobe narrow; height of median saddle about three-quarters entire ventral lobe. Eight species. [For more information about the irregularity of the inner whorls, see McCaleb, 1968, pl. 9,*9, 12, 16.* For general discussion about the genus, see Nassichuk, 1975, p. 139.]

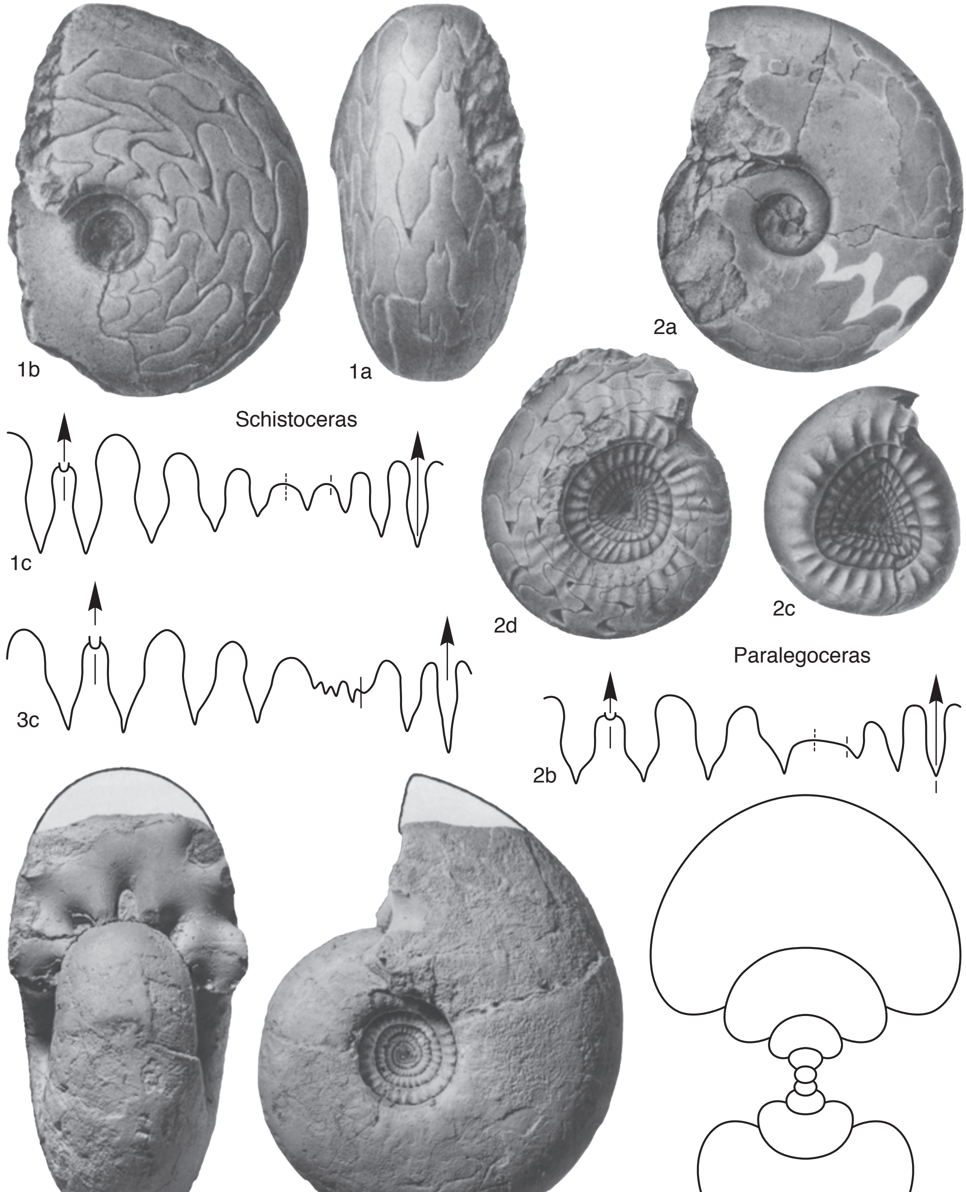

FIG. 65. Schistoceratidae (p. 108–111).

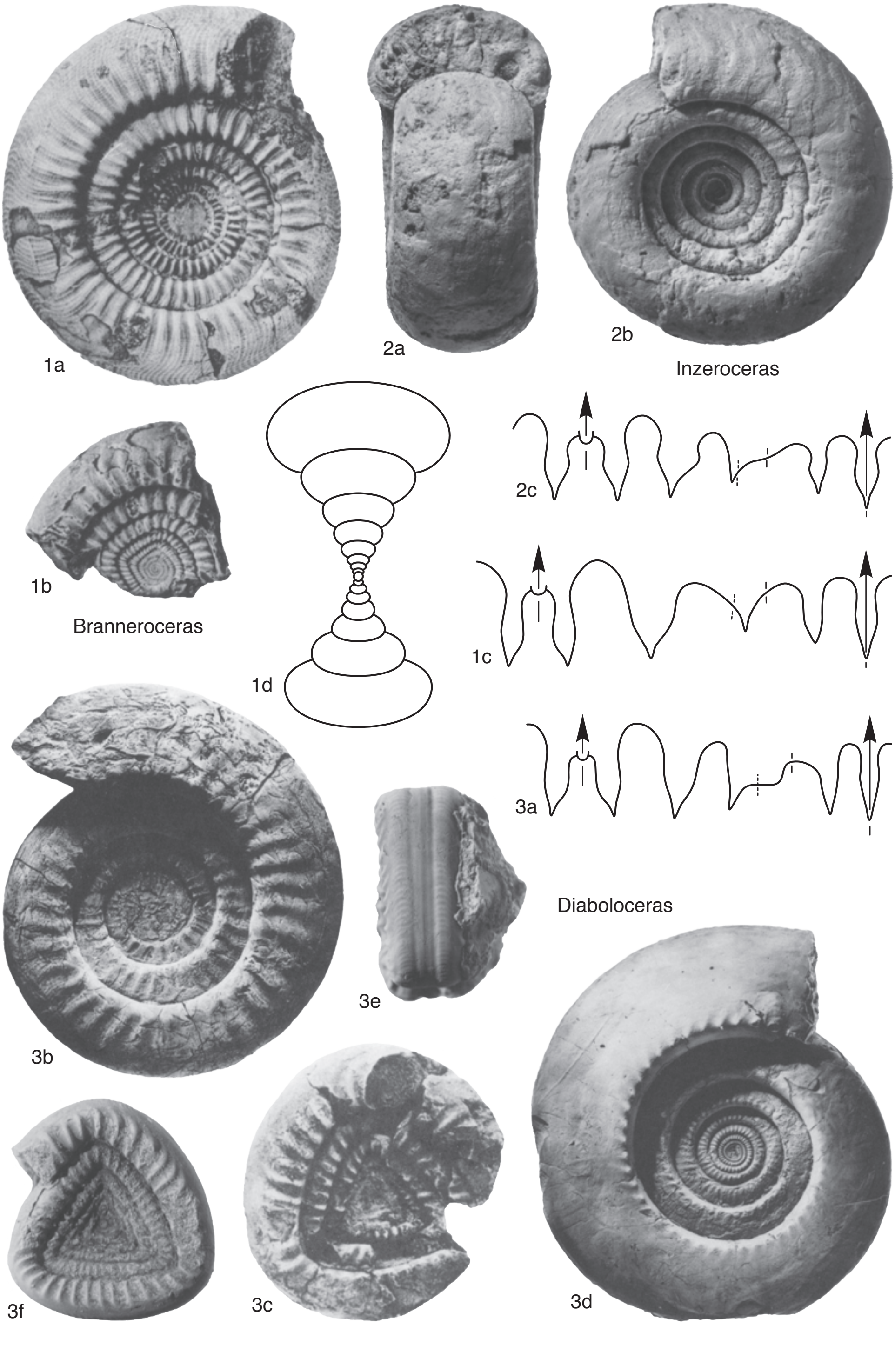

FIG. 66. Schistoceratidae (p. 108–111).

Pennsylvanian (upper Bashkirian–Moscovian): Spain, Ukraine (Donets), Algeria, China (Gansu, Guangxi, Guizhou, Xinjiang), Japan, Iran, Kyrgyzstan, Uzbekistan, Canada (Northwest Territories), USA (Arkansas, Oklahoma, Texas, Nevada).——FIG. 66,*1a–d.* **B. branneri* (SMITH); *a,* side view, Brentwood Limestone Member, Bloyd Formation, 11 km southwest of Harrison, Boone County, Arkansas, SUI 11694, ×0.8; *b,* side view of fragment, limestone conglomerate of Brentwood Member, Devil's Den State Park on Lee Creek, about 12 km southwest of Winslow, Washington County, SUI 11693, ×1.9 (McCaleb, 1968); *c,* suture, SUI 1975, east side of Gaither Mountains, about 11 km southwest of Harrison, Boone County, Arkansas, ×1.5 (Miller & Moore, 1938); *d,* cross section, Morrowan, Arkansas, ×4.1 (Ruzhentsev, 1950).

Diaboloceras MILLER & FURNISH, 1940c, p. 527 [**D. varicostatum;* OD] [=*Trigonogastrioceras* LIBROVICH, 1957, p. 255 (type, *T. uralicum* LIBROVICH, 1957, p. 256, OD); =?*Rodiezmoceras* WAGNER-GENTIS in MOORE & others, 1971, p. 349 (type, *R. bisati,* OD)]. Conch very large, umbilicus always wide; inner whorls exhibit triangular coiling and may develop keel and two ventral grooves. Ribs on flanks weak, ornamentation reticulate. Second umbilical lobe on dorsal side of lateral lobe, not yet separate; sutural formula: $(E_1E_mE_1)AL(U_2)U_1I$ [German], $(V_1V_1)L(U_1U_2)$:ID [Russian]. Eight species. [*Trigonogastrioceras* was based on an immature specimen; for discussion, see GORDON, 1965, p. 267. *Rodiezmoceras,* based on three poorly preserved specimens, also has coarse ribs, but the axis of the umbilical lobe lies on the lateral flank; it may be a representative of *Diaboloceras* or *Paralegoceras.* For discussion of genus, see NASSICHUK, 1975, p. 147; SAUNDERS, MANGER, & GORDON, 1977, p. 124; and RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 63.] *Pennsylvanian (upper Bashkirian–Moscovian):* Spain, Russia (Novaia Zemlia, South Urals, Siberia), Ukraine (Donets), China (Xinjiang), Japan, Canada (Northwest Territories), USA (Alabama, Arkansas, Kentucky, Oklahoma, Texas).——FIG. 66,*3a.* **D. varicostatum,* suture, Braggs Mountain, southeastern Muskogee, Oklahoma, USA, lower Atoka Formation, SUI 1418, diameter at approximately 50 mm, ×1.3 (Miller & Furnish, 1958a).——FIG. 66,*3b–c. D. neumeieri* QUINN & CARR, conglomeratic limestone in Trace Creek Shale Member, Bloyd Formation, 3.2 km west of Woolsey, Washington County, Arkansas, USA; *b,* holotype, UA L11WO1, ×0.3; *c,* paratype, UA L11WO2, side view of fragment, ×1.7 (McCaleb, 1968).——FIG. 66,*3d. D. ruzhencevi* ANDRIANOV, upper Bashkirian, Siberia, ×0.17 (Ruzhentsev & Ganelin, 1971).——FIG. 66,*3e–f. D. uralicum* (LIBROVICH), Sibai Canyon, Urtazym area, Orenburgskaia oblast', South Urals, Kordailov Formation, upper Bashkirian, ×3 (Librovich, 1957).

Eoschistoceras RUZHENTSEV, 1952a, p. 914 [**E. turkestanicum;* OD]. Triangular coiling of early whorls less pronounced than in *Paralegoceras.* Width of umbilicus decreasing during ontogeny. Ornamentation reticulate, with umbilical ribs. Suture line similar to *Paralegoceras,* but second umbilical lobe becoming trifurcate. Two species. *Pennsylvanian (Kasimovian–Gzhelian):* Kazakhstan, USA (Oklahoma).——FIG. 65,*3a–c.* **E. turkestanicum; a–b,* holotype, south of Karatau, promontories of Turkestan Range, Kazakhstan, lower Gzhelian, PIN 700/2, ×1; *c,* suture, PIN 700/3, whorl height at about 19.5 mm, whorl width 24.5 mm, ×1.5 (Ruhentsev, 1952a).

Inzeroceras RUZHENTSEV, 1974b, p. 35 [**I. bellum* RUZHENTSEV, 1974b, p. 36; OD]. Conch discoidal, evolute, with wide umbilicus. No triangular coiling of early whorls. Sculpture consisting of weak umbilical plications and well-developed lirae. Ventral lobe fairly broad, divided by high median saddle into two lanceolate branches. Adventitious lobe pouched; primary umbilical lobe has rudimentary crenulations centered on umbilical seam. One species from one locality. [RUZHENTSEV and BOGOSLOVSKAIA (1978, p. 64) included *Inzeroceras* in the family Christioceratidae, regarding it as a forerunner of *Christioceras* with its trifid mode of lateral lobes.] *Pennsylvanian (Moscovian):* Russia (South Urals). ——FIG. 66,*2a–c.* **I. bellum,* holotype, Askyn River, Solontsy, Bashkortostan, PIN3470/1; *a–b,* ×3; *c,* suture, whorl height at 4.3 mm, whorl width 7.8 mm, ×3.4 (Ruzhentsev, 1974b).

Paralegoceras HYATT, 1884 in 1883–1884, p. 327 [**Goniatites iowensis* MEEK & WORTHEN, 1860, p. 471; M] [=*Bendoceras* PLUMMER & SCOTT, 1937, p. 208 (type, *Goniatites texanus* SHUMARD, 1863, p. 109, OD), for discussion, see MILLER & FURNISH, 1940c, p. 522]. Conch large, subdiscoidal; early whorls evolute, with triangular coiling. Adult stages moderately involute. Ornamentation reticulate, transverse umbilical nodes present, disappearing at maturity. Ventral lobe wide, with high median saddle. Second umbilical lobe independent in adult stage, sutural formula: $E_1E_mE_1ALU_2U_1I$ [German], $(V_1V_1)LU_1:U_2$:ID [Russian]. Five species, two questionable. [For discussion, see GORDON, 1965, p. 267.] *Pennsylvanian (Moscovian):* ?Slovakia, China (Xinjiang), Japan, USA (Arkansas, Iowa, California, Ohio, Oklahoma, Texas), Peru. ——FIG. 65,*2a–b.* **P. iowense* (MEEK & WORTHEN), holotype, Cherokee Formation, Wapello County, Iowa, USA, Desmoinesian, UI 11098; *a,* side view, ×0.5; *b,* suture, diameter at approximately 60 mm, ×0.8 (Miller & Furnish, 1940c).——FIG. 65,*2c–d. P. texanum* (SHUMARD), Clarita, Coal County Oklahoma, USA, lower Atoka Formation; *c,* side view, SUI 13996, ×1.3; *d,* side view, SUI 13998, ×0.7 (Miller & Furnish, 1940c).

Paraschistoceras PLUMMER & SCOTT, 1937, p. 248 [**Ammonites hildrethi* MORTON, 1836, p. 149; OD] [=*Pintoceras* PLUMMER & SCOTT, 1937, p. 245 (type, *P. postvenatum,* OD), *nom. nud.,* legally established by first revising authors, MILLER & FURNISH, 1958a, p. 257, subjective synonym of *Paraschistoceras strawnense* PLUMMER & SCOTT, 1937, p. 248)]. Conch evolute, with wide umbilicus on young stages, but moderately wide at maturity;

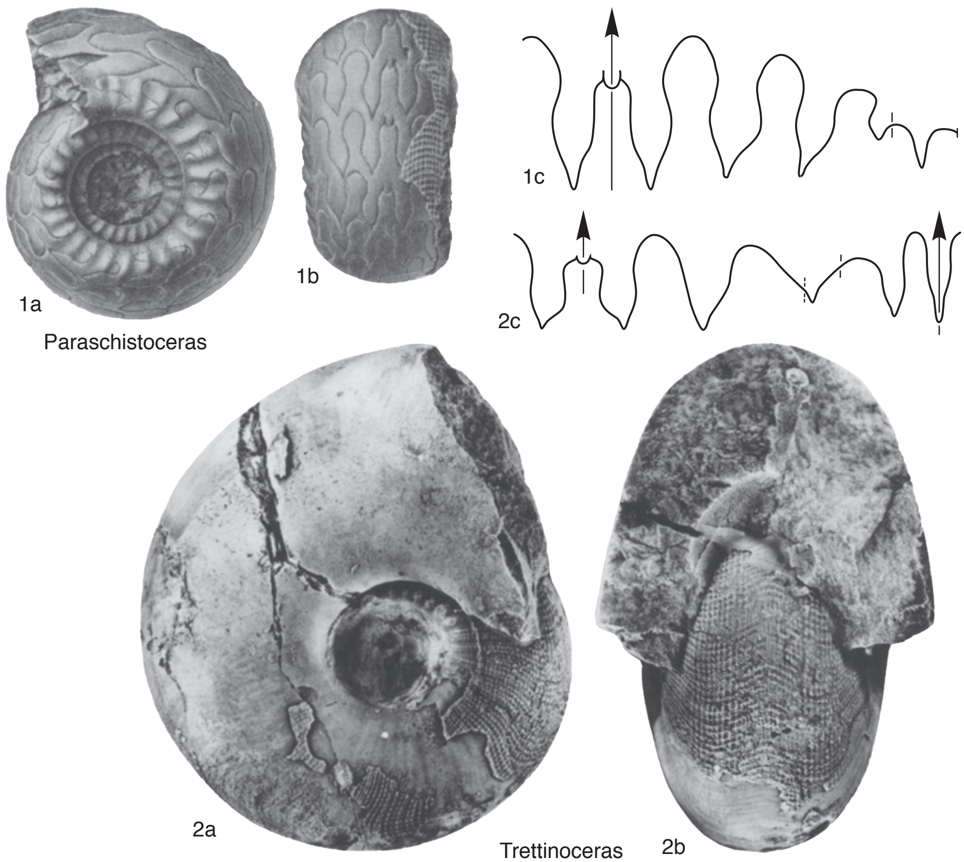

FIG. 67. Schistoceratidae (p. 111–112).

no triangular coiling of inner whorls. Growth striae biconvex; longitudinal lirae present, but reticulate ornamentation inconspicuous. Umbilical shoulder nodose during early growth stages, shell surface smooth at maturity. Median saddle almost as high as first lateral saddle; second umbilical lobe weakly trifurcate. Sutural formula $E_1E_mE_1ALU_{2v}U_{2m}:U_{2d}U_1I$ [German], (V_1V_1) $LU_1U_{2.2}U_{2.1}:U_{2.2}ID$ [Russian]. Four species. [This genus is similar to *Eoschistoceras* and may be its senior synonym.] *Pennsylvanian (Kasimovian–Gzhelian):* Russia and Kazakhstan (South Urals), Russia (Siberia), Uzbekistan (Fergana), USA (Illinois, Kansas, Missouri, Ohio, Oklahoma, Pennsylvania, Texas).——FIG. 67,*1a–b.* **P. hildrethi* (MORTON), Kansas City, Missouri, USA, Muncie Creek shale, Missourian, ×1.5 (Miller & Furnish, 1940c).——FIG. 67,*1c. P. postvenatum* (PLUMMER & SCOTT), suture, 24 km south of Holdenville, Hughes County, Oklahoma, USA, Wewoka Formation, Desmoinesian, SUI 1962, diameter at approximately 75 mm, ×0.7 (Miller & Furnish, 1958a).

Trettinoceras NASSICHUK, 1975, p. 136 [**T. ellesmerensis* NASSICHUK, 1975, p. 137; OD]. Conch moderately involute, with relatively narrow umbilicus; early whorls triangularly coiled. Umbilical nodes conspicuous in immature stages, absent at maturity. Ornamentation reticulate, consisting of longitudinal lirae and more pronounced sinuous growth lamellae. Height of median saddle exceeding slightly half height of entire ventral lobe. One species from one locality, of uncertain affinity. *Pennsylvanian (Moscovian [Atokan]):* Canada (Northwest Territories).——FIG. 67,*2a–c.* **T. ellesmerensis,* holotype, north side of Hare Fiord, northern Ellesmere Island, GSC 33810; *a–b,* ×2.2; *c,* suture, diameter at 42 mm, magnification not stated (Nassichuk, 1975).

Family PSEUDOPARALEGOCERATIDAE Librovich, 1957

[Pseudoparalegoceratidae LIBROVICH, 1957, p. 255]

Conch form with wide to moderately wide umbilicus. No triangular inner whorls. Shell surface smooth. Suture line without addi-

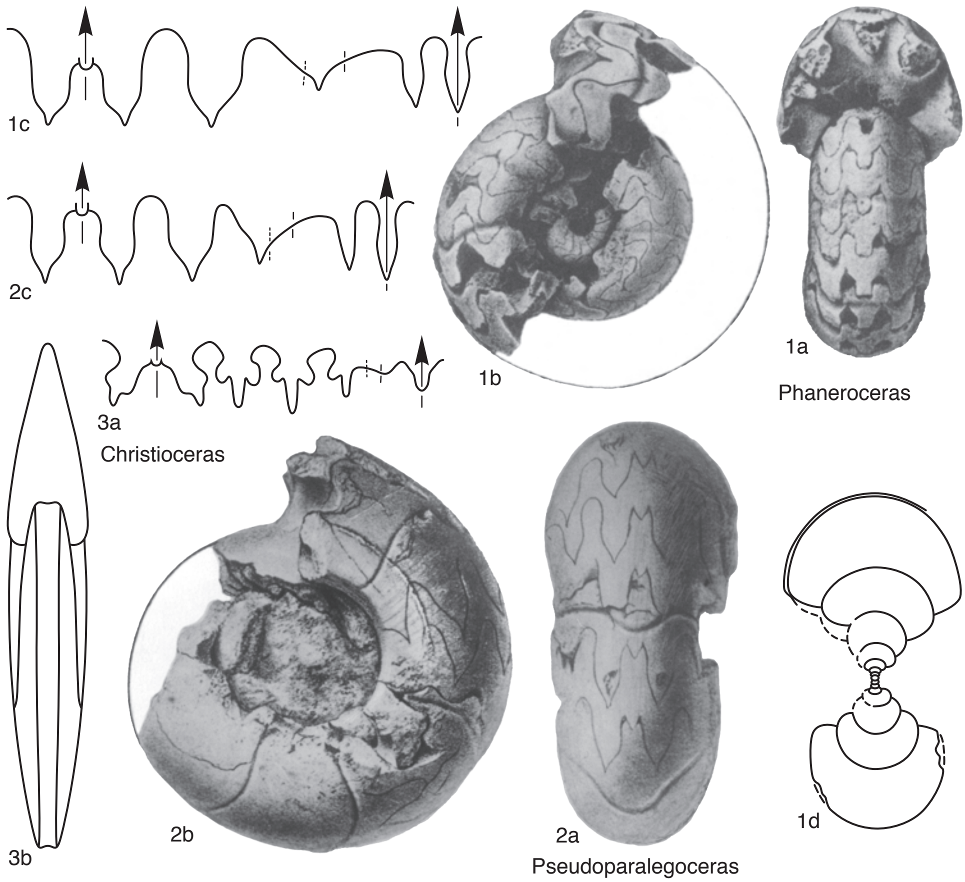

FIG. 68. Pseudoparalegoceratidae and Christioceratidae (p. 113–119).

tional elements. Median saddle exceeding three-quarters height of entire ventral lobe. Primary umbilical lobe centered on umbilical shoulder or adjacent flank. *Pennsylvanian (upper Bashkirian–Kasimovian).*

Pseudoparalegoceras MILLER, 1934a, p. 18 [**Gastrioceras russiense* TSVETAEVA, 1888, p. 42; OD] [=*Strawnoceras* PLUMMER & SCOTT in PLUMMER & HORNBERGER, 1935, p. 20 (type, *S. brazoense,* M, *nom. nud.*)]. Width of umbilicus one-third to about one-half conch diameter. Growth lines sinuous, reticulate. Axis of umbilical lobe shifted to flank, lying slightly outside umbilical shoulder. Six species. [This genus is transitional to *Phaneroceras*; for discussion, see GORDON, 1965, p. 263.] *Pennsylvanian (upper Bashkirian–Kasimovian):* Russia (Moscow Basin, North Urals), Kazakhstan (South Urals), Spain, China (Guizhou), Japan, USA (Alaska, Arkansas, New Mexico, Oklahoma, Texas).——FIG. 68,*2a–c.* **P. russiense* (TSVETAEVA), Russian platform, Moscow Basin, Moscovian; *a–b,* ×0.75 (Tsvetaeva, 1888, adapted from Bogoslovskii, Librovich, & Ruzhentsev, 1962); *c,* suture, ×0.8 (Miller & Furnish, 1940c, adapted from Karpinskii, 1889, fig. 22a).

Phaneroceras PLUMMER & SCOTT, 1937, p. 189 [**Gastrioceras compressum* HYATT, 1891, p. 355; OD] [=*Eoparalegoceras* DELÉPINE, 1939, p. 34 (type, *E. clariondi,* M); for discussion, see GORDON, 1965, p. 263]. Axis of umbilical lobe centered on umbilical shoulder or wall. Ten species. [This genus is transitional to *Pseudoparalegoceras.* For discussion, see MCCALEB, 1968, p. 55, and NASSICHUK, 1975, p. 110. View of conch of type species is not available; type species of poorly defined genus is doubtful.] *Pennsylvanian (upper Bashkirian–Moscovian):* Spain, Morocco, Algeria, Ukraine (Donets), Russia (Siberia), China (Guizhou), Japan, Canada (Northwest Territories), USA (Arkansas, Ohio, Oklahoma, Texas), Mexico, Peru.——FIG. 68,*1a–d. P. kesslerense* (MATHER), holotype, Fayetteville, western slope of East Mountain, Kessler limestone member of Bloyd Formation, Washington County, Arkansas, USA, WMUC 16123; *a–b,* ×2; *c,* suture, based on holotype, ×2.5 (Miller & Moore, 1938); *d,* cross section, USNM 119677, ×1.4 (Gordon, 1965).

Family ORULGANITIDAE Ruzhentsev, 1965

[Orulganitidae RUZHENTSEV, 1965, p. 13] [=Yakutoceratidae LIBROVICH, 1968, p. 159]

Conch form discoidal to globular, moderately to completely involute; umbilicus moderately narrow to narrow. Early whorls generally with triangular coiling; adult whorls normally coiled. Sculpture consisting of longitudinal lirae; biconvex growth lines faint. No tubercles or nodes. Prongs of ventral lobe relatively narrow, median saddle usually half as high or considerably higher than entire ventral lobe. *Pennsylvanian (lower Moscovian).*

Orulganites RUZHENTSEV, 1960c, p. 143 [**Owenoceras trianguliumbilicatum* Y. POPOV, 1960, p. 87; OD]. Conch form subdiscoidal, with moderately wide umbilicus. Longitudinal lirae faint. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*1a–d.* **O. trianguliumbilicatus* (POPOV); *a–b,* holotype, western slope of Orulgan Range, north of Dzhardzhan, River Syncha Basin, Syncha-Soguru creek, Tiksa Formation, ×1 (Popov, 1960); *c–d,* Sette-Daban Range, River Tompo Basin, Sukhoi creek, Natalin Formation, PIN 3088/16, ×1.5 (Ruzhentsev & Ganelin, 1971).

Aldanites Y. POPOV, 1970, p. 124 [**A. rotundus* Y. POPOV, 1970, p. 125; OD]. Similar to *Orulganites,* but no triangular whorls. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*4a–b.* **A. rotundus,* holotype, Sukhoi Creek, Tompo River Basin, Sette-Daban region, South Yakutia, Natalin Formation, TsGM 28/8717, ×1 (Y. Popov, 1970).

Kayutoceras RUZHENTSEV & GANELIN, 1971, p. 59 [**K. triangulare* RUZHENTSEV & GANELIN, 1971, p. 60; OD]. Early whorls triangular-subglobular, with very strong constrictions, involute; umbilicus moderately wide. Later stages with narrow umbilicus and normal coiling. Sculpture consisting of irregularly located lirae; two tracks of thicker lirae on ventral side. Height of median saddle reaching two-thirds entire ventral lobe. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*7a–e.* **K. triangulare; a–b,* side view, apertural view of immature specimen, right bank of Paren' River, Omolon Massif, PIN 3088/8, ×2; *c–d,* left bank of Gornoi River, Omolon Massif, PIN 3088/9, ×1; *e,* holotype, suture, right bank of Paren' River, Omolon Massif, PIN 3088/3, whorl height at 12.6 mm, whorl width 22 mm, ×1.5 (Ruzhentsev & Ganelin, 1971).

Parayakutoceras Y. POPOV, 1970, p. 123 [**P. secretum;* OD]. Conch form thickly discoidal, involute; umbilicus narrow. Longitudinal lirae faint. Growth lines with ventral salient at maturity. Ventral lobe relatively wide, median saddle reaching two-thirds height of entire ventral lobe. Four species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*6a.* **P. secretum;* side view, middle Kolyma Massif, Zyrianka River, Agidzhin Formation, ×1 (Y. Popov, 1970).——FIG. 69,*6b. P. discoidale* (RUZHENTSEV), holotype, suture, Omulev uplift, Taryn-Yuriakh River, Agidzhin Formation, PIN 3088/67, whorl height at 17.7 mm, whorl width 19.0 mm, ×1 (Ruzhentsev, 1975).

Yakutoceras Y. POPOV, 1965, p. 70 [**Y. aldanicum* Y. POPOV, 1965, p. 71; OD] [=*Mezorulganites* ANDRIANOV, 1985, p. 27 (type, *M. borealis,* OD)]. Conch form subdiscoidal to subglobular, moderately evolute, with moderately wide umbilicus. Longitudinal ornamentation present; constrictions on immature stages may be present. Three species. [This genus is transitional to *Orulganites* and may be its junior synonym. The name was proposed by LIBROVICH, 1947, p. 64, without sufficient description and indication of type species; formal description and type species by Y. POPOV, 1965, p. 70. For discussion, see RUZHENTSEV & GANELIN, 1971, p. 57. *Mezorulganites* differs slightly in its suture.] *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*2a–c.* **Y. aldanicum; a–b,* Sobopol River, Orulgan Range, Yakutia, Yupenchin Formation, TsGM 19/8717, ×1; *c,* suture, Popovka River, Kolyma Massif, Siberia, Burgalii Formation, TsGM 15/8717, whorl height at 14 mm, ×1.3 (Y. Popov, 1970).

?Yakutoglaphyrites RUZHENTSEV, 1960c, p. 143 [**Owenoceras involutum* Y. POPOV, 1960, p. 88; OD]. Conch form thickly discoidal, involute, with narrow umbilicus. Ornamentation reticulate. Prongs of ventral lobe lanceolate; height of median saddle exceeding three-quarters height of entire ventral lobe. One species from one locality. [This genus is insufficiently known, and its generic independence is uncertain.] *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*5a–c.* **Y. involutum* (POPOV), holotype, Yuel-Siktiakh River, Orulgan Range, Suorgan Formation, TsGM 32/8717; *a–b,* ×1 (Popov, 1960); *c,* suture, whorl height at 30 mm, magnification not indicated (Popov, 1970).

Yanshinoceras ANDRIANOV, 1985, p. 24 [**Y. alexandri;* OD]. Conch form large, with triangular coiling on all stages except last whorl. Umbilicus moderately wide and triangular on early and middle stages.

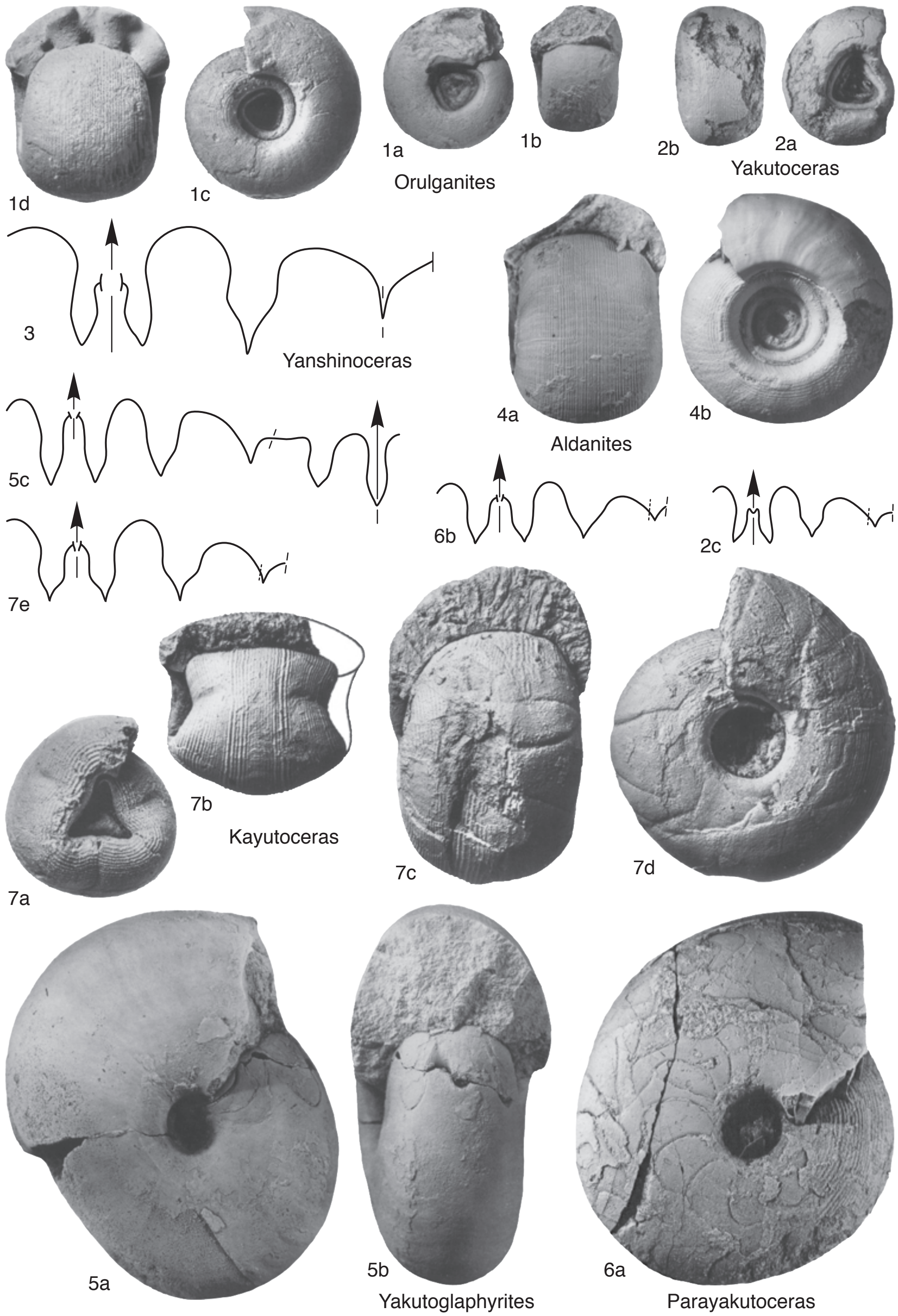

FIG. 69. Orulganitidae (p. 114–116).

Sculpture consisting of irregularly spaced longitudinal lirae and fine transverse striae. Constrictions on early and middle stages. Ventral and adventitious lobes comparatively narrow; lateral lobe situated at umbilical edge. One species. *Pennsylvanian (lower Moscovian):* Russia (Siberia).——FIG. 69,*3*. **Y. alexandri,* Iudomy River Basin, Setan'in Formation, TsGM 4/10137, whorl height at 11 mm, whorl width 30 mm, ×6.3 (Andrianov, 1985).

Family WELLERITIDAE Plummer & Scott, 1937

[Welleritidae PLUMMER & SCOTT, 1937, p. 375] [=Aqishanocerataceae WANG, 1981, p. 472; =Aqishanoceratidae WANG, 1981, p. 472]

Conch form discoidal, moderately evolute to involute, with moderately narrow umbilicus. Triangular coiling of inner whorls in some forms. Ornamentation consisting of biconvex striae or densely spaced riblets forming ventral sinus, commonly reticulate. In the course of phylogeny, additional suture elements in ventrolateral and umbilical areas. *Pennsylvanian (upper Bashkirian–Moscovian).*

Subfamily WELLERITINAE Plummer & Scott, 1937

[*nom. transl.* MILLER & FURNISH in MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 66, *ex* Welleritidae PLUMMER & SCOTT, 1937, p. 375]

Ventral side flattened, in some forms with ventral groove. In the course of phylogeny, development of second adventitious lobe and several additional suture elements in umbilical area. *Pennsylvanian (Moscovian).*

Wellerites PLUMMER & SCOTT, 1937, p. 376 [**W. mohri* PLUMMER & SCOTT, 1937, p. 377; OD] [=*Walkerites* SMITH, 1938, p. 31 (type, *W. vulgaris,* OD)]. Conch form discoidal, with moderately narrow umbilicus; ventral side flattened. Growth lamellae rather prominent, with deep ventral and lateral sinus. Transverse ribs on inner whorls, submedian sulcus on later stages. Median saddle of ventral lobe as high as entire ventral lobe. Second adventitious lobe relatively large. Several umbilical lobes on flanks and umbilical shoulder. Sutural formula: $(E_1E_mE_1)A_2A_1LU$ ... [German], (V_1V_1) L^1LU ... [Russian]. Three species. [For discussion, see MILLER & FURNISH, 1958a, p. 264.] *Pennsylvanian (Moscovian):* Russia (South Urals), Japan, USA (Ohio, Oklahoma, Texas).——FIG. 70,*1a–c*. **W. mohri,* 1.6 km east of Millsap, Pinto County, Texas, Millsap Lake Formation, Desmoinesian; *a–b,* SUI 13844, ×1; *c,* SUI 13843, ×0.8 (Miller & Furnish, 1958a).

Aqishanoceras WANG, 1981, p. 473 [**A. bellum;* OD]. Conch form similar to *Winslowoceras,* with groove on concave ventral side. Ornamentation consisting of biconvex, densely spaced riblets. Ventral lobe wide, median saddle about half as high as entire lobe. Lateral lobes relatively narrow, lanceolate; outer umbilical lobe acute, on umbilical wall. Sutural formula: $(E_1E_mE_1)ALU_2U_1I$ [German], $(V_1V_1)LU_1U_2{:}ID$ [Russian]. One species. *Pennsylvanian (Moscovian):* China (Xinjiang).——FIG. 70,*2a–c*. **A. bellum,* holotype, southeast of Aqishan, eastern Xinjiang, upper part of Yamansu Formation, ?Moscovian; *a,* side view, ×4; *b,* cross section, ×4; *c,* suture, whorl height at 5.5 mm, ×6 (Wang, 1981).

Eowellerites RUZHENTSEV, 1957, p. 59 [**Bendoceras moorei* PLUMMER & SCOTT, 1937, p. 216; OD] [=*Bendites* MILLER & FURNISH, 1958a, p. 267, obj.]. Conch form thin-discoidal, evolute; umbilicus wide, ventral side flattened or concave. Biconvex growth striae crossed by longitudinal lirae producing reticulate ornamentation. Suture line with small second adventitious lobe. Sutural formula: $(E_1E_mE_1)A_2A_1LU_2U_1I$ [German], (V_1V_1) $L^1LU_2U_1ID$ [Russian]. Three species. [For discussion, see GORDON, 1965, p. 273.] *Pennsylvanian (Moscovian):* Japan, USA (Arkansas, Texas).——FIG. 70,*4a*. **E. moorei* (PLUMMER & SCOTT), holotype, suture, 5.6 km east of Rochelle, McCulloch County, Texas, Smithwick Shale, Desmoinesian, UT P4847, whorl height at 7.0 mm, whorl width 4.8 mm, ×2.5 (Plummer & Scott).——FIG. 70,*4b*. *E. discoidalis* GORDON, holotype, outline, Van Buren, Crawford County, Arkansas, upper Atokan Formation, Atokan, USNM 119682, ×0.8 (Gordon, 1965).

?Faqingoceras YANG, 1978, p. 189 [**F. discoideum* YANG, 1978, p. 190; OD]. Conch form lenticular to thickly discoidal, relatively involute; umbilicus moderately wide. Flanks parallel, ventral side slightly flattened. Ornamentation with sigmoidal, biconvex growth striae, forming ventral sinus; one or several deep constrictions may be present. Ventral lobe moderately wide, median saddle half height of entire lobe, ventrolateral saddle broadly rounded. Adventitious lobe V-shaped. No additional suture elements. Four species. [The phylogenetic relationship of this genus is uncertain; the similarity of the sculpture suggests a relationship to Welleritidae.] *Pennsylvanian (Moscovian):* China (Guizhou), Japan.——FIG. 71*a–b*. **F. discoideum,* holotype, Riupansui City, northwestern slope of Faqing, Suicheng district, Guizhou, upper part of Dala Formation, CAGS Beijing 0213, ×1 (Yang, 1978).——FIG. 71*c–d*. *F. ruzhencevi* NISHIDA, KYUMA, & EGASHIRA, Mine City, Isa Quarry, Akiyoshi, Yamaguchi Prefecture, Akiyoshi Limestone, upper Moscovian, ASM 51780; *c,* immature specimen, side view with constriction, ×2; *d,* suture, enlarged (Nishida, Kyuma, & Egashira, 1996).

Winslowoceras MILLER & DOWNS, 1948, p. 678 [**W. henbesti* MILLER & DOWNS, 1948, p. 679; OD].

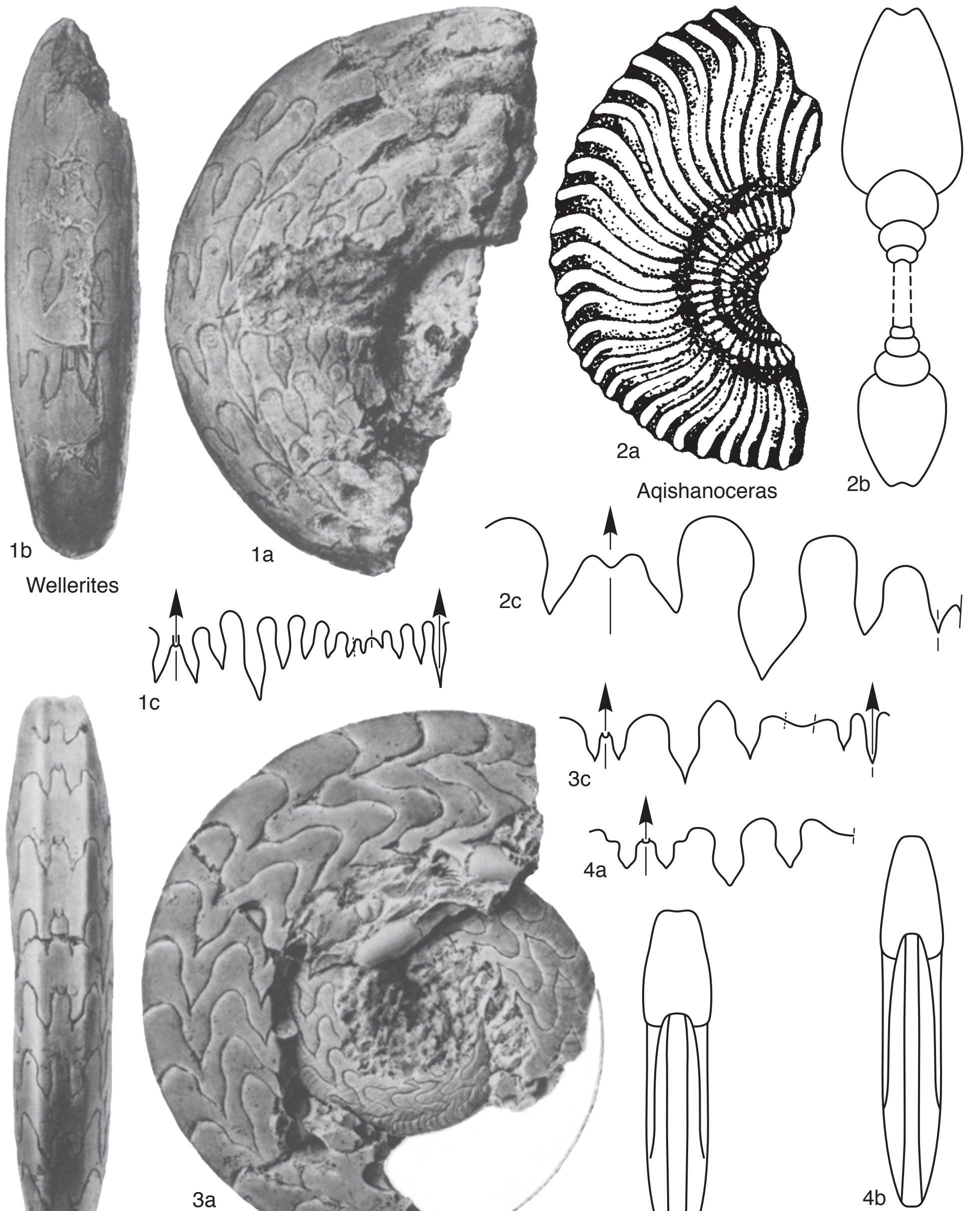

FIG. 70. Welleritidae (p. 116–118).

Conch form discoidal, moderately evolute, with rather wide umbilicus; early whorls triangularly coiled. Ventrolateral shoulders subangular, ventral side flattened or concave. Growth lines biconvex and crossed by faint longitudinal lirae. Ventral lobe short, relatively small. Second umbilical lobe on umbilical wall. Sutural formula $(E_1E_mE_1)ALU_2:U_1I$ [German], $(V_1V_1)LU_1U_2:ID$ [Russian]. Two or three species. *Pennsylvanian (Moscovian):* China (Guizhou), Japan, Canada (Northwest Territories), USA (Arkansas, Oklahoma).——FIG. 70,*3a–d.* **W. henbesti,* holotype, Railroad tunnel at Winslow,

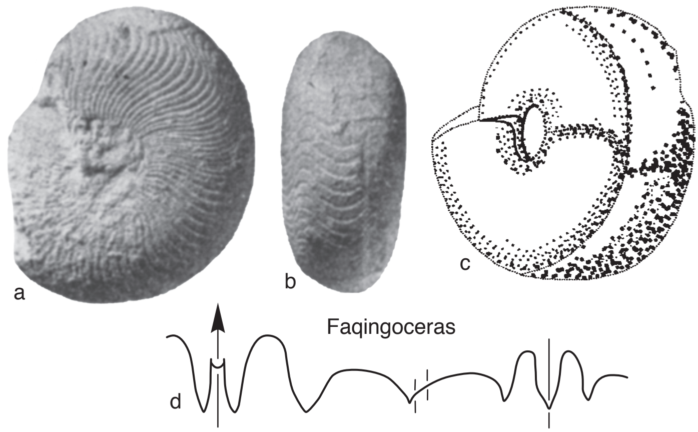

FIG. 71. Welleritidae (p. 116).

Washington County, Arkansas, USA, Winslow Formation, Atokan, USNM 118929; *a–b,* ×1; *c,* suture, ×1.1 (Miller, Furnish, & Schindewolf, 1957); *d,* outline, ×0.6 (Gordon, 1965).

Subfamily AXINOLOBINAE Bogoslovskii, Librovich, & Ruzhentsev, 1962

[Axinolobinae BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 388]

Ventral lobe wide, with subdivided prongs. Sutural formula $(E_{1d}E_{1v}E_mE_{1v}E_{1d})ALU_2U_1D$ [German], $(V_{1.1}V_{1.2}V_{1.2}V_{1.1})LU_1U_2{:}ID$ [Russian]. [The subfamily evolved from early schistoceratids, possibly from *Paraphaneroceras* (for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 63).] *Pennsylvanian (upper Bashkirian).*

Axinolobus GORDON, 1960, p. 149 [**A. modulus;* OD]. Ventral side narrowly rounded; umbilicus moderately wide. Sculpture consisting of relatively prominent transverse striae, strongest on umbilical shoulder. Three species. *Pennsylvanian (upper Bashkirian):* Russia (South Urals), Spain, Algeria, USA (Arkansas, Oklahoma).——FIG. 72,*2a–b.* **A. modulus,* holotype, 5 km northwest of Gore, Muskogee County, Oklahoma, Witts Springs Formation, upper Morrowan, USNM 119684; *a,* suture, diameter at 71 mm, whorl height 25.1 mm, whorl width 18 mm, ×0.9; *b,* outline, ×0.6 (Gordon, 1965).——FIG. 72,*2c. A. quinni* MCCALEB & FURNISH, east of Gene Autry, Johnston County, Oklahoma, Gene Autry Shale, Golf Course Formation, Bloydian, SUI 11700, ×1 (McCaleb, 1968).——FIG. 72,*2d. A. percostatus* (Schmidt, 1955), La Camocha coal mine, Gijón, Spain, upper Bashkirian, Collection Jongmans, Heerlen, ×1 (new, courtesy of H. W. J. van Amerom).

Paraphaneroceras RUZHENTSEV in RUZHENTSEV & GANELIN, 1971, p. 56 [**Diaboloceras peroccidens* GORDON, 1969, p. 8; OD]. Conch form similar to *Diaboloceras,* early whorls irregular, but not triangularly coiled. Ornamentation reticulate; transverse ribs forming ventral and lateral sinuses. Numerous radial-elongate tubercles developed along umbilical shoulder. Ventral lobe extremely wide with very high median saddle, its prongs being as wide as adventitious lobe. Saddle between lateral and umbilical lobe wide, as in *Diaboloceras.* One species. [The systematic position of this genus is questionable. RUZHENTSEV & BOGOSLOVSKAIA (1978, p. 63) included *Paraphaneroceras* in the family Axinolobidae, regarding it as forerunner of *Axinolobus* with its bifid prongs of the ventral lobe. For discussion, see TITUS, 1997, p. 158.] *Pennsylvanian (upper Bashkirian):* USA (Nevada).——FIG. 72,*1a–b.* **P. peroccidens* (GORDON), Las Vegas, Indian Springs area, Bird Spring Formation, Bloydian; *a,* holotype, USNM 161550, ×1; *b,* paratype, suture, USNM 161552, whorl height at approximately 24 mm, ×1.2 (Gordon, 1969).

Family CHRISTIOCERATIDAE Nassichuk & Furnish, 1965

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 63, *ex* Christioceratinae NASSICHUK & FURNISH, 1965, p. 725]

Conch form discoidal, evolute; at maturity moderately evolute, with ventral groove. Sculpture on early whorls consisting of prominent ribs extending from umbilicus

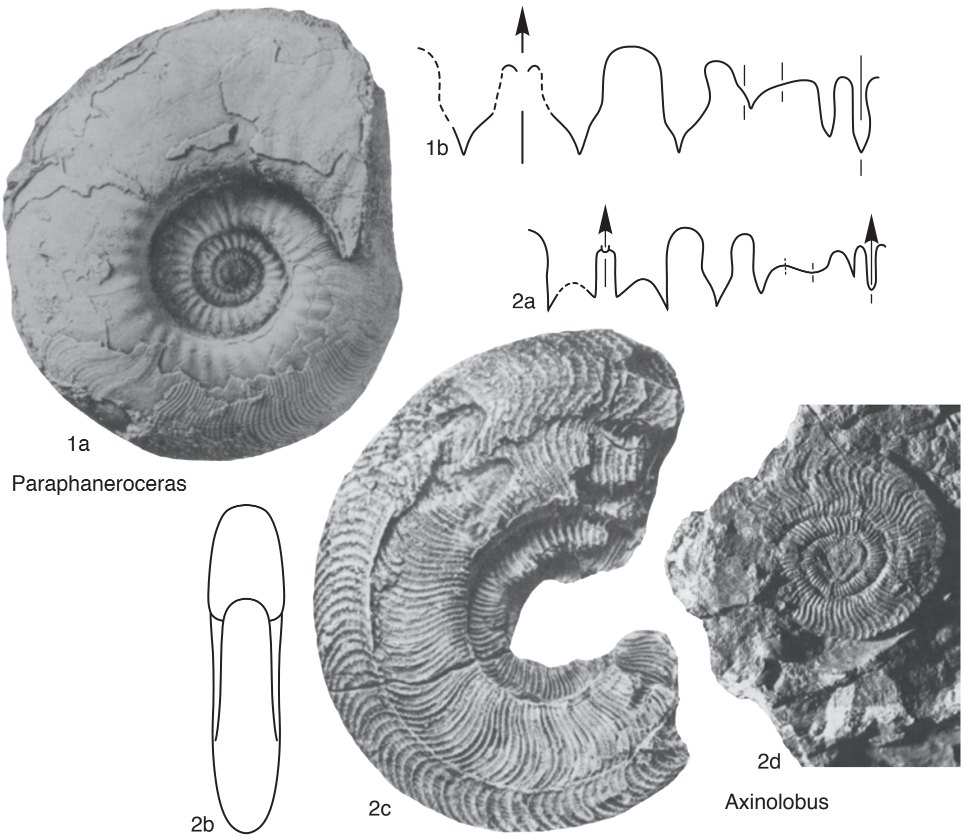

FIG. 72. Welleritidae (p. 118).

to ventral side. Trifurcation of lateral and umbilical lobes as well as of prongs of ventral lobe. [The family evolved from early schistoceratids, maybe *Inzeroceras* (for discussion, see RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 64).] *Pennsylvanian (Moscovian).*

Christioceras NASSICHUK & FURNISH, 1965, p. 725 [**C. trifurcatum* NASSICHUK & FURNISH, 1965, p. 726; M] [=*Parawinslowoceras* ABRAMOV, 1970, p. 375 (type, *P. domokhtovi* Y. POPOV, 1970, p. 136, M), *nom. nud.*]. Ventral groove and umbilical or ventrolateral nodes at maturity. Sutural formula: $(E_1E_mE_1)(A_vA_mA_d)(L_vL_mL_d)(U_{1v}U_{1d}:U_{1d})I$ [German], $(V_1V_1)(L_2L_1L_2)(U_2U_1U_2)(I_2I_1:I_2)D$ [Russian]. Two species. [*Parawinslowoceras* was established without a diagnosis.] *Pennsylvanian (Moscovian):* Russia (Siberia), Canada (Northwest Territories), USA (Texas).——FIG. 68,*3a–b*. **C. trifurcatum,* holotype, Hare Fiord reef, Ellesmere Island, Northwest Territories, Canada, GSC 19879; *a,* suture, diameter at 19 mm, ×3; *b,* outline, ×3.7 (Nassichuk & Furnish, 1965).

GONIOLOBOCERATOIDEA

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Superfamily GONIOLOBOCERATOIDEA Spath, 1934

[*nom. transl.* Ruzhentsev & Bogoslovskaia, 1978, p. 66, *ex* Gonioloboceratidae Spath, 1934, p. 15]

Conch form discoidal to globular, in general involute; umbilicus narrow. Ventral lobe wide, with diverging sides; sides straight or slightly curved. Median saddle usually exceeding half height of ventral lobe. Sutural formula: $(E_1E_mE_1)$AL:UI [German], (V_1V_1)LU:ID [Russian]. *Pennsylvanian (Bashkirian)–Cisuralian (Asselian).*

Family WIEDEYOCERATIDAE Ruzhentsev & Bogoslovskaia, 1978

[Wiedeyoceratidae Ruzhentsev & Bogoslovskaia, 1978, p. 85]

Conch form subdiscoidal to globular. Some forms with umbilical nodes or plications on young stages. Suture relatively simple; ventral lobe with steep sides. First lateral saddle rounded, lobes may be also rounded. Adventitious lobe usually shorter than ventral lobe. *Pennsylvanian (Bashkirian–Gzhelian).*

Wiedeyoceras Miller, 1932, p. 79 [**Eumorphoceras sanctijohanis* Wiedey, 1929, p. 321; OD] [=*Gordonites* Miller & Furnish, 1958b, p. 685 (type, *Anthracoceras missouriense* Miller & Owen, 1939, p. 147, OD), for discussion, see Furnish & Spinosa, 1966, p. 254.] Conch form subdiscoidal to thickly discoidal; involute, with narrow umbilicus. Ornamentation consisting of fine transverse striae, slightly sinuous, with shallow sinus and salients; sometimes faint spiral lirae present. Faint nodes along umbilical margin may be present on inner whorls. Ventral lobe with steep sides; adventitious lobe pointed. Eight species. *Pennsylvanian (Bashkirian–Moscovian):* Ukraine (Donets), China (Ningxia, Xinjiang), USA (Arkansas, Illinois, Iowa, Oklahoma).——Fig. 73,*2a–c.* **W. sanctijohanis* (Wiedey), Squirrel Hollow, Greene County, Iowa, Cherokee Shale, Desmoinesian; *a–b,* SUI 12386, ×2; *c,* suture, SUI 12387, ×6 (Furnish & Spinosa, 1966).

Donetzoceras Librovich, 1946, p. 79 [**Gastrioceras donetzense* Librovich, 1939a, p. 136; OD]. Conch relatively small, thickly discoidal. Inner whorls evolute, later stages involute. Sculpture consisting of nodelike riblets and umbilical plications that disappear at maturity. Growth lines forming shallow ventral sinus and ventrolateral salient. Shallow lateral sulci may be developed. Ventral lobe pointed; median saddle about half as high as entire ventral lobe. Adventitious lobe rounded and shorter than ventral lobe. Five species. [For discussion, see Saunders, Manger, & Ramsbottom, 1979, p. 1136.] *Pennsylvanian (upper Bashkirian–Moscovian):* Great Britain, Belgium, Netherlands, Germany, Ukraine (Donets), Algeria, Morocco.——Fig. 73,*5a–c.* **D. donetzense* (Librovich), Khartsiskoe, Donets Basin, I-Formation, Ukraine, upper Bashkirian; *a–b,* holotype, VSEGEI 70A, ×4; *c,* suture, diameter at 12.1 mm, VSEGEI 70 B, ×6.3 (Saunders, Manger, & Ramsbottom, 1979).

Luganoceras A. Popov, 1979, p. 54 [**L. originale;* OD]. Conch form similar to *Wiedeyoceras,* but umbilicus very narrow. Ventral lobe extremely wide, with divergent, almost straight sides; first lateral saddle broadly rounded. Adventitious lobe wide and shallow but pointed. One species from one locality. *Pennsylvanian (Moscovian):* Ukraine (Donets).——Fig. 73,*4.* **L. originale,* suture of holotype, Golubevo, Luganka River, Donets Basin, K Formation, Member K7, VSEGEI 123, magnification not stated (A. Popov, 1979).

Mangeroceras Sturgeon & others, 1982, p. 1474 [**M. canfieldense* Sturgeon & others, 1982, p. 1475; M]. Conch form and sculpture similar to *Donetzoceras.* Ventral lobe with sigmoidal sides; adventitious lobe large. Prongs of ventral lobe and adventitious lobe pointed at base. One species. [This genus is closely related to *Donetzoceras* and *Wiedeyoceras* and may be a junior synonym of either one.] *Pennsylvanian (Moscovian):* USA (Ohio).——Fig. 73,*1.* **M. canfieldense,* suture, Canfield, Mahoning County, Putnam Hill Shale, Allegheny Group, OSU 30713, diameter at approximately 35 mm, ×1.4 (Sturgeon & others, 1982).

Pennoceras Miller & Unklesbay, 1942, p. 147 [**P. seamani;* OD]. Conch subglobular, umbilicus closed. Sculpture consisting of prominent straight ribs. Suture line primitive in general, with rounded elements. Median saddle low, not reaching half height of entire ventral lobe. Three species, two questionable. [The relationship of this genus is uncertain, and assignment to the Wiedeyoceratidae is tentative.] *Pennsylvanian (Kasimovian–Gzhelian):* USA (Ohio, Oklahoma, Kansas, Pennsylvania).——Fig. 73,*3a–d.* **P. seamani,* lectotype (by Mapes & others, 1997, p. 219), Creighton, Allegheny County, Pennsylvania, Brush Creek Limestone,

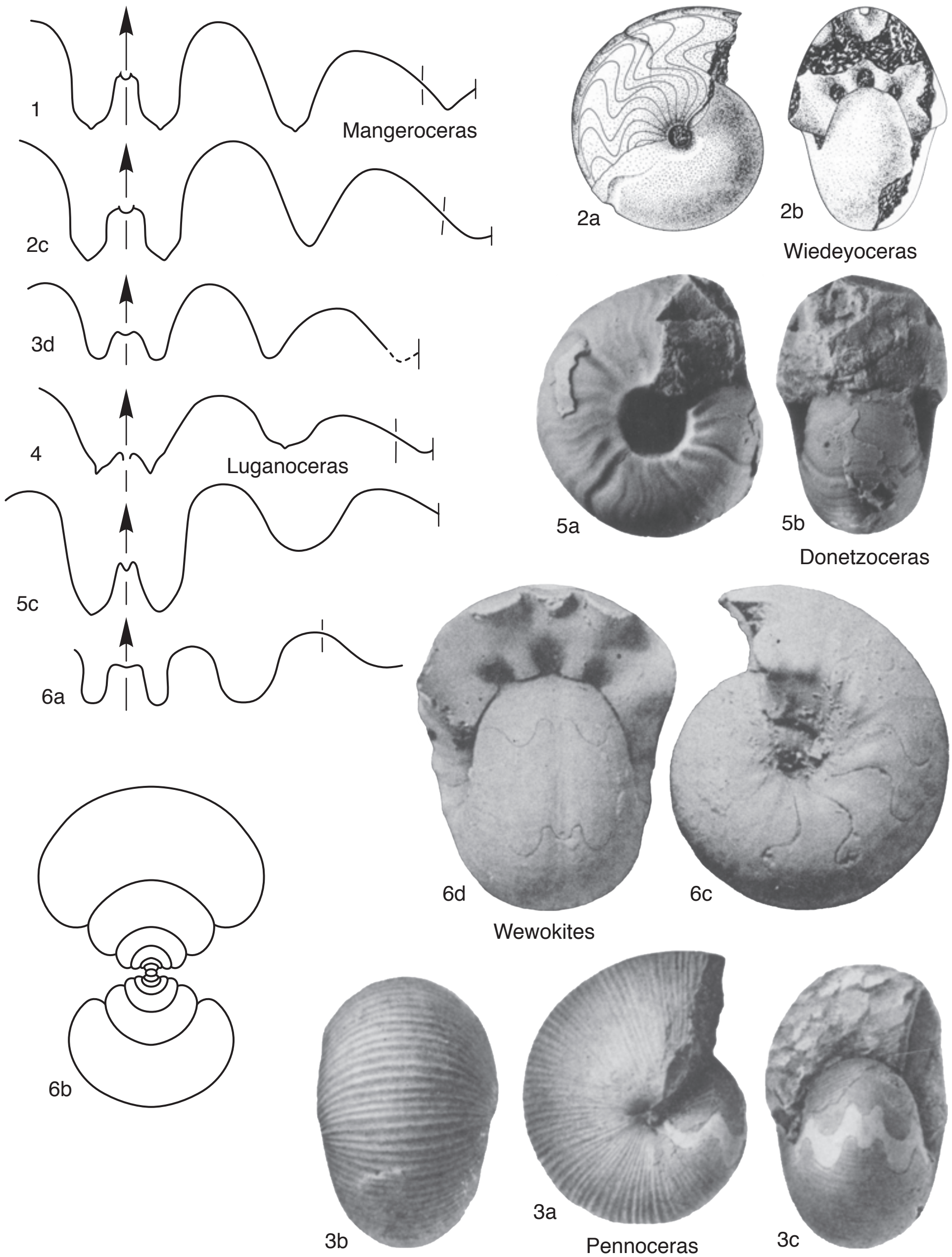

FIG. 73. Wiedeyoceratidae (p. 120–122).

Conemaugh, Missourian, CM 22292; *a–c,* ×1; *d,* suture, diameter at approximately 8 mm, enlarged (adapted from Miller & Unklesbay, 1942).

?Wewokites FURNISH & BEGHTEL, 1961, p. 290 [**Gastrioceras venatum* GIRTY, 1911, p. 149; OD]. Conch very small, subdiscoidal to subglobular, involute throughout; umbilicus relatively wide. Growth lines biconvex. Umbilical shoulder nodose, sometimes extending as low ridges toward ventral side. Ventral furrow may be present. Suture line primitive: lobes and saddles rounded, even at their basis; median saddle relatively high. Two species. [The holotype does not show ventral furrow. The relationship of this genus is uncertain; its assignment is questionable because it may represent immature forms of a larger genus. For discussion, see UNKLESBAY, 1962, p. 64.] *Pennsylvanian (upper Moscovian):* USA (Oklahoma).——FIG. 73,*6a–b*. **W. venatus* (GIRTY), west of Okmulgee, Okmulgee County, Wewoka Formation; *a,* suture, magnification not stated; *b,* cross section, approximately ×3.5 (Furnish & Beghtel, 1961).——FIG. 73,*6c–d*. *W. newelli* UNKLESBAY, holotype, 3.9 km west of Okmulgee, Highway 56, Okmulgee County, Wewoka Formation, upper Desmoinesian, OU 3830-34, 4206, ×6 (Unklesbay, 1962).

Family GONIOLOBOCERATIDAE Spath, 1934

[Gonioloboceratidae SPATH, 1934, p. 15] [=Gonioglyphioceratidae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 86]

Conch form in general discoidal, involute, with narrowly rounded or oxyconic ventral side, sometimes with external or ventrolateral grooves. Ventral lobe extremely wide, with strongly diverging sides; median saddle broad, with diverging sides, higher than half height of entire ventral lobe. First lateral saddle narrowly rounded, subacute, or acute. Adventitious lobe broad and pointed, seldom rounded. [Family Gonioglyphioceratidae was erected for genera with rounded adventitious lobe.] *Pennsylvanian (upper Bashkirian)–Cisuralian (Asselian).*

Gonioloboceras HYATT, 1900, p. 551 [**Goniatites goniolobus* MEEK, 1877, p. 98; OD] [=*Milleroceras* HYATT, 1900, p. 550 (type, *Goniatites parrishi* MILLER & GURLEY, 1896, p. 36, OD, =*Goniatites goniolobus* MEEK, 1877, p. 98); =*Gurleyoceras* MILLER, 1932, p. 76 (type, *Gonioloboceras welleri* SMITH, 1903, p. 125, OD, =*Goniatites goniolobus* MEEK, 1877, p. 98); for discussion, see MILLER & DOWNS, 1950a, p. 194, 196]. Conch form subdiscoidal, involute, with extremely narrow umbilicus. Ventral lobe with high and broad median saddle and extremely divergent sides. First lateral saddle narrow and acute; adventitious lobe triangular, ventral side convex, dorsal side concave. Six species. [For discussion, see FURNISH & GLENISTER, 1971, p. 303. The inner whorls are not known for this genus.] *Pennsylvanian (upper Bashkirian–Gzhelian):* Ukraine (Donets), Morocco, China (Xinjiang), USA (Kansas, Ohio, Missouri, New Mexico, Oklahoma, Texas).——FIG. 74,*2a–c*. **G. goniolobum* (MEEK), holotype, New Mexico, USA, upper Pennsylvanian, USNM 156437; *a–b,* ×1; *c,* suture, diameter at 65 mm, ×1.5 (Furnish & Glenister, 1971).

Gonioglyphioceras PLUMMER & SCOTT, 1937, p. 336 [**Gonioloboceras welleri gracile* GIRTY, 1911, p. 153; OD] [=*Eudissoceras* MILLER & OWEN, 1937, p. 408 (type, *E. collinsvillense* MILLER & OWEN, 1937, p. 409, OD)]. Ventral side narrow, bicarinate. Suture line similar to *Gonioloboceras,* but adventitious lobe rounded. Four species. [For discussion, see FURNISH & GLENISTER, 1971, p. 303. *Eudissoceras* is based on immature specimens of *Gonioglyphioceras gracile* (GIRTY) and is therefore regarded as a junior synonym of *Gonioglyphioceras;* for discussion, see UNKLESBAY, 1962, p. 69.] *Pennsylvanian (Moscovian–Kasimovian):* Ukraine (Donets), USA (Oklahoma).——FIG. 75,*2a–c*. **G. gracile* (GIRTY), about 3.2 km west of Lovelady school, east of Ada, Pontotoc County, Oklahoma, USA, lower Wewoka Formation, Desmoinesian, SUI 8811; *a–b,* ×1.5 (Furnish & Glenister, 1971); *c,* suture, ×2.6 (Plummer & Scott, 1937, adapted from Girty, 1915).

Gonioloboceratoides NASSICHUK, 1975, p. 74 [**G. curvatus* NASSICHUK, 1975, p. 75; OD]. Conch form discoidal and highly involute; umbilicus narrow. Umbilical shoulder narrowly rounded, umbilical walls flat. Venter rounded, at maturity slightly flattened. Fine growth striae with ventral and lateral sinus. Prongs of ventral lobe broad and rounded during ontogeny, bluntly pointed at maturity. First lateral saddle asymmetric, rounded and twice as broad as adventitious lobe. Two species. *Pennsylvanian (Moscovian):* Canada (Northwest Territories), USA (Missouri).——FIG. 75,*3a–c*. **G. curvatus,* holotype, Ellesmere Island, Hare Fiord, Hare Fiord Formation, Atokan, Northwest Territories, GSC 33688; *a–b,* ×2; *c,* suture, diameter at 43 mm, enlarged (Nassichuk, 1975).

?Megatrochoceras YANG, 1978, p. 158 [**M. striatum;* OD]. Conch very large, subdiscoidal and involute, with very narrow umbilicus. Ventral side broadly rounded, becoming oxycone at maturity. Ornamentation consisting of biconvex growth lines forming ventral sinus. Ventral lobe wide, with sinuous sides, median saddle higher than half height of entire lobe; ventrolateral saddle rounded. Adventitious lobe acute, with sinuous dorsal side. One species. [The relationship and generic assignment is questionable for this genus.] *Pennsylvanian (upper Bashkirian):* China (Guizhou).——FIG. 74,*1a–b*. **M. striatum,* holotype, West Guizhou, ?upper Bashkirian; *a,* side view, ×0.5; *b,* suture, reversed, ×0.6 (Yang, 1978).

Mescalites FURNISH & GLENISTER, 1971, p. 304 [**G. discoidale* BÖSE, 1920, p. 52; OD]. Conch form similar to *Gonioloboceras*, but with weak furrow on ventral side; umbilicus covered by a callus at maturity. Suture similar to *Gonioloboceras*, but at maturity with small additional ventral element close to siphuncle. Sutural formula: ($E_1E_2E_mE_2E_1$) ALUI [German], ($V_1V_2V_2V_1$)LU:ID [Russian]. Two species. [Some species placed in this genus are questionable.] *Pennsylvanian (upper Gzhelian)–Cisuralian (Asselian):* Slovenia, *upper Gzhelian;* USA (New Mexico, Oklahoma, Texas), *Asselian.*——FIG. 74,*3a–d*. **M. discoidale* (BÖSE); *a–c,* Tularosa, Otero County, New Mexico, USA, middle Bursum

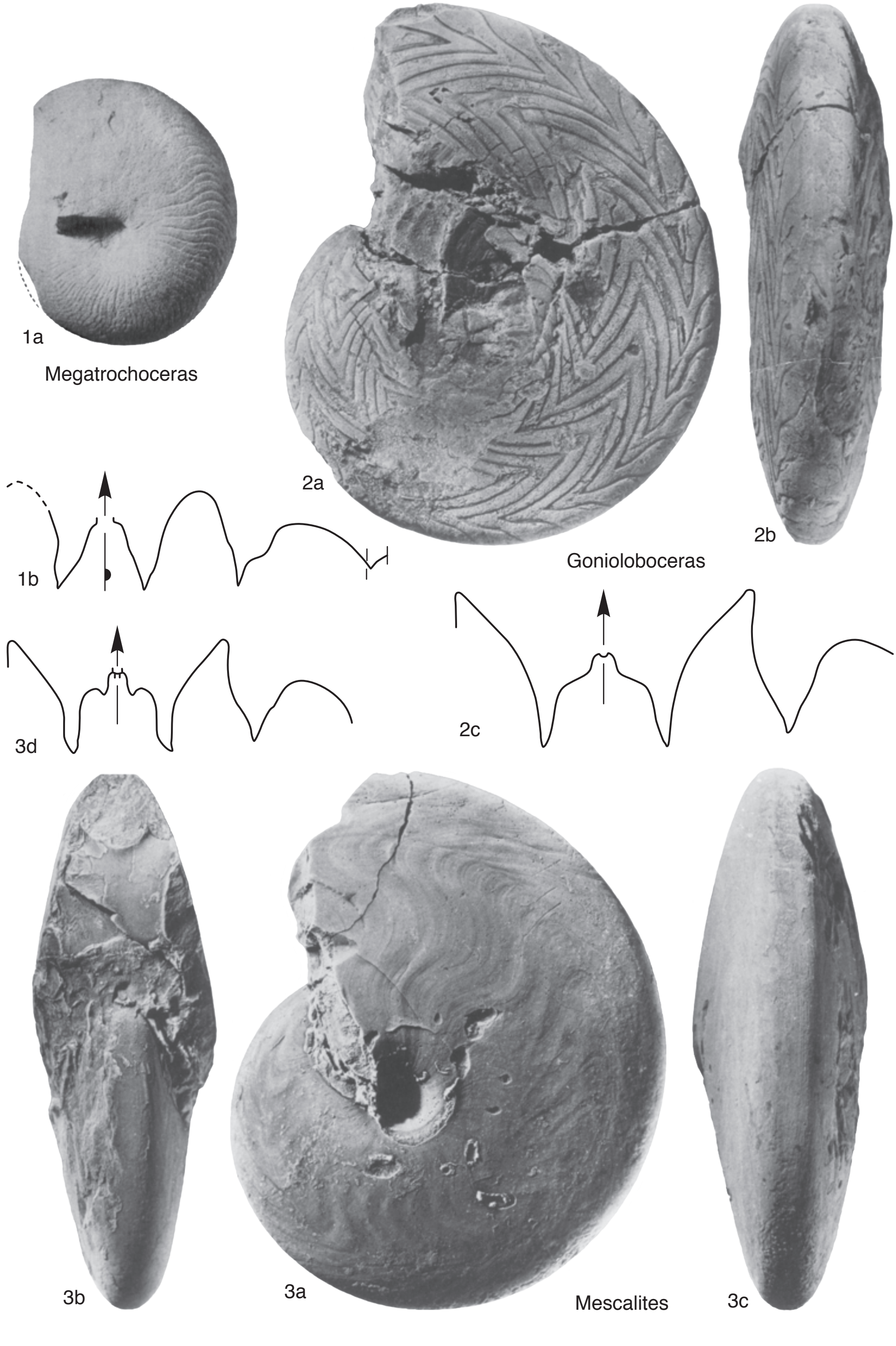

FIG. 74. Gonioloboceratidae (p. 122–125).

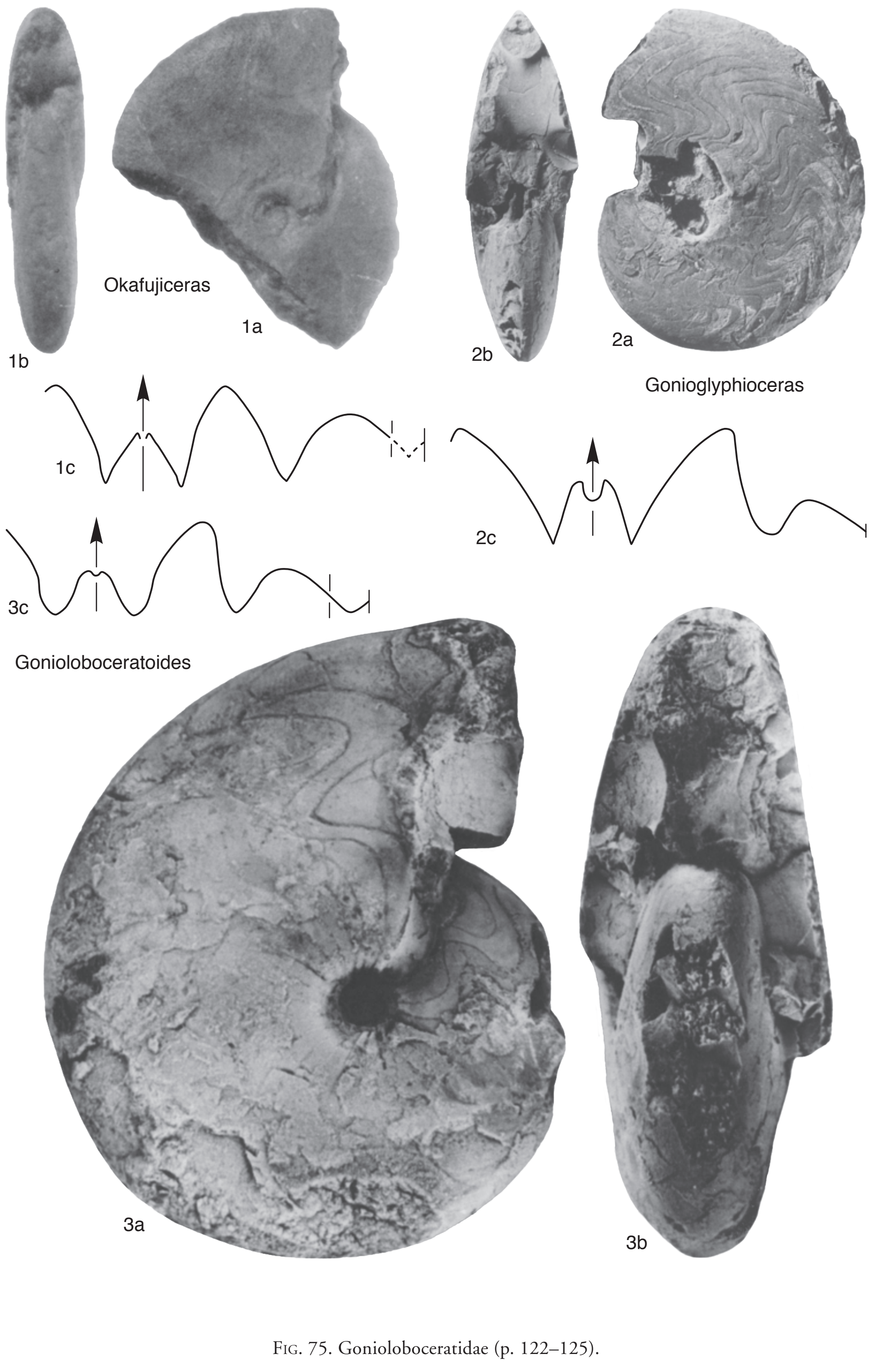

FIG. 75. Gonioloboceratidae (p. 122–125).

Formation, Asselian, SUI 33020, ×1.5; *d,* suture, SUI 8876B, diameter at 50 mm, ×1.5 (Furnish & Glenister, 1971).

Okafujiceras NISHIDA & KYUMA, 1982, p. 40 [**O. isaense;* OD]. Conch small, discoidal, with very narrow umbilicus and rapid increase in whorl height. Suture of adult whorls with wide ventral lobe, V-shaped prongs, and widely diverging sides; median saddle not exceeding half height of entire lobe. First lateral saddle subacute, adventitious lobe V-shaped. One species. *Pennsylvanian (upper Bashkirian):* Japan.——FIG. 75,*1a–c.* **O. isaense,* holotype, Mine City, Isa Quarry, Akiyoshi, Yamaguchi Prefecture, ASM 5552; *a–b,* ×1; *c,* suture, diameter at approximately 24 mm (Nishida & Kyuma, 1982).

ADRIANITOIDEA

BRIAN F. GLENISTER,[1] WILLIAM M. FURNISH,[2] and ZHOU ZUREN[3]

[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa; [3]Nanjing Institute of Geology and Palaeontology]

Superfamily ADRIANITOIDEA Schindewolf, 1931

[*nom. correct.* RUZHENTSEV, 1957, p. 58, *pro* Adrianitida nov. superfam. BÖHMERS, 1936, p. 29, *nom. transl. ex* Adrianitidae SCHINDEWOLF, 1931, p. 199]

Conch small (diameter at maturity commonly 2.5–5 cm, range 1–7 cm), highly variable: widely evolute to involute, globular to (rarely) fusiform or discoidal. Dimorphism probably common, but documentation inadequate. Mature modifications ordinarily comprise slight geniculation, marked subterminal constrictions and terminal flare, and modification of peristome to form pair of conspicuous ventrolateral lappets. Constrictions common, frequently reflected on both internal mold and shell surface. Sculpture variable, but commonly comprises fine longitudinal and transverse elements that form pronounced reticulate pattern; ribs rare. Characterized by sutures with ventral prongs narrower than adjacent lateral lobe, low secondary ventral saddle, and numerous (8–34) subequal, undivided, narrow, pointed, medially constricted (lingulate) external and internal so-called lateral lobes. Basic sutural formula: $(V_1V_1)LU{:}U^1ID$ [Russian], $(E_1E_mE_1)LU_2U_1I$ [German].

Elements of lateral lobe (L) and internal lobe (I) remained entire. Lobes were added in umbilical saddle, those first formed migrating to internal suture. Subsequent additions to both internal and external suture, thus: $(V_1V_1)LUU^3U^4U^5U^5{:}U^4U^2U^1ID$. Sutural trace conspicuously arched in some advanced forms. [Superfamily members are normally rare, abundance and diversity being greatest in the middle Guadalupian (Wordian). There are superficial homeomorphs of some associated taxa, especially Agathiceratoidea, but they represent a distinctive and separate lineage.] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Family ADRIANITIDAE Schindewolf, 1931

[Adrianitidae SCHINDEWOLF, 1931, p. 199] [=Dunbaritidae MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 67, *nom. transl.* RUZHENTSEV, 1960d, p. 229, *ex* Dunbaritinae MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 67]

Description as for superfamily. Twelve of 19 recognized adrianitin genera occur in the Wordian Stage, and 7 of them are completely restricted to that interval. [Gradation in conch form, sculpture, and sutural complexity exists between virtually all adrianitids, and this major complex constitutes the Adrianitinae. Rare monotypic extremes are recognized as the simple 10-lobed sutures of the Dunbaritinae, rounded lobes with parallel sides characterize the Texoceratinae, and extremes in conch form are recognized as the advanced Hoffmanniinae.] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Subfamily ADRIANITINAE Schindewolf, 1931

[*nom. transl.* MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 66, *ex* Adrianitidae SCHINDEWOLF, 1931, p. 199] [=Pamiritellinae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 87; =Emilitinae LEONOVA & BOGOSLOVSKAIA, 1990, p. 88]

Evolutionary complex comprising all adrianitids with exception of advanced evolute Hoffmanniinae and suturally distinctive Dunbaritinae and Texoceratinae. [The generic taxobases are, in order of perceived significance: lobe count, path of sutural trace (straight to strongly arched), conch form (especially umbilical ratio U/D), sculpture (smooth, transverse, longitudinal, reticulate, unusual such as scalloped), and mature modifications (probably warrant greater importance, but are preserved and reported relatively rarely; DAVIS, 1972).] *Pennsylvanian (upper Moscovian [Desmoinesian])–Lopingian (Wuchiapingian).*

Adrianites GEMMELLARO, 1887, p. 41 [**A. elegans* GEMMELLARO, 1887, p. 43; SD DIENER, 1921, p. 20]. Conch relatively narrow (W/D, 0.6) with wide umbilicus (U/D, 0.2) and evenly reticulate sculpture. Sutural trace moderately arched, with six pairs of external lateral lobes to umbilical shoulders. Six named species. *Guadalupian (Wordian):* Italy (Sicily), Oman, China (Xinjiang, Jilin, ?Xizang), ?Malaya, Canada (British Columbia), Croatia, Indonesia (Timor), Afghanistan, Tajikistan (?Pamir), USA (?Texas), Russia (?Southern Urals).——FIG. 76,*3a–d*. **A. elegans,* Sosio limestone; *a–c*, lectotype (herein), MGUP 85A of GEMMELLARO (1887, pl. 6,*14–15*), ×2; *d*, topotype, GPIT 24409-13, diameter at 14 mm (new).

Aricoceras RUZHENTSEV, 1950, p. 203 [**Adrianites ensifer* GEMMELLARO, 1887, p. 46; OD] [=*Metaricoceras* RUZHENTSEV, 1950, p. 203 (type, *Agathiceras cancellatum* form. *discoidalis* HANIEL, 1915, p. 75, OD)]. Conch globular, with narrow umbilicus; sculpture evenly reticulate, outlining shallow sinus on flanks; mature peristome with long ventrolateral lappets. Sutural trace forming low arch, with four or five pairs of external lateral lobes to umbilical shoulders. Four named species. [This genus is similar to *Neocrimites*, but with evenly reticulate sculpture, lappets, and arched sutural trace.] *Cisuralian (Artinskian [probably Baigendzhinian])–Guadalupian (Wordian):* Canada (British Columbia), Italy (Sicily), Iraq (Kurdistan), Oman, Indonesia (Timor), Australia (New South Wales, Queensland).——FIG. 77,*1a–e*. **A. ensifer* (GEMMELLARO), Sosio limestone, Wordian, Sicily; *a–b*, lectotype (herein), MGUP 82A of GEMMELLARO (1887, pl. 6,*11–12*), ×2 (new); *c–d*, paralectotype, MGUP 82B of GEMMELLARO (unfigured), ×2 (new); *e*, paralectotype, MGUP 82C of GEMMELLARO (1887, pl. 6,*13*), diameter ranging 10–19 mm (modified after Gemmellaro, 1887).

Crimites TUMANSKAIA, 1937a, p. 146 [**Agathericeras Krotowi* KARPINSKII, 1889, p. 66; SD GLENISTER & FURNISH, 1961, p. 726] [?=*Istycoceras* PAVLOV, 1967, p. 74 (type, *I. bodylevskyi,* OD)]. Similar to *Emilites* (globular, involute), from which it was derived, but suture characterized by three pairs of external lateral lobes, three pairs of internal laterals, and three or four smaller lobes on each umbilical wall. Fourteen named species. *Cisuralian (Asselian)–Guadalupian (Wordian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), Indonesia (Timor), USA (Nevada).——FIG. 76,*1a–c*. **C. krotowi* (KARPINSKII), Artinskian, Urals; *a–b,* Aktastinian, Southern Urals, ×1.5 (Ruzhentsev, 1956b); *c*, Baigendzhinian, Central Urals, diameter at 10 mm (Bogoslovskaia, 1962).

Doryceras GEMMELLARO, 1887, p. 82 [**D. fimbriatum;* OD]. Conch small (1 cm at maturity; USNM 499156, probable dimorph 25% smaller) with deep subterminal constriction and strong terminal flare of mature peristome lacking lappets and any other significant modification of premature apertural contours. Fine ribs form high salient across umbilical wall, and broad shallow sinus across flat venter. Suture comprises three pairs of external lateral lobes, two pairs of internal laterals, and additional lobe centered on umbilical seam. One named species (assignment of *D. stouckenbergi* GEMMELLARO, 1888 is questionable). [This genus is interpreted herein as an adrianitin paedomorph.] *Guadalupian (Wordian):* Italy (Sicily).——FIG. 76,*2a–g*. **D. fimbriatum*, Sosio limestone; *a–b*, lectotype (herein), MGUP 126A of GEMMELLARO (1887, pl. 10,*26*), ×4; *c–d*, paralectotype, MGUP 126B of GEMMELLARO (1887, pl. 10,*28*), ×4; *e–f*, topotype, USNM 499154, ×4; *g*, composite, diameter approximately 5 mm, based on paralectotype, MGUP 126C of GEMMELLARO (1887, pl. 10,*27*) and topotypes GPIT 24409-19 and USNM 499154 (new).

Emilites RUZHENTSEV, 1938, p. 265 [**Paralegoceras incertum* BÖSE, 1919, p. 100; OD] [=*Plummerites* MILLER & FURNISH, 1940a, p. 103, obj.]. Conch globular with small umbilicus (U/D, commonly 0.1), and scalloped transverse sculpture. Suture comprises two pairs of external lateral lobes and two pairs of internal laterals. External suture characterized by irregularly denticulate third lateral saddle across umbilical wall. Sutural formula: $(V_1V_1)LU:U^1ID$ [Russian]. Seven species, representing primitive forms of subfamily. *Pennsylvanian (upper Moscovian)–Cisuralian (Sakmarian)*: USA (Texas, Oklahoma), Canada (Arctic Archipelago, Ellesmere Island), Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Uzbekistan (Fergana), southern China (Guangxi).——FIG. 78,*4a–c*. **E. incertus* (BÖSE), Virgilian, western Texas; *a–b*, ×2; *c*, diameter at 10 mm (Miller & Furnish, 1940a).

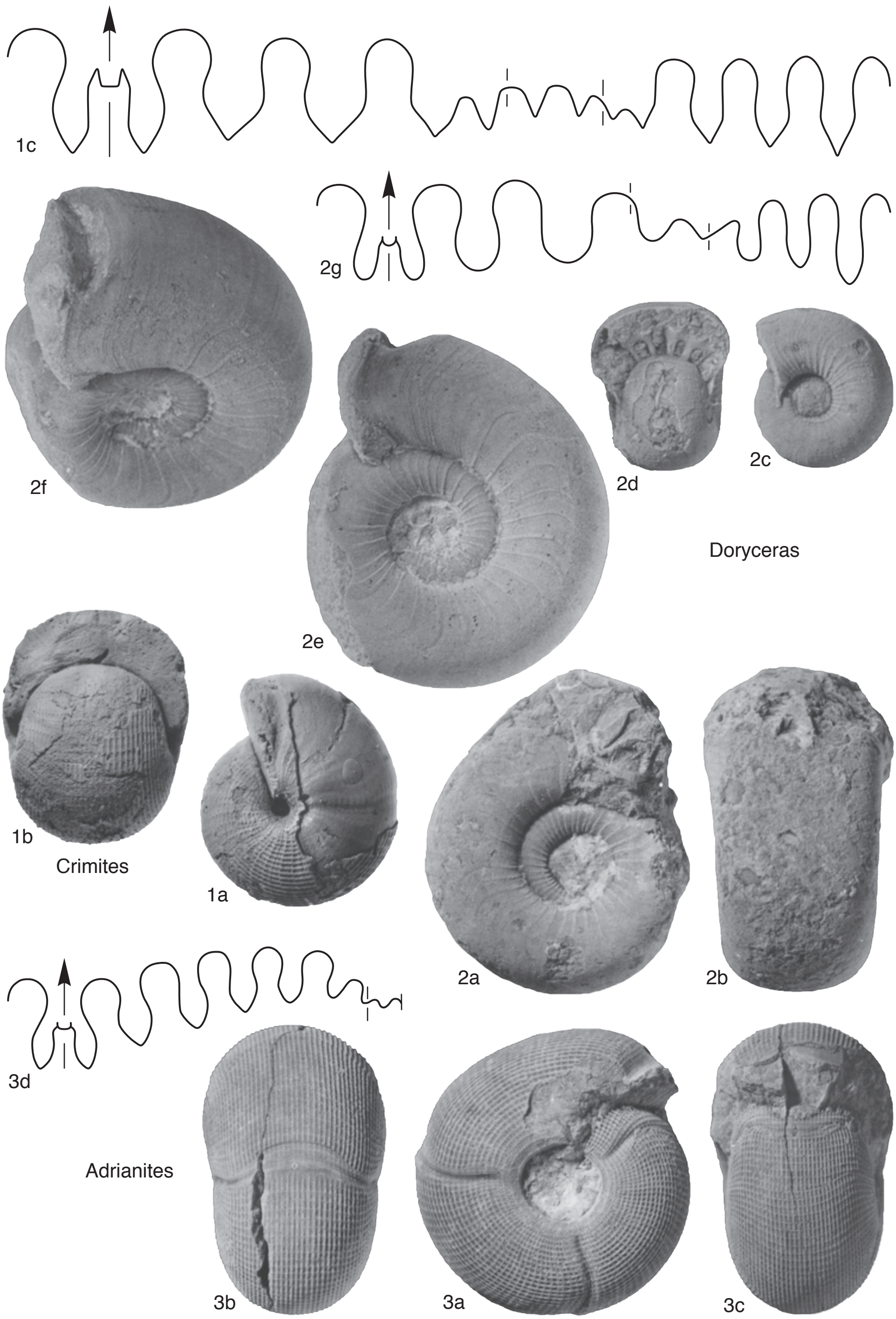

FIG. 76. Adrianitidae (p. 126).

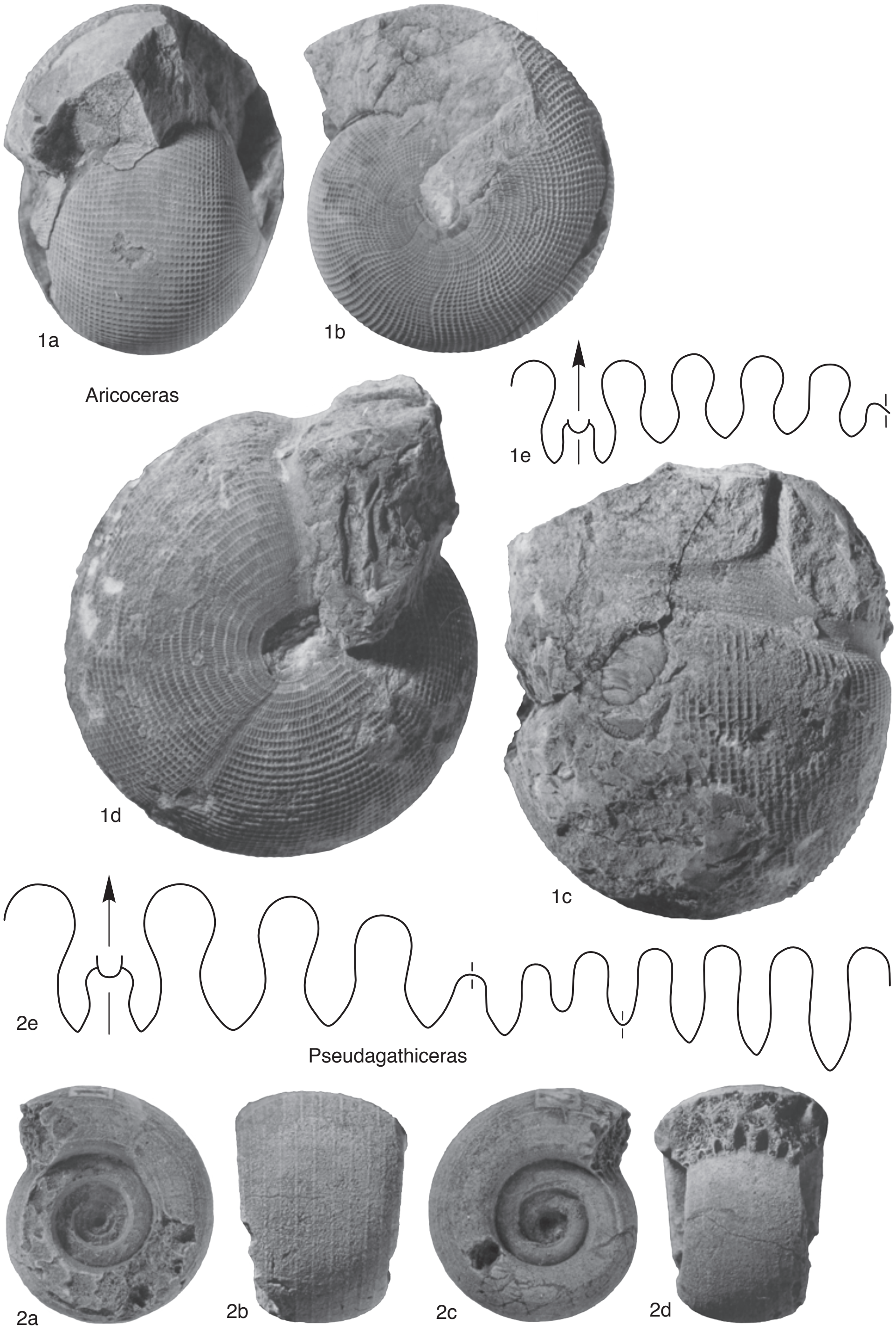

FIG. 77. Adrianitidae (p. 126–132).

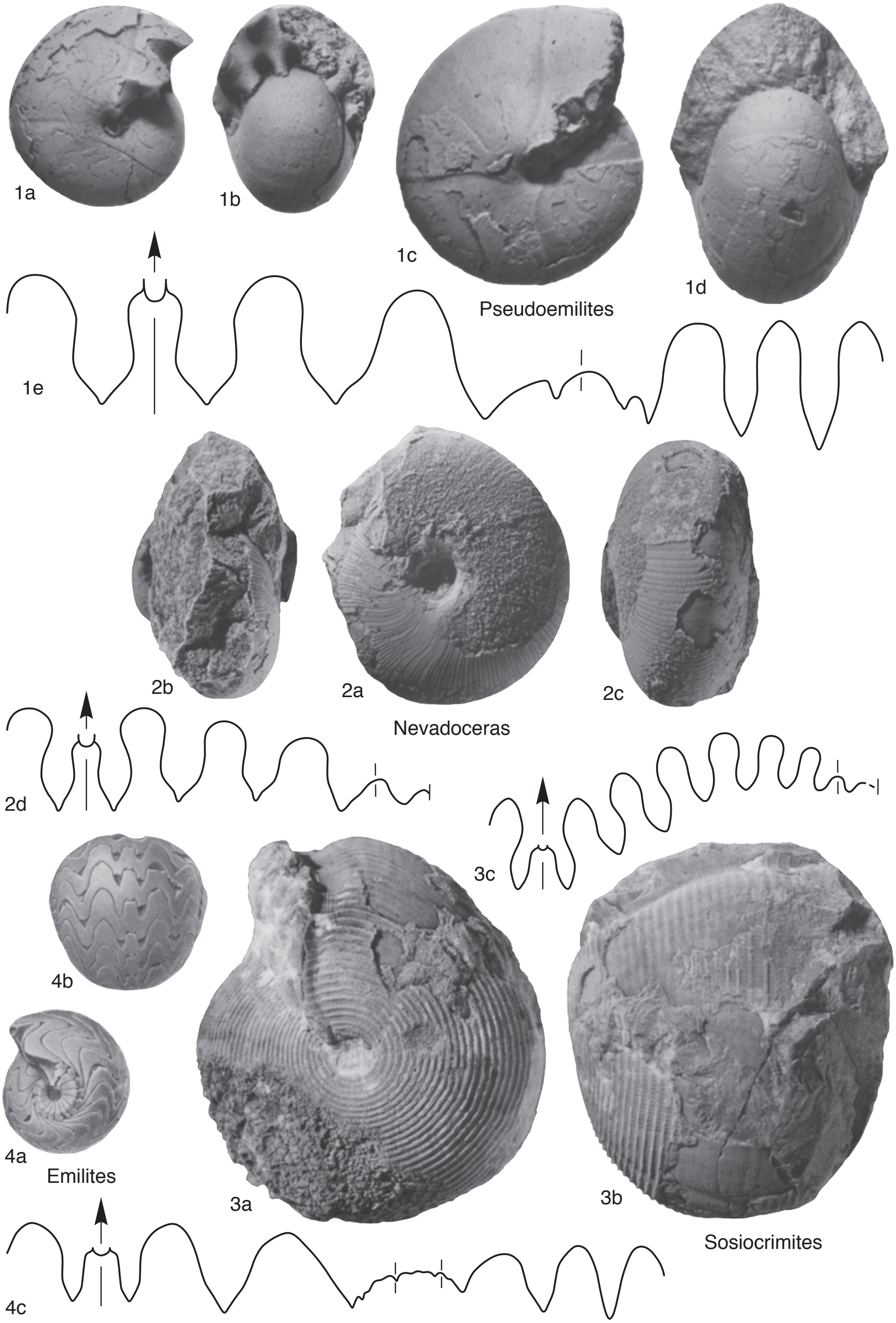

FIG. 78. Adrianitidae (p. 126–133).

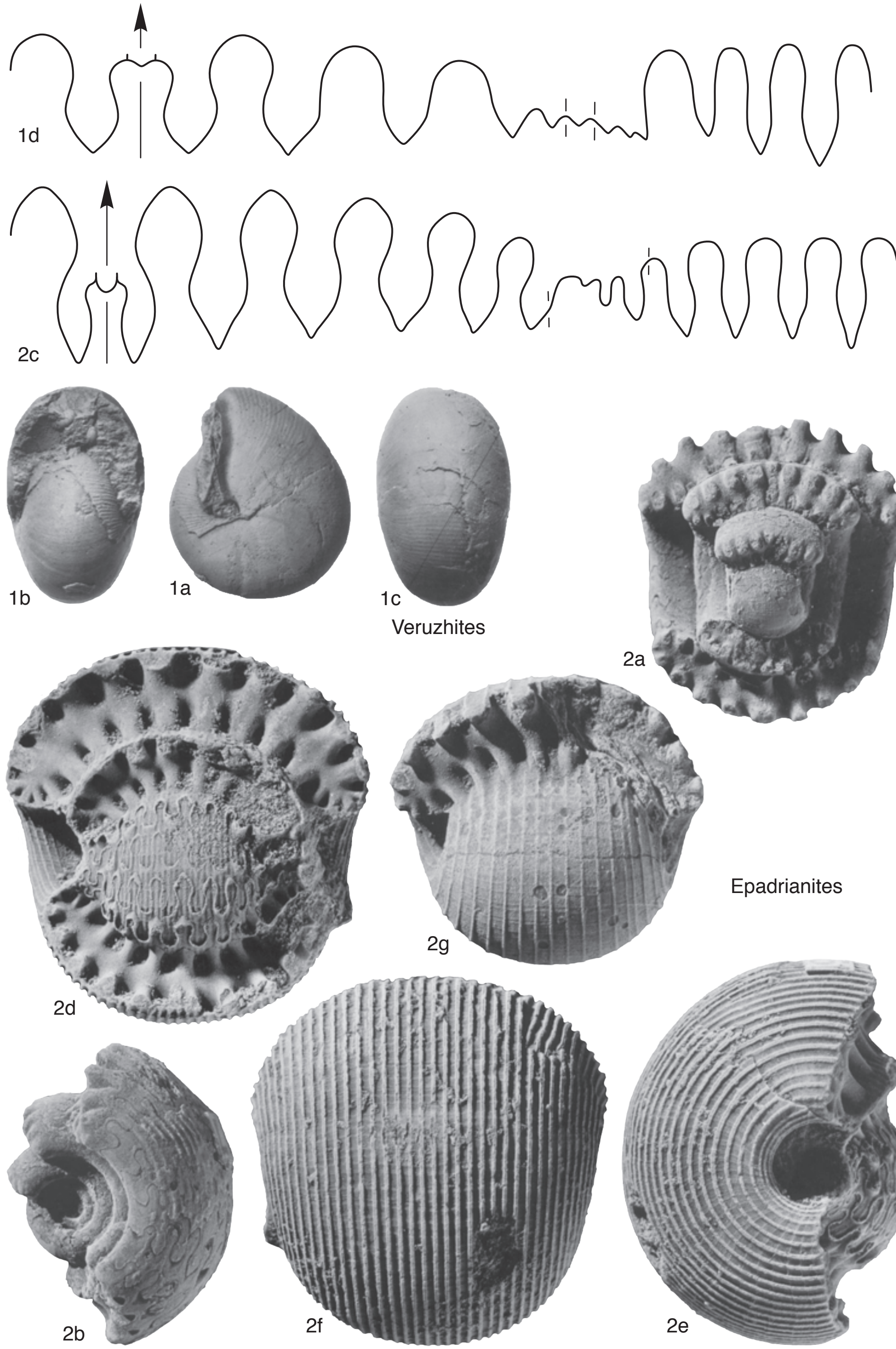

FIG. 79. Adrianitidae (p. 131–134).

Epadrianites SCHINDEWOLF, 1931, p. 200 [**Agathiceras timorense* BOEHM, 1908, p. 321; OD] [=*Basleoceras* RUZHENTSEV, 1950, p. 203 (type, *Agathiceras Beyrichi* HANIEL, 1915, p. 83, OD)]. Conch large (diameter at maturity up to 7 cm), globular, with moderately large umbilicus and longitudinal lirae much stronger than transverse sculpture. Mature modifications incompletely known, but comprise slight geniculation, reduction of umbilical diameter, subterminal constriction, and terminal flare that probably extended into ventrolateral lappets. Sutural trace transverse; suture comprises four or five pairs of external lateral lobes, three or four pairs of internal lateral lobes, and two or three additional lobes on each umbilical wall. Seven named species. *Guadalupian (Wordian)–Lopingian (Wuchiapingian):* Indonesia (Timor), China (Jilin, Guizhou), Italy (Sicily), Oman, Croatia, Mexico (Coahuila), Azerbaijan (Dzhulfa).——FIG. 79,*2a–c.* **E. timorensis* (BOEHM), Amarassi beds, Wuchiapingian, Amarassi, Timor; *a–b*, holotype, MTHD (same as BOEHM, 1908, pl. 11,*3a–c,* fig. 1a–b), ×2; *c*, topotype, SUI 12685A, diameter at 40 mm (new).——FIG. 79,*2d–f. E. involutus* HANIEL, lectotype, Amarassi beds, Bihati, Timor, MTHD 12751 (same as HANIEL, 1915, pl. 5,*8a,b*), ×2 (new).——FIG. 79,*2g. E. beyrichi*, paralectotype (herein), MTHD 12745, Wordian, Basleo beds, Basleo, Timor (probable source of suture, HANIEL, 1915, fig. 23), ×2 (new).

Neoaricoceras RUZHENTSEV, 1950, p. 203 [**Adrianites Kingi* GEMMELLARO, 1887, p. 47; OD]. Similar to *Sosiocrimites* in general conch form and mature modifications, but characterized by closed mature umbilicus and virtual absence of longitudinal sculpture. Sutural trace moderately and uniformly arched, with seven pairs of external lateral lobes to umbilical shoulders. One species. *Guadalupian (Wordian):* Italy (Sicily).——FIG. 80,*3a–c.* **N. kingi* (GEMMELLARO), Sosio limestone; *a–b,* lectotype (herein), MGUP 81A of GEMMELLARO (1887, pl. 9,*31–32*), ×2; *c*, paralectotype, composite, MGUP 81B of GEMMELLARO (1887, pl. 9,*35*) and USNM 509805, diameter at 13 mm (new).

Neocrimites RUZHENTSEV, 1940a, p. 838 [**Adrianites fredericksi* EMEL'IANTSEV, 1929, p. 150; OD] [=*Metacrimites* RUZHENTSEV, 1950, p. 202, *partim* (type, *Adrianites newelli* MILLER & FURNISH, 1940a, p. 117, OD); =*Millerites* CANTÚ CHAPA, 1997, p. 66 (type, *Adrianites newelli* MILLER & FURNISH, 1940a, p. 117, OD)]. Similar to *Crimites* (globular, involute), from which it was derived, but longitudinal sculpture may be much stronger than transverse. Sutural trace directly transverse with four or five pairs of external lateral lobes, three or four pairs of internal laterals, and two or three smaller lobes on umbilical wall. Fifteen named species. *Cisuralian (Artinskian [Baigendzhinian])–Guadalupian (Capitanian):* southern Kazakhstan (Southern Urals), Tajikistan (Pamir), Russia (Urals, northern Caucasus), USA (Texas), Mexico (Coahuila), Indonesia (Timor), China (Xizang, Guangxi, Guizhou, Gansu), ?Western Australia.——FIG. 80,*1a–c.* **N. fredericksi* (EMEL'IANTSEV), Baigendzhinian, Southern Urals; *a–b*, ×1.5; *c*, diameter at 18 mm (Ruzhentsev, 1956b).

Nevadoceras SCHIAPPA, SPINOSA, & SNYDER, 1995, p. 1075 [**N. steeli;* OD]. Similar to *Crimites* in simple sutural characteristics, but with narrower conch and wider umbilicus. Distinctive scaliform striae form shallow sinus across venter and a rounded salient across dorsolateral flank. One species. *Cisuralian (Artinskian):* USA (Nevada).——FIG. 78,*2a–d.* **N. steeli; a–c*, ×1.5; *d*, diameter at 18 mm (Schiappa, Spinosa, & Snyder, 1995).

Palermites TUMANSKAIA, 1937b, p. 377 [**Adrianites Distefanoi* GEMMELLARO, 1887, p. 48; OD]. Conch large (diameter 3–5 cm at maturity; bimodal size distribution in topotypes of type species suggests dimorphism), compressed (W/D, 0.6), characterized by retention of evolute form to maturity (U/D, 0.5). Juvenile shell smooth; transverse sculpture with low dorsolateral and ventral salients becoming progressively more prominent in ultimate volution. Mature modifications comprise slight geniculation in coiling, penultimate constriction, and terminal flare of aperture that includes formation of narrow, divergent ventrolateral lappets. Sutural trace gently arched. Suture comprises five pairs of external lateral lobes, five pairs of internal laterals, and two additional lobes on umbilical wall. Two species. *Guadalupian (Wordian)*: Italy (Sicily), Ukraine (?Crimea), Iraq (Kurdistan), northern China (?Jilin).——FIG. 81*a–e.* **P. distefanoi* (GEMMELLARO), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 76A of GEMMELLARO (1887, pl. 9,*36–37*), ×2; *c–d*, topotype, SUI 32456, ×2; *e*, paralectotype, composite, MGUP 76B of GEMMELLARO (1887, pl. 9,*40*), external suture, and paralectotype, MGUP 76C (unfigured), internal, diameter approximately 18 mm (new).

Pamiritella TUMANSKAIA, 1963, p. 75 [**Adrianites vinogradovi* TUMANSKAIA, 1949, p. 76; OD] [?=*Pamirioceras* PAVLOV, 1967, p. 71 (type, *P. markovskii,* OD)]. Incompletely known, but probably distinguishable by combination of weak sculpture, narrow conch (W/D, 0.4–0.5), involute form (U/D, of 0.25 decreased to 0.05 as mature modification), and possession of slightly arched sutural trace with five or six pairs of external lateral lobes. One named species. *Cisuralian (Kungurian [Bolorian]):* Tajikistan (Pamir).

Pseudagathiceras SCHINDEWOLF, 1931, p. 200 [**Agathiceras (Doryceras?) Wichmanni* HANIEL, 1915, p. 85; OD]. Conch evolute, similar to *Doryceras* in general form but larger and commonly with strong but variable sculpture. Suture comprises total of 16–18 lobes; depending on whorl section, 3 or 4 pairs of lobes on external lateral flanks, 1 or 2 pairs on umbilical wall, and 2 or 3 pairs internally. Three named species (questionable grouping). *Guadalupian (?Wordian):* Indonesia (Timor), Japan (Kitakami), Mexico (Coahuila).——FIG. 77,*2a–e.* **P. wichmanni* (HANIEL), Basleo beds, Basleo,

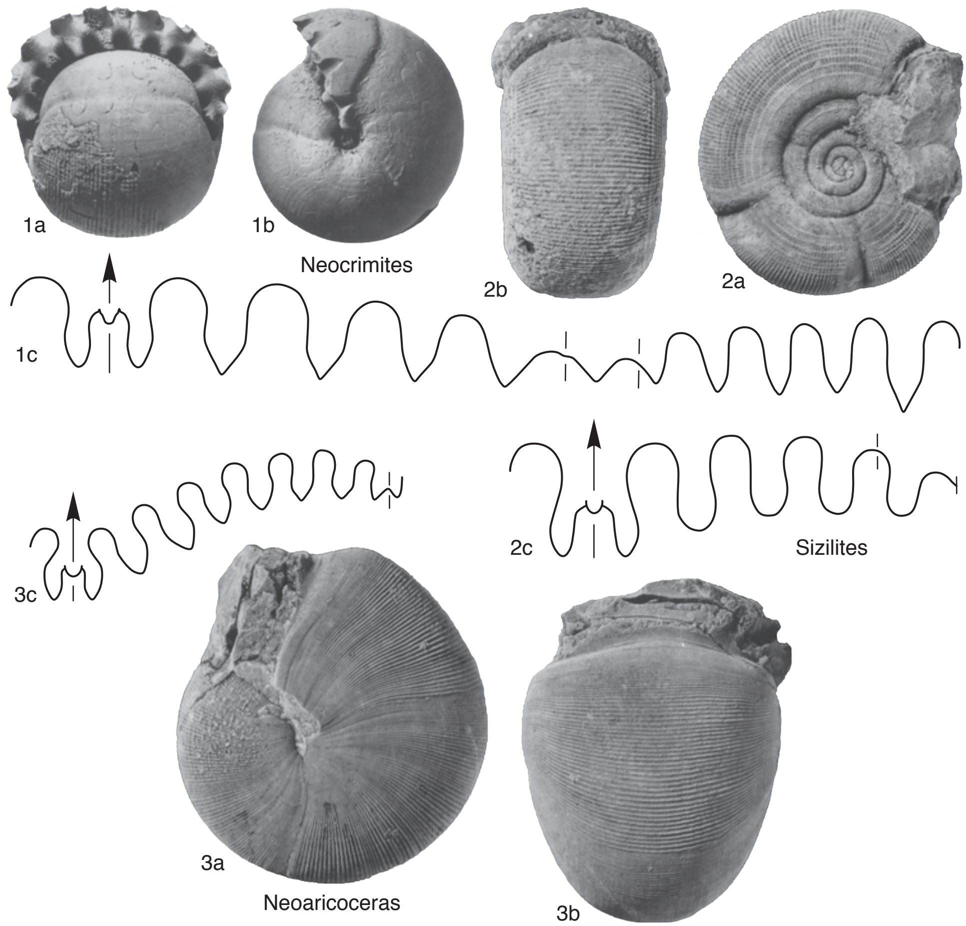

FIG. 80. Adrianitidae (p. 131–132).

Timor, lectotype (herein), MTHD 12752 (same as HANIEL, 1915, pl. 5,*15a–c,* ?text-fig. 24); *a–d,* ×2; *e,* diameter at 16 mm (new).

Pseudoemilites LEONOVA, 1988, p. 32 [**P. asianus;* OD]. Smooth, involute, globular adrianitins characterized by anomalously primitive suture: ten lobes, prongs of ventral lobe only slightly narrower than corresponding first lateral, secondary ventral saddle almost aligned with lateral saddles. Second external and second internal lateral lobes both prominently bidentate. One species. [Suture resembles those of Pennsylvanian adrianitins in some respects, but phyletic relationships are unclear.] *Cisuralian (Kungurian [Bolorian]):* Tajikistan (Pamir).——FIG. 78,*1a–e.* **P. asianus; a–d,* ×2; *e*, diameter about 15–17 mm (adapted from Leonova & Dmitriev, 1989).

Sizilites TUMANSKAIA, 1937b, p. 377 [**Adrianites affinis* GEMMELLARO, 1888, p. 16; OD]. Conch small (15 mm at maturity), compressed (W/D, 0.6), evolute (Umin /D, 0.40). Sculpture reticulate; forwardly arched transverse elements predominate on venter, whereas longitudinal lirae are dominant on dorsolateral flanks. Mature aperture constricted strongly, ultimate peristome flared (expanded), probably forming dorsolateral lappets. Sutural trace slightly arched; suture comprises four pairs of linked external lateral and internal lateral lobes. Three species (Sicilian species possibly dimorphs). *Guadalupian (Wordian)*: Italy (Sicily), Iraq (Kurdistan).——FIG. 80,*2a–c.* **S. affinis* (GEMMELLARO), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 88 of GEMMELLARO (1888, pl. D,*6–7*), ×2.67; *c*, topotype, SUI 62700, Rocca di Salomone, diameter at 12 mm (new).

Sosiocrimites RUZHENTSEV, 1950, p. 202 [**Adrianites insignis* GEMMELLARO, 1887, p. 44; OD] [?=*Subcrimites* LIANG, 1982, p. 652 (type, *Neocrimites (Subcrimites) compressus,* OD)]. Conch form and sculpture generally similar to ancestor, *Neocrimites*, but with mature modifications comprising slight geniculation, deep subterminal constriction, and terminal

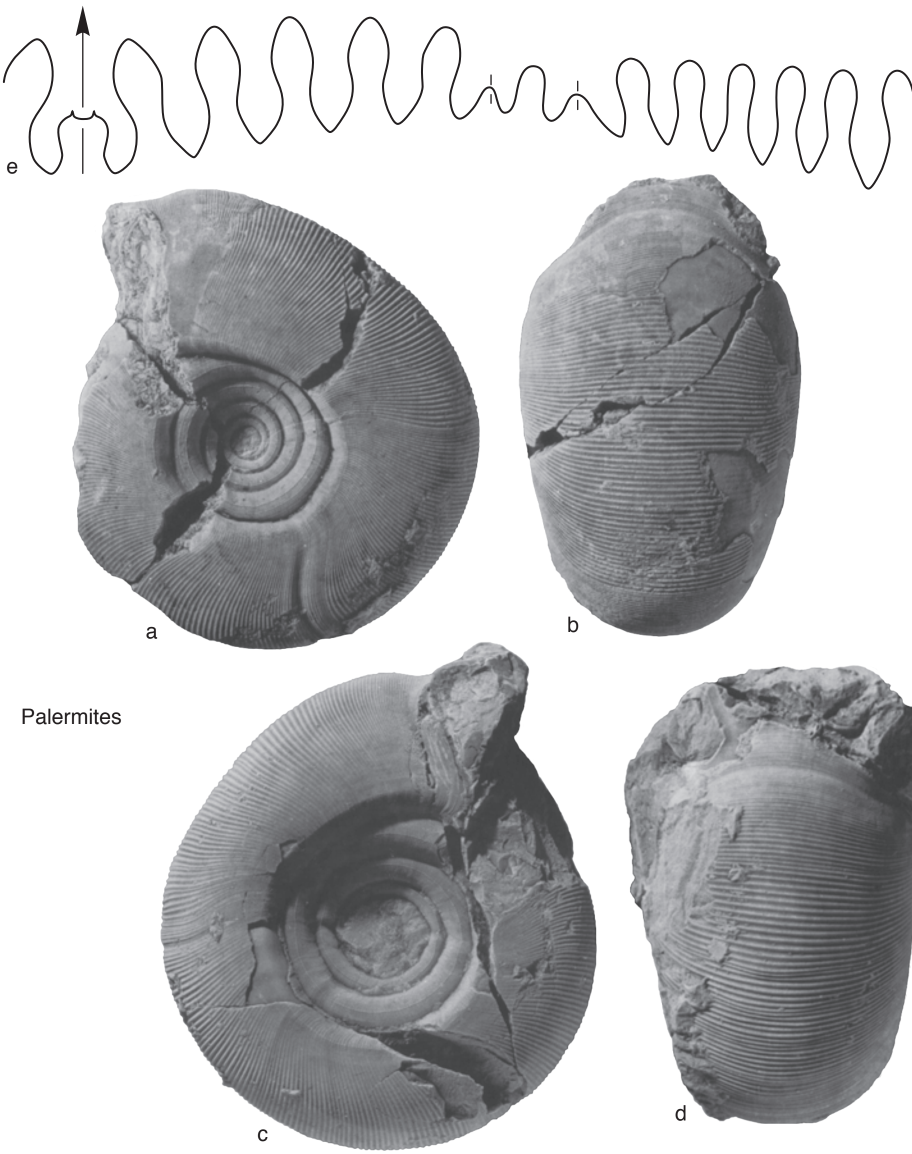

FIG. 81. Adrianitidae (p. 131).

flare (expansion) that extends ultimate peristome as ventrolateral lappets. Characterized by moderate and uniformly arched sutural trace with six or seven pairs of external lateral lobes to umbilical shoulder. Four species. *Cisuralian (Artinskian [Yakhtashian])–Guadalupian (Wordian):* Italy (Sicily), Tunisia (?Djebel Tebaga), Ukraine (Crimea), Tajikistan (Pamir), Iraq (Kurdistan), Oman, ?Malaysia, China (?Jilin, ?Xizang), USA (?Texas).——FIG. 78,*3a–c*. **S. insignis* (GEMMELLARO), Sosio limestone, Sicily; *a–b,* lectotype (herein), MGUP 84 of GEMMELLARO (1887, pl. 6,*8–9*), ×2; *c*, topotype, MGPU I2866, Canavari Collection (GRECO, 1935, pl. 14,*12a,b*), Rocca di Salomone, diameter at 16 mm (new).

Veruzhites LEONOVA, 1988, p. 33 [**V. pamiricus;* OD]. Similar to *Crimites* in globular conch form and number of lobes, but narrower (W/D, 0.6 at maturity) and differing in possession of anomalously high secondary ventral saddle and ventral prongs of width subequal to adjacent first lateral lobe.

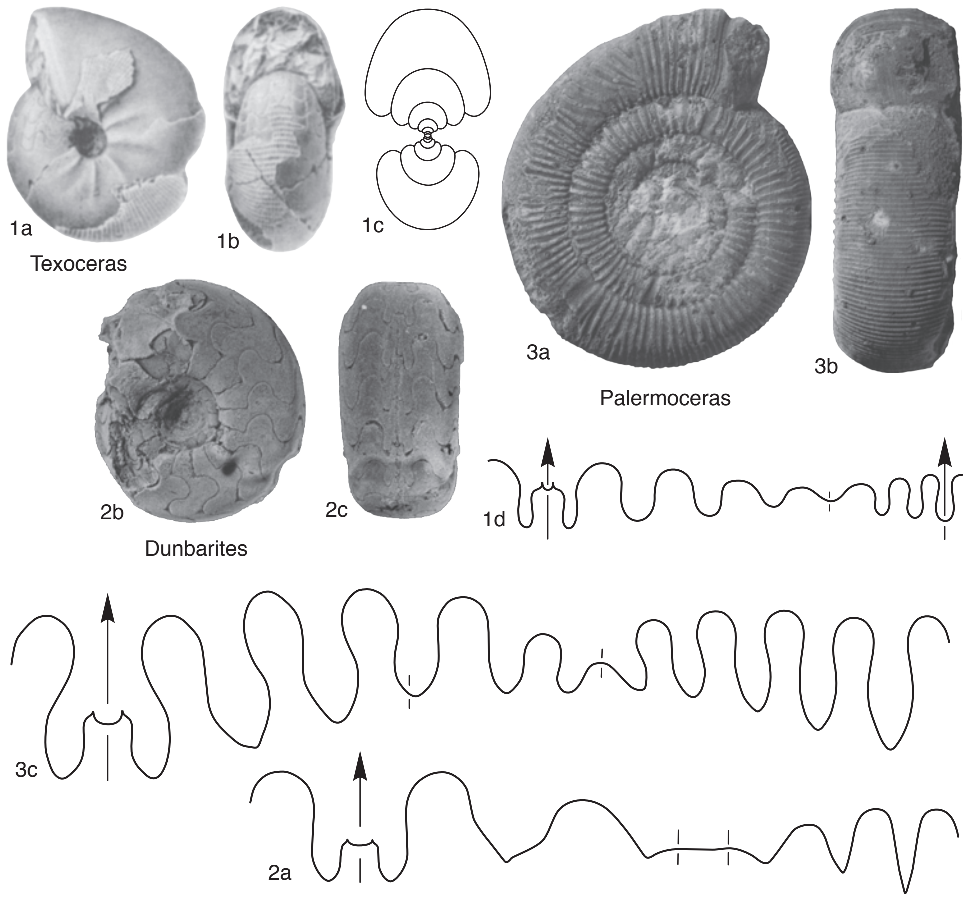

FIG. 82. Adrianitidae (p. 134–135).

One species. *Cisuralian (Artinskian [Yakhtashian]–Kungurian [Bolorian]):* Tajikistan (Pamir).——FIG. 79,*1a–d*. **V. pamiricus*, Bolorian, southeastern Pamir; *a–c*, ×1.5 (Leonova, 1988); *d*, diameter at 14 mm (modified by C. Spinosa, adapted from Leonova, 1988).

Subfamily DUNBARITINAE Miller, Furnish, & Schindewolf, 1957

[Dunbaritinae MILLER, FURNISH, & SCHINDEWOLF, 1957, p. 67] [=Dunbaritidae RUZHENTSEV, 1960d, p. 229]

Rare, aberrant, discoidal adrianitids characterized by combination of evolute conch form and few (10) lobes. Sutural formula: $(V_1V_1)LU{:}U^1ID$ [Russian]. [Adrianitoidean affinites are indicated by basic sutural formula and incipient denticulation (unrecorded previously) of secondary umbilical saddle (U/U^1). The conch form and the nature of the constrictions are unique.] *Pennsylvanian (Moscovian–Gzhelian)*.

Dunbarites MILLER & FURNISH, 1940c, p. 532 [**Paralegoceras rectilaterale* MILLER, 1930, p. 402; OD]. Whorl section quadrate with rounded ventrolateral shoulders and relatively flat flanks and venter. Constrictions on internal mold radial from umbilicus to midflank, where they deepen into conspicuous conical pit and steeply arched forward on ventrolateral flank, and transverse or with shallow backward sag across venter. Secondary umbilical saddle faintly crenulate, commonly with discernible secondary lobe at crest. Two named species. *Pennsylvanian (Moscovian–Gzhelian):* USA (western Texas, Oklahoma).——FIG. 82,*2a*. **D. rectilateralis*

(MILLER), Gaptank Formation, Virgilian, western Texas, lectotype (herein), YPM 12934A, diameter at 10 mm (Miller & Furnish, 1940c).——FIG. 82,*2b–c*. *D.* n. sp., Desmoinesian, Wewoka Formation, SUI 48683, ×3 (new).

Subfamily PALERMOCERATINAE new subfamily

[Palermoceratinae ZHOU & GLENISTER, herein] [=Hoffmanniinae MOJSISOVICS, 1888, p. 20; =Hoffmanninae (*sic*) SPATH, 1934, p. 16, first formal usage; =Hoffmanniidae PLUMMER & SCOTT, 1937, p. 359; RUZHENTSEV, 1960d, p. 229] [type genus, *Palermoceras* ZHOU & GLENISTER, herein, p. 135]

Narrow, widely evolute adrianitids with strong ribs. *Guadalupian (Wordian).*

Palermoceras ZHOU & GLENISTER, *nom. nov.* herein, p. 218, *pro Hoffmannia* GEMMELLARO, 1887, p. 49; LEONOVA, 2002, p. 65, junior homonym, ICZN *Code* Article 52; *non* HEINEMANN & WOCK, 1877, modern moth insect; *nec* FORCART, 1953, modern Gastropoda, Mollusca [**Adrianites (Hoffmannia) Hoffmanni* GEMMELLARO, 1887, p. 49; OD]. Conch small (2–3 cm at maturity), thinly discoidal (W/D, 0.4), umbilicus wide (U/D, 0.5), whorls with uniformly rounded umbilical walls. Numerous strong ribs are directly transverse across umbilical wall, doubling in number on venter through both bifurcation and intercalation near umbilical shoulder, and forming low ventral salient. Sutural trace arched with five pairs of external lateral lobes and four pairs of internal laterals. Two named species. [The assignment of *Hoffmannia burgensis* GEMMELLARO, 1888, to the genus is doubtful.] *Guadalupian (Wordian):* Italy (Sicily), USA (?Texas).——FIG. 82,*3a–c*. **P. hoffmanni* (GEMMELLARO), Sosio limestone; *a–b,* lectotype (herein), MGUP 78A of GEMMELLARO (1887, pl. 7,*1,3*), ×2; *c,* topotype, MGUP 79 of GEMMELLARO (1888, pl. C,*18;* presence of two additional pairs of lobes illustrated by GEMMELLARO in internal suture close to umbilical seam has not been verified), diameter approximately 20 mm (new).

Subfamily TEXOCERATINAE Ruzhentsev & Bogoslovskaia, 1978

[Texoceratinae RUZHENTSEV & BOGOSLOVSKAIA, 1978, p. 87]

Distinctive, compressed, involute adrianitids, lacking lappets, and characterized by lobes that are parallel-sided and rounded at base. [The scalloped sculpture of *Texoceras* has been interpreted (RUZHENTSEV & BOGOSLOVSKAIA, 1978) to justify inclusion of *Doryceras* within the subfamily and to indicate ancestry in *Emilites*. Although sutures are generally similar, neither genus is considered more closely related than implied by common familial assignment (the crenulate growth lines of type *Doryceras* are unlike the scallops of *Texoceras*), and the single unique feature of *Texoceras* is the shape of the lobes.] *Guadalupian (Roadian).*

Texoceras MILLER & FURNISH, 1940a, p. 110 [**Agathoceras (sic) texanum* GIRTY, 1908, p. 501; OD]. Conch 2–3 cm at maturity, compressed (W/D, 0.5) with small umbilicus (U/D, 0.2). Growth lines and coarse dorsolateral plications are directly transverse. Growth lines characterized by prominent scallops whose cusps extend forward and coalesce with those that precede them to form fine longitudinal lirae. Mature modifications comprise deep subterminal constriction and flared ultimate peristome, without lappets. All lobes rounded at base, most are parallel sided; sutural trace directly transverse, formula: $(V_1V_1)LUU^3{:}U^2U^1ID$ [Russian]. One species. *Guadalupian (Roadian):* USA (western Texas), China (?Xizang).——FIG. 82,*1a–d*. **T. texanum* (GIRTY), Bone Spring Limestone, western Texas; *a–b*, ×1.33; *c*, diameter at 15 mm; *d*, diameter at 16 mm (Miller, Furnish, & Schindewolf, 1957).

SHUMARDITOIDEA

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Superfamily SHUMARDITOIDEA Plummer & Scott, 1937

[*nom. transl.* Basse, 1952, p. 581, *ex* Shumarditidae Plummer & Scott, 1937, p. 287]

Conch relatively narrow, evolute to involute, and without strong ornament. Basic sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian], $(E_1E_mE_1)$ALUI [German]. Dorsal lobe (D) deeply trifid in all but ancestral forms and rare terminal paedomorphs. Sutural phylembryogenesis involved tripartition of the umbilical lobe (U) in advanced Parashumarditidae and all of the descendant Perrinitidae, and development of strongly denticulate lobes that diverge to narrow crests of intervening saddles in advanced Perrinitidae. *Pennsylvanian (Moscovian)–Guadalupian (Roadian).*

Family SOMOHOLITIDAE Ruzhentsev, 1938

[Somoholitidae Ruzhentsev, 1938, p. 280]

Probable ancestral Shumarditoidea, with evolute conch, and with longitudinal lirae dominant in all but terminal representative (*Neoshumardites*). Narrow ventral prongs and all remaining sutural elements except the umbilical lobe (U) are medially inflated to prominently pouched. Sutural formula: (V_1V_1)LU:ID [Russian], $(E_1E_mE_1)$ALUI [German]. Evolutionary succession probably: *Somoholites* (Moscovian–Artinskian) > *Andrianovia* (?Asselian, Sakmarian) > *Neoshumardites* (Artinskian). *Pennsylvanian (Moscovian [Desmoinesian])–Guadalupian (Roadian).*

Somoholites Ruzhentsev, 1938, p. 280 [**Gastrioceras beluense* Haniel, 1915, p. 54; OD]. Somoholitids characterized by combination of strong longitudinal lirae and lobes (except U) that are inflated medially, but not to the extent of developing paired pouches. Thirteen named species. *Pennsylvanian (Moscovian [Desmoinesian])–Cisuralian (Artinskian [Aktastinian Substage]):* Indonesia (Timor), USA (Texas, Oklahoma, Kansas, Missouri, Ohio, Pennsylvania, Nevada, Oregon), Canada (Arctic Archipelago: Ellesmere Island, Yukon), Kazakhstan (Southern Urals), Russia (Urals, Verkhoian, Okhotskii Massif), Tajikistan (Pamir), China (Xinjiang, Guizhou).——Fig. 83,*3a–c*. **S. beluensis* (Haniel), Somohole beds, Asselian–Sakmarian, Timor; *a–b,* ×1; *c,* diameter at 30 mm (Saunders, 1971).

Andrianovia Boardman, Work, & Mapes, 1994, p. 49 [**Preshumardites sakmarae* Ruzhentsev, 1938, p. 283; OD]. Somoholitids characterized by combination of strong longitudinal lirae and external lateral lobe, internal lateral lobe and dorsal lobe (L, I, D) are strongly pouched medially. Three named species. *Cisuralian (?Asselian, Sakmarian):* Russia (Southern Urals, Verkhoian), Kazakhstan (Southern Urals), Indonesia (?Timor).——Fig. 83,*2a–c*. **A. sakmarae* (Ruzhentsev), Sakmarian; *a–b,* ×0.67; *c,* diameter approximately 13 mm (Ruzhentsev, 1951).

Neoshumardites Ruzhentsev, 1936b, p. 1084 [**N. triceps;* OD]. Somoholitids that lack longitudinal sculpture. Suture generally similar to *Andrianovia*, but pouching of external lateral, internal lateral, and dorsal lobes (L, I, D) less strongly developed (degree to which this is a function of ontogeny is uncertain), and internal lobes much narrower. Three named species. *Cisuralian (Sakmarian)–Guadalupian (Roadian):* Russia (Southern Urals, Verkhoian), Canada (Northwest Territories).——Fig. 83,*1a–c*. **N. triceps; a–b,* ×0.67; *c,* diameter approximately 40 mm (Ruzhentsev, 1956b).

Family PARASHUMARDITIDAE Boardman, Work, & Mapes, 1994

[Parashumarditidae Boardman, Work, & Mapes, 1994, p. 55]

Evolute shumarditoideans characterized by symmetry of subdivisions as primary internal lateral lobe (I) evolved from tridentate to incipiently trifid $(I_{2(v)}I_1I_{2(d)})$: inner (dorsal) subdivision of I, i.e., $(I_{2(d)})$, is larger than outer two subdivisions ($I_{2(v)}$ and I_1), and secondary saddle of that dorsal subdivision $(I_1/I_{2(d)})$ is slightly to much higher than saddle that bounds the ventral subdivision $(I_{2(v)}/I_1)$. Primary external lateral and umbilical lobes (L and U) also changed from tridentate (L) or undivided (U) to trifid in the course of evolution. Prongs of ventral lobe (V_1V_1) generally simple (undivided), but may be bidentate. *Pennsylvanian (Moscovian–Gzhelian [Desmoinesian–Virgilian]).*

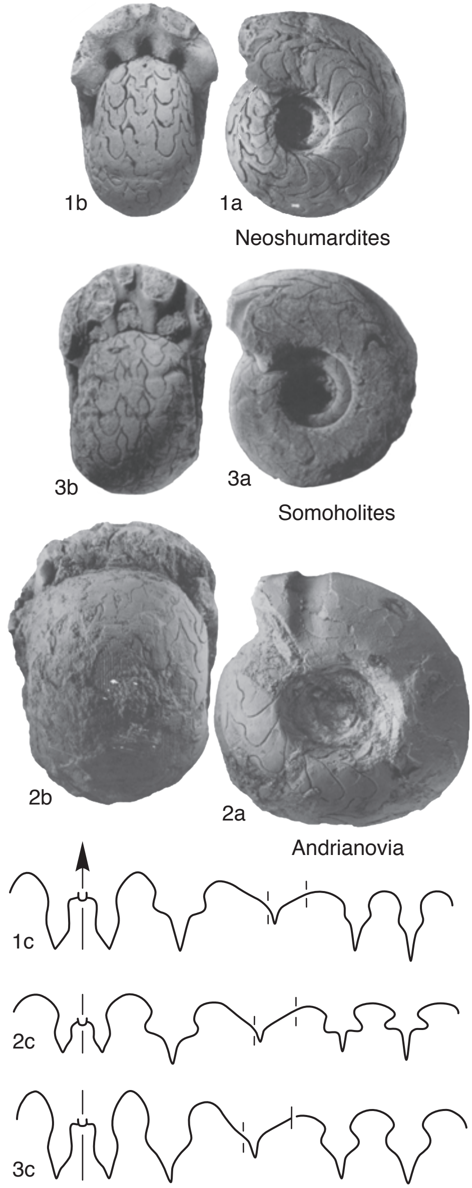

FIG. 83. Somoholitidae (p. 136).

Parashumardites RUZHENTSEV, October 19, 1939b, p. 851 [**Shumardites senex* MILLER & CLINE, 1934a, p. 184; OD] [=*Subshumardites* SCHINDEWOLF, post November 7, 1939a, p. 440 (type, *Shumardites fornicatus* PLUMMER & SCOTT, 1937, p. 300, OD)]. Parashumarditids distinguished by undivided prongs (V_1) in the ventral lobe, and by tripartition ($U_2U_1U_2$) of the umbilical lobe. Sutural formula: $(V_1V_1)(L_2L_1L_2)U_2U_1{:}U_2(I_2I_1I_2)D$ [Russian]. Five named species. *Upper Pennsylvanian*: USA (Texas, Oklahoma), Canada (Arctic Archipelago: Ellesmere Island), *Missourian–Virgilian;* Russia (Southern Urals, Moscow Basin), *Kasimovian*.——FIG. 84,*1a–d.* **P. senex* (MILLER & CLINE), Missourian, Oklahoma; *a–c,* lectotype, Nellie Bly Formation, SUI 641B (NASSICHUK, 1969, p. 126), ×1 (new); *d*, hypotype, Quivira Shale, SUI 62490, diameter at 37 mm (new, courtesy of D. M. Work & W. B. Saunders).——FIG. 84,*1e. P. eurinus* RUZHENTSEV, Zhigulian, Pennsylvanian, Southern Urals, height at 11 mm, diameter ranging from 30 to 35 mm (Ruzhentsev, 1950).

Aktubites RUZHENTSEV, 1955b, p. 1108 [**A. trifidus;* OD]. Ancestral parashumarditids characterized by combination of undivided prongs of ventral lobe (V_1), undivided primary umbilical lobe (U), and only incipient tripartition of the primary external lateral and internal lateral lobes (L and I). Sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian]. One species. *Pennsylvanian (Moscovian):* Kazakhstan (Southern Urals), Russia (Verkhoian), Spain; USA (Oklahoma, Ohio, Texas), *Middle Pennsylvanian (Desmoinesian)*.——FIG. 85,*2a–c.* **A. trifidus*, Moscovian, Southern Urals; *a–b,* ×1.33; *c,* diameter approximately 25 mm (Ruzhentsev, 1955b).

Eoshumardites Y. POPOV, 1960, p. 84 [**Shumardites (E.) lenensis* POPOV, 1960, p. 85; OD]. Conch proportions as in *Parashumardites;* paths of fine ribs and constrictions almost directly transverse, but display slight variation. General form of suture also closely similar to *Parashumardites,* especially in degree of tripartition and asymmetry of subdivisions in primary external and internal lateral lobes (L and I). However, primary umbilical lobe (U) remained undivided; diagnostically, prongs of ventral lobe are bidentate, the dorsal denticle being deeper than corresponding ventral denticle. Sutural formula: $(V_1V_1)(L_2L_1L_2)U{:}(I_2I_1I_2)D$ [Russian]. One or two species. [The latter relationship is duplicated only rarely in Goniatitina. *Eoshumardites* is interpreted as an aberrant terminal endemic. Two of the named species are from the same sample, and sutures in the 1960 and 1970 papers are slightly different interpretations of the same specimens. Y. POPOV (1960) suggested possible dimorphism, expressed as slightly different conch form and slight differences in growth lines across venter.] *Pennsylvanian (?Moscovian):* Russia (northern Verkhoian).——FIG. 84,*2a–c.* **E. lenensis; a–b,* plastoholotype, Tiksin Formation, SUI 35153 (holotype, 52/8717 of POPOV, 1970), ×0.67; *c*, composite based on plastoholotype, reinterpretation of published sutures (POPOV, 1970, fig. 25–26), and topotypes PIN 4473/18 and 4473/19, diameter ranging 25–45 mm (new).

Eovidrioceras BOARDMAN, WORK, & MAPES, 1994, p. 55 [**E. inexpectans;* OD]. Parashumarditids of

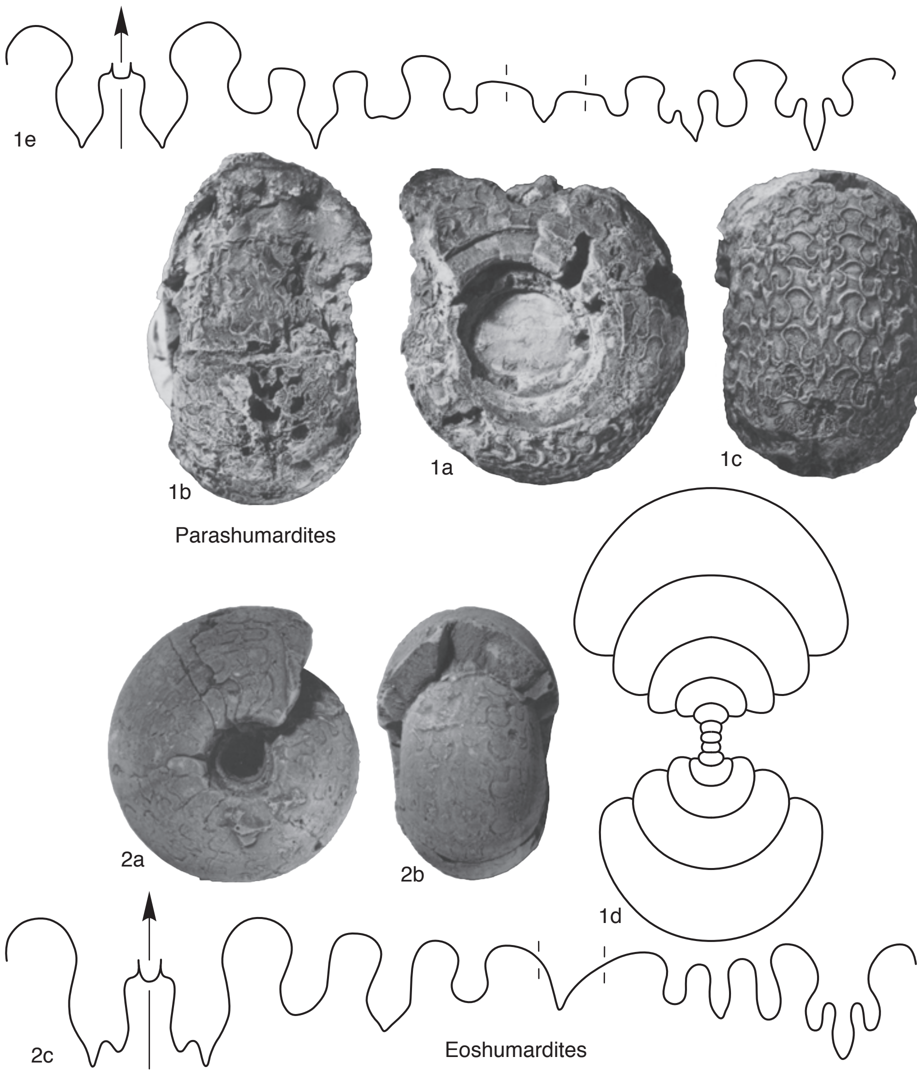

FIG. 84. Parashumarditidae (p. 137).

intermediate sutural advancement, characterized by combination of undivided prongs of ventral lobe (V_1), nearly complete isolation of the three subdivisions of both the primary external and internal lateral lobes (L and I), and undivided primary umbilical lobe (U). Sutural formula: $(V_1V_1)(L_2L_1L_2)$ $U{:}(I_2I_1I_2)D$ [Russian]. Inner (dorsal) subdivision of the internal lateral lobe ($I_{2(d)}$) is significantly larger than the two remaining subdivisions of I, and secondary saddle $I_1/I_{2(d)}$ is much higher than saddle $I_{2(v)}/I_1$. Two species. [The juvenile sutures of the ancestral (Virgilian) vidrioceratid *Vidrioceras conlini* (MILLER & DOWNS, 1950a) are virtually identical to those of mature (Missourian) *Eovidrioceras inexpectans* (BOARDMAN, WORK, & MAPES, 1994), affording strong evidence that this parashumarditid genus represents the direct ancestor of the Vidrioceratidae and ultimately the entire Cycloloboidea.] *Upper Pennsylvanian:* USA (Oklahoma), *Missourian*; Uzbekistan (southern Fergana: Karachatyr Range), *Pennsylvanian (Gzhelian)* [Gzhelian *fide* A. V. POPOV, 1992, but BOARDMAN, WORK, & MAPES (1994) suggest Kasimovian on overall faunal analysis].——FIG. 85,*1a–c.* **E. inexpectans*, Dewey Formation, Oklahoma; *a–b,* ×2; *c,* diameter at 14 mm (Boardman, Work, & Mapes, 1994).

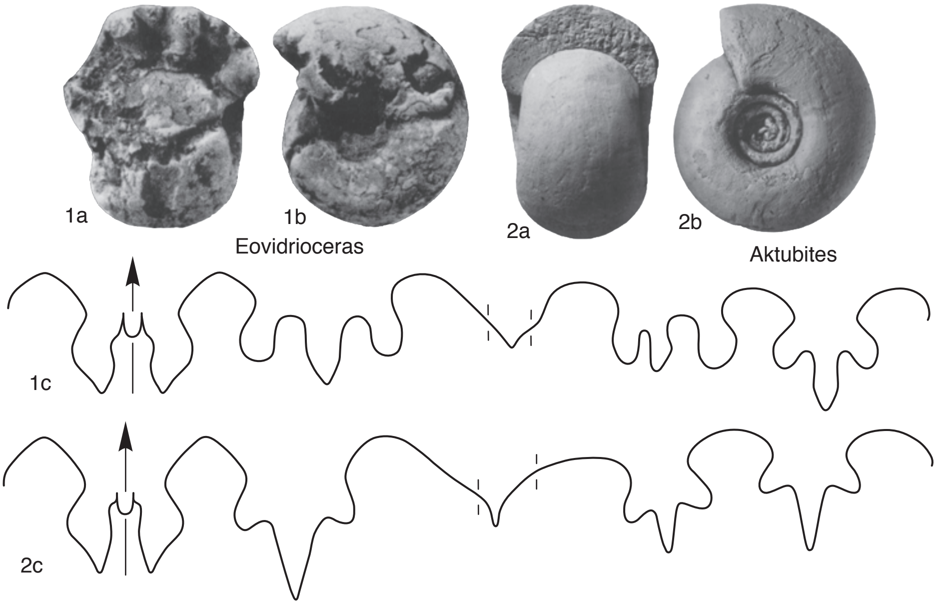

FIG. 85. Parashumarditidae (p. 137–139).

Family SHUMARDITIDAE Plummer & Scott, 1937

[Shumarditidae PLUMMER & SCOTT, 1937, p. 287]

Evolute shumarditoideans (Umin/D, 0.25–0.5), possibly derived from the ancestral somoholitid *Somoholites* but differing in absence of longitudinal sculpture (lirae) and in possession of broader ventral lobe with higher secondary ventral saddle. External lateral lobe evolved from pouched to fully trifid ($L > L_2L_1L_2$). Internal lateral lobe simple (but with median inflation) to incipiently trifid, the latter with diagnostic asymmetry: i.e., where lobe is divided, outer (ventral) subdivision ($I_{2(v)}$) is larger than dorsal ($I_{2(d)}$), and secondary saddle of the ventral subdivision ($I_{2(v)}/I_1$) is higher than secondary saddle that bounds the dorsal subdivision ($I_1/I_{2(d)}$). Primary umbilical lobe (U) remained undivided, or (rarely) notched dorsally. Dorsal lobe (D) simple, with median inflation, to conspicuously tridentate. External lobes may be bidentate in advanced representatives. Evolutionary succession: *Preshumardites* (Missourian) >*Pseudaktubites* (Missourian–Virgilian) > *Shumardites* (Virgilian). *Pennsylvanian (Kasimovian–Gzhelian [Missourian–Virgilian]).*

Shumardites SMITH, 1903, p. 134 [**S. simondsi;* OD] [=*Postaktubites* RUZHENTSEV, 1955b, p. 1108 (type, *Shumardites cuyleri* PLUMMER & SCOTT, 1937, p. 297, OD)]. Advanced shumarditids characterized by incipient bipartition of prongs of the ventral lobe (V_1), near or complete isolation of the three subdivisions of the lateral lobe ($L_2L_1L_2$), and by umbilical lobe that is either entire or notched by shallow crenulation near umbilical seam. Sutural formula: $(V_1V_1)L_2L_1L_2U{:}(I_2I_1I_2)D$ [Russian]. Five named species. *Upper Pennsylvanian:* USA (Texas), *Virgilian;* Kazakhstan (Southern Urals), Russia (Southern Urals, Moscow Basin), *Gzhelian.*——FIG. 86*a–b*. **S. simondsi*, Wayland Shale, Virgilian, northcentral Texas; *a,* diameter at 25 mm (Miller & Downs, 1950a); *b,* diameter at 56 mm (estimated) (Boardman, Work, & Mapes, 1994).——FIG. 86*c–f. S. cuyleri* (PLUMMER & SCOTT), Virgilian, northcentral Texas; *c–d,* Finis Shale, ×1 (Miller & Downs, 1950a); *e,* height at 25 mm (estimated) (Boardman, Work, & Mapes, 1994); *f,* hypotype, Bluff Creek Shale, SUI 55646, diameter at 50 mm (new, courtesy of D. M. Work & W. B. Saunders).

Preshumardites PLUMMER & SCOTT, 1937, p. 288 [**Gastrioceras gaptankense* MILLER, 1930, p. 401; OD]. Ancestral shumarditids characterized by

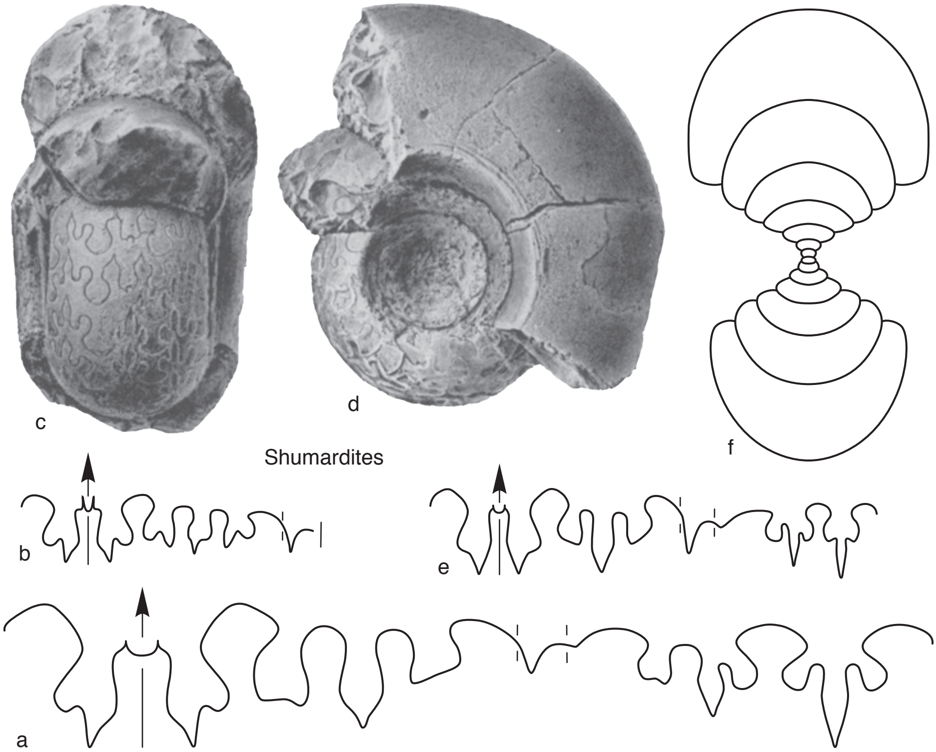

FIG. 86. Shumarditidae (p. 139–140).

external lateral lobe, internal lateral lobe, and prongs of ventral lobe (L, I, and V_1) that are conspicuously inflated medially but do not form lateral pouches. Sculpture restricted to growth lamellae that trace broad ventral salient (i.e., longitudinal lirae not developed). Three species. *Upper Pennsylvanian (Kasimovian):* USA (western and northcentral Texas, Kansas, Missouri, Illinois, Pennsylvania).——FIG. 87,*2a–e.* **P. gaptankensis* (MILLER); *a–d,* Wolf Mountain Shale, Graford Formation, north-central Texas; *a,* ×3; *b–c,* ×1.5 (Boardman, Work, & Mapes, 1994); *d,* hypotype, SUI 55600, diameter at 56 mm (new, courtesy of D. M. Work & W. B. Saunders); *e,* Gaptank Formation, western Texas, height at 15 mm, diameter about 35–40 mm (Saunders, 1971).

Pseudaktubites BOARDMAN, WORK, & MAPES, 1994, p. 50 [**Preshumardites stainbrooki* PLUMMER & SCOTT, 1937, p. 292; OD]. Shumarditids of intermediate sutural complexity in which both external and internal lateral lobes (L and I) have prominent lateral pouches but do not achieve incipient trifurcation. Two species. *Upper Pennsylvanian:* USA (Texas, Oklahoma, Kansas).——FIG. 87,*1a–d.* **P. stainbrooki* (PLUMMER & SCOTT), Colony Creek Shale, Caddo Creek Formation, Virgilian, north-central Texas; *a–c,* ×2; *d,* diameter approximately 48 mm (Boardman, Work, & Mapes, 1994).

Family PERRINITIDAE Miller & Furnish, 1940

[Perrinitidae MILLER & FURNISH, 1940a, p. 137] [=Shumarditidae PLUMMER & SCOTT, 1937, p. 287, *partim*; RUZHENTSEV in BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 388; =Paraperrinitinae THARALSON, 1984, p. 822, *non* TOUMANSKAIA, 1939]

Relatively involute shumarditoideans in which the primary external, umbilical, and internal lobes (L, U, I) are fully tripartite. Lobes characteristically diverge to narrow crests of adjacent saddles and are strongly subdivided in the most advanced forms. Evolutionary succession: *Properrinites* (Asselian–Artinskian) > *Metaperrinites* (Artinskian–Kungurian) > *Perrinites* (Artinskian–Roadian). [THARALSON (1984) proposed the subfamily Paraperrinitinae as differing from

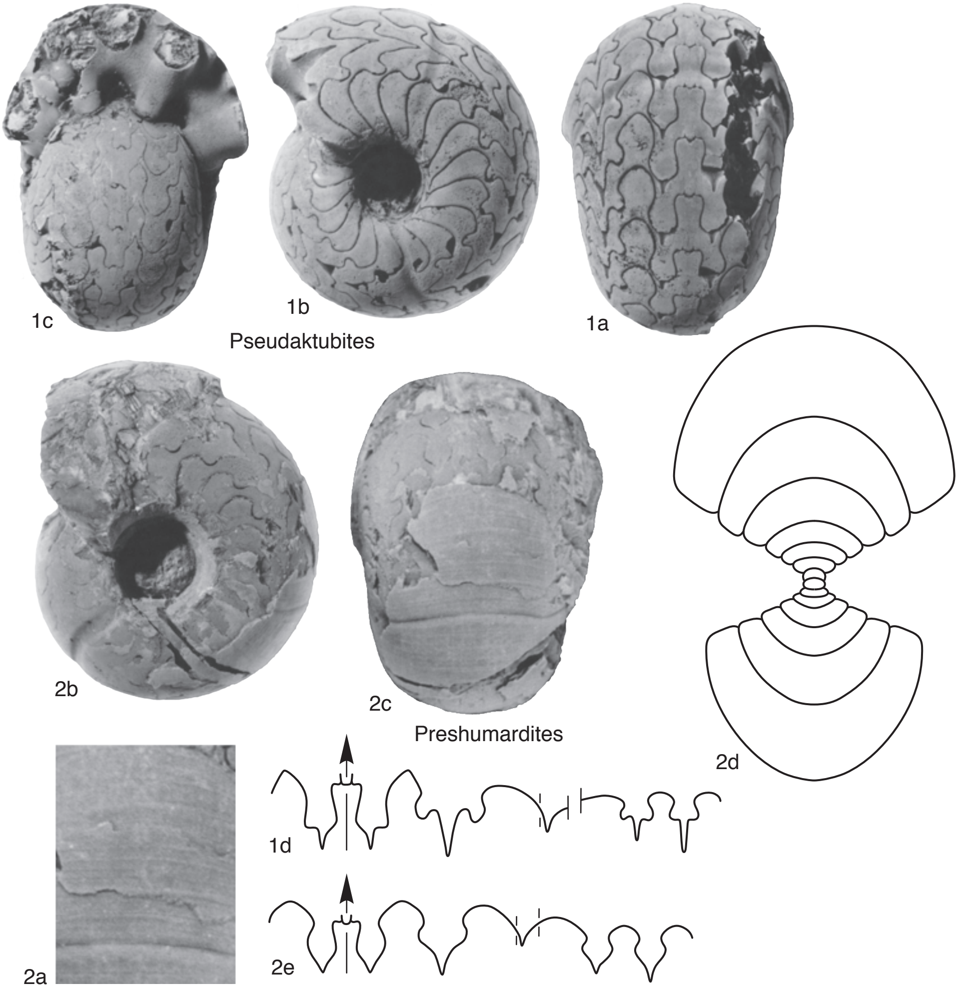

FIG. 87. Shumarditidae (p. 140).

the Perrinitinae in complete subdivision of the third internal lateral lobe. However, as the author acknowledged (THARALSON, 1984, p. 809), large specimens of the most advanced perrinitin species (e.g., *Perrinites vidriensis* BÖSE, 1919) may display incipient subdivision of the third internal lateral lobe into two lobes. Consequently, any possible differentiation of the two subfamilies would involve difficult and complex analysis of interaction of ontogenetic and evolutionary development. The classification scheme proposed by THARALSON therefore appears unrealistic and is rejected herein. Derived from advanced Pennsylvanian parashumarditids (BOARDMAN, WORK, & MAPES, 1994; compare Fig. 89*d* and Fig. 84,*1e* herein).] *Cisuralian (Asselian)–Guadalupian (Roadian).*

Perrinites BÖSE, 1919, p. 155 [**P. vidriensis;* OD] [=*Perrimetanites* LEONOVA, 1983, p. 51 (type, *P. progressus*, OD)]. Advanced perrinitids that achieved conch diameters as great as 30 cm; at moderate size, whorls are equidimensional (H/W, 0.7–1.25), umbilicus small (Umin/D, 0.05–0.2), and hyponomic sinus deep. Mature sutures display

3 or 4 discrete first-order subdivisions on ventral flank of each prong of ventral lobe (V_1), and 3 or 4 prominent subdivisions on each flank of dorsal lobe (D); second-order subdivisions are common in external sutures of large specimens. Umbilical lobe complex is somewhat variable, but formula commonly $(V_1V_1)L_2L_1L_{2.1}L_{2.2}U_2(U_{1.2}U_{1.1}):(U_{2.2}U_{2.1})(I_{2.2}I_{2.1})I_1I_2D$ [Russian]. Six named species. [Ventral bifurcation ($I_{2.2}$) of the third dorsolateral lobe (I_2) is almost completely suppressed in advanced species.] *Cisuralian (Artinskian)–Guadalupian (Roadian):* Americas (widespread from Venezuela and Colombia to Idaho), Tajikistan (Pamir), Ukraine (?Crimea), Afghanistan (Bamyan Mountains), China (Xinjiang, Qinghai), Thailand (Saraburi Area, including Muak Lek), Indonesia (Timor).——Fig. 88,*2a. *P. vidriensis*, Cathedral Mountain Formation, western Texas, diameter at 23 mm (Tharalson, 1984).——Fig. 88,*2b–d. P. hilli*, Kungurian–Roadian, Texas; *b–c,* Leonard Formation, western Texas, ×1.33; *d*, Blaine Formation, northcentral Texas, diameter at 65 mm (Miller & Furnish, 1940a).

Metaperrinites Ruzhentsev, 1950, p. 166 [**Properrinites cumminsi vicinus* Miller & Furnish, 1940a, p. 143; OD] [=*Paraperrinites* Tumanskaia, 1939, p. 17 (type, *Perrinites Brouweri* Smith, 1927a, p. 55; OD: the type designated by Smith, 1927a, p. 55, pl. 14,*1–2*, i.e., holotype *fide* ICZN *Code* Article 73(a)(i) is a marathonitid), *sensu* Tharalson, 1984, p. 827, *partim*; =*Shuangyangites* Liang, 1982, p. 650 (type, *S. involutus,* OD); =*Mapirites* Leonova, 1983, p. 44 (type, *M. latumbilicatus,* OD); =*Shyndoceras* Leonova, 1983, p. 47 (type, *S. obsoletum,* OD); =*Nepirrites* Leonova, 1983, p. 48 (type, *N. medius,* OD); =*Ripernites* Leonova, 1983, p. 50 (type, *R. pressulus,* OD)]. Perrinitids intermediate and gradational between *Properrinites* and *Perrinites* in size, conch form, depth of hyponomic sinus, and overall complexity of suture. Whorls generally depressed (H/W, 0.7–1.2), and umbilicus variable (Umin/D, 0.1–0.4). Mature sutures display 1–3 first-order subdivisions on ventral flank of each prong of ventral lobe (V_1), dorsal lobe (D) has either one or two prominent notches on each flank; second-order subdivisions generally weakly developed but may occur in all external saddles in advanced species. Both fourth external lateral saddle and fourth internal lateral saddle generally lie beneath but close to alignment of adjacent saddles. Nine named species. *Cisuralian (Artinskian–Kungurian)*: USA (Texas, New Mexico, California, Nevada), Tajikistan (Pamir), Ukraine (?Crimea), China (Guizhou, Guangxi, Jilin, Xinjiang), Thailand (Loei), Indonesia (Timor).——Fig. 88,*1a–c.* **M. vicinus* (Miller & Furnish), Clyde Formation, Kungurian, northcentral Texas; *a–b,* ×1.5; *c*, diameter at 55 mm (Miller & Furnish, 1940a).

Properrinites Elias, 1938, p. 102 [**Perrinites Bösei* Plummer & Scott, 1937, p. 307; OD; *non P. plummeri* Elias, 1938, p. 104, by action of Miller & Furnish, 1940a, p. 139; *fide* ICZN *Code* Article 24] [=*Subperrinites* Tharalson, 1984, p. 809 (type, *Perrinites bakeri* Plummer & Scott, 1937, p. 390, OD)]. Ancestral perrinitids of medium size (maximum conch diameter 15 cm) with depressed whorls (H/W, 0.6–0.9), moderate umbilicus (Umin/D, 0.2–0.5), and shallow hyponomic sinus. Mature sutures have a single discrete first-order subdivision on ventral flank of each prong of ventral lobe (V_1) and a dorsal lobe (D) that is prominently trifid; second-order subdivisions are either absent or incipient and confined to first lateral saddle. Crest of fourth external lateral saddle and fourth internal lateral saddle lie beneath general sutural alignment. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.2})U_2U_1:U_2(I_{2.2}I_{2.1})I_1I_2D$ [Russian]. Six named species. *Cisuralian (Asselian–Sakmarian):* USA (Texas, New Mexico, Kansas, Nebraska, Nevada), Canada (Yukon), Tajikistan (Pamir), southern China (Guangxi), Indonesia (Timor).——Fig. 89*a–c.* **P. boesei* (Plummer & Scott), Admiral Formation, northcentral Texas; *a–b,* ×2; *c,* diameter at 53 mm (adapted from Tharalson, 1984).——Fig. 89*d–f. P. bakeri*, Lenox Hills Formation, western Texas; *d,* diameter at 8.3 mm; *e,* diameter at 17 mm; *f,* diameter at 50 mm (adapted from Tharalson, 1984).

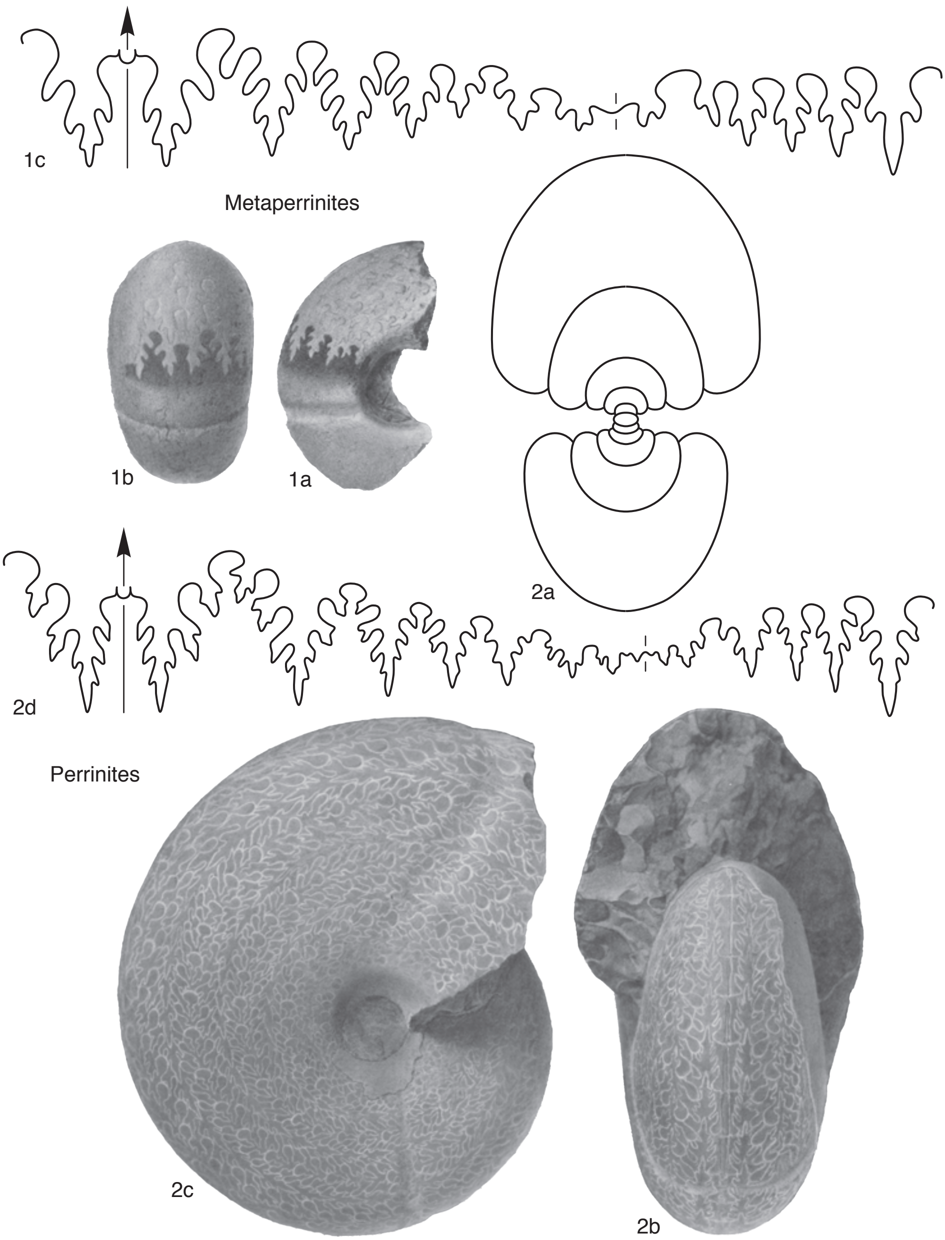

FIG. 88. Perrinitidae (p. 141–142).

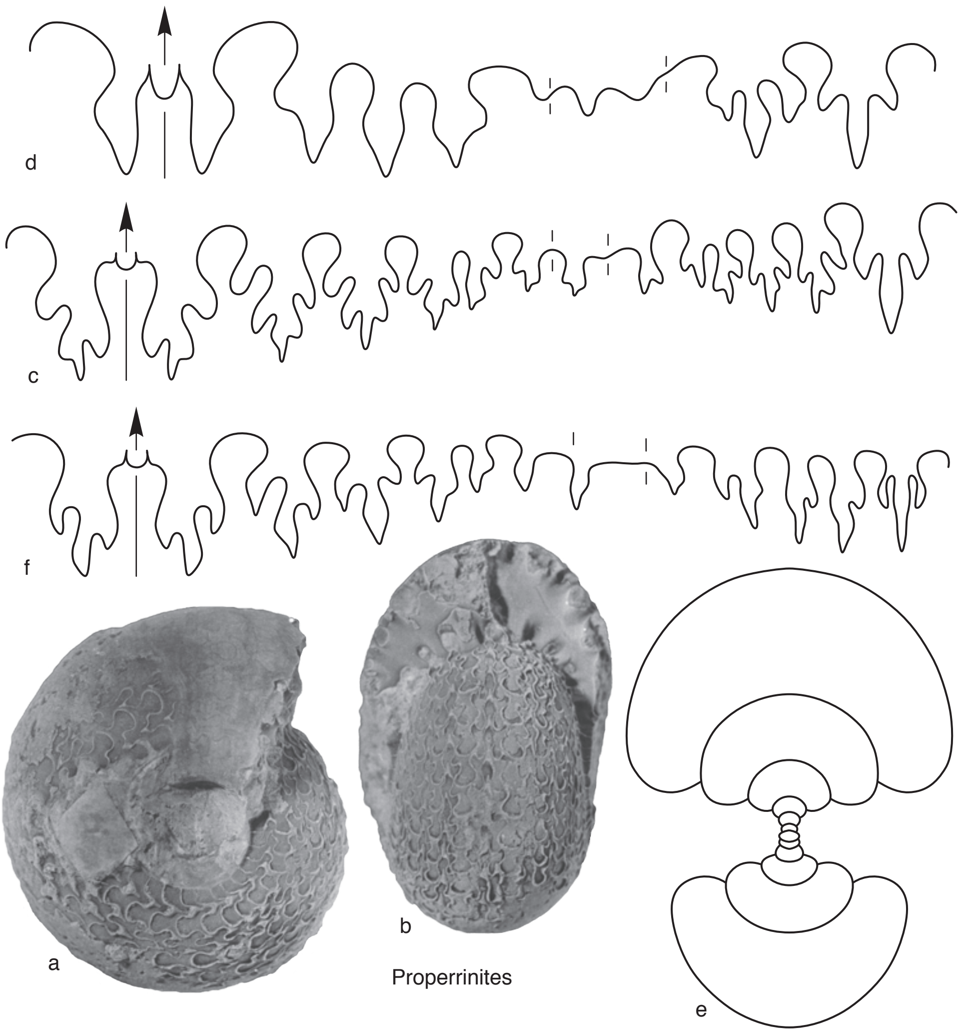

FIG. 89. Perrinitidae (p. 142).

CYCLOLOBOIDEA

Brian F. Glenister,[1] William M. Furnish,[2] and Zhou Zuren[3]

[[1]retired, formerly of the University of Iowa; [2]deceased, formerly of the University of Iowa; [3]Nanjing Institute of Geology and Palaeontology]

Superfamily CYCLOLOBOIDEA Zittel, 1895

[*nom. transl.* Miller & Furnish, 1954, p. 687, *ex* Cyclolobidae Zittel, 1895, p. 408]

Conch variable, from spherical to lenticular, but commonly broad and large (many greater than 20 cm), with small to closed umbilicus. Ribs and constrictions, when present, are approximately transverse, but commonly trace a lateral salient with median backward sag, and rounded ventral sinus. The basic sutural formula comprises 20 lobes: $(V_1V_1)L_2L_1L_2U_2U_1U_2{:}I_2I_1I_2(D_2D_1D_2)$ [Russian], $(E_1E_mE_1)A_vA_mA_dL_vL_mL_dU_vU_mU_d(I_1I_mI_1)$ [German]. Subdivisions of dorsally situated U_2 usually lie on the umbilical wall, but in rare cases they migrated into internal suture. Total number of lobes may reach 60, due mainly to repeated bifurcation and subsequent full isolation of external lateral lobe and internal lateral lobe lying successively closest to umbilicus. Dorsal lobe broadly tripartite, in most forms, to extent that designation of incipient trifurcation is warranted. Sutural elements are characteristically parallel-sided. Most lobes are bidentate or tridentate in ancestral family, the Vidrioceratidae. However, both lobes and saddles became complexly denticulate during phylogenesis of the descendant Cyclolobidae. [The superfamily evolved from the shumarditoidean family Parashumarditidae, in the late Pennsylvanian, and diversified in the Permian to range throughout that system.] *Pennsylvanian (Gzhelian [Virgilian])–Lopingian (Changhsingian).*

Family VIDRIOCERATIDAE Plummer & Scott, 1937

[Vidrioceratidae Plummer & Scott, 1937, p. 129] [=Neostacheoceratinae Tumanskaia, 1939, p. 18; =Pamiritinae Tumanskaia, 1939, p. 18; =Glassoceratinae Ruzhentsev, 1960d, p. 231; =Peritrochiinae Ruzhentsev & Bogoslovskaia, 1978, p. 86]

Ancestral cycloloboideans with thickly subdiscoidal to globular conch (W/D, 0.5–1.0). Shell smooth, growth lines approximately transverse; mature peristome commonly modified by constriction and formation of ventrolateral lappets. Total number of lobes increased during phylogenesis from 16 to more than 50. However, note that in the 8-lobed parashumarditid ancestor, *Eovidrioceras*, both the primary external lateral lobe (L) and the primary internal lateral lobe (I) are incipiently trifid, thus: $(V_1V_1)(L_2L_1L_2){:}U(I_2I_1I_2)D$ [Russian]. Denticulation is confined to lobe bases; except for simple lobes near umbilicus, most external lobes are tridentate and internals are bidentate. Dorsal lobe (D) almost invariably broad and deeply trifid. *Pennsylvanian (Gzhelian [Virgilian])–Lopingian (Changhsingian).*

Vidrioceras Böse, 1919, p. 146 [**V. Uddeni;* OD] [=*Hypershumardites* A. Popov, 1992, p. 54 (type, *H. zacharovi*, OD)]. Vidrioceratids in which constrictions form a high, rounded ventral salient. Suture characterized by shallowly to deeply bidentate form of third external lateral lobe. Sutural formula: $(V_1V_1)L_2L_1L_2(U_2U_1U_2){:}I_2I_1I_2D$ [Russian]. Seven named species. *Pennsylvanian (Gzhelian)–Cisuralian (Artinskian):* Russia and Kazakhstan (Southern Urals), Uzbekistan (Fergana: Karachatyr Range), Indonesia (Timor: Artinskian Bitauni beds); USA (Texas, Oklahoma), *Virgilian.*——Fig. 90,*2a–d.* **V. uddeni*, upper Gaptank Formation, western Texas; *a–c,* ×1.33; *d*, diameter at 17 mm (Miller & Furnish, 1940a).——Fig. 90,*2e.*

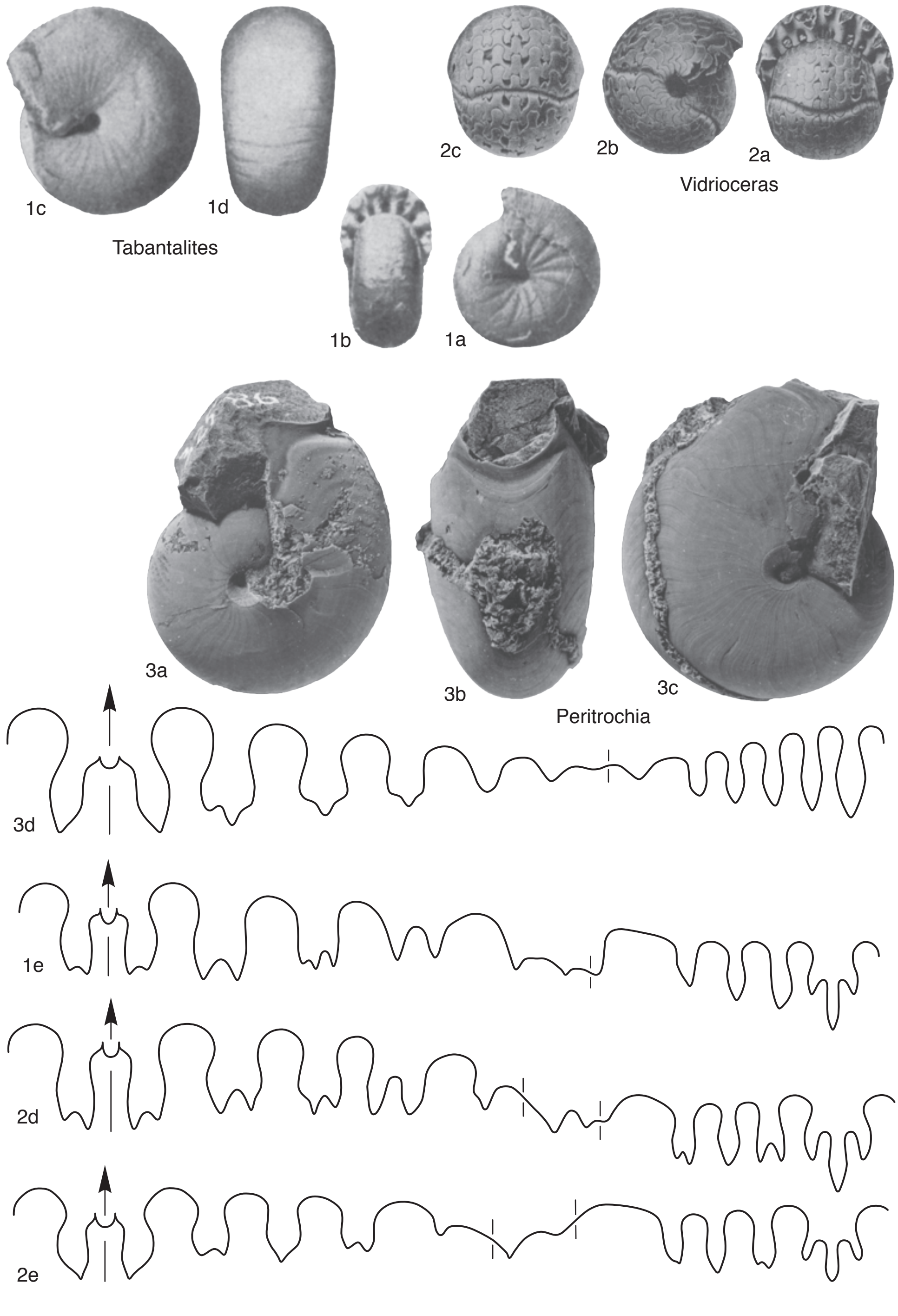

FIG. 90. Vidrioceratidae (p. 145–150).

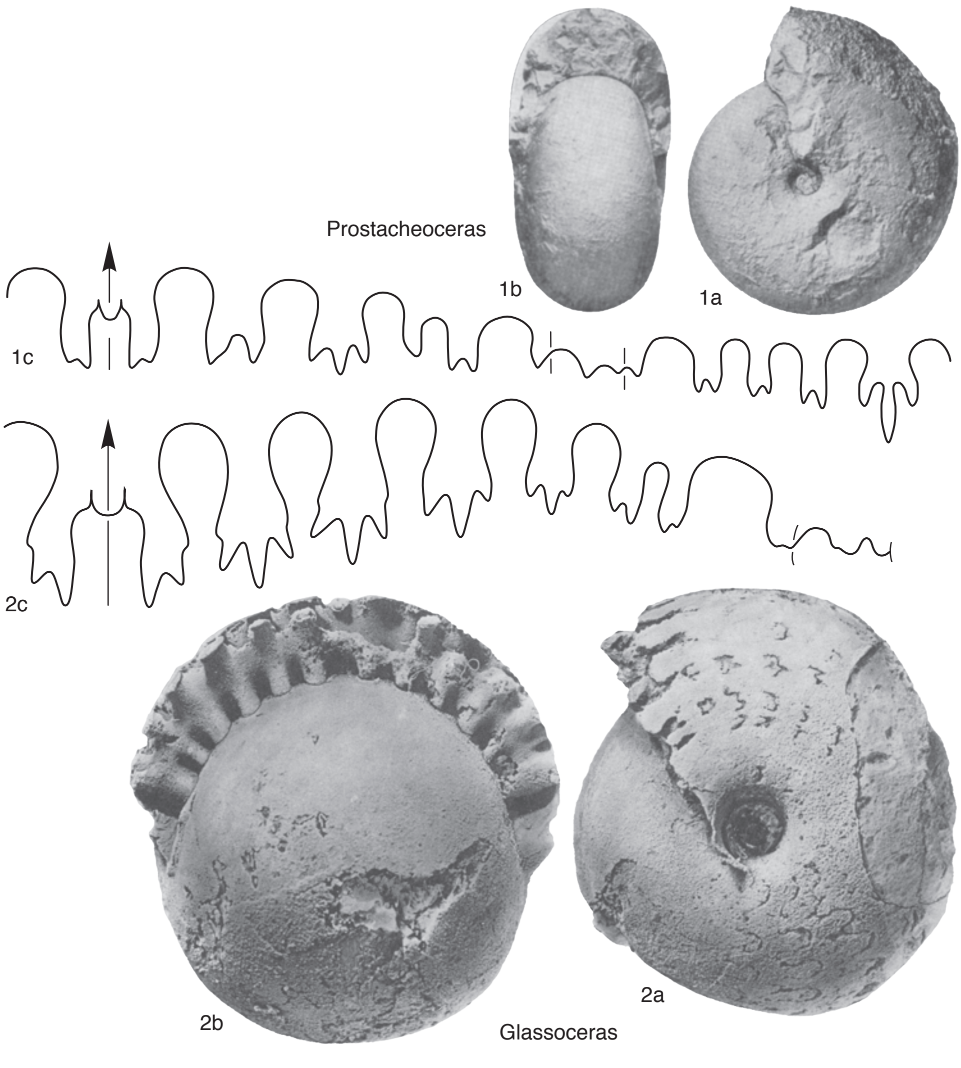

FIG. 91. Vidrioceratidae (p. 147–149).

V. borissiaki RUZHENTSEV, Gzhelian, Southern Urals, height at 8.3 mm, diameter approximately 17 mm (Ruzhentsev, 1950).

Glassoceras RUZHENTSEV, 1960d, p. 231 [**Stacheoceras normani* MILLER & FURNISH, 1957b, p. 1055; OD] [=*Subglassoceras* RUZHENTSEV, 1960d, p. 232 (type, *Stacheoceras bransonorum* MILLER & CLINE, 1934b, p. 293, OD)]. Spherical, smooth-shelled vidrioceratids in which mature suture comprises five or six pairs of external lateral lobes and one less pair of internal laterals. Prongs of ventral lobe and several adjacent external lateral lobes exhibit minor denticulation above bidentate or tridentate lobe base. Sutural trace arched slightly. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})U_2U_1(U_{2.1}:U_{2.1})I_{2.1.1}I_{2.1.1}I_{2.1}I_1I_2D$ [Russian]. Two species. [This genus could be interpreted as an ancestral cycloloboidean but is better regarded as a separate lineage of Vidrioceratidae (GLENISTER & FURNISH, 1987, p. 994).] *Guadalupian (Roadian):* USA (western Texas, Wyoming).——FIG. 91,*2a–c*. **G. normani* (MILLER & FURNISH), Road Canyon Formation, western Texas; *a–b*, ×1.5; *c*, diameter at 34 mm (Miller & Furnish, 1957b).

Martoceras TUMANSKAIA, 1938a, p. 107 [**Marathonites Dieneri* SMITH, 1927a, p. 46; OD] [=*Pamirites* TUMANSKAIA, 1938a, p. 107 (type, *P. clinei,* OD); ?=*Grioceras* TUMANSKAIA, 1939, p. 18 (type,

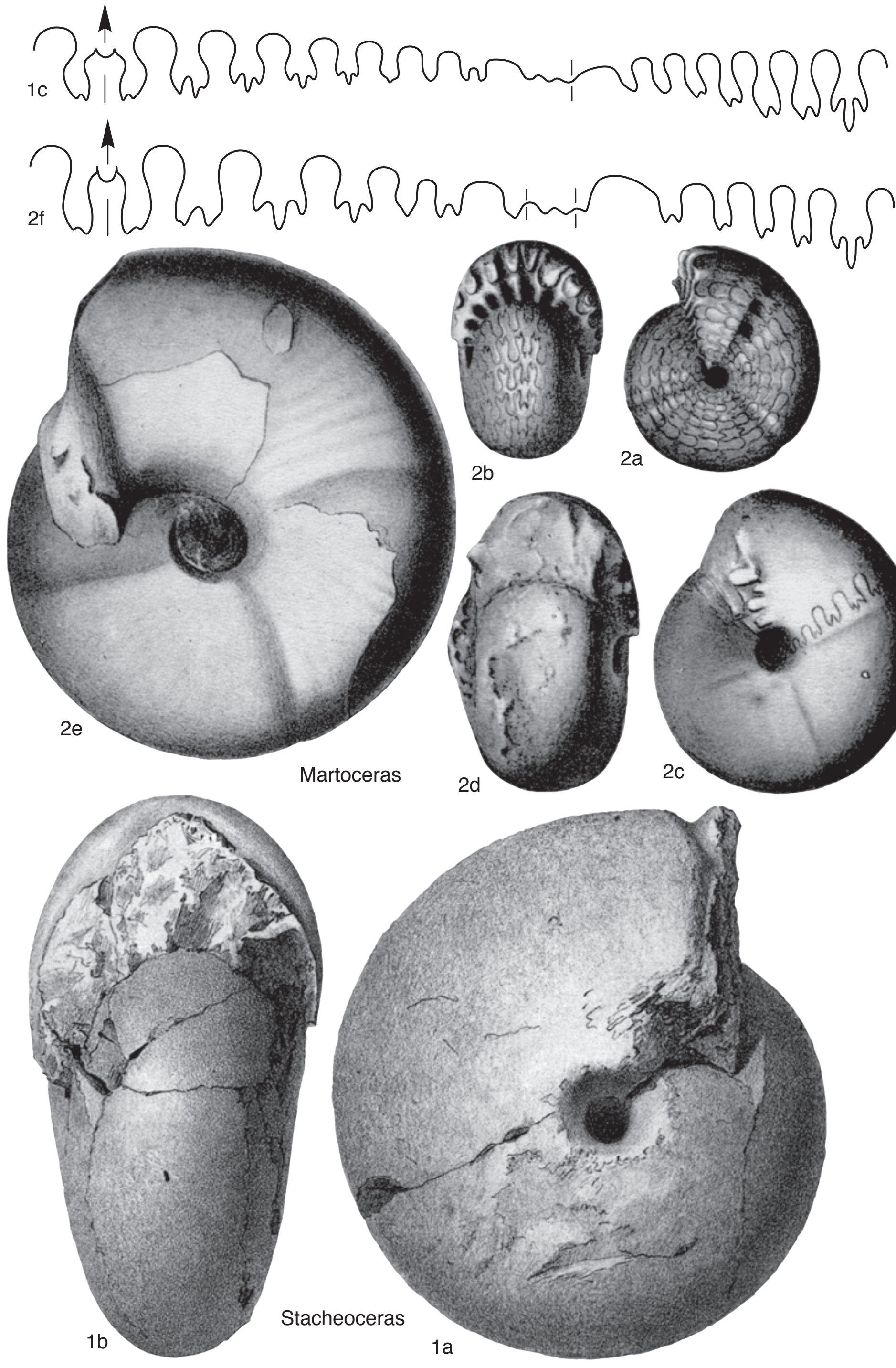

FIG. 92. Vidrioceratidae (p. 147–149).

Stacheoceras burnense var. *kermensis* TUMANSKAIA, 1931, p. 92, OD); ?=*Chengxianites* XU in XU & WEI, 1977, p. 572 (type, *C. hunanensis*, OD); =*Waagenina sensu* RUZHENTSEV, 1940e, p. 118; RUZHENTSEV *in* BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 396; ZHOU, 1979, p. 392 (type interpreted as *Waagenia subinterrupta* KROTOV, 1885, p. 205; SD, see notation herein under vidrioceratid genus *Stacheoceras,* below).] Conch subdiscoidal, diameter up to 7 cm. Mature modifications comprise subterminal constriction and terminal flare (expansion), with broad ventrolateral lappets. External lateral lobes number four or five pairs, and internal laterals one less (three or four); the last in each series commonly is bipartite. Sutural formula of advanced species: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})U_2U_1U_{2.1}:U_{2.1}I_{2.1}I_{2.1}I_1I_2D$ [Russian]. Eight named species. *Cisuralian (Asselian)–Guadalupian (Wordian)*: Indonesia (Timor), Venezuela, Mexico, Italy (Sicily), Russia (Urals), Ukraine (Crimea), Kazakhstan (Southern Urals), Tajikistan (Pamir), southern China (Hunan, Guizhou).——FIG. 92,*2a–e*. **M. dieneri* (SMITH), Somohole beds, Asselian–Sakmarian, Timor, Indonesia*,* ×1 (Haniel, 1915, pl. 6,*12a–b, 6a–b*; pl. 7,*1*; adapted from Smith, 1927a, p. 46).——FIG. 92,*2f. M. subinterruptum* (KROTOV), Southern Urals, diameter approximately 24 mm (Ruzhentsev, 1956b).

?Neoglassoceras ZAKHAROV, 2004, p. 522 [**N. caucasicum*; OD]. Inadequately known, from single specimen, similar to vidrioceratids in general suture pattern, especially dorsad paired lateral lobes and digitations at all lobe bases, but differing in possession of popanoceratid-like compressed conch. One species. *Lopingian (Changhsingian):* Russia (northwestern Caucasus).

Peritrochia GIRTY, 1908, p. 498 [**P. erebus;* M]. Conch small (mature diameter 2 cm), with biconvex growth lines. Mature modifications comprise subterminal constriction and subsequent flare (expansion) of peristome, and formation of a pair of broad ventrolateral lappets bounding an accentuated hyponomic sinus. Suture is characterized by undivided prongs of ventral lobe (V_1) and a dorsal lobe (D) that lacks division in all growth stages. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.1}U_2U_1:U_2I_{2.1}I_{2.1}I_1I_2D$ [Russian]. One species. [The origin of the fourth external lobe and fourth internal lobe ($L_{2.1}$ and $I_{2.1}$) through subequal bifurcation of the third laterals (L_2 and I_2) relates *Peritrochia* to the Vidrioceratidae rather than to the Marathonitidae.] *Guadalupian (Roadian):* USA (western Texas).——FIG. 90,*3a–d*. **P. erebus*, upper Cutoff Formation, topotypes; *a*, SUI 32586, ×2; *b–c,* SUI 32585, ×2 (new); *d*, diameter at 11 mm (Miller & Furnish, 1940a).

Prostacheoceras RUZHENTSEV, 1937, p. 410 [**Marathonites juresanensis* MAKSIMOVA, 1935, p. 283; OD]. Conch relatively narrow, with rounded ventrolateral flanks. Two subdivisions of the third external lateral lobe ($L_{2.1}L_{2.1}$) are almost fully isolated at 2 cm conch diameter. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})U_2U_1U_{2.1}:U_{2.1}I_2I_1I_2D$ [Russian]. Fourteen named species. [This genus is regarded as a plausible ancestor to the cyclolobid subfamily Kufengoceratinae.] *Cisuralian (Asselian)–Guadalupian (Wordian):* Russia and Kazakhstan (Southern Urals), Tajikistan (Pamir), Ukraine (Crimea), Italy (Sicily), Afghanistan, Malaysia, Thailand (Muak Lek, Loei), China (Jilin, Hunan, Xinjiang), Canada (British Columbia), USA (Texas).——FIG. 91,*1a–c.* **P. juresanense* (MAKSIMOVA), Asselian, Southern Urals; *a–b,* ×0.67; *c*, diameter approximately 20 mm (Ruzhentsev, 1951).

Stacheoceras GEMMELLARO, 1887, p. 26 [**S. mediterraneum* GEMMELLARO, 1887, p. 29; SD DIENER, 1921, p. 22] [=*Waagenia* KROTOV, 1885, p. 204, *non* NEUMAYR, 1878, *nec* KRIECHBAUMER, 1874; =*Waagenina* KROTOV, 1888, p. 474 (type, *Arcestes antiquus* WAAGEN, 1879, p. 28, SD MILLER & FURNISH, March 15, 1940a, p. 131; *non* RUZHENTSEV, post Nov. 4, 1940e, p. 118; *fide* NASSICHUK, 1977, p. 574 and BOGOSLOVSKAIA, 1978, p. 65); =*Neostacheoceras* SCHINDEWOLF, 1931, p. 201 (type, *N. hanieli,* OD); =*Furnishites* CANTÚ CHAPA, 1997, p. 73 (type, *Stacheoceras rothi* MILLER & FURNISH, 1940a, p. 132, OD); =*Parastacheoceras* EHIRO & MISAKI, 2005, p. 9 (type, *P. bidentatum*, OD)]. Advanced vidrioceratids that may exceed 10 cm in mature conch diameter. Mature modifications comprise deep subterminal constriction and associated flare (expansion) of the peristome and long narrow ventrolateral lappets. External suture consists of 6–12 pairs of lateral lobes; prongs of ventral lobe (V_1) are bidentate or tridentate, and first external lateral lobe (L_2) is bidentate to quadridentate. Internal suture generally has one less pair of lobes than external; most internal lobes exhibit conspicuous dorsal flexure adapically. Sutural formula for moderately complex forms: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}L_{2.1.1.1}L_{2.1.1.1.1}(L_{2.1.1.1.1.1}L_{2.1.1.1.1.1})U_2U_1U_2:I_{2.1.1.1}L_{2.1.1.1}I_{2.1.1}I_{2.1}I_1I_2D$ [Russian]. Forty-three species. *Cisuralian (Artinskian [Aktastinian])–Lopingian (Changhsingian):* Italy (Sicily), Slovenia, Ukraine (Crimea), Azerbaijan (Caucasus), Tajikistan (Pamir), Afghanistan, Iraq (Kurdistan), Oman, Tunisia (Djebel Tebaga), Pakistan (Salt Range), India (Himalayas), China (Gansu, Xinjiang, Yunnan, Guizhou, Xizang, ?Hunan, ?Guangxi, Zhejiang, Sichuan), Indonesia (Timor), Malaysia, Madagascar, Japan (Kitakami), Mexico (Coahuila, ?Guerrero), USA (Texas, California, Wyoming), Canada (Ellesmere Island, British Columbia), East Greenland.——FIG. 92,*1a–b*. **S. mediterraneum*, Sosio Limestone, Wordian, Sicily; lectotype (herein), MGUP 68 of GEMMELLARO (1887, pl. 4,*2–3*), ×1 (Gemmellaro, 1887).——FIG. 92,*1c. S. toumanskyae* MILLER & FURNISH, La Difunta beds, Capitanian, Guadalupian, Coahuila, Mexico, diameter at 30 mm (Miller & Furnish, 1940a).

Tabantalites RUZHENTSEV, 1952b, p. 76 [**T. bifurcatus;* OD]. Conch thinly discoidal and evolute in earliest growth stages, but involute with depressed whorls at maturity (U/D, 0.05; W/D, 0.6). Suture is similar to those of advanced *Vidrioceras*, with bifid third external lateral lobe; perhaps distinguishable by undivided (lanceolate) form of internal lateral lobes. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})U_2U_1$:$U_2I_2I_1I_2D$ [Russian]. Three species. [Shell thickening on the umbilical shoulder forms a spiral ridge around the umbilicus similar to those common in Marathonitidae. This has been interpreted to suggest affinities, but sutural ontogeny of the third external lateral lobe ($L_{2.1}L_{2.1}$) necessitates assignment to the Vidrioceratidae.] *Cisuralian (Asselian–lower Sakmarian [Tastubian Substage]):* Kazakhstan (Southern Urals), Tajikistan (Pamir), Russia (?Verkhoian), Canada (Yukon).——FIG. 90,*1a–e.* **T. bifurcatus*, Asselian, Southern Urals; *a–b*, ×2; *c–d*, ×1.5; *e*, width at 18 mm, diameter approximately 30 mm (Ruzhentsev, 1952b).

Family CYCLOLOBIDAE Zittel, 1895

[Cyclolobidae ZITTEL, 1895, p. 408]
[=Timoritidae BÖHMERS, 1936, p. 61]

Advanced cycloloboideans characterized by numerous, extensively denticulate lobes. During phylogenesis, prongs of ventral lobe became strongly expanded, number of external lobes across flanks to umbilical shoulder increased from 3 pairs to 12 pairs, denticulation of lobes extended almost to crest of saddles, and sutural trace became strongly arched. *Guadalupian (Roadian)–Lopingian (Changhsingian).*

Subfamily KUFENGOCERATINAE Zhao, 1980

[Kufengoceratinae ZHAO, 1980, p. 79]

Small ancestral cyclolobids with phragmocone diameters 2–10 cm, but mature conchs generally less than 10 cm. Sutures have 3 to 5 pairs of denticulate external lateral lobes across flanks to umbilical shoulders, and several small lobes on each umbilical shoulder and wall. Denticulation of lateral lobes is generally confined to adapical two-thirds of suture. Prongs of ventral lobe are approximately one-half width of corresponding first lateral lobe, and their ventral flank is either smooth or weakly denticulate. Sutural trace almost directly transverse. [*Kufengoceras* RUZHENTSEV, 1956a, was suppressed as a synonym of *Shengoceras* CHAO, 1955; however, the subfamilial name remains valid, ICZN *Code* Article 40a (ZHOU, GLENISTER, & FURNISH, 2000, p. 78). Subfamily derived from the Cisuralian Vidrioceratidae, plausibly from *Prostacheoceras* RUZHENTSEV (1937) through *Guiyangoceras* ZHOU (1985).] *Guadalupian (Roadian)–Lopingian.*

Shengoceras CHAO, 1955, p. 141 [**Waagenoceras simplex* CHAO, 1955, p. 138; OD; subjective senior synonym of *Shengoceras lenticulare* CHAO, 1955, p. 141, by page priority] [=*Kufengoceras* RUZHENTSEV, 1956a, p. 160 (type, *Waagenoceras simplex* CHAO, 1955, p. 138, OD); =*Parakufengoceras* LEONOVA, 2002, p. 91 (type, *P. primitivum,* OD)]. Subglobular kufengoceratins, with uniformly rounded venter and flanks and moderately wide umbilicus. Internal mold smooth, except for faint ribs and constrictions, both tracing uniformly rounded low ventral salient. External suture characterized by narrow secondary ventral saddle, ventral prongs with extensive ventral and dorsal denticulations in mature stages, three pairs of moderately denticulate lobes across flanks, and several simpler lobes on umbilical shoulder and wall. Two or three species. [The holotype of *Shengoceras lenticulare* was collected in direct association with most of the type material of *Waagenoceras simplex* CHAO, the type species of *Kufengoceras*. The single feature that distinguishes the two forms is the irregular ventral angularity of the ultimate whorl of *S. lenticulare*, which we attribute to preservational deformation.] *Guadalupian (Roadian–Capitanian), Lopingian (?Wuchiapingian)*: southern China (Guangxi, southern Jiangxi, northeastern Guangdong), Mexico (Coahuila).——FIG. 93,*3a–f.* **S. simplex* (CHAO), Kuhfeng Shale, Wordian, Guangxi; *a–c,* ×0.67; *d–e*, ×1 (Chao, 1955); *f*, topotype, NIGP 128936A, diameter approximately 30 mm (new).

Guiyangoceras ZHOU, 1985, p. 196 [**G. guiyangense*; OD]. Similar in conch form and number of lobes to *Shengoceras.* Slightly more primitive sutural features, partly a function of small size, comprise broadly quadrate secondary ventral saddle, smooth ventral flank of ventral prongs (V_1), and less extensive denticulation of all lobes. Sutural formula: $(V_1V_1)L_2L_1(L_{2.1}L_{2.1})(U_2U_1U_2)I_{2.1}$:$I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Two species. [*Guiyangoceras* was probably derived from the vidrioceratin genus *Prostacheoceras* RUZHENTSEV (1937); the two genera are comparable in conch form and sutural formula and differ mainly in extensive denticulation of most external lobes in the former. *Guiyangoceras* is the probable ancestor of the Kufengoceratinae, which in turn gave rise to the Cyclolobinae.] *Guadalupian (Roadian):* southern China (upper Dangchong Formation, Hunan).——FIG. 93,*4a–d.* **G. guiyangense; a–c,* ×2; *d,* diameter approximately 15 mm (Zhou, 1985).

Liuzhouceras ZHAO, 1980, p. 79 [**Waagenoceras shengi* CHAO, 1955, p. 140; OD]. Inadequately known genus, probably similar to *Shengoceras* in conch form and suture, but strongly ribbed. Two species.

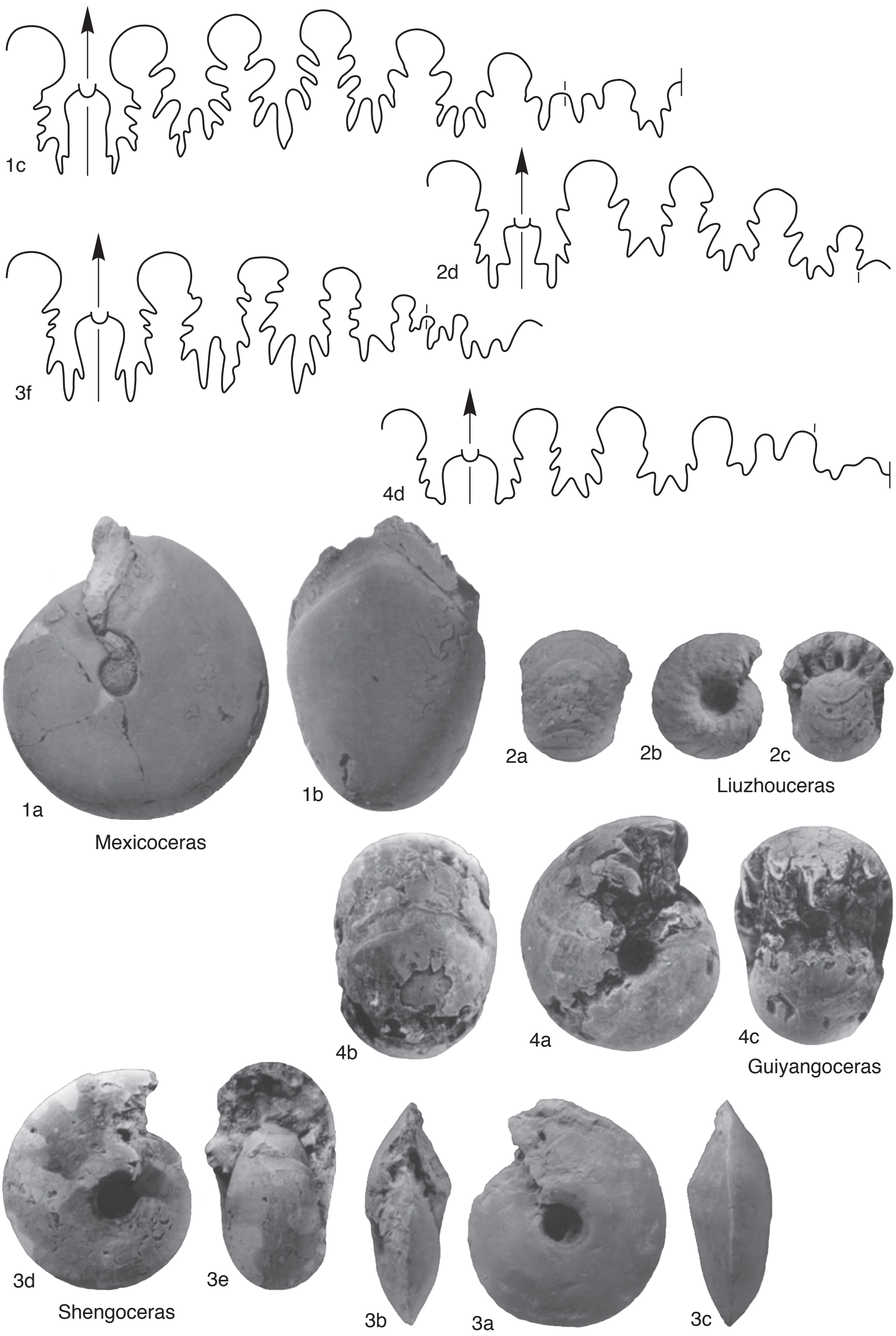

FIG. 93. Cyclolobidae (p. 150–153).

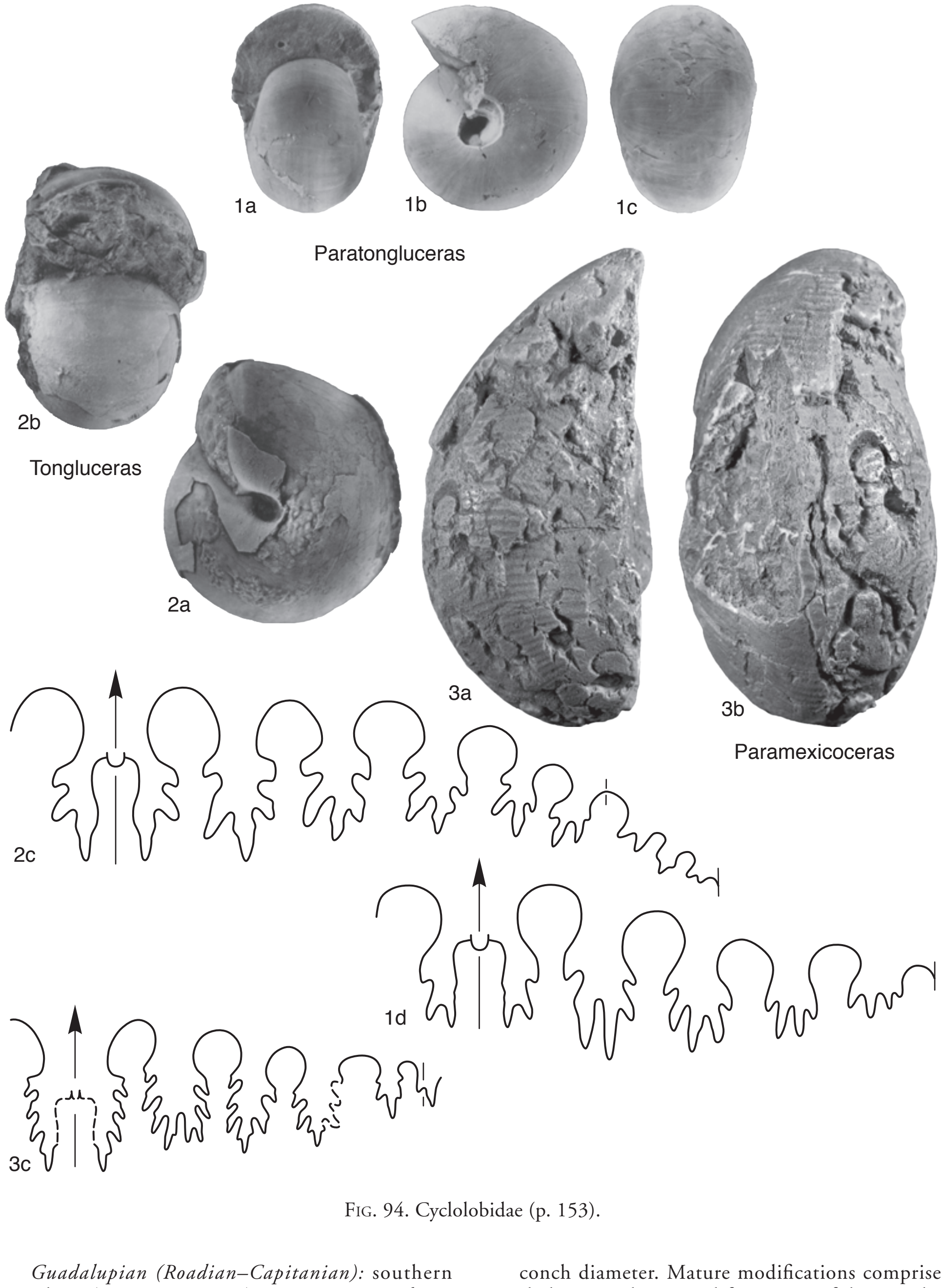

FIG. 94. Cyclolobidae (p. 153).

Guadalupian (Roadian–Capitanian): southern China (Guangxi, Hunan).——FIG. 93,*2a–d*. **L. shengi* (CHAO), Kuhfeng Shale, Guangxi; *a–c,* ×1 (Chao, 1955); *d*, holotype, diameter approximately 18 mm, NIGP 7465 (new).

Mexicoceras RUZHENTSEV, 1955a, p. 701 [**Waagenoceras cumminsi* var. *guadalupense* GIRTY, 1908, p. 502; OD]. Smooth, globular to subglobular conchs that commonly reach maturity at less than 10 cm conch diameter. Mature modifications comprise slight geniculation and formation of deep, wide, subterminal constriction with accentuated ventral salient. Mature external suture is characterized by narrow ventral lobe and five pairs of moderately denticulate lobes to umbilical shoulders. Sutural formula: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}(L_{2.1.1.1}L_{2.1.1.1})$ $U{:}I_{2.1.1}I_{2.1.1}I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Four named species. *Guadalupian (Wordian–Capitanian)*: USA (western Texas), Mexico (Coahuila), southern China (Jiangxi, Hunan, Jilin).——FIG. 93,*1a–c*. **M. guadalupense* (GIRTY), Wordian, Texas; *a–b*, topotype, USNM 144423 (same as MILLER & FURNISH, 1940a, pl. 41,*3–4,* pl. 42,*6*), ×1 (new); *c*, diameter at 40 mm (Miller & Furnish, 1940a).

Paramexicoceras Y. POPOV, 1970, p. 139 [**P. aldanense;* OD]. Kufengoceratins with small umbilicus (U/D, approximately 0.1) and slightly depressed whorls; characterized by conspicuous ribs in all growth stages that form a broadly rounded ventral sinus in ultimate volution. External sutures consist of four pairs of strongly denticulate lateral lobes across flanks to umbilical shoulders, plus several simpler elements on each umbilical wall. Two species. *?Guadalupian, Lopingian:* Russia (southern Verkhoian), Central East Greenland (Jameson Land).——FIG. 94,*3a–c*. **P. aldanense*, holotype, age uncertain, alluvial source, southern Verkhoian, plastoholotype, SUI 35151, NIIGA 56/8717; *a–b*, ×1 (Popov, 1970); *c*, diameter approximately 60 mm, sketched in part (new).

Paratongluceras ZHAO & ZHENG, September 1977, p. 247 [**P. subglobosum*; OD] [?=*Shimenites* XU in XU & WEI, April 1977, p. 571 (type, *S. hunanensis,* OD); if the synonym relationship is confirmed, *Shimenites* would be the subjective senior synonym and would replace *Paratongluceras* as the valid name for the genus]. Similar to *Shengoceras* in conch form and gross features of suture. External suture comprises four pairs of lateral lobes to umbilical shoulders, each with long digits in lobe base but comparatively little other serration. One species. *Guadalupian (Roadian–Wordian):* southern China (Jiangxi, Hunan).——FIG. 94,*1a–d*. **P. subglobosum*, Hutang Formation, Jiangxi; *a–c,* ×0.67 (Zhao & Zheng, 1977); *d*, holotype, NIGP 44611 (same as Zhao & Zheng, 1977, fig. 19b), diameter at 43 mm (new).

Tongluceras ZHAO & ZHENG, 1977, p. 245 [**T. lengwuense*; OD]. Conch globose, and similar in most features to *Mexicoceras*, including slight geniculation and formation of deep, wide, subterminal constriction at mature aperture. All elements of external suture closely similar to those of *Shengoceras*, but sutural trace slightly arched, five pairs of denticulate lateral lobes to umbilical shoulders. Two species. [Numerous external lobes and a slight arch of sutural trace suggest this genus is an ancestor of Cyclolobinae.] *Guadalupian* (probably *Roadian):* lower Dingjiashan Formation, southern China (Zhejiang).——FIG. 94,*2a–c*. **T. lengwuense*; *a–b*, ×0.67 (Zhao & Zheng, 1977); *c*, paratype, NIGP 44606 (same as Zhao & Zheng, 1977, fig. 17b), diameter at 31 mm (new).

Subfamily CYCLOLOBINAE Zittel, 1895

[*nom. transl.* ZHAO, 1980, p. 79, *ex* Cyclolobidae ZITTEL, 1895, p. 408]

Large cyclolobids, commonly 20–30 cm diameter at maturity. Suture advanced, characterized by 7 to 12 pairs of external lateral lobes across flanks to umbilical shoulders, each with extreme denticulation that extends almost to crest of saddle. Prongs of ventral lobe subequal in width or wider than corresponding first lateral lobe, and, like dorsal flank, ventral side is extensively denticulate. Sutural trace becoming progressively more strongly arched forward during phylogenesis. [This subfamily is derived indirectly from the Vidrioceratidae, probably through the kufengoceratin genus *Tongluceras* ZHAO & ZHENG (1977) and the ancestral cyclolobin *Demarezites* RUZHENTSEV (1955a).] *Guadalupian (Roadian)–Lopingian (Changhsingian)*.

Cyclolobus WAAGEN, 1879, p. 21 [**Phylloceras Oldhami* WAAGEN, 1872, p. 353; OD] [=*Krafftoceras* DIENER, 1903, p. 162 (type, *Cyclolobus (Krafftoceras) Haydeni* DIENER, 1903, p. 167, SD DIENER, 1921, p. 27); =*Godthaabites* FREBOLD, 1932, p. 17 (type, *G. kullingi,* OD); =*Procycloceras* TUMANSKAIA, 1939, p. 19, *nom. nud.*]. Conch commonly 10–20 cm diameter at maturity, compressed, with narrow umbilicus (U/D, 0.1–0.2). Growth lines biconvex; ribs and constrictions conspicuous in juveniles, generally absent in large specimens. Mature modifications comprise slight geniculation and formation of deep subterminal constriction with accentuated ocular and hyponomic sinuses. All sutural elements strongly denticulate; genus characterized by tertiary subdivision near crest of first external lateral saddle. Prongs of ventral lobe wide; 9 to 12 pairs of subequal external lateral lobes diminish in size to umbilical shoulders; sutural trace is strongly arched. Seven species. *Lopingian (Wuchiapingian–Changhsingian):* Pakistan (Salt Range), India (Kashmir, Himalaya), China (southern Xizang), Japan (Kitakami), Russia (Maritime Territory), Armenia (?Vedi River), Indonesia (Timor), Western Australia, Madagascar, USA (California), Greenland.——FIG. 95*a*. **C. oldhami* (WAAGEN), Chhidru Formation, Lopingian, Salt Range, Pakistan, diameter at 125 mm (Furnish, 1966).——FIG. 95*b–g*. *C. walkeri* DIENER; *b–f*, Ambilobé beds, Ankitohazo, northern Madagascar, ×0.75; *g*, Chhidru Formation, Lopingian, Salt Range, Pakistan, diameter approximately 50 mm (Furnish & Glenister, 1970).

Changhsingoceras ZHAO, LIANG, & ZHENG, 1978, p. 78 (CHAO & LIANG in CHAO, 1965, p. 1820, *nom. nud.*) [**C. meishanense;* OD]. Inadequately known genus, resembling some *Cyclolobus* in possession of strongly ribbed, globular juvenile stage that became proportionally narrower with growth. Suture is generally similar to that of *Cyclolobus*, especially in presence of distinctive tertiary subdivision near crest of first lateral saddle, but differs in

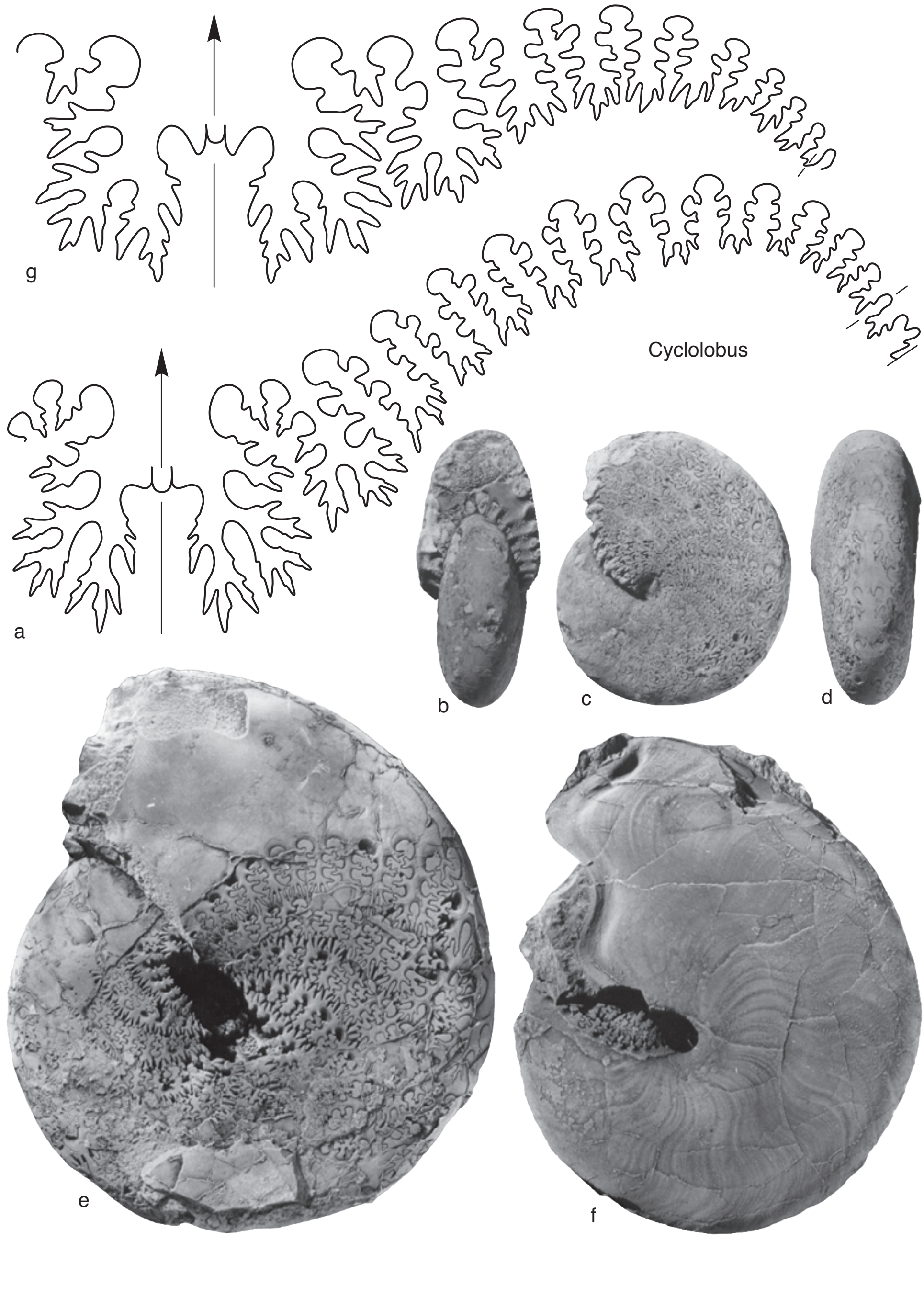

FIG. 95. Cyclolobidae (p. 153).

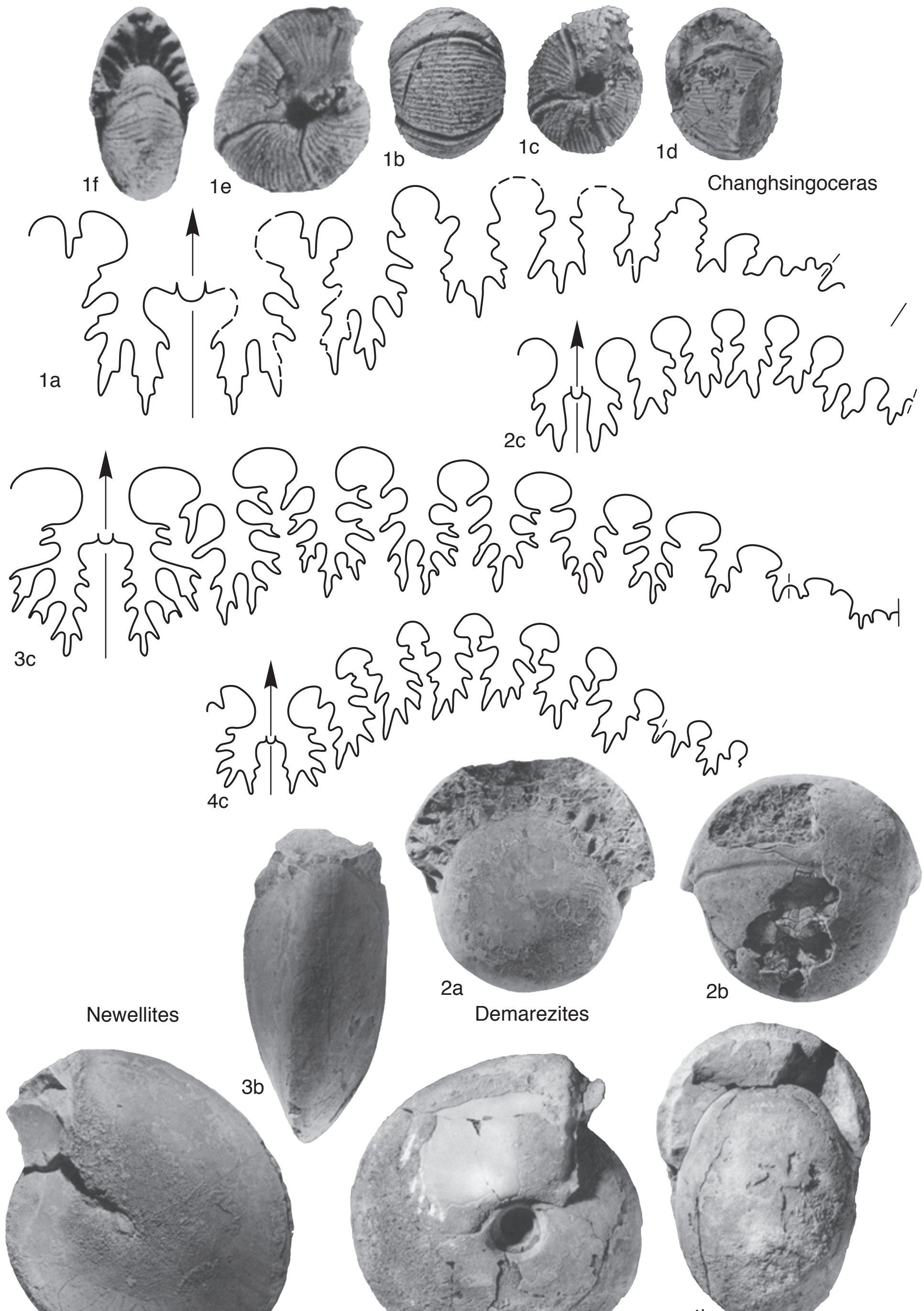

FIG. 96. Cyclolobidae (p. 153–156).

possession of seven pairs of external lateral lobes to umbilical shoulder. Three species. *Lopingian (Changhsingian):* China (Zhejiang, Sichuan, Anhui, Shanxi, Hunan), Russia (Maritime Territory). ——FIG. 96,*1a*. **C. meishanense*, holotype, Meishan Member, Changhsing Limestone, Zhejiang, NIGP 34266, diameter approximately 75 mm (new). ——FIG. 96,*1b–f*. *C. sichuanense* ZHAO, LIANG, & ZHENG, Mingyuexia Member, Dalong Formation, Sichuan; *b–d*, ×1; *e–f*, ×0.67 (Zhao, Liang, & Zheng, 1978).

Demarezites RUZHENTSEV, 1955a, p. 703 [**Waagenoceras oyensi* GERTH, 1950, p. 250; OD]. Smooth, globose (W/D, 0.9–1.0) ancestral cyclolobins. Characterized by 7 pairs of moderately denticulate external lobes to umbilical shoulders, the 5–6 lobe pairs being incompletely isolated, even at 50 mm phragmocone diameter. Prongs of ventral lobe (V_1) have ventral flanks that are weakly sinuous rather than denticulate. Six or seven species (only three described). [This genus is probably derived from the kufengoceratin genus *Tongluceras* ZHAO & ZHENG, from which it differs by its larger size, more strongly arched sutural trace, and possession of seven rather than five pairs of denticulate external lobes.] *Guadalupian (Roadian–Wordian):* Indonesia (Timor), Mexico (Coahuila), USA (western Texas, Idaho), Canada (?British Columbia).——FIG. 96,*2a–c*. **D. oyensi* (GERTH), lectotype, GIUA-E229, Tae Wei beds, ?Roadian, Timor; *a–b,* ×0.5; *c*, diameter ranging 50–55 mm (Glenister & Furnish, 1987).

Kurdiceras VAŠÍČEK & KULLMANN, 1988, p. 104 [**K. latum*; OD]. Familial assignment uncertain, based on rare juveniles. Incipient trifurcation of primary lateral lobe undiagnostic. Widely evolute form, path of growth lines (high salient across flanks and venter, with minor backward sags on ventrolateral shoulder and venter) and ventrolateral constrictions suggest affinity with cyclolobids. One species. *Guadalupian (Wordian):* Iraq (Kurdistan).

Newellites FURNISH & GLENISTER in DAVIS, FURNISH, & GLENISTER, 1969, p. 105 [**Waagenoceras richardsoni* PLUMMER & SCOTT, 1937, p. 158; OD]. Cyclolobids of intermediate sutural complexity that reach mature conch diameter of 15–20 cm. Juveniles similar to *Waagenoceras*, with globular form, open umbilicus, transverse ribs, and strong forward arch of sutural trace. In contrast, mature body whorl smooth, with umbilicus closed by geniculate coiling; whorl section lenticular, and venter acutely angular. Mature external suture comprises eight pairs of lobes to umbilical shoulders and forms weakly arched sutural trace. One species. *Guadalupian (Wordian):* USA (western Texas).——FIG. 96,*3a–c*. **N. richardsoni* (PLUMMER & SCOTT), Manzanita Member, Cherry Canyon Formation; *a–b*, ×0.37 (Davis, Furnish, & Glenister, 1969); *c*, diameter at 60 mm (Miller & Furnish, 1940a).

Timorites HANIEL, 1915, p. 108 [**T. curvicostatus* HANIEL, 1915, p. 109; SD DIENER, 1921, p. 25] [=*Hanieloceras* MILLER, 1933, p. 413 (type, *Waagenoceras intermedium* WANNER, 1932, p. 272, OD); =*Wanneroceras* TUMANSKAIA, 1937c, p. 93 (type, *Waagenoceras Gemmellaroi* HANIEL, 1915, p. 120, M); ?=*Subeothinites* ZAKHAROV, 1984, p. 151 (type, *E. pamiriensis,* OD); =*Coahuiloceras* CANTÚ CHAPA, 1997, p. 82 (type, *Timorites schucherti* MILLER & FURNISH, 1940a, p. 175, OD)]. Similar to *Cyclolobus,* but conch broader and commonly retaining ribs to maturity. External suture with 8 to 11 pairs of lobes to umbilical shoulders, and lacking a tertiary subdivision near crest of first lateral saddle. Seventeen named species. *Guadalupian (Capitanian)–Lopingian (Wuchiapingian):* Indonesia (Timor), USA (western Texas), Mexico (Coahuila), Russia (Maritime Territory, Amur), Azerbaijan, Iran (north, central), Tajikistan (?Pamir), China (Yunnan, Xizang), Japan (Kitakami).——FIG. 97*a–b*. **T. curvicostatus*, Amarassi beds, Wuchiapingian, Soefa, Timor, lectotype (herein), PIUB 29b of HANIEL (1915, pl. 52,*9a–c*), ×2 (new).——FIG. 97*c–i*. *T. schucherti* MILLER & FURNISH, La Difunta beds, Capitanian, Coahuila, Mexico; *c–f*, ×2; *g–h,* ×1.2 (Miller, 1944); *i,* diameter at approximately 70 mm (Miller & Furnish, 1940a).

Waagenoceras GEMMELLARO, 1887, p. 11 [**W. Mojsisovicsi*; SD DIENER, 1921, p. 25]. Intermediate in size, conch form, and sutural complexity between *Demarezites* and *Timorites*. External suture has seven or eight pairs of lobes to umbilical shoulders, each more complexly denticulate than in *Demarezites;* seven to eight lobe pair incompletely isolated. Sutural formula for advanced forms: $(V_1V_1)L_2L_1L_{2.1}L_{2.1.1}L_{2.1.1.1}L_{2.1.1.1.1}(L_{2.1.1.1.1.1}L_{2.1.1.1.1.1})U_2U_1U_2{:}(I_{2.1.1.1.1}I_{2.1.1.1.1})I_{2.1.1.1}I_{2.1.1}I_{2.1}I_1I_2(D_2D_1D_2)$ [Russian]. Ten named species. *Guadalupian (Wordian–Capitanian):* Italy (Sicily), Iraq (Kurdistan), Oman, Indonesia (Timor), Russia (Amur), China (Guizhou, Fujian, Gansu), Mexico (Coahuila, Sonora, ?Guerrero), USA (western Texas), Canada (British Columbia).——FIG. 96,*4a–c*. **W. mojsisovicsi*, Sosio limestone, Wordian, Sicily; *a–b*, lectotype, MGUP 34 of GEMMELLARO (1887, pl. 2,*1–2*), ×0.5 (Davis, Furnish, & Glenister, 1969); *c*, composite, diameter ranging 50–100 mm (Miller & Furnish, 1940a).

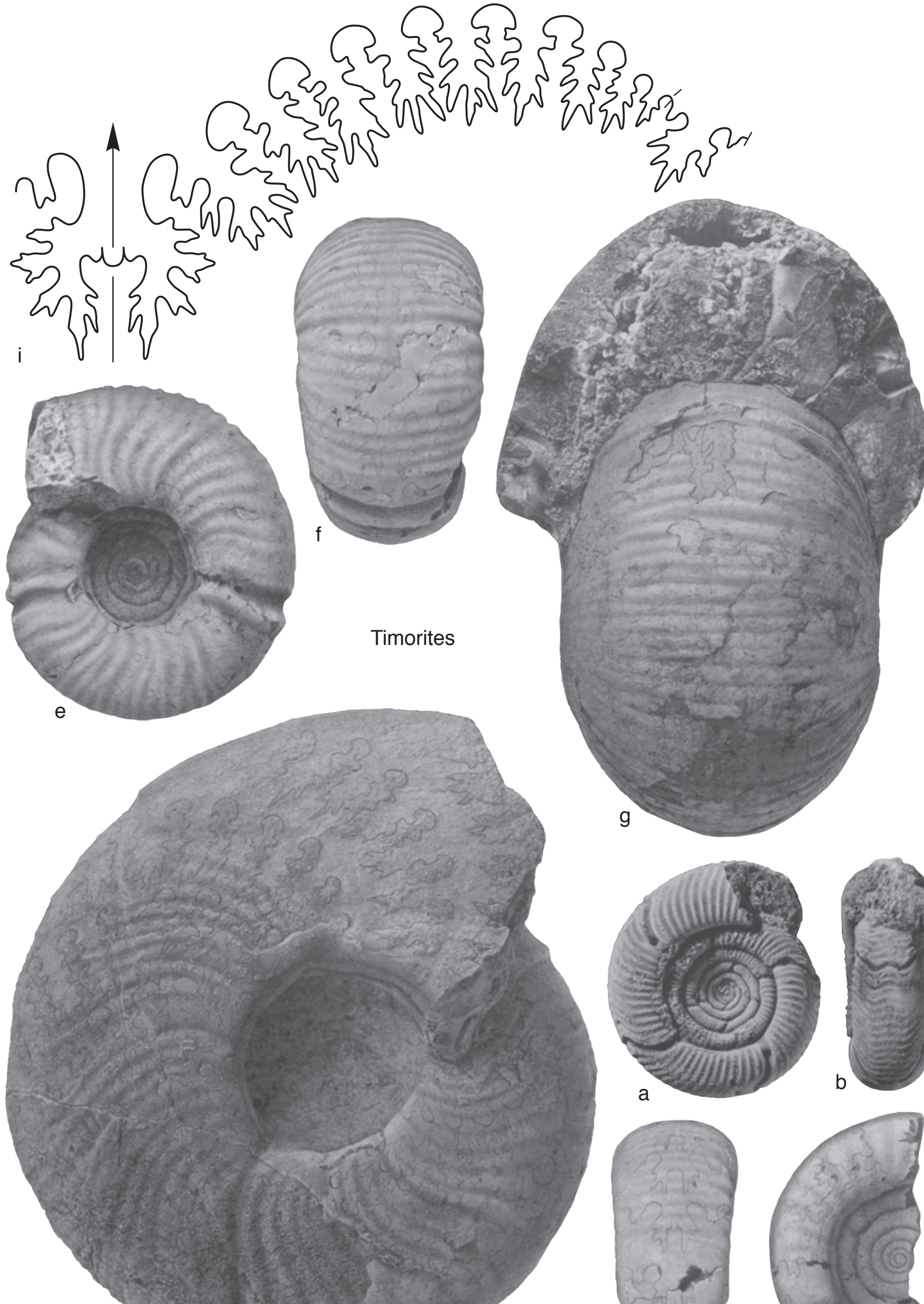

FIG. 97. Cyclolobidae (p. 156).