CARBONIFEROUS AND PERMIAN AMMONOIDEA (GONIATITIDA AND PROLECANITIDA)

WILLIAM M. FURNISH,[1] BRIAN F. GLENISTER,[2]
JÜRGEN KULLMANN,[3] and ZHOU ZUREN[4]

[[1]deceased, formerly of the University of Iowa; [2]retired, formerly of the University of Iowa;
[3]University of Tübingen, Germany; [4]Nanjing Institute of Geology and Palaeontology]

Order GONIATITIDA Hyatt, 1884

[*nom. transl.* RUZHENTSEV, 1957, p. 56, *ex* suborder Goniatitinae HYATT, 1884 in 1883–1884, p. 307]

Conch form very variable, predominantly involute, with narrow or even closed umbilicus; some forms evolute, with wide umbilicus. Umbilici always imperforate. Position of the siphuncle ventral throughout the whole order except for the superfamily Pseudohaloritoidea, which displays a variable position of the siphuncle, mostly subcentral or within the septal flexure. Some genera (*Kirsoceras, Agathiceras,* and *Maximites*) start with a central or at least subventral position of the siphuncle on an early growth stage and change the position to ventral during ontogeny. The basic suture consists of six or eight lobes in the suborder Tornoceratina (basic sutural formula: EALI or EALUI [German], VLU:D or VLU:ID [Russian]), the ventral lobe being simple, in some advanced forms bifid or trifid. The suborder Goniatitina possesses regularly a subdivided ventral lobe, usually with a median saddle and small median lobe (basic sutural formula: $(E_1E_mE_1)$ALUI [German], (V_1V_1)LU:ID [Russian]); in the suborder Tornoceratina the mode of subdivided ventral lobe is restricted to some advanced forms in the Famennian superfamily Praeglyphioceratoidea and the Carboniferous families Voehringeritidae, Karagandoceratidae, and Maximitidae. Additional adventitious and umbilical lobes may be present. Advanced forms display complicated subdivisions of the suture line as well as digitalized lobes and saddles. *Middle Devonian (Eifelian)–Lopingian (Changhsingian).*

[In the following text, sutural formulae marked with [German] are given in the suture-symbol terminology of WEDEKIND (1913a, 1916), while formulae marked with [Russian] correspond to the symbol terminology of RUZHENTSEV (1949b). For comparison, see KULLMANN & WIEDMANN, 1970; WIEDMANN & KULLMANN, 1981.]

Suborder TORNOCERATINA Wedekind, 1918

[*nom. correct.* RUZHENTSEV, 1957, p. 56, *pro* Tornoceracea WEDEKIND, 1918, p. 103]

Ventral lobe usually simple, undivided (exceptions: several representatives of the above mentioned families).

The suborder comprises six superfamilies, three of which are restricted to the Devonian period: Tornoceratoidea ARTHABER, 1911; Dimeroceratoidea HYATT, 1884 in 1883–1884; and Praeglyphioceratoidea RUZHENTSEV, 1957. The root stock of most Carboniferous and Permian ammonoids embody the superfamily Prionoceratoidea HYATT, 1884 in 1883–1884, the only Devonian superfamily containing taxa that crossed the Devonian–Carboniferous boundary. The superfamily Karagandoceratoidea LIBROVICH, 1957, is restricted to the Mississippian, and the superfamily Pseudohaloritoidea RUZHENTSEV, 1957, appeared in the Pennsylvanian and is predominantly distributed in the Permian period. *Middle Devonian (Eifelian)–Lopingian (Changhsingian).*

Superfamily TORNOCERATOIDEA Arthaber, 1911

[*nom.transl. et correct.* RUZHENTSEV, 1957, p. 56, *ex* Tornoceratea ARTHABER, 1911, p. 177]

Restricted to the Devonian period. *Middle Devonian (Eifelian)–Upper Devonian (Famennian).*

Superfamily DIMEROCERATOIDEA Hyatt, 1884

[*nom. transl.* Bartzsch & Weyer, 1988a, p. 136, *ex* Dimerocerae Hyatt, 1884 in 1883–1884, p. 330]

Restricted to the Devonian period. *Upper Devonian (Famennian).*

Superfamily PRAEGLYPHIOCERATOIDEA Ruzhentsev, 1957

[Praeglyphioceratoidea Ruzhentsev, 1957, p. 57]

Restricted to the Devonian period. *Upper Devonian (Famennian).*

PRIONOCERATOIDEA

Jürgen Kullmann

[University of Tübingen, Germany]

Superfamily PRIONOCERATOIDEA Hyatt, 1884

[*nom. transl.* Bartzsch & Weyer, 1988a, p. 136, *ex* Prionocerae Hyatt, 1884 in 1883–1884, p. 328]

Shell surface mostly smooth, rarely with ribbing or ventrolateral furrows, keels, grooves, and spiral ornamentation. Growth lines convex or biconvex. Constrictions common, either restricted to flanks or crossing venter. Sutures with primary ventral, lateral, and dorsal lobes, in addition with prominent and usually pointed adventitious and umbilical lobes. Ventral lobe in general simple, V-shaped, narrow, or pouched; lateral lobe small and close to umbilicus; sutural formula: EALUI [German], VLU:ID [Russian]. Only the Carboniferous side-branch family Voehringeritidae comprises forms with a subdivided ventral lobe and median saddle. *Upper Devonian (Famennian [Platyclymenia Zone])–Mississippian (Serpukhovian).*

Family PRIONOCERATIDAE Hyatt, 1884

[*nom. correct.* Bogoslovskii, 1971, p. 180, *pro* Prionocerae Hyatt, 1884 in 1883–1884, p. 328] [=Aganididae J. P. Smith, 1903, p. 112; =Imitoceratidae Ruzhentsev, 1950, p. 87; =Prionoceratinae Korn, 1994, p. 37; =Balviinae Korn in Korn & Klug, 2002, p. 276]

Adult conch form involute, with narrow or closed umbilicus. Shell surface mostly smooth. Early growth stages usually involute, rarely first whorls evolute. Close relationship to family Gattendorfiidae, some genera are transitional. *Upper Devonian (Famennian [Platyclymenia Zone])–Mississippian (Serpukhovian).*

Prionoceras Hyatt, 1884 in 1883–1884, p. 328 [**Goniatites divisus* Münster, 1832, p. 24; OD; *non* Buckman, 1920, p. 155] [=*Haugiceras* Cossmann, 1900, p. 43, *nom. subst.,* obj.; =*Postprolobites* Wedekind, 1913b, p. 87 (type, *P. yakowlewi,* SD Wedekind, 1918, p. 157, =*Goniatites divisus* Münster, 1832, p. 43; for discussion, see Schindewolf, 1923, p. 402)]. Conch form subdiscoidal to subglobular, involute, with punctiform umbilicus. Growth lines fine and linear with hyponomic sinus. Adult whorls with 3–4 weak constrictions, beginning at umbilicus, rather deep on flanks, usually not crossing venter. Ventral lobe with diverging or parallel sides. Four species (one questionable). *Upper Devonian (middle Famennian [upper Platyclymenia Zone]):* Great Britain, Germany, Austria, Spain, Algeria, Morocco, ?Czech Republic, Russia (South Urals), Kazakhstan (South Urals, Karaganda), Iran, China (Inner Mongolia), ?Canada.——Fig. 1,*1a–c.* **P. divisum* (Münster); *a–b,* Ouarurut, Saoura Valley, Algeria, magnification not indicated (Petter, 1959); *c,* suture, Beul, Rhenish Massif, Germany, GÖT 372-13, ×5 (Korn, 1994).

Balvia Lange, 1929, p. 60 [**Gattendorfia globularis* Schmidt, 1924, p. 120; OD] [=*Kenseyoceras* Selwood, 1960, p. 169 (type, *K. (K.) rostratum* Selwood, 1960, p. 171, =*Prionoceras biforme* Schindewolf, 1937, p. 32, OD); =*Kenseyoceras (Mayneoceras)* Selwood, 1960, p. 171 (type, *Glatziella nucleus* Schmidt, 1924, p. 119, M); =*Effenbergia* Korn in Korn & Klug, 2002, p. 195 (type, *Balvia lens* Korn, 1992, p. 35, OD)]. Conch very

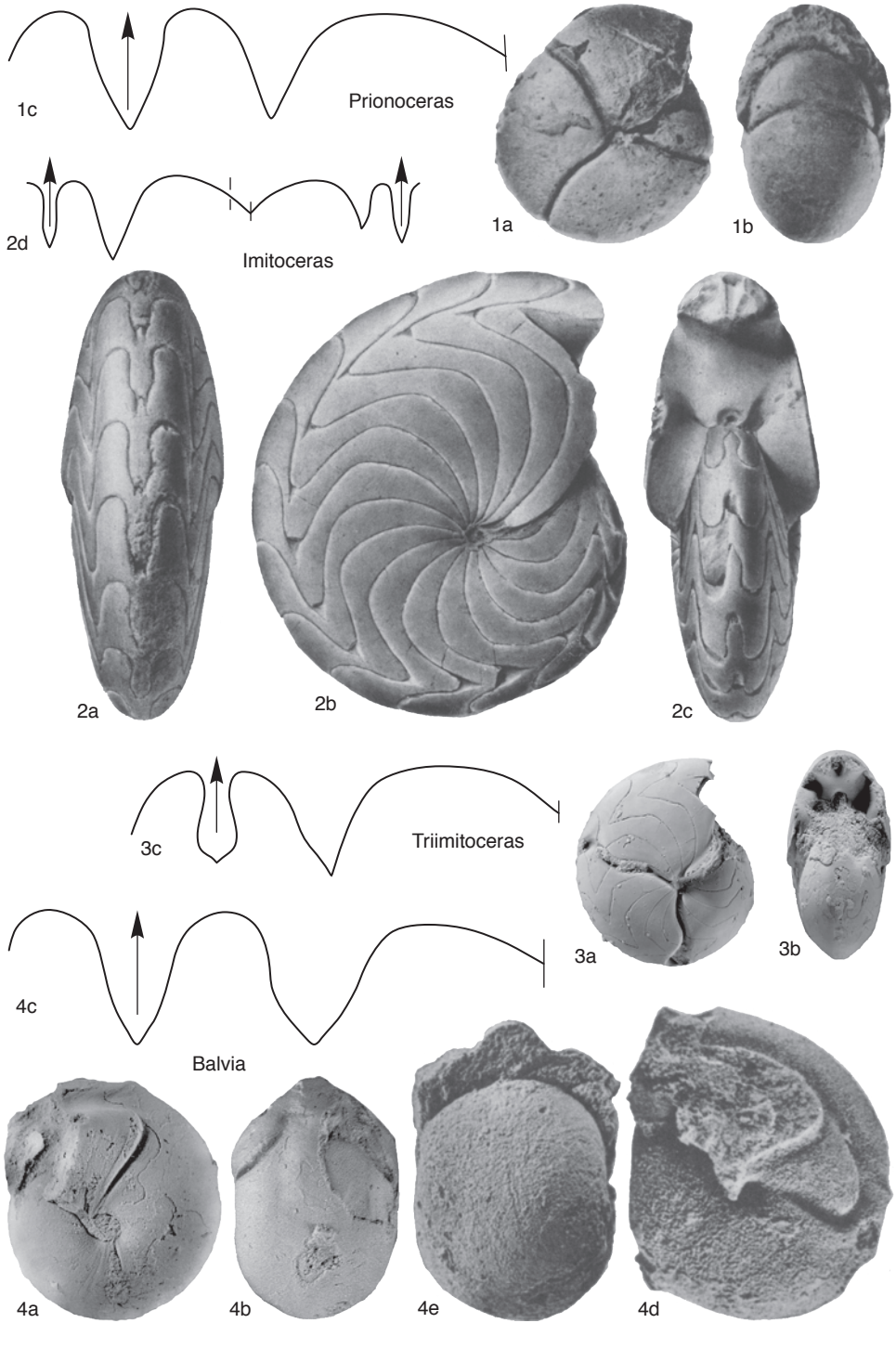

FIG. 1. Prionoceratidae (p. 2–6).

small, lenticular to subglobose, completely involute, with closed umbilicus. Early whorls slightly evolute. Growth lines fine, prorsiradiate, concave-convex, with well-developed ventrolateral salient and hyponomic sinus. Flanks with one or several weak constrictions combined with a parallel wall on apertural side, which usually swing forward at venter to form grooves bounding a median keel. Apertural modifications may be present. Suture similar to *Prionoceras*. About ten species. [Some authors (Becker, 1996) regard *Kenseyoceras* and *Mayneoceras* as subgenera of *Balvia* with transitional characteristics: *Balvia (Kenseyoceras)* displays a biform conch, *Imitoceras*-like early whorls; later, after a single constriction a strong keel and ventral rostrum is formed. Apertural modification is terminated by a constriction. *Balvia (Mayneoceras)* is thought to contain species with regularly spaced constrictions that pass into sulci bordering median keel; parabolic ears are developed periodically. The differences are regarded herein as being of nongeneric significance. *Effenbergia* was erected for forms with constrictions restricted to flanks only.] *Upper Devonian (upper Famennian [Wocklumeria Zone]):* Great Britain, Germany, Austria, Poland, China (Guilin, Guizhou), Algeria, Morocco, USA (Indiana).——Fig. 1,*4a–c. *B. globularis* (Schmidt); *a–b,* Müssenberg, Rhenish Massif, Germany, Bed 31, SMF 60169, ×3; *c,* suture, Fezzou, Morocco, GPIT 1748/14, ×12 (Korn, 1994).——Fig. 1,*4d–e. B. biformis* (Schindewolf), Stourscombe, Cornwall, England; *d,* holotype of *Kenseyoceras rostratum* Selwood, GSM 87058, ×4.5; *e,* topotype, GSM 87061, ×3 (Selwood, 1960).

?Cunitoceras Weyer, 1972b, p. 339 [**C. schindewolfi;* OD; =*Imitoceras globosum* Schindewolf, 1951a, p. 46, *non* Schindewolf, 1923, p. 335, obj.]. Conch form lenticular or globose, completely involute; umbilicus very narrow or closed. Ventral lobe wide, funnel shaped. One species and one questionable species. *Mississippian (upper Tournaisian):* Germany, Spain, USA (Michigan, Missouri).——Fig. 2,*2a–b. *C. schindewolfi,* holotype, Erdbach limestone, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, Collection Fuhrmann, Clausthal; *a,* ×1.4; *b,* suture, reversed image, ×1.5 (Schindewolf, 1951a).

Imitoceras Schindewolf, 1923, p. 325 [**Ammonites rotatorius* de Koninck, 1844, p. 565; SD Schindewolf, 1926b, p. 70; =*Goniatites ixion* Hall, 1860, p. 125 (see Schindewolf, 1923, p. 326)] [=*Aganides* de Montfort, 1808, p. 30, *nom. nud.;* =*Brancoceras* Hyatt, 1884 in 1883–1884, p. 325 (type, *Goniatites ixion* Hall, 1860, p. 125, OD), *non* Steinmann, 1881, p. 133]. Conch form discoidal to globular. Young stages with narrow umbilicus; adult shell form usually with relatively high aperture and very narrow or punctiform umbilicus. Growth lines usually fine, linear, rarely coarse. Constrictions may be present. Ventral lobe narrow, more or less parallel sided or slightly pouched; adventitious lobe asymmetric. Many species. [The assignment of several species to *Imitoceras* is uncertain.] *Mississippian (middle Tournaisian–upper Tournaisian):* Belgium, Germany, Austria, Algeria, Russia, China (Xizang, Yunnan), Australia (West Australia), Canada (Alberta, British Columbia), USA (Arkansas, Iowa, Illinois, Indiana, Michigan, Ohio, Kentucky, Montana, ?New Mexico, Nevada).——Fig. 1,*2a–d. *I.* aff. *rotatorium* (de Koninck), Rockford, Jackson County, Indiana, Rockford limestone, Osagean; *a–c*, ×0.9; *d,* suture, ×0.8 (Miller, Furnish, & Schindewolf, 1957).

Irinoceras Ruzhentsev, 1947c, p. 281 [**I. arcuatum* Ruzhentsev, 1947c, p. 283; OD]. Thickly discoidal, involute, with narrow or punctiform umbilicus. Growth lines coarse, rectilinear, convex, with deep hyponomic sinus. No ribs, constrictions, grooves, or spiral ornamentation. Ventral lobe pouched. Ten species. [The illustrated species is closely related to the holotype and is the same age.] *Mississippian (upper Tournaisian–Serpukhovian):* Ireland, France, Spain, Germany, Serbia, South Urals, Tajikistan, China (Xinjiang), Algeria, Morocco, Australia (New South Wales, Queensland), Canada (British Columbia), USA (Arkansas, Michigan).——Fig. 2,*5a–d. I. stevanovici* Kullmann, holotype, Družetić, Serbia, Serpukhovian, MHN S9; *a–c*, ×2; *d*, suture at 12 mm diameter, ×1.4 (Stevanović & Kullmann, 1962).

Mimimitoceras Korn, 1988a, p. 606 [**M. trizonatum* Korn, 1988a, p. 607; OD]. Conch form lenticular to globose, involute, with narrow to punctiform umbilicus. Inner whorls subglobose, with extreme narrow umbilicus. Growth lines rectilinear, mostly convex, with shallow hyponomic sinus. Several constrictions per whorl, sometimes aperturally combined with wall on flanks, type species with three constrictions and triangularly coiled. Many species. [This genus is closely related to *Balvia*.] *Upper Devonian (Famennian [Clymenia–Wocklumeria Zone])–Mississippian (lower Tournaisian):* Great Britain, Germany, Austria, Italy, Poland, France, Spain, Italy, Algeria, Morocco, Russia (South Urals), China (Guizhou, Xinjiang), USA (Ohio).——Fig. 2,*1a–c. *M. trizonatum; a–b*, holotype, Reigern, Rhenish Massif, Germany, Wocklum limestone, *Wocklumeria* Zone, upper Famennian, SMF 51250, ×3; *c*, paratype, suture at 13.6 diameter, whorl height at 7.2 mm, SMF 51251, ×7.3 (Korn, 1988a).

Paragattendorfia Schindewolf, 1924, p. 105 [**P. humilis;* OD] [=*Globimitoceras* Korn, 1993a, p. 585 (type, *Imitoceras globiforme* Vöhringer, 1960, p. 145, OD)]. Conch form lenticular to thickly discoidal, involute, with narrow, but open umbilicus. Increase of whorl height during ontogeny slow, with low aperture height on all stages; width of umbilicus increasing slightly during ontogeny in most species. Growth lines usually fine, rectilinear, crossing venter with or without hyponomic sinus. Constrictions absent in most species. Ventral lobe small, V-shaped, rarely parallel sided. Six species and four questionable species. [For discussion, see Bartzsch & Weyer, 1987, p. 64. *Globimitoceras* was erected for species with narrow umbilicus

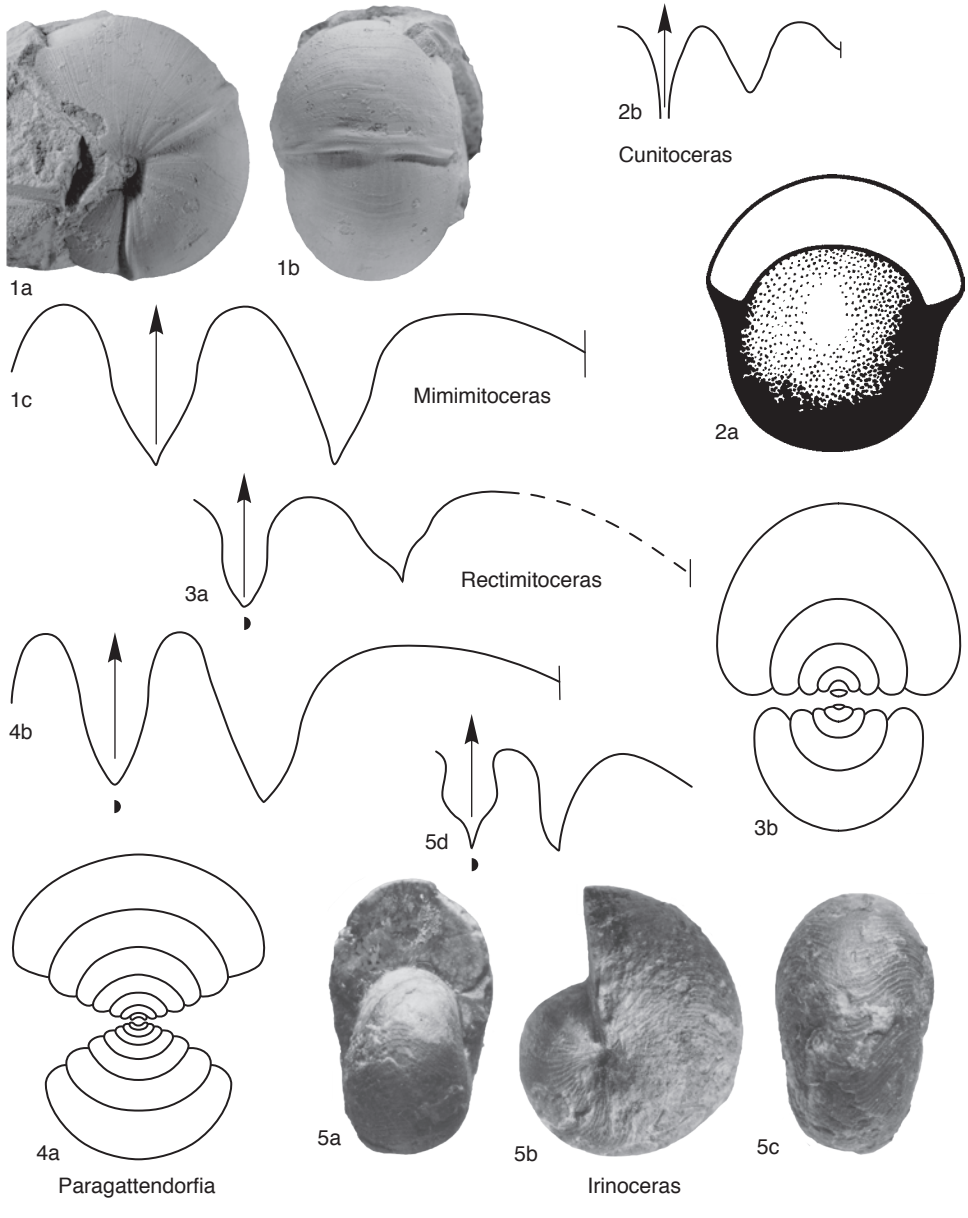

FIG. 2. Prionoceratidae (p. 4–6).

during almost the entire ontogeny. There are no suitable illustrations of the holotype available.] *Mississippian (lower Tournaisian):* Germany, France, Morocco, China (Guizhou).——FIG. 2,*4a–b. P. patens* VÖHRINGER, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian; *a*, cross section of topotype, GPIT 1130/80, ×2.2 (Vöhringer, 1960); *b*, suture of holotype, GPIT 1130/78, ×6 (Korn, 1994).

Rectimitoceras BECKER, 1996, p. 34 [**Goniatites linearis* MÜNSTER, 1832, p. 22; OD]. Conch involute throughout ontogeny. Median and adult stages without constrictions. Ventral lobe lanceolate and at least as deep as the asymmetric and wide adventitious lobe. More than ten species. *Upper Devonian (upper Famennian [Platyclymenia–Wocklumeria Zone]), Mississippian (?Tournaisian):* Austria, Great Britain, Germany, Spain, Morocco, Russia (North

and South Urals), Kazakhstan (South Urals, Karaganda), China (Guizhou).——Fig. 2,*3a. *R. lineare* (Münster), suture of holotype at 22 mm diameter, Schübelhammer, Frankenwald, Germany, *?Clymenia* Zone, upper Famennian, BSM AS VII 23, image reversed, ×3.4 (Becker, 1996).——Fig. 2,*3b. R. substriatum* (Münster), cross section, Hönnetal railway cut, bed 4, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/162, at 15 mm diameter, ×2.9 (Vöhringer, 1960).

Triimitoceras Korn & others, 2003, p. 78 [**T. epiwocklumeriforme* Korn & others, 2003, p. 79; OD]. Conch pachycone to discoidal, with triangularly coiled juvenile stage. Umbilicus extremely narrow. Three deep constrictions present on steinkerns of early and middle stages. Suture with slightly pouched ventral lobe and large, V-shaped adventitious lobe that is considerably deeper than ventral lobe. One species. *Mississippian (upper Tournaisian):* Morocco.——Fig. 1,*3a–c. *T. epiwocklumeriforme*, holotype, Taouz, Jebel Ouaoufilal, east of Ksar Bouhamed, Tafilalt, Oued Znaïgui Formation, MB C.3910; *a–b,* ×2; *c,* suture at 13.4 mm diameter, whorl width 6.7 mm, whorl height 7.7 mm, ×4.4 (Korn & others, 2003).

Family GATTENDORFIIDAE Bartzsch & Weyer, 1987

[*nom. transl.* Kullmann, herein, *ex* Gattendorfiinae Bartzsch & Weyer, 1987, p. 61] [=Acutimitoceratinae Korn, 1994, p. 37]

Adult conch form moderately involute or evolute; inner whorls always evolute. Shell surface with rursiradiate growth lines or ribbing, without furrows and keels. *Upper Devonian (upper Famennian)–Mississippian (upper Tournaisian [Kinderhookian–Osagean]).*

Gattendorfia Schindewolf, 1920, p. 123 [**Goniatites subinvolutus* Münster, 1839, p. 23; OD]. Conch form lenticular to thickly discoidal, with broadly rounded, rarely flattened venter. Early whorls evolute, later moderately evolute. Umbilicus wide to moderately wide, rarely becoming narrow during ontogeny. Fine or coarse growth lines are convex, with hyponomic sinus, sometimes crenulate. Ornamentation in some forms reticulate, rarely with faint ribs; several constrictions may be present. Suture with paralell-sided ventral lobe; lateral lobe on or close to umbilical wall. Many species. *Mississippian (lower Tournaisian):* Great Britain, France, Germany, Austria, Poland, Russia and Kazakhstan (South Urals), Kazakhstan (Karaganda), China (Guizhou, Xinjiang), USA (Indiana, ?Missouri, Montana, New Mexico, ?Nevada, Utah).——Fig. 3,*1a–e. *G. subinvoluta* (Münster), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone; *a–b,* GPIT 1130/86; *c*, GPIT 1130/85, ×1; *d*, suture, suture at 33 mm diameter, GPIT 1130/86, ×2.9 (Vöhringer, 1960); *e*, cross section at 30 mm diameter, GPIT 1130/86, ×1.1 (Vöhringer, 1960).

Acutimitoceras Librovich, 1957, p. 263 [**Imitoceras acutum* Schindewolf, 1923, p. 338; OD]. Shell form lenticular to pachycone, venter rounded, rarely oxycone. Early ontogenetic stages evolute; middle and adult stages with narrow umbilicus. Growth lines mostly fine and linear, constrictions variable in number and position. Suture line usually with parallel-sided, relatively deep ventral lobe; adventitious lobe as deep as ventral lobe. [This genus is transitional to *Nicimitoceras. Sulcimitoceras* and *Hasselbachia* are regarded herein as synonyms of *Acutimitoceras (Stockumites);* see below). The ranges of subgenera *Stockumites* and *Streeliceras* are practically identical, and *Acutimitoceras* is restricted to the lower Tournaisian.] *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian).*

A. (Acutimitoceras). Shell form oxyconic at middle and adult stages. Ventral lobe deep and often wide, adventitious lobe asymmetric. Three species. *Mississippian (lower Tournaisian):* Austria, Germany, China (Guizhou).——Fig. 3,*4. *A. (A.) acutum* (Schindewolf), cross section, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/54, ×2.1 (Vöhringer, 1960).

A. (Stockumites) Becker, 1996, p. 36 [**Imitoceras intermedium* Schindewolf, 1923, p. 333; OD] [=*Sulcimitoceras* Kuzina, 1985, p. 46 (type, *S. yatskovi* Kuzina, 1985, p. 47, OD); ?=*Hasselbachia* Korn & Weyer, 2003, p. 95 (type, *Imitoceras multisulcatum* Vöhringer, 1960, p. 141, OD)]. Shell form compressed to globular, always with rounded venter; ventral lobe deep and narrow. More than 10 species, without special characteristics; descriptions need special biometric investigations. [*Sulcimitoceras* was erected for small discoidal forms with intraventral ridges or furrows developed in intermediate ontogenetic stages similar to Homoceratinae (compare Fig. 52,*1–3,* p. 87–89); this character is not regarded herein as being of generic significance. *Hasselbachia* was erected for species with small conchs and low apertures regarded herein as being of specific rather than generic significance. The illustrated species is based on original material.] *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian):* Austria, France, ?Great Britain, Ireland, Spain, Germany, Poland, Russia and Kazakhstan (South Urals), Kazakhstan (Karaganda), Mongolia, China (Guilin, Guizhou), Morocco, Australia (New South Wales), USA (?Illinois, ?Iowa, ?Ohio, ?Nevada, Missouri), Canada (Alberta). ——Fig. 3,*5a–b. A. (S.) antecedens* (Vöhringer), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/61; *a*, suture, reversed, ×2.9; *b*, cross section, ×2.3 (Vöhringer, 1960).

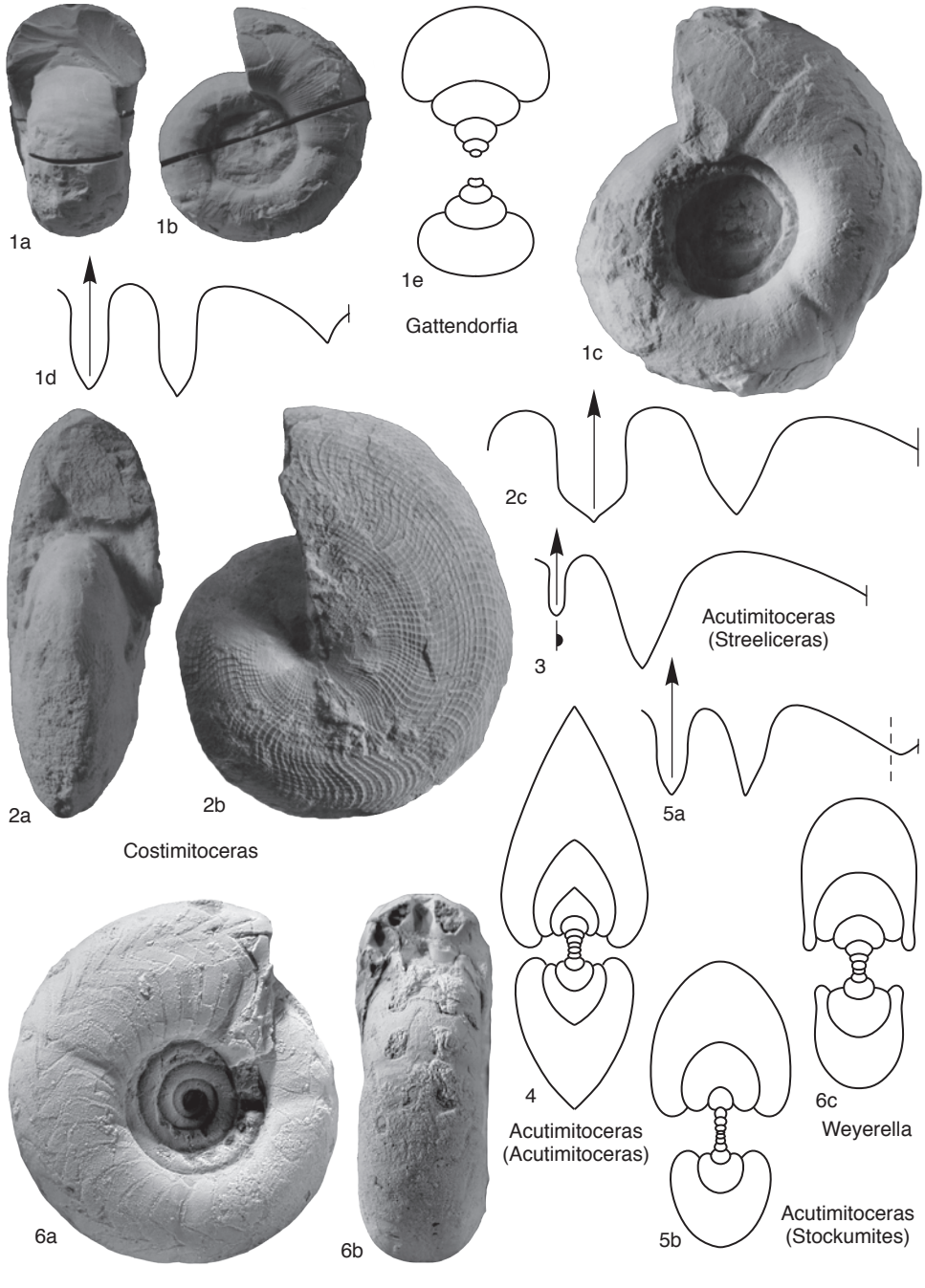

FIG. 3. Gattendorfiidae (p. 6–8).

A. (Streeliceras) BECKER, 1996, p. 37 [**Imitoceras heterolobatum* VÖHRINGER, 1960, p. 136; OD]. Shell form discoidal, adult stages with closed umbilicus. Ventral lobe significantly shorter than adventitious lobe. Seven species. *Upper Devonian (upper Famennian [upper Wocklumeria Zone])–Mississippian (lower Tournaisian):* Germany, Poland, China (Guizhou).——FIG. 3,3. **A. (S.)*

heterolobatum (Vöhringer), suture, reversed, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, lower Tournaisian, GPIT 1130/165, ×1.8 (Vöhringer, 1960).

Costimitoceras Vöhringer, 1960, p. 148 [**C. ornatum;* OD]. Conch form as in *Acutimitoceras*, but with riblike transversal striae and prominent spiral lires producing reticulate sculpture. Two species. *Mississippian (lower Tournaisian):* Germany, China (Guizhou).——Fig. 3,*2a–c. *C. ornatum,* holotype, Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/81; *a–b*, ×2; *c*, suture, ×4.3 (Korn, 1994).

Gattenpleura Weyer, 1976, p. 843 [**G. bartzschi* Weyer, 1976, p. 846; OD]. Conch form and suture line similar to *Gattendorfia*, but with prominent schizotomous ribs on flanks and venter. Late whorls overlapping preceding whorls. Two species. *Mississippian (lower Tournaisian):* Germany, ?Poland. ——Fig. 4,*4a–c. *G. bartzschi,* Saalfeld, quarry Pfaffenberg southwest, Thüringen, Germany, *Gattendorfia* Zone; *a,* holotype, MB.C.766.1, ×1 (Weyer, 1976); *b,* cross section, MB.C.766.6, ×1.1; *c,* suture at 13.5 mm diameter, whorl height 4.6 mm, ×5 (Bartzsch & Weyer, 1988b).

Kazakhstania Librovich, 1940, p. 67 [**Gattendorfia (Kazakhstania) karagandaensis* Librovich, 1940, p. 68; OD]. Conch thin-discoidal, on all growth stages evolute, with wide umbilicus. Growth lines fine or coarse, several constrictions in most species. Ventral lobe long, slightly bell shaped, adorally narrowed. Five species. *Mississippian (middle Tournaisian–upper Tournaisian):* Great Britain, Kazakhstan (Karaganda), Mongolia, USA (Arkansas, Indiana, Michigan, Ohio, Kentucky).——Fig. 4,*1a–b. *K. karagandaensis,* holotype, Ak-Bas-tau Mountains, North Kazakhstan, middle Tournaisian, CNIGR 48/5450; *a*, ×1; *b*, suture, whorl height at 9 mm, ×3.4 (Librovich, 1940).

?Nicimitoceras Korn, 1993a, p. 585 [**Imitoceras subacre* Vöhringer, 1960, p. 120; OD] [?=*Acutimitoceras (Acrimitoceras)* Ruan, 1995a, p. 348 (type, *Imitoceras acre* Vöhringer, 1960, p. 121, OD)]. Conch form similar to *Acutimitoceras,* early evolute stage restricted; umbilicus narrow or punctiform on adult stages. Ventral lobe relatively small and V-shaped, rarely parallel sided; adventitious lobe deeper than ventral lobe, acute, comparatively wide. Three species. [This genus is transitional to *Acutimitoceras* and may be its junior synonym.] *Mississippian (lower Tournaisian):* Germany, China(Guizhou).——Fig. 4,*3a–b. *N. subacre* (Vöhringer), Hönnetal railway cut, Rhenish Massif, *Gattendorfia* Zone, Germany; *a,* suture of holotype, reversed, GPIT 1130/5, ×2.9; *b,* cross section of paratype, GPIT 1130/8, ×2.1 (Vöhringer, 1960).

Weyerella Bockwinkel & Ebbighausen, 2006, p. 116 [**W. protecta* Bockwinkel & Ebbighausen, 2006, p. 117; OD]. Conch form of early whorls evolute as in *Gattendorfia*, late whorls similar to *Gattenpleura,* after adult change of proportions overlapping preceding whorls. Four species. *Mississippian (lower Tournaisian):* Germany, Morocco, China (Guizhou).——Fig. 3,*6a–b. *W. protecta,* Tafilalt, Morocco, *Gattendorfia* Zone, holotype, MB.C.3837.1, lateral and dorsal views, ×2.5 (Bockwinkel & Ebbighausen, 2006).——Fig. 3,*6c. W. concava* (Vöhringer), cross section of paratype, Hönnetal railway cut, *Gattendorfia* Zone, Rhenish Massif, Germany, GPIT 1130/107, ×2 (Vöhringer, 1960).

?Zadelsdorfia Weyer, 1972b, p. 344 [**Gattendorfia asiatica* Librovich, 1940, p. 49; OD] [?=*Acutimitoceras (Follimitoceras)* Ruan, 1995a, p. 348 (type, *Imitoceras (Imitoceras) folliforme* Ruan, 1981a, p. 70, OD)]. Conch form similar to *Gattendorfia;* at early growth stages evolute, but later rather involute, with small umbilicus. Constrictions present in some species. Ventral lobe slightly bell shaped, orad narrowed. More than ten species. [This genus is closely related and transitional to *Gattendorfia* and may be its younger synonym.] *Mississippian (middle Tournaisian):* Germany, Portugal, Morocco, Kazakhstan (Karaganda), China (Xinjang, Xizang), USA (?Arkansas, Iowa, ?Indiana, Michigan, Missouri, Ohio).——Fig. 4,*2a–c. *Z. asiatica* (Librovich), holotype, Karaganda region, North Kazakhstan, CNIGR 19/5450; *a–b*, ×1; *c*, suture, whorl height at 30 mm, ×1 (Librovich, 1940).

Family PSEUDARIETITIDAE Bartzsch & Weyer, 1987

[*nom. transl.* Kullmann, herein, *ex* Tribus Pseudarietitini Bartzsch & Weyer, 1987, p. 61]

Adult conch moderately involute or evolute. Shell surface with concave coarse ribs that do not cross venter; ventrolateral furrows and keel may be present. *Mississippian (lower Tournaisian).*

Pseudarietites Frech, 1902, p. 62 [**P. silesiacus* Frech, 1902, p. 63; M] [=*Pseudoarietites* Wedekind, 1918, p. 131, *nom. van.*]. Thin discoidal, evolute, with wide umbilicus. Flanks with prominent linear ribs. Venter with keel and usually two furrows, rarely oxycone. Growth lines with shallow ventral sinus; no constrictions. Ventral lobe parallel sided, adventitious lobe deep and rounded, lateral lobe shallow, centering on umbilical seam. Six species. *Mississippian (lower Tournaisian):* Germany, Austria, Poland, China (Guizhou), Australia.——Fig. 5,*2a. *P. silesiacus,* holotype, Wroclaw UWR 17773s, ×2.4 (Dzik, 1997).——Fig. 5,*2b–c. P. westfalicus* (Schmidt), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone; *b*, suture, GPIT 1130/119, ×8.3; *c*, cross section, hypotypoid, GPIT 1130/121, ×1.8 (Vöhringer, 1960).

Paprothites Bartzsch & Weyer, 1987, p. 62 [**Pseudarietites westfalicus dorsoplanus* Schmidt, 1924, p. 152; OD]. Conch form as in *Pseudarietites*, but with broadly rounded ventral side, without keel and ventral furrows. Six species. *Mississippian (lower Tournaisian):* Germany, Poland,

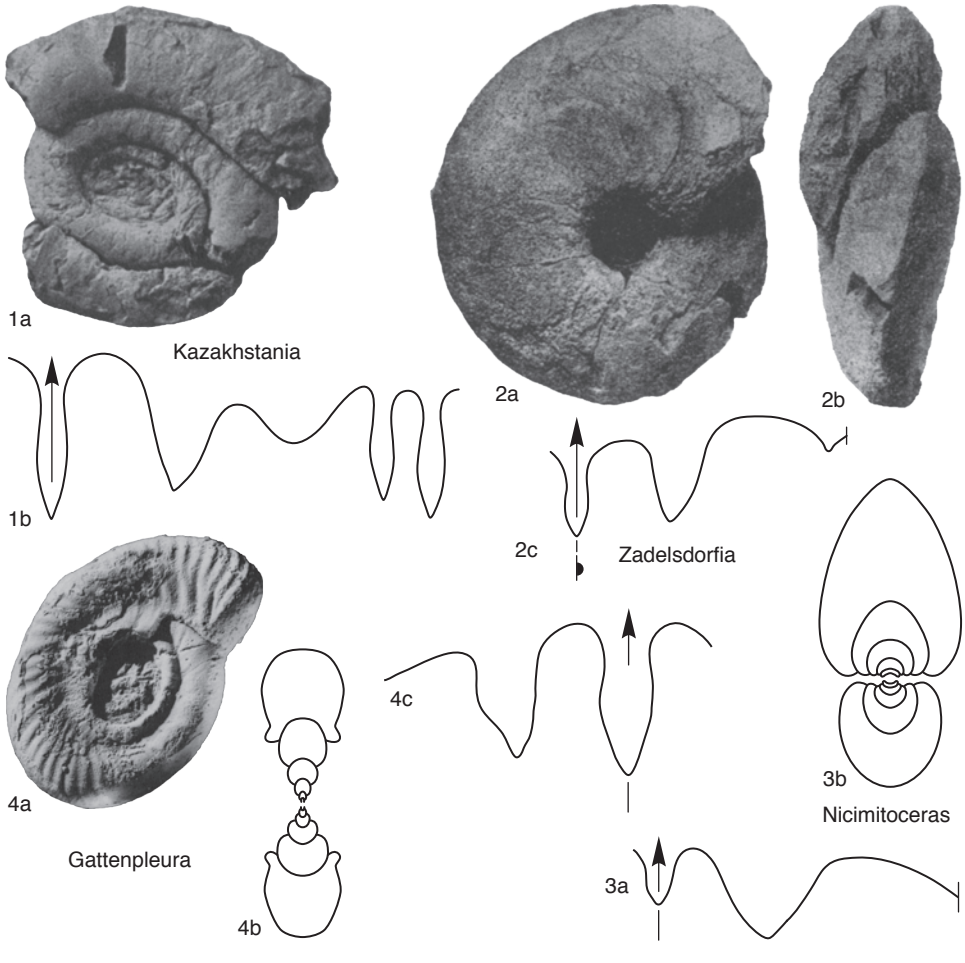

FIG. 4. Gattendorfiidae (p. 8).

China (Guizhou).——FIG. 5,*4a–c*. **P. dorsoplanus* (SCHMIDT), Hönnetal railway cut, Rhenish Massif, Germany, *Gattendorfia* Zone, GPIT 1130/120; *a–b,* GPIT 1130/116, ×3 (Korn, 1994); *c,* cross section, GPIT 1130/117, ×4.2 (Vöhringer, 1960).

Paralytoceras FRECH, 1902, p. 83 [**Clymenia crispa* TIETZE, 1871, p. 135; M]. Conch form discoidal, evolute, with moderately wide umbilicus. Venter at later stages broadly rounded or oxycone and always with separate keel. Growth striae lamellate or sometimes crenulate; simple riblets present. Ventral lobe wide, inconspicuous ventral saddle questionable; ventrolateral saddle rounded, adventitious lobe deep. Five species. [This genus is supposedly close to the root group of Karagandoceratoidea; for discussion, see WORK & MAPES, 2002, p. 910.] *Mississippian (lower Tournaisian):* Germany, Poland, China (Guizhou), Australia (?Queensland).——FIG. 5,*3a–b*. **P. crispum* (TIETZE), holotype, Dzikowiez limestones, Lower Silesia, Poland, MB.C.4692; *a*, side view, ×1.5; *b*, suture, whorl height at 12 mm (Weyer, 1965).

Family VOEHRINGERITIDAE Bartzsch & Weyer, 1988

[*nom. transl.* KULLMANN, herein, *ex* Tribus Voehringeritini BARTZSCH & WEYER, 1988a, p. 136]

Ventral lobe wide, orad diverging, bifid, with small median saddle, no increase of sutural elements in umbilical area. Sutural formula: $(E_1E_mE_1)$ALUI [German], (V_1V_1) LU:ID [Russian]. [*Voehringerites* MANGER,

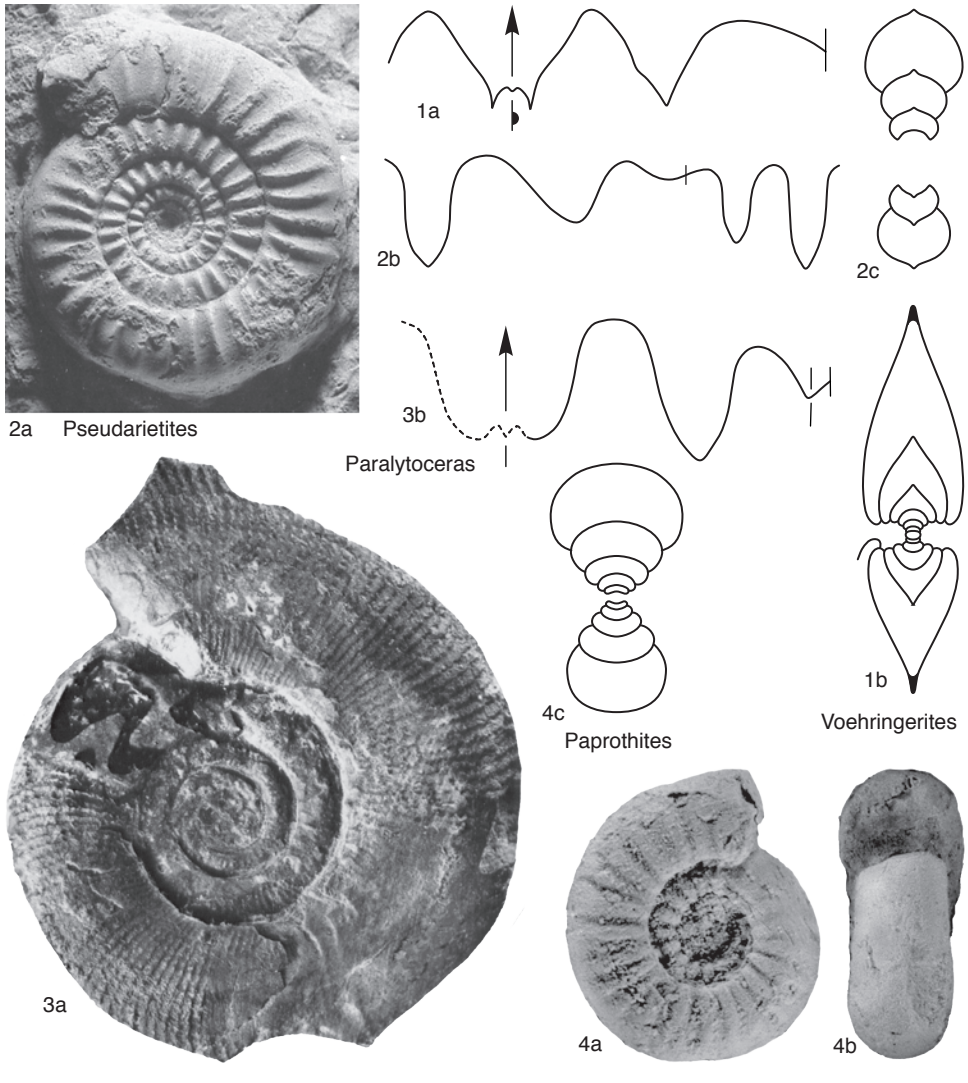

FIG. 5. Pseudarietitidae and Voehringeritidae (p. 8–10).

the only genus known so far, is thought to arise from keeled forms of the Gattendorfiidae (BARTZSCH & WEYER, 1988a, p. 138), e.g., *Acutimitoceras acutum* (SCHINDEWOLF). The mode of subdivision of the ventral lobe resembles the development in early representatives of the suborder Goniatitina, in contrast to the mode of the Devonian Praeglyphioceratoidea and the Carboniferous Karagandoceratoidea with their trifid partition of the parallel-sided ventral lobe.] *Mississippian (lower Tournaisian).*

Voehringerites MANGER, 1971, p. 35 [**Karagandoceras peracutum* VÖHRINGER, 1960, p. 168; OD]. Early whorls thinly discoidal and evolute; later stages moderately involute, with narrow umbilicus and keel. Ventral lobe bifid; median lobe inconspicuous. Lateral saddle strongly asymmetric. Adventitious lobe relatively small, asymmetric. One species. *Mississippian (lower Tournaisian):* Germany. ——FIG. 5,*1a–b.* **V. peracutum* (VÖHRINGER), holotype, Hönnetal railway cut, Rhenish Massif, *Gattendorfia* Zone, GPIT 1130/127; *a*, suture, reversed, at diameter of 21.5 mm, whorl height 12 mm, whorl width 6.8 mm, ×4.3 (Korn, 1994); *b*, cross section, ×2.3 (Vöhringer, 1960).

KARAGANDOCERATOIDEA

JÜRGEN KULLMANN

[University of Tübingen, Germany]

Superfamily KARAGANDOCERATOIDEA Librovich, 1957

[*nom. transl.* KULLMANN, herein, *ex* Karagandoceratidae LIBROVICH, 1957, p. 264]

Ventral lobe complex, with tendency to increase suture elements in ventral and umbilical areas. Conch form discoidal to lenticular; adult stages narrowly rounded or oxycone and with separate keel. Ventral lobe wide, subdivided at least at its base. Root group possibly the advanced pseudoarietitid *Paralytoceras.* [For discussion, see WORK & MAPES, 2002, p. 910, and BECKER & WEYER, 2004, p. 25.] *Mississippian (Tournaisian–Serpukhovian).*

Family KARAGANDOCERATIDAE Librovich, 1957

[Karagandoceratidae LIBROVICH, 1957, p. 264]

No increase of suture elements in the umbilical area. Ventral lobe wide, subdivided in the mode of Praeglyphioceratoidea by trifid partition of the ventral portion of suture: E > ($E_2E_1E_2$) [German], V > ($V_2V_1V_2$) [Russian], in contrast to the mode of *Voehringerites* (Voehringeritidae) or Muensteroceratidae with bifid subdivision of the ventral lobe: E > (E_1E_1) > ($E_1E_mE_1$) [German], V > (V_1V_1) [Russian]. [The group is probably derived as in *Voehringerites:* similarly but independently from one or several stocks within the Prionoceratoidea. *Karagandoceras* is thought to have evolved from *Imitoceras acre* VÖHRINGER, possibly via *Paralytoceras* (BARTZSCH & WEYER, 1988a, p. 134). Some authors include the family in superfamily Prionoceratoidea HYATT (for discussion, see BECKER & WEYER, 2004).] *Mississippian (Tournaisian [Kinderhookian–Osagean]).*

Karagandoceras LIBROVICH, 1940, p. 88 [**K. galeatum* LIBROVICH, 1940, p. 90; OD]. Conch form lenticular, involute, with acute ventral margin. Ventral lobe wide, its sides subparallel to divergent; height of saddles within ventral lobe variable, median part of ventral lobe relatively wide. Adventitious lobe very broad and deep, asymmetric. Lateral lobe centers on umbilical wall. Sutural formula: ($E_2E_1E_2$) AL:UI [German], ($V_2V_1V_2$)LU:ID [Russian]. One species. *Mississippian (lower Tournaisian–middle Tournaisian):* ?Germany, *lower Tournaisian;* Kazakhstan (Karaganda), *middle Tournaisian.*——FIG. 6,*2a–c.* **K. galeatum,* holotype, Ak-Bas-tau Mountains, North Kazakhstan, middle Tournaisian, CNIGR 61/5450; *a–b*, side view, ×4; *c*, suture, ×3.3 (Librovich, 1940).

Bartzschiceras BECKER & WEYER, 2004, p. 26 [**B. mirandum;* OD]. Conch form oxyconic as in *Acutimitoceras* and *Nicimitoceras*, but ventral lobe with incipient and beginning tripartition, in general incipiently trifid. Ventrolateral saddle subangular, elevated, and narrow, adventitious lobe asymmetric and acute, dorsal saddle on flanks highly arched. One species. *Mississippian (lower Tournaisian):* Germany, France.——FIG. 6,*3.* **B. mirandum,* holotype, suture, La Serre Bed 3C2, Montagne Noire, France, MB.C.3733, whorl height at 26.5 mm, ×1.8 (Becker & Weyer, 2004).

Masonoceras WORK & MANGER, 2002, p. 574 [**M. kentuckiense* WORK & MANGER, 2002, p. 575; OD]. Conch thinly subdiscoidal to discoidal with acute ventral margin in late ontogeny. Wide, trifid ventral lobe with moderately high median saddle and asymmetric ventral prongs; narrow, asymmetrically rounded lateral saddle; exceptionally deep, asymmetric lateral lobe; small, rounded umbilical lobe. Three species. *Mississippian (upper Tournaisian [lower Osagean]):* USA (Kentucky, Ohio, Missouri), Australia (New South Wales).——FIG. 6,*1a–c.* **M. kentuckiense,* holotype, Morhead, northeastern Kentucky, Nancy Member, Borden Formation, SUI 95340; *a*, side view; *b*, apertural view, ×3.5; *c*, suture, diameter at 17.1 mm, whorl height 10.3 mm, magnification not stated (Work & Manger, 2002).

Family PRODROMITIDAE Arthaber, 1911

[Prodromitidae ARTHABER, 1911, p. 177] [=Qiannanitidae BECKER, 1993, fig. 7.7]

Suture line changing from relatively simple to highly complex structure; total number of umbilical lobes from 10 to over 50, in some forms irregularly subdivided or denticulate. [Some authors regard this family or some of the genera as belonging to the order Prolecanitida; for discussion,

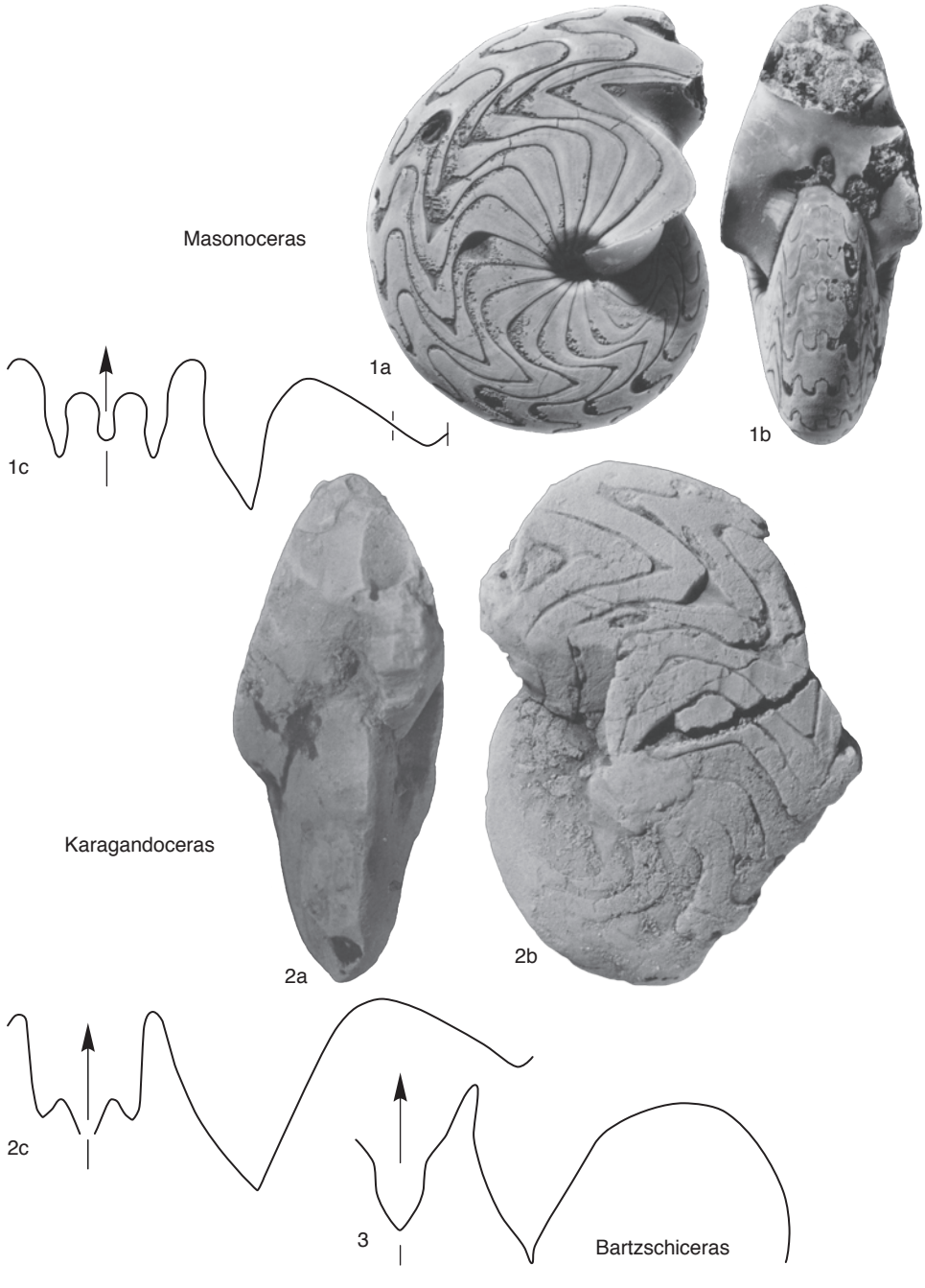

FIG. 6. Karagandoceratidae (p.11).

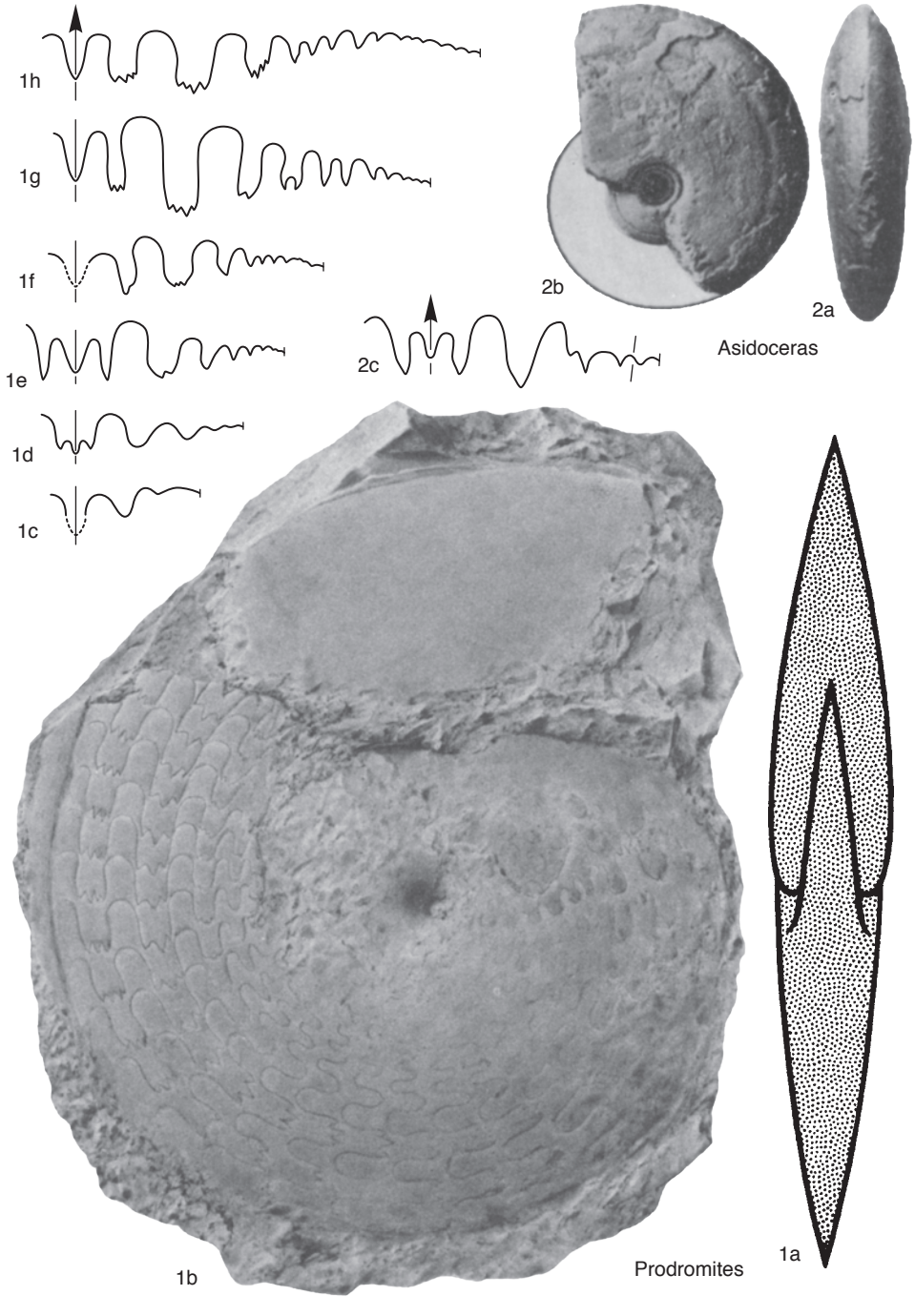

FIG. 7. Prodromitidae (p. 14).

see WORK, MAPES, & THOMPSON, 1988. The family grouping may be artificial; the relationship of genera cannot be proven because of lack of ontogenetic sequences.] *Mississippian (Tournaisian–Serpukhovian [Kinderhookian–Osagean]).*

Prodromites SMITH & WELLER, 1901, p. 255 [**Goniatites gorbyi* MILLER, 1891, p. 90; OD]. Conch thinly lenticular with keeled venter and very small umbilicus. Several lobes adjacent to venter denticulated. Sutural formula: $E_1E_mE_1$?L?U_2...U_1 [German], $V_2V_1V_2UU^1U^2$... [Russian]. One species. [The ontogenetic development of this genus is incompletely known.] *Mississippian (Tournaisian [Kinderhookian–Osagean]):* ?Canada (Alberta), USA (Iowa, Illinois, Indiana, Missouri).——FIG. 7,*1a–h. *P. gorbyi* (MILLER); *a–b,* holotype, Pin Hook bridge, Pettis County, Missouri, Chouteau limestone, Kinderhookian, WMUC 6208, ×1 (Miller, Furnish, & Schindewolf, 1957); *c–h,* ontogeny of sutures, enlarged (Miller & Collinson, 1951).

?Acrocanites SCHINDEWOLF, 1922, p. 15 [**A. multilobatus;* OD]. Conch form similar to *Prodromites*, but with moderately wide umbilicus. Six or seven regular lanceolate lobes on flanks. Two species. [The ontogenetic development of the suture is unknown. WEYER (1972a) assumed a trifid ventral lobe similar to the homeomorphic *Neopharciceras kurbatovi,* with the sutural formula $E_1E_mE_1LU_{2-7}$... (German), $V_2V_1V_2UU^1U^2$.... (Russian).] *Mississippian (middle Tournaisian–upper Tournaisian):* Belgium, Germany, Algeria.——FIG. 8,*3a–b. *A. multilobatus,* holotype, Geodes horizon, Zadelsdorf, Thuringia, Germany, ?middle Tournaisian, Museum Gera; *a*, side view of internal mold, ×3; *b*, suture, ×5 (Schindewolf, 1939b).

?Asidoceras RUZHENTSEV, 1975, p. 37 [**A. nikolaevi* RUZHENTSEV, 1975, p. 38; OD]. Conch form similar to *Qiannanites*, but umbilicus narrow, whorls highly involute. Ventrolateral grooves present, no prominent sculpture. Ventral lobe deeply subdivided, with rather deep median lobe and acute prongs, adjacent lobe acute; saddle between both lobes rounded. Four small acute lobes of different size on dorsal portion of flanks and near umbilicus. One species. [This genus is based on a single specimen of an isolated exposure of Mississippian age. The ontogenetic development of the suture is unknown, and the systematic relationship is uncertain.] *Mississippian (series not specified):* Russia (Kolyma).——FIG. 7,*2a–c. *A. nikolaevi,* holotype, Beresovka River, Kolyma Range, Siberia, PIN 3088/17; *a–b*, ×1.25; *c*, suture, whorl height at 17 mm, ×1.6 (Ruzhentsev, 1975).

Eoprodromites WORK, MAPES, & THOMPSON, 1988, p. 775 [**E. kinderhooki* WORK, MAPES, & THOMPSON, 1988, p. 776; OD].Conch form similar to *Prodromites*, with narrow umbilicus. Early and intermediate stages exhibit dorsolateral plications. Lateral and wide umbilical lobe irregularly subdivided; asymmetric. Sutural formula: $(E_1E_mE_1)$?L?U_2U_1I [German], $(V_2V_1V_2)UU^1$:ID [Russian]. One species. *Mississippian (Tournaisian [Kinderhookian]):* USA (Missouri).——FIG. 8,*1a–d. *E. kinderhooki,* Clarence Cannon Dam, Salt River, north of Perry, Ralls County, Hannibal Shale; *a–c,* topotype, SUI 62420, ×3 (Work & Mapes, 2002); *d,* suture of holotype, SUI 54746, diameter at 29.2 mm and whorl height at 18 mm (Work, Mapes, & Thompson, 1988).

Paraqiannanites KUZINA, 2000, p. 18 [**P. boreus* KUZINA, 2000, p. 19; OD]. Conch discoidal, oxycone, and involute as in *Qiannanites;* umbilicus narrow but open. Ornamentation consisting of thin, closely spaced, irregularly dichotomizing and intercalating ribs. Ventral lobe deeply subdivided, with acute prongs, median saddle almost half as high as entire lobe, with rounded median lobe; first lateral saddle rounded, adventitious lobe deep and acute. Two acute lobes at umbilical wall. Sutural formula: $(E_1E_mE_1)ALU_2$:U_1I [German], $(V_2V_1V_2)$ LU^1:UID [Russian]. One species. [This genus may be related to *Stenocyclus* SCHINDEWOLF; for discussion, see KUZINA, 2000, p. 18.] *Mississippian (upper Tournaisian):* Russia (Pai Khoi).——FIG. 8,*4a–e. **P. boreus,* holotype, Peyakha River, left tributary of the Kara River, Komi region, Slova Formation, Tournaisian-Visean boundary beds, PIN 2775/510; *a–b,* ×1; *c,* ×1.5; *d*, ventral view, ×3; *e*, suture, whorl height at 19 mm, whorl width 9.5 mm, ×7 (Kuzina, 2000).

Qiannanites RUAN, 1981a, p. 133[140] [**Q. acutus* RUAN, 1981a, p. 134; OD]. Conch discoidal, oxycone, involute; umbilicus moderately narrow, aperture rather high. Growth striae and faint ribs slightly biconvex, almost radiate; ribbing dense, with crenistriate denticulation. Ventral lobe deeply subdivided, with acute prongs; first lateral saddle subacute, adventitious lobe acute. Two small umbilical lobes near umbilicus; one rounded at umbilical seam. Sutural formula: $(E_1E_mE_1)$AL?U_2:? [German], $(V_2V_1V_2)$L?U^1?U^2: ? [Russian]. One species. [The ontogenetic development of the suture is unknown, and the systematic relationship of the genus is uncertain.] *Mississippian (lower Tournaisian):* China (Guizhou), ?Poland.——FIG. 8,*2a–c. **Q. acutus,* holotype, Wangyu, Laowapu, Huishui region, Guizhou, China, Wangyu Formation, NIGP 33614; *a–b,* ×1; *c,* suture, reversed, ×1.1 (Ruan, 1981a).

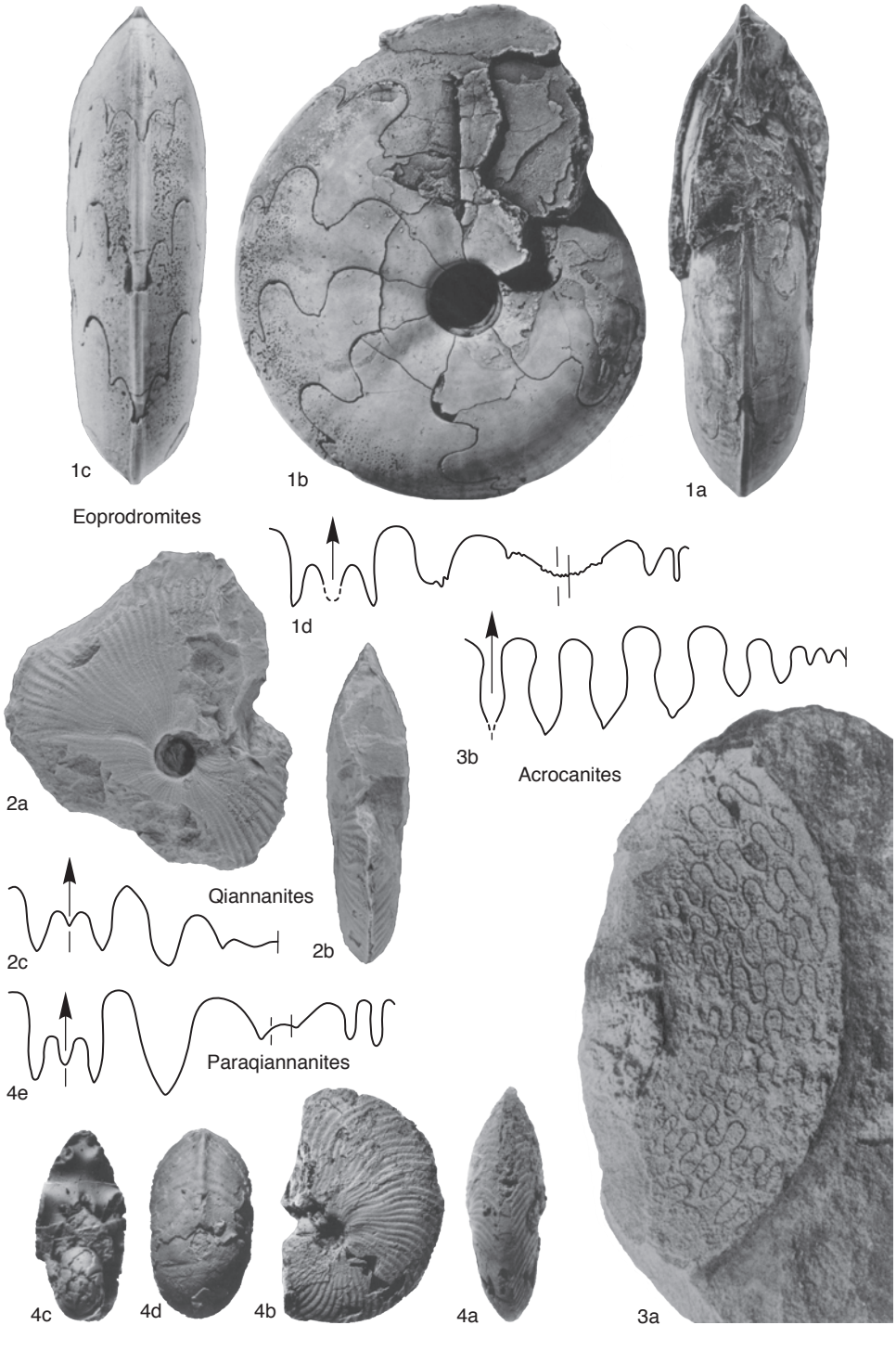

FIG. 8. Prodromitidae (p. 14).

PSEUDOHALORITOIDEA

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 PSEUDOHALORITOIDEA Ruzhentsev, 1957

[*nom. transl.* BECKER & KULLMANN, 1996, p. 738, *ex* Pseudohaloritidae RUZHENTSEV, 1957, p. 57] [=Schouchangoceratacеae ZHAO & ZHENG, 1977, p. 225; =Cheiloceratacеae GLENISTER & FURNISH, 1981, p. 63, *partim*; FREST, GLENISTER, & FURNISH, 1981, p. 8]

Conch small to intermediate sized, very small to closed umbilicus, smooth or with longitudinal lirae or transverse ribs. Mature aperture modified in some forms. Siphuncle usually subcentral or situated within dorsal septal flexure in most ontogenetic stages, but ventral-marginal position in earliest ontogeny suggests common phylogenetic origin within the Goniatitida. External lobes smooth to serrate, sutural formula VLU:ID [Russian], EALUI [German]. Two families, Maximitidae and Pseudohaloritidae, based on position of siphuncle and form of ventral lobe. *Middle Pennsylvanian (Moscovian)–Lopingian (Changhsingian).*

Family MAXIMITIDAE Ruzhentsev, 1960

[Maximitidae RUZHENTSEV, 1960d, p. 197]

Small pseudohaloritoideans characterized by incipiently to weakly bifid ventral lobe and siphuncle close to venter in all but juvenile whorls. Sutural formula: (V_1V_1) LU:ID [Russian], E_1E_1ALUI [German]. *Middle Pennsylvanian (Moscovian)–Upper Pennsylvanian (Kasimovian).*

Maximites MILLER & FURNISH, 1957a, p. 1045 [**Imitoceras cherokeense* MILLER & OWEN, 1939, p. 145; OD]. Conch small (to 1 cm diameter), broadly subdiscoidal, involute, and lacking prominent ornament. Lateral and ventrolateral sinuses in growth lines accentuated near maturity to form ventrolateral lappets. Siphuncle subcentral in juvenile whorls, close to venter subsequently. Ventral lobe superficially bifid, with low median saddle. Five species. [The ontogenetic modification of ventral lobe to a distinctive, rectangular, shallowly bifid form coincided with the migration of the siphuncle from subcentral to subventral and with the crowding of the septa, which may represent the mechanical response to proximity of the siphuncle and the ventral shell.] *Middle Pennsylvanian (Moscovian)–Upper Pennsylvanian (Kasimovian):* USA (Missouri, Oklahoma), Canada (Arctic Archipelago: Ellesmere Island), Ukraine (Donetz Basin), northern China (Ningxia).——FIG. 9*a–e*. **M. cherokeensis* (MILLER & OWEN), lectotype, SUI 13484B, Cherokee Formation, Middle Pennsylvanian, Missouri; *a,* cross section, ×8; *b*, diameter at 4 mm (Miller & Furnish, 1957a); *c–e,* ×8 (Frest, Glenister, & Furnish, 1981).

Family PSEUDOHALORITIDAE Ruzhentsev, 1957

[Pseudohaloritidae RUZHENTSEV, March 1957, p. 57] [=Thalassoceratidae CHAO, 1954, p. 17, *partim*; RUZHENTSEV, 1960d, p. 205; RUZHENTSEV in BOGOSLOVSKII, LIBROVICH, & RUZHENTSEV, 1962, p. 370; =Pseudohaloritidae MILLER & FURNISH, November 1957a, p. 1044, junior synonym and homonym; =Shouchangoceratacеae ZHAO & ZHENG, 1977, p. 225; ZHOU, 1985, p. 182; ZHOU, 1987, p. 301]

Small- to medium-sized pseudohaloritoideans with closed umbilicus and conspicuously modified mature aperture, smooth or with variously developed coarse longitudinal lirae or transverse ribs. Siphuncle usually subcentral or situated within dorsal septal flexure. External lobes smooth to serrate. Sutural formula: VLU:ID [Russian], EALUI [German]. [The three subfamilies are based on the advent and extent of sutural serration. Most genera were endemics of isolated biotopes within a restricted South China Sea. Dimorphism is common, and the family is incompletely analyzed.] *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian).*

Subfamily PSEUDOHALORITINAE Ruzhentsev, 1957

[*nom. transl.* GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236, *ex* Pseudohaloritidae RUZHENTSEV, 1957, p. 57] [=Pseudohaloritidae ZHAO & ZHENG, 1977, p. 233, *partim*; ZHOU, 1985, p. 182; ZHOU, 1987, p. 303]

Pseudohaloritids with serrations restricted to lobe bases. *Cisuralian (Kungurian).*

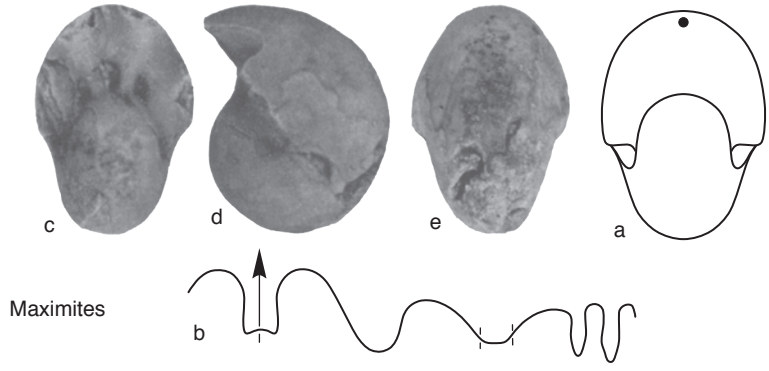

FIG. 9. Maximitidae (p. 16).

Pseudohalorites YABE, 1928, p. 19*, partim*, pl. 6,*1–2;* YABE in YABE & HAYASAKA, 1920, p. 13, *partim*, pl. 19,*16, nom. nud.;* CHAO, 1954, p. 16, *partim*, pl. 6,*13–14,* pl. 7,*1–4* [**P. subglobosus;* OD] [=*Hunanites* CHAO, 1940, p. 71, *partim* (type, *H. hsiehi,* OD)]. Conch moderate size (4 cm maturity), globular to subglobular, umbilicus closed. Juvenile whorls characterized by deeply incised constrictions; transverse ribs only on later whorls, fasciculate to varying degrees. Mature aperture conspicuously modified; ventrolateral salients weak to incipient; ventral sinus broad, shallow. Siphuncle proportionally large (diameter one-fifth to one-third chamber height), retrochoanitic, usually subcentral or situated within dorsal septal flexure but ventral-marginal in first and second whorls. Protoconch large, subdivided by a septum similar to *Tornoceras.* Ventral, lateral, and umbilical lobes serrated; internal lobes smooth. Five species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 10*a–l.* **P. subglobosus,* Chihsian Mudstone; *a–c,* ×1.5 (new); *d–f,* ×2; *g–i,* ×1.5 (Zhou, 1985); *j,* diameter at 23 mm (Miller & Furnish, 1957a); *k,* diameter at 16 mm (new); *l,* diameter at 22 mm (Zhou, 1985).

Zhonglupuceras ZHOU, 1985, p. 188 [**Pseudohalorites celestris* YABE, 1928, p. 21; OD; =*P. celestris* YABE in YABE & HAYASAKA, 1920, p. 13, pl. 19,*17–18, nom. nud.;* =*P. celestris* var. *densistriatus* CHAO, 1954, p. 19 is interpreted as microconch] [=*Hunanites* CHAO, 1940, p. 71, *partim*, pl. 10,*10–16* (type, *H. hsiehi*, OD); =*Zhaolorites* BARTZSCH & WEYER, 1988a, p. 139, obj.]. Similar to *Pseudohalorites* in conch form, but more compressed and lacking constrictions in juvenile stages. Microconch is two-thirds diameter of macroconch, displays extreme modification of mature aperture. Ventral lobe lanceolate or tongue shaped. Four species. *Cisuralian (Kungurian)*: southern China (Hunan), USA (Texas), Oman.——FIG. 11*a–g.* **Z. celestre* (YABE), Chihsian Mudstone, central Hunan; *a–c,* macroconch, ×1.5; *d–f,* microconch, ×1.5; *g,* height at 10 mm, diameter at approximately 18 mm (Zhou, 1985).

Subfamily SHOUCHANGOCERATINAE Zhao & Zheng, 1977

[*nom. transl.* GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236, *ex* Shouchangoceratidae ZHAO & ZHENG, 1977, p. 225]

Pseudohaloritids characterized by smooth lobes. [Genera are differentiated primarily on sculpture.] *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian).*

Shouchangoceras ZHAO & ZHENG, 1977, p. 226 [**S. shouchangense;* OD]. Conch compressed and of moderate size (to 5 cm). Ultimate one-third of mature body chamber flat, forming weakly geniculate lateral profile. Mature aperture conspicuously constricted. Prominent transverse ribs form shallow dorsolateral sinus and deeper rounded sinus on venter; coarse longitudinal lirae produce reticulate sculpture in some growth stages. Siphuncle situated within flexure of dorsal lobe. Five species. [*Shouchangoceras reticulatum* ZHAO & ZHENG may be the macroconch of the type species of *Sangzhanites* (*S. aberrans;* ZHOU & others, 1995, Acta Palaeontologica Sinica 34(5):547, pl. 1,*1–13*).] *Guadalupian:* southern China (Zhejiang, Jiangxi, Jiangsu, Fujian, Hubei, Guangdong), USA (western Texas).——FIG. 12,*1a–b.* **S. shouchangense,* Dingjiashan Formation, western Zhejiang; *a,* ×1; *b,* height at 11 mm, diameter at approximately 20 mm (Zhao & Zheng, 1977).——FIG. 12,*1c–e. S. subglobosum,* Hutang Formation, eastern Jiangxi, ×1 (Zhao & Zheng, 1977).

Aulacaganides ZHOU, 1985, p. 188 [**A. hunanicus;* OD]. Resembles the more common shouchangoceratin *Neoaganides* in conch form; differs in presence of deep ventrolateral sulcus and in long, narrow, angular form of lateral lobe. One species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 12,*2a–c.* **A. hunanicus,* Dangchong Formation;

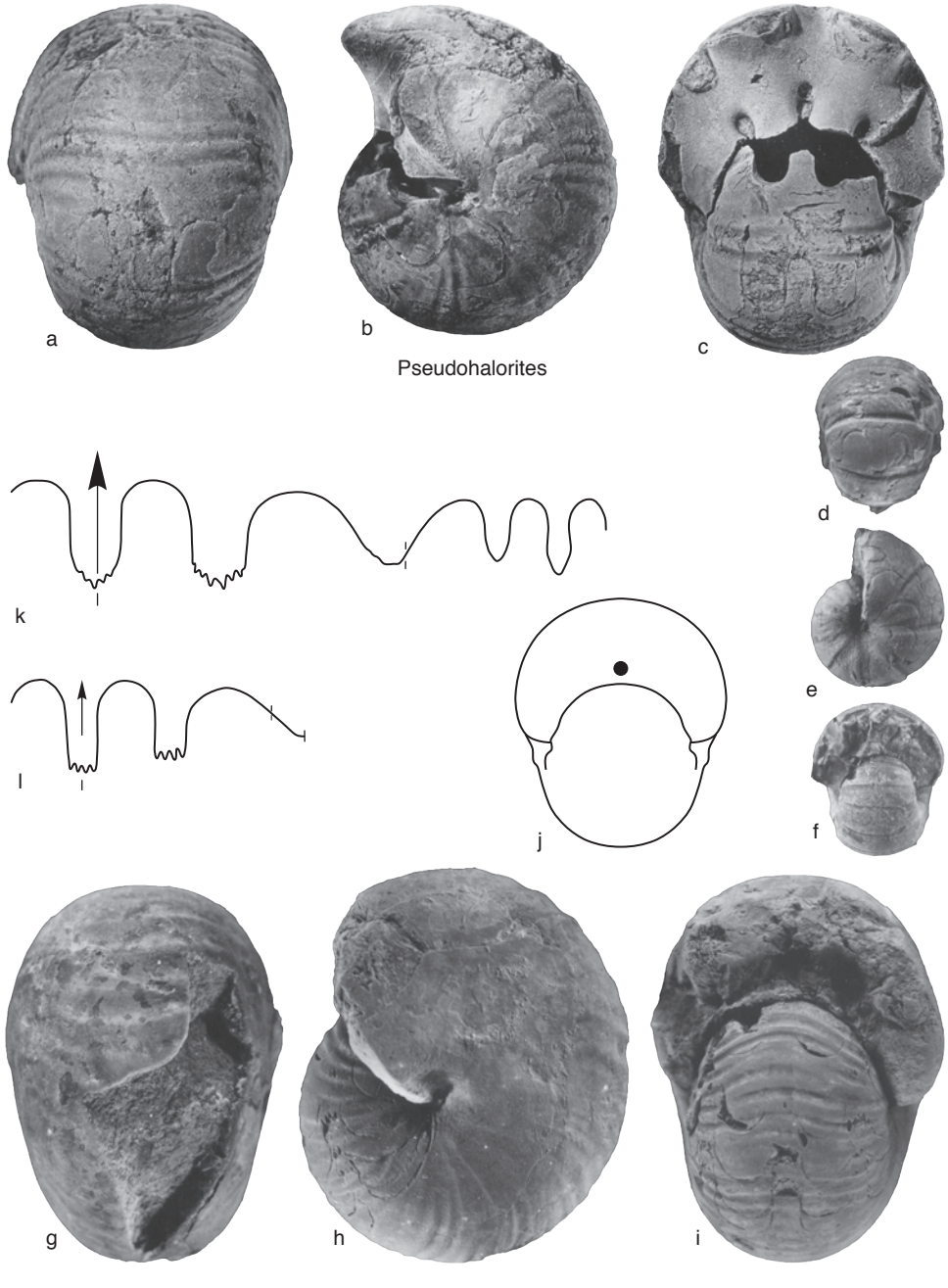

FIG. 10. Pseudohaloritidae (p. 17).

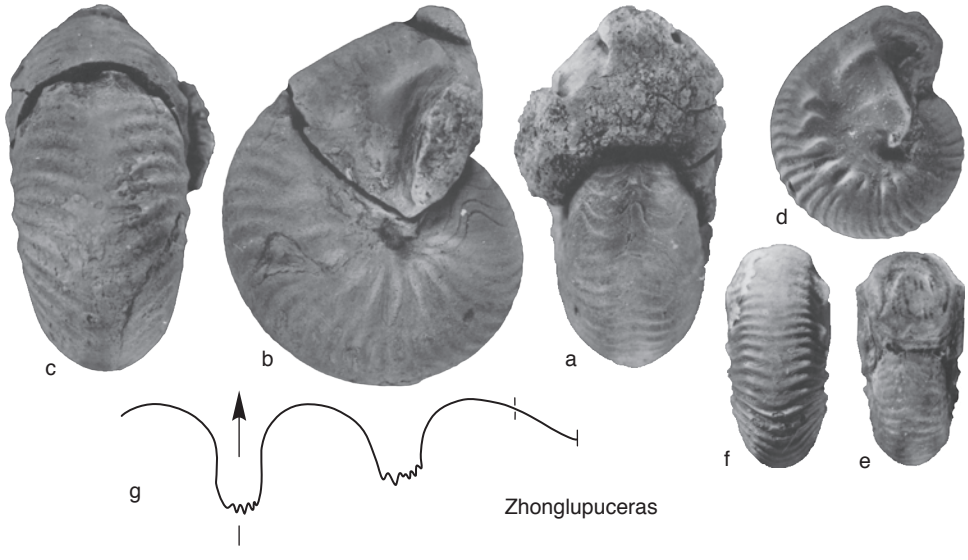

FIG. 11. Pseudohaloritidae (p. 17).

a–b, ×3; *c,* height at 9 mm, diameter approximately 13 mm (Zhou, 1985).

Elephantoceras ZHAO & ZHENG, 1977, p. 232 [**E. spinonodosum;* OD]. Similar to *Erinoceras*, but nodes coarser. Characterized by ventrolateral lappets. Two species. *Guadalupian:* southern China (Zhejiang, Jiangxi).——FIG. 12,*4a–d. *E. spinonodosum,* lower Dingjiashan Formation, western Zhejiang; *a–c*, ×2; *d,* width at 6 mm, diameter approximately 8 mm (Zhao & Zheng, 1977).

Erinoceras ZHAO & ZHENG, 1977, p. 231 [**E. ellipticum;* OD] [?=*Linwuceras* XU in XU & WEI, 1977, p. 559 (type, *L. hunanense,* OD)]. Conch small (to 2 cm) with strongly divergent ventral margin in ultimate one-third of mature body chamber. Strong longitudinal lirae and transverse ribs intersect to produce coarsely nodose surface. External lateral lobe may be distinctively narrow. Two named species may represent dimorphs. *Guadalupian:* southern China (Zhejiang, Hunan, ?Guangdong).——FIG. 12,*3a–d. *E. ellipticum,* Dingjiashan Formation, western Zhejiang; *a–c*, ×2; *d*, height at 6 mm, diameter approximately 10 mm (Zhao & Zheng, 1977).

Lianyuanoceras ZHOU, 1985, p. 187 [**L. shenjiachongense;* OD]. Discoidal shouchangoceratins characterized by combination of fine growth lines and longitudinal lirae in early growth stages, and coarse transverse ribs with weak longitudinal lirae in late stages. All lobes rounded. One species. *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 12,*5a–c. *L. shenjiachongense,* Chihsian Mudstone; *a–b,* ×1.5; *c,* height at 8 mm, diameter approximately 14 mm (Zhou, 1985).

Neoaganides PLUMMER & SCOTT, 1937, p. 350 [**N. grahamensis;* OD]. Conch subdiscoidal to subglobular; mature diameter commonly 1–2 cm, but Cisuralian forms may exceed 5 cm. Lacking coarse ribs; growth lines form shallow reentrant on flanks and deeper sinus on venter. Siphuncle subcentral, ventrad of dorsal septal flexure. Many species. *Upper Pennsylvanian (Kasimovian)–Lopingian (Changhsingian):* USA (Texas, Oklahoma, Kansas, Iowa, Ohio), Southern Urals, northern Iran, southern China (Hunan, Jiangxi, Hubei).——FIG. 13,*1a–d. *N. grahamensis,* Virgilian, Texas; *a–c*, ×5.5 (Frest, Glenister, & Furnish, 1981); *d*, diameter at 3 mm (Miller & Furnish, 1957a).

Qinglongites ZHENG, 1981, p. 108 [**Q. curvatus;* OD]. Similar to *Sosioceras* in conch form and mature modifications; Runzelschicht also comparable, but with longitudinal lineation. V-shaped ventral lobe is unknown in other pseudohaloritids. Four species. *Lopingian (Changhsingian):* southern China (Guizhou).——FIG. 14,*1a–d. *Q. curvatus*, Dalong Formation; *a–c,* ×1.5; *d,* diameter at 17.5 mm (Zheng, 1981).

Sangzhites ZHAO & ZHENG, 1977, p. 230 [**S. aberrans;* OD]. Conch globular, intermediate in size (3 cm); both longitudinal lirae and transverse ribs are coarse, ribs being particularly prominent on ultimate volution. Mature aperture has pair of dorsolateral lappets and longer pair in ventrolateral position. Suture and siphuncle as in *Shouchangoceras.* Two

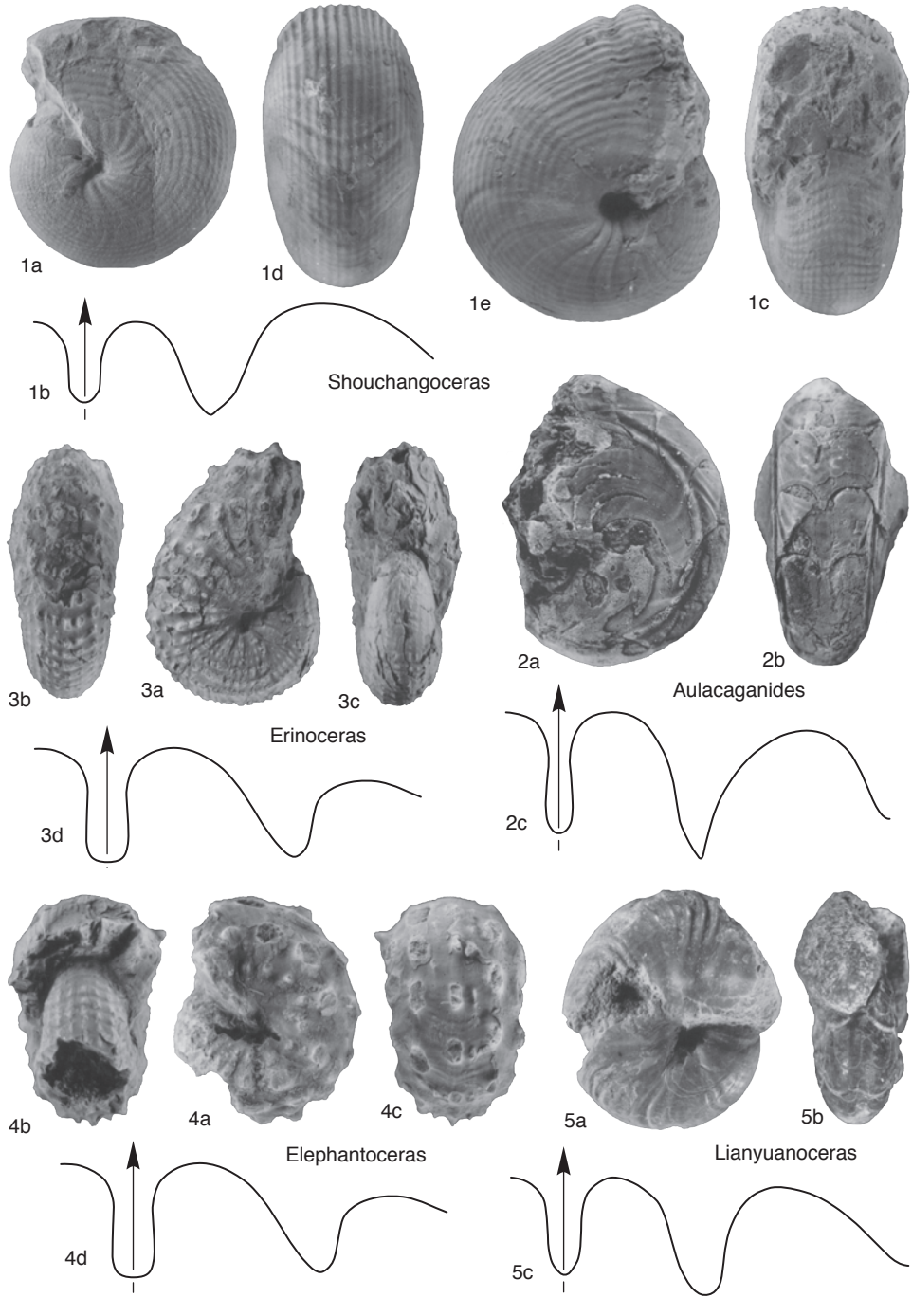

FIG. 12. Pseudohaloritidae (p. 17–19).

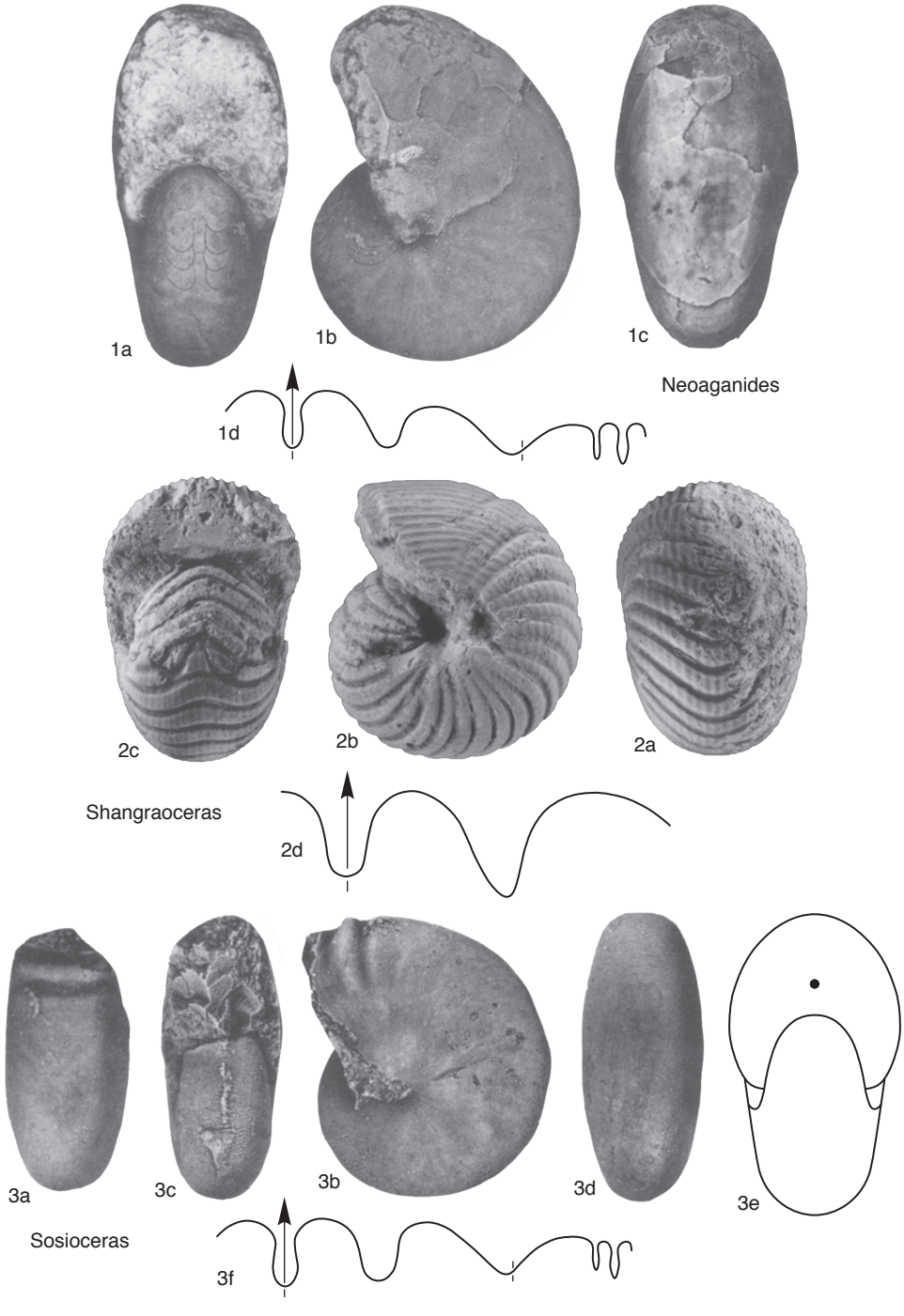

FIG. 13. Pseudohaloritidae (p. 19–22).

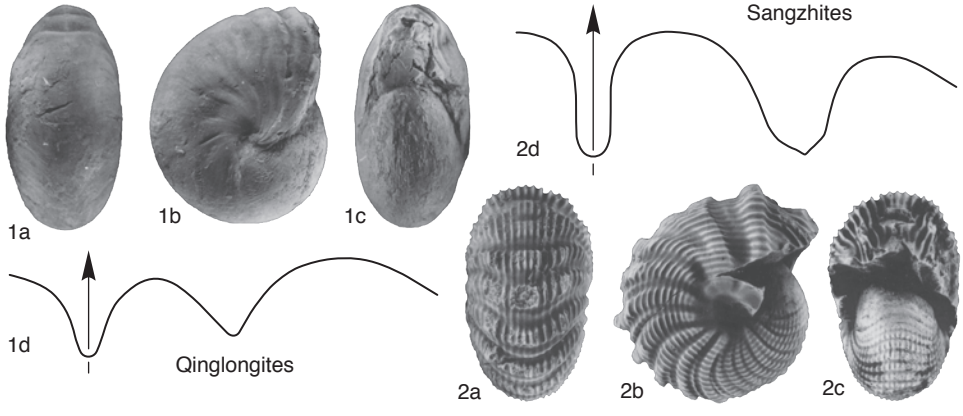

FIG. 14. Pseudohaloritidae (p. 19–22).

species. *Guadalupian:* southern China (Zhejiang, Hunan).——FIG. 14,*2a–d. *S. aberrans,* Maokou Formation, northwestern Hunan; *a–c,* ×1; *d,* height at 8 mm, diameter approximately 14 mm (Zhao & Zheng, 1977).

Shangraoceras ZHAO & ZHENG, 1977, p. 227 [**S. robustum;* OD]. Similar to *Shouchangoceras* in conch form and suture, but perhaps distinguishable by more prominent and wide transverse ribs (wider, flatter tops). Two named species may represent dimorphs. *Guadalupian:* southern China (Jiangxi, Zhejiang, Hunan).——FIG. 13,*2a–d. *S. robustum,* Hutang Formation, eastern Jiangxi; *a–c,* ×1; *d,* diameter approximately 26 mm (Zhao & Zheng, 1977).

Sosioceras FREST, GLENISTER, & FURNISH, 1981, p. 26 [**Brancoceras pygmaeum* GEMMELLARO, 1888, p. 26; OD]. Diminutive, subdiscoidal shouchangoceratins, less than 2 cm conch diameter; mature modifications comprise prominent double constrictions near aperture, and flat venter in body chamber. Dorsal Runzelschicht commonly displays raised axial ridge. One species. *Guadalupian (Wordian):* Italy (Sicily).——FIG. 13,*3a–f. *S. pygmaeum* (GEMMELLARO), Sosio limestone; *a–d,* ×4 (Frest, Glenister, & Furnish, 1981); *e,* diameter at 6 mm; *f,* diameter at 5 mm (Miller & Furnish, 1957a).

Subfamily YINOCERATINAE Ruzhentsev, 1960

[Yinoceratinae RUZHENTSEV, 1960d, p. 207] [=Lanceoloboceratidae CHAO in ZHAO & ZHENG, 1977, p. 234; ZHOU, 1979, p. 391; =Lanceolobocerati nae GLENISTER, NASSICHUK, & FURNISH, 1979, p. 236; FREST, GLENISTER, & FURNISH, 1981, p. 41; ZHOU, 1985, p. 183, 194; ZHOU, 1987, p. 303]

Pseudohaloritids characterized by total serration of all lobes and saddles in external suture. [Component taxa appear to display extreme intraspecific variation in both strength of sculpture and degree of serration of sutural elements, but existing collections do not permit confident taxonomic analysis.] *Cisuralian (Kungurian)–Guadalupian.*

Yinoceras CHAO, 1954, p. 19 [**Y. lenticulare;* OD] [=*Shaoyangoceras* ZHOU, 1979, p. 390 (type, *S. jiangjiachongense,* OD); FREST, GLENISTER, & FURNISH, 1981, p. 42; ZHOU, GLENISTER, & FURNISH, 2002, p. 428]. Conch subglobular, characterized by strong transverse ribs that trace shallow ventral sinus; longitudinal sculpture variable but inconspicuous. Digitation of sutural elements highly irregular and variable. Three species. [The lenticular shape of the monotype of *Y. lenticulare* is considered to be a result of preservational deformation. Illustrated external sutures (Fig. 15,*2d–e*) differ in details of serration. Such differences are due partly to preservation but also reflect extreme intraspecific variation.] *Cisuralian (Kungurian):* southern China (Hunan).——FIG. 15,*2a–e. *Y. lenticulare,* Chihsia Mudstone, Dangchong Formation; *a–c,* ×2 (Zhou, 1979); *d,* diameter at 17 mm; *e,* NIGP 7156, diameter at 10 mm (adapted from Chao, 1954).

Lanceoloboceras CHAO in ZHAO & ZHENG, 1977, p. 234 (CHAO, 1957 (ms), *nom. nud.*) [**L. reticulatum;* OD]. Similar to *Yinoceras* in conch form, but ribs forming deeper ventral sinus; ribs and lirae subequal in size, producing subdued reticulate sculpture. Serration of suture more regular than in *Yinoceras* and ventral lobe broader. One species. *Guadalupian:* southern China (Sichuan).——FIG. 15,*1a–d. *L. reticulatum,* ?Maokou Formation; *a–c,* ×1; *d,* diameter at 43 mm (Zhao & Zheng, 1977).

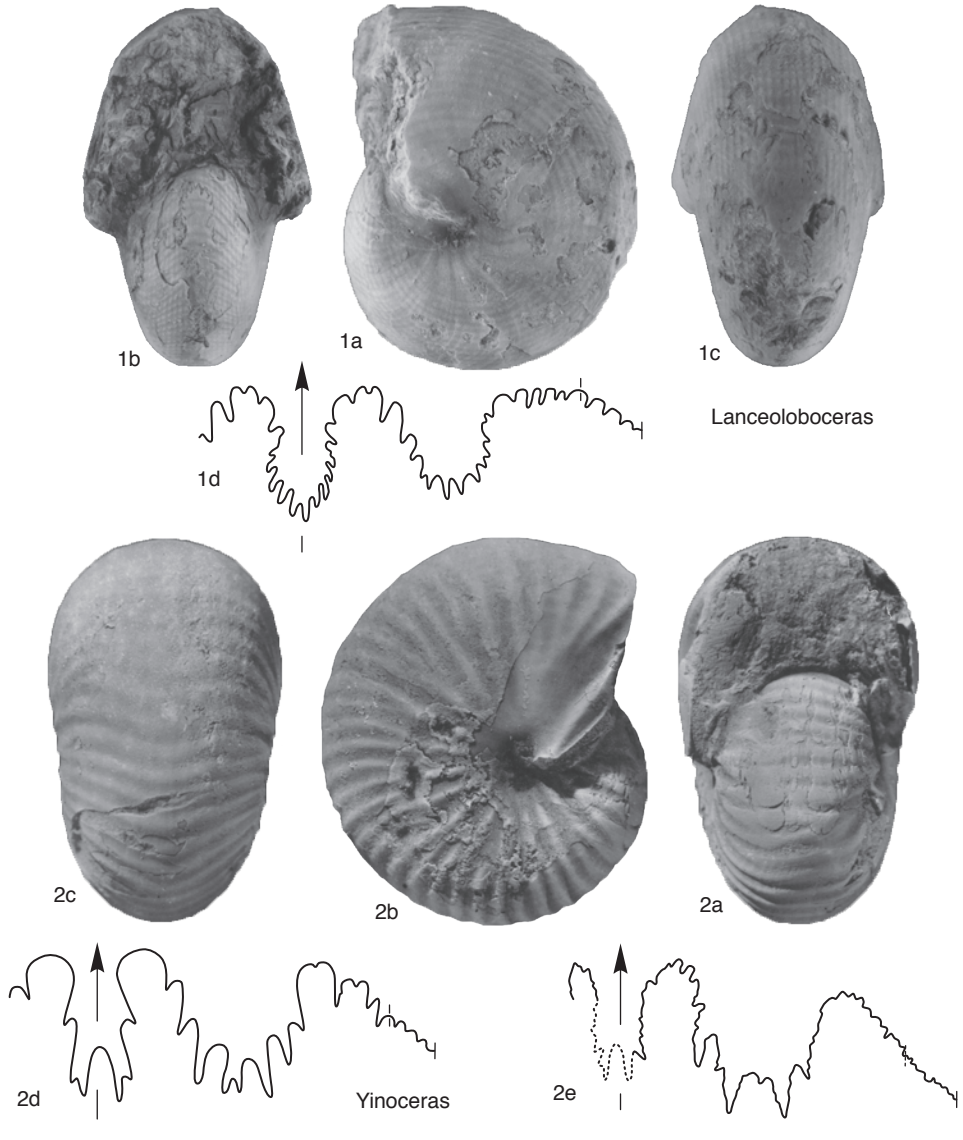

FIG. 15. Pseudohaloritidae (p. 22).

Suborder GONIATITINA Hyatt, 1884

[*nom. correct.* Miller & Furnish, 1954, p. 687, *pro* Goniatitinae Hyatt, 1884 in 1883–1884, p. 307]

Conch form in general thickly discoidal to globular, rarely lenticular or oxycone. Ventral lobe subdivided by median saddle usually embracing a small median lobe. Basic sutural formula ($E_1E_mE_1$)AL:UI [German], (V_1V_1)LU:ID [Russian]; advanced genera with extremely complicated subdivision, mainly of adventitious, lateral, or umbilical lobes. Derived from Prionoceratidae or Karagandoceratidae. *Mississippian (Tournaisian [upper Kinderhookian])–Lopingian (Wuchiapingian).*

PERICYCLOIDEA

Jürgen Kullmann

[University of Tübingen, Germany]

Superfamily PERICYCLOIDEA Hyatt, 1900

[*nom. transl.* Ruzhentsev, 1960d, p. 200, *ex* Pericyclidae Hyatt, 1900, p. 551]

Conch shape variable. Shell surface smooth or with faint or prominent transverse sculpture; constrictions may be present. Ventral lobe commonly narrow or moderately wide, median saddle relatively low. Adventitious lobe on ventrolateral portion of flanks; lateral lobe usually smaller than other lobes. Sutural formula: ($E_1E_mE_1$)AL:UI [German], (V_1V_1)LU:ID] [Russian]. *Mississippian (Tournaisian–Serpukhovian [upper Kinderhookian–upper Chesterian]).*

Family PERICYCLIDAE Hyatt, 1900

[Pericyclidae Hyatt, 1900, p. 551]

With prominent transverse sculpture; some species with spiral ornamentation or tubercles. Ornament highly variable, ranging from fine to coarse ribs. Ventral lobe with parallel or orad diverging sides. First lateral saddle rounded or subacute, but rarely acute; lateral lobe acute. [The phylogenetic relationship of this family is uncertain and may be an artificial grouping.] *Mississippian (Tournaisian–lower Visean [Kinderhookian–Osagean]).*

Subfamily PERICYCLINAE Hyatt, 1900

[*nom. transl.* Miller, Furnish, & Schindewolf, 1957, p. 58, *ex* Pericyclidae Hyatt, 1900, p. 551]

Ventral lobe with subparallel, parallel, or convergent sides. First lateral saddle broad and rounded. *Mississippian (Tournaisian–lower Visean [Kinderhookian–Osagean]).*

Pericyclus Mojsisovics, 1882, p. 141 [**Goniatites princeps* de Koninck, 1844, p. 579; SD Hyatt, 1884 in 1883–1884, p. 330] [=*Trapezopericyclus* Turner, 1948, p. 51 (type, *Pericyclus trapezoidalis* Crick, 1899, p. 432, OD); for discussion, see Schindewolf, 1951b, p. 306]. Conch form discoidal to thickly discoidal with narrow to wide umbilicus. Sculpture consisting of prominent simple or (rarely) dichotomous ribs, split close to umbilicus; one species with spiral ornamentation. Ventral lobe with parallel sides and low median saddle; first lateral saddle broadly rounded. Six species, one questionable. [For discussion about this genus, see Turner, 1948, p. 50; Schindewolf, 1951a, p. 77; Gordon, 1965, p. 174.] *Mississippian (upper Tournaisian):* Belgium, Great Britain, Ireland, Russia (Komi, South Urals), Algeria, Morocco, China (Xinjiang), USA (Arkansas).——Fig. 16,*1a–c.* **P. princeps* (de Koninck), holotype, Calcaire de Calonne, Vaulx, Belgium, upper Tournaisian; *a–b,* ×1.5; *c*, suture, magnification not stated (Delépine, 1940).——Fig. 16,*1d. P. latumbilicatus* Kuzina, holotype, Silova-Yakha River, Pai-Khoy, Silova Formation, upper Tournaisian, PIN 2775/501, suture at 7 mm whorl height, 8 mm whorl width, ×10 (Kuzina, 2000).

Asiacyclus Librovich in Bogoslovskii, Librovich, & Ruzhentsev, 1962, p. 366 [**Pericyclus asiaticus* Librovich, 1940, p. 122; OD]. Conch form narrowly umbilicate. Sculpture consisting of

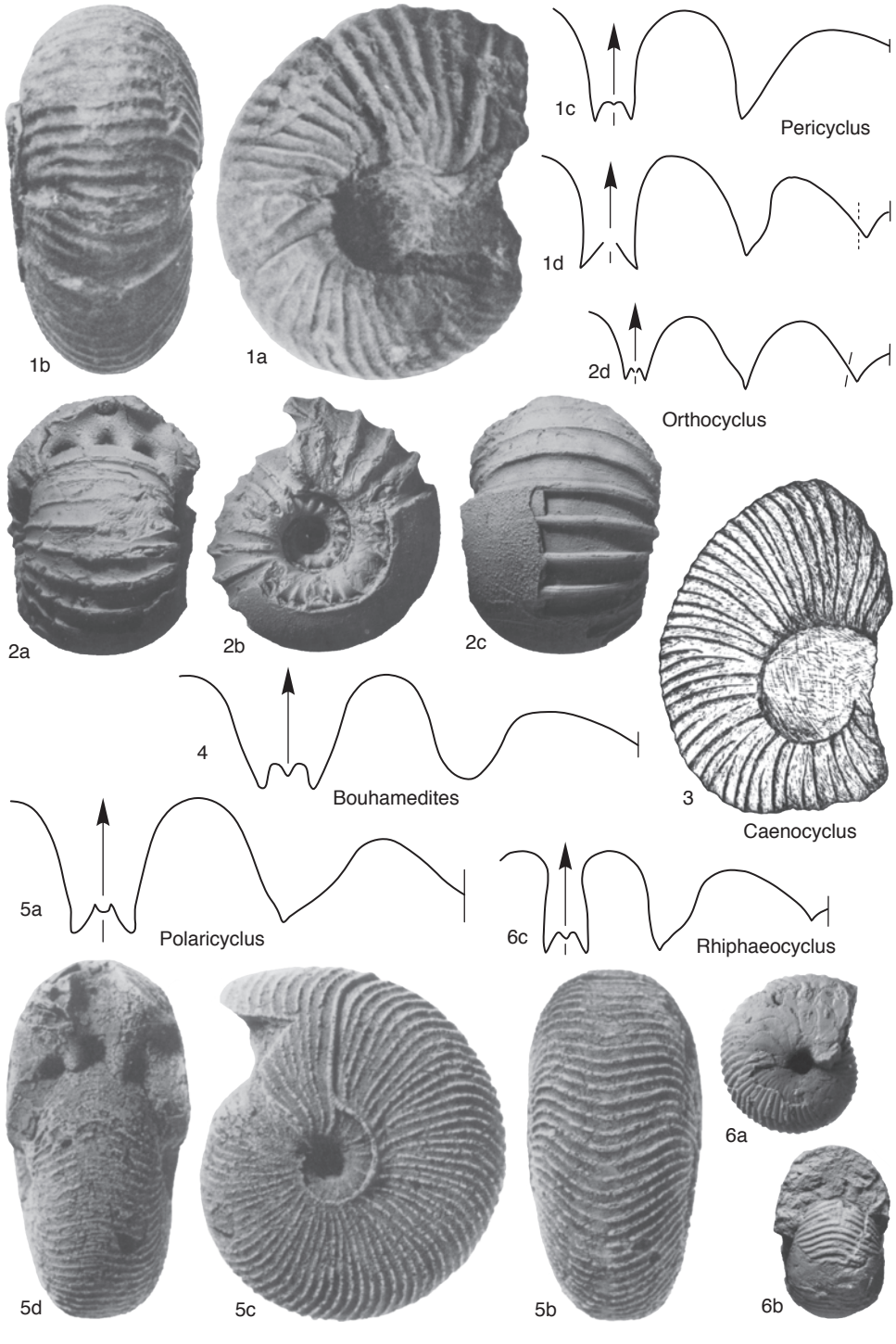

FIG. 16. Pericyclidae (p. 24–28).

many faint simple ribs, sometimes dichotomizing. Constrictions and faint spiral ornamentation may be present. Suture as in *Pericyclus*. Nine species. *Mississippian (upper Tournaisian):* Great Britain, Ireland, Kazakhstan (Karaganda).——Fig. 17,*7. *A. asiaticus* (Librovich), holotype, River Malenki Chiderty, Kazakhstan, CNIGR 92/5450, ×1 (Librovich, 1940).

?Bouhamedites Korn & others, 2003, p. 86 [**B. enigmaticus* Korn & others, 2003, p. 87; OD]. Conch thickly discoidal, with almost closed umbilicus. Ornament with about 80 smooth riblets forming a shallow lateral and deeper sinus across venter. Adventitious lobe rounded. One species. [The type species, the only known specimen and being less than 10 mm in diameter, may represent a juvenile specimen of unknown affinity.] *Mississippian (Tournaisian):* Morocco.——Fig. 16,*4. *B. enigmaticus,* holotype, Taouz, Jebel Ouaoufilal, east of Ksar Bouhamed, Tafilalt, Oued Znaïgui Formation, MB C.3987, suture at 8.9 mm diameter, whorl height 4.9 mm, whorl width 5.6 mm, ×7.8 (Korn & others, 2003).

?Caenocyclus Schindewolf, 1922, p. 17 [**Pericyclus (Caenocyclus) perisphinctoides* Schindewolf, 1922, p. 16; M]. Conch form discoidal, with wide umbilicus. Sculpture with prominent polyschizotomous ribs. Suture unknown. One species. [Only the poorly preserved holotype of the type species is known; assignment to the family is uncertain, and the genus may be a junior synonym of *Pericyclus* or *Ammonellipsites*.] *Mississippian (?middle Tournaisian):* Germany.——Fig. 16,*3. *C. perisphinctoides*, holotype, Geodes horizon, Zadelsdorf, Thuringia, ×1 (Schindewolf, 1926b).

Goniocycloides Work & Nassichuk in Work, Nassichuk, & Richards, 2000, p. 35 [**G. ochakensis;* OD]. Conch form and ornamentation as in *Goniocyclus,* but ventral lobe attenuate and with relatively high median saddle reaching about one-third of its entire length. First lateral saddle asymmetric and narrowly rounded. One species. *Mississippian (upper Tournaisian [middle Osagean]):* Canada (British Columbia).——Fig. 17,*4a–c. *G. ochakensis,* holotype, eastern side of Ochak Mountain, east-central British Columbia, Mount Head Formation, GSC 103185; *a–b*, ×2.5; *c*, paratype, suture, GSC 103187, diameter at 16 mm (Work, Nassichuk, & Richards, 2000).

Goniocyclus Gordon, 1986, p. 21 [**Goniatites blairi* Miller & Gurley, 1896, p. 35; OD] [=*Nematocyclus* Gordon, 1986, p. 28, *nom. nud.* (type, *Pericyclus (Goniocyclus) filaris* Gordon, 1986, p. 26, M)]. Conch form discoidal, ventral side broadly or narrowly rounded, umbilicus usually wide. Ribs rursiradiate, bending backward on outer flanks and meeting in acute or slightly obtuse angle. Spiral ornamentation in some species; no constrictions. Suture as in *Pericyclus,* with very low ventral lobe and concave-outward sides. Many species. [For discussion about this genus, see Work, 2002, p. 187.] *Mississippian (middle Tournaisian):* Germany, Portugal, Morocco, Russia (Moscow Basin, South Urals), USA (Idaho, Missouri, Montana, New Mexico, Nevada).——Fig. 17,*1a–d. *G. blairi* (Miller & Gurley), Alamo Peak, about 7.9 km southeast of Alamogordo, Otero County, New Mexico, Caballero Formation, middle Kinderhookian, USNM 377536; *a–c*, ×2; *d*, suture at 6 mm whorl height, ×7.8 (Gordon, 1986).

Hammatocyclus Schindewolf, 1951a, p. 81 [**Pericyclus (Hammatocyclus) homoceratoides* Schindewolf, 1951a, p. 82; OD]. Similar to *Pericyclus*, conch form thickly discoidal, with moderately wide umbilicus. Sculpture in early stages with nodes and small ribs on umbilical margin, later smooth; constrictions may be present. Six species. *Mississippian (middle Tournaisian–lower Visean [Osagean]):* Belgium, Great Britain, Germany, Russia (North Urals), Algeria, USA (Montana, ?Utah).——Fig. 17,*3. *H. homoceratoides*, suture of holotype, reversed, Erdbach limestone, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, upper Tournaisian, Collection Fuhrmann, Clausthal, ×2.1 (Schindewolf, 1951a).

Neopericyclus Popov, 1965b, p. 45 [**N. kokdzharensis* Popov, 1965b, p. 46; OD]. Similar to *Ammonellipsites*, but with ornamentation consisting of faint polyschizotomous ribs, which split close to umbilicus. Four species. *Mississippian (upper Tournaisian):* France, Germany, Ireland, Algeria, Morocco, Kyrgyzstan (Tian Shan).——Fig. 17,*2a–b. *N. kokdzharensis*, holotype, Kok-Dzhar River, Tian Shan, Kyrgyzstan, Akchetash Formation, IG ANK 2766/86, ×1 (Popov, 1968).——Fig. 17,*2c. N. hauchecornei* (Holzapfel), suture, Erdbach limestone, Iberg, Harz Mountains, Germany, Collection Fuhrmann, Clausthal, reversed, ×1.1 (Schindewolf, 1951a).

Orthocyclus Kuzina, 2000, p. 21 [**Ammonellipsites ? raricostatus* Kuzina, 1980, p. 71; OD]. Conch form subglobular, with low aperture; umbilicus moderately wide. Straight coarse ribbing widely spaced. Ventral lobe has a very low median saddle and lobe with roundly diverging sides. First lateral saddle broadly rounded, adventitious lobe moderately deep and at tip narrowly rounded. Two species. *Mississippian (upper Tournaisian):* Russia (Komi, South Urals).——Fig. 16,*2a–d. *O. raricostatus* (Kuzina), holotype, Silova-Iakha River, Pai-Khoy, Silova Formation, PIN 2775/198; *a–c,* ×1.5; *d,* suture at 8.4 mm whorl height and whorl width 18.1, ×2.4 (Kuzina, 2000).

Parahammatocyclus Riley, 1996, p. 78 [**P. chaigleyensis;* OD]. Similar to *Hammatocyclus*, but tubercles restricted to early and middle growth stages. Ventral lobe with divergent sides; first lateral saddle rounded and deep. One species. *Mississippian (lower Visean):* Great Britain.——Fig. 17,*5. *P. chaigleyensis,* suture, reversed image, Hodder Mudstone Formation, Arundian, BGS RH1631, at 3.5 mm whorl height, 5.8 mm whorl width (Riley, 1996).

Polaricyclus Riley, 1990b, p. 139 [**Fascipericyclus polaris* Gordon, 1957, p. 33; OD]. Conch form similar to *Ammonellipsites*, pachyconic, with narrow umbilicus. Sculpture with prominent simple or

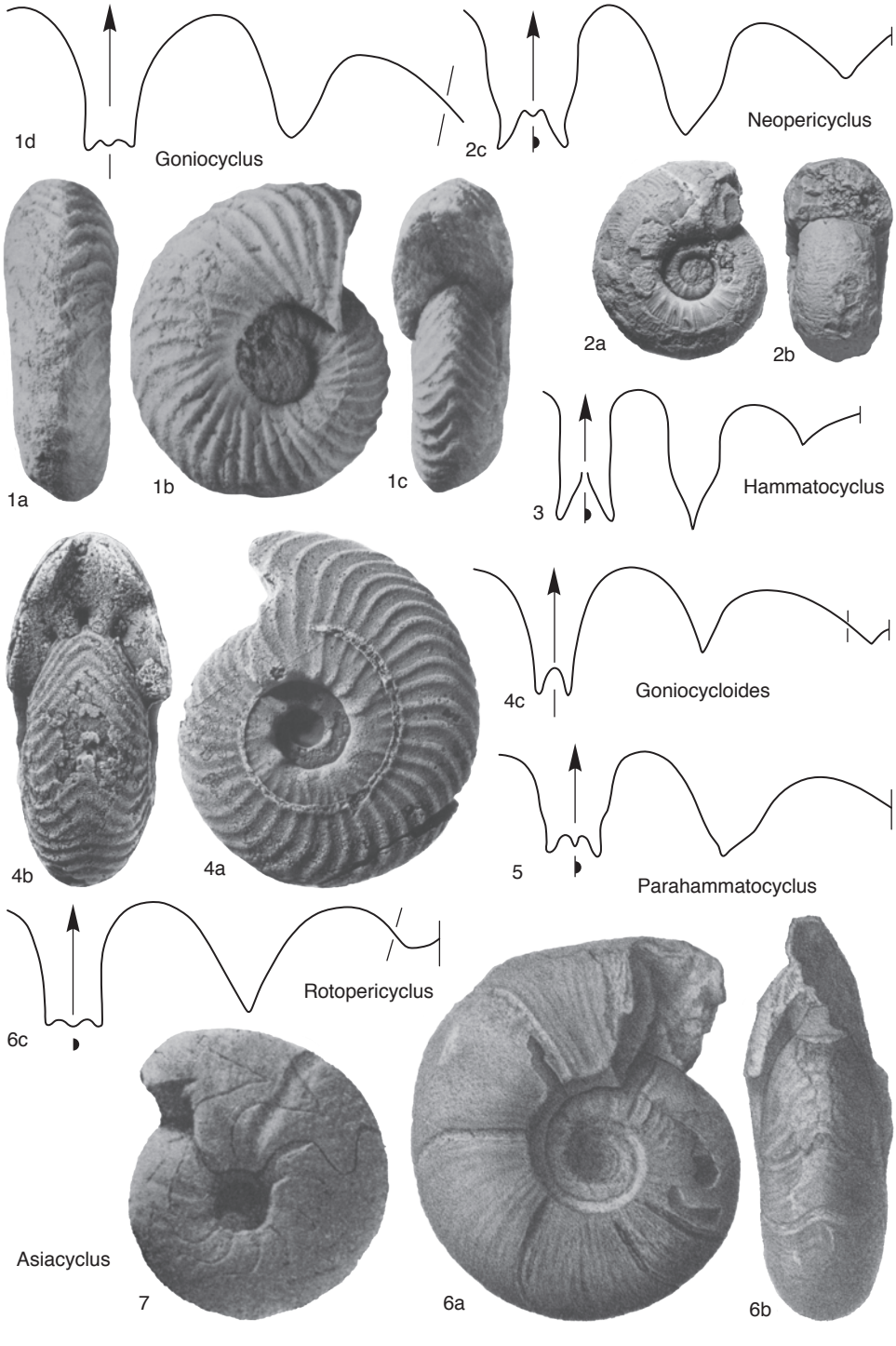

FIG. 17. Pericyclidae (p. 24–28).

dichotomous ribs. Ventral lobe with orad diverging sides, median saddle low; first lateral saddle broadly rounded. Five species. *Mississippian (upper Tournaisian–lower Visean [Osagean]):* Great Britain, Russia (South Urals); Canada (British Columbia), USA (Alaska, Kansas), *lower Visean.*——Fig. 16,*5a. *P. polaris* (Gordon), suture, Kiligwa River, De Long Mountains, Brooks Range, northern Alaska, Kuna Formation, middle or upper Osagean, USNM 118953, enlarged, diameter at about 16 mm (Work, Nassichuk, & Richards, 2000).——Fig. 16,*5b–d. P. canadensis* Work & Nassichuk in Work, Nassichuk, & Richards, Ochak Mountain, British Columbia, Canada, lower Head Formation, lower Visean, ×2.5 (Work, Nassichuk, & Richards, 2000).

Rhiphaeocyclus Kuzina, 1973, p. 23 [**R. mutabilis;* OD]. Conch form globular at early growth stages, at maturity discoidal; involute, umbilicus very narrow, later closed. Distinct ribs at immature stages, smooth at maturity. Suture similar to *Pericyclus;* ventral lobe at orad part slightly narrowing, first lateral saddle broadly rounded, and lateral lobes wide. One species. *Mississippian (upper Tournaisian):* ?Ireland, Russia (North Urals).——Fig. 16,*6a–c. *R. mutabilis,* Kozhim River, Kos'vin Formation, North Urals, Russia; *a–b,* paratype, PIN 2775/105, ×1.5; *c*, holotype, suture, PIN 2775/101, whorl height at 14.2 mm, whorl width 13.2 mm, ×2.3 (Kuzina, 1973).

Rotopericyclus Turner, 1948, p. 50 [**Pericyclus rotuliformis* Crick, 1899, p. 434; OD]. Similar to *Hammatocyclus*, but with narrow umbilicus and prominent ribs on later stages. Small tubercles may be at edge of umbilicus. Ventral lobe with vertical and parallel flanks. Four species, one questionable. *Mississippian (middle Tournaisian–lower Visean [upper Kinderhookian]):* Belgium, Great Britain, Ireland, Algeria, Morocco, Kyrgyzstan (Tian Shan), USA (Idaho, Nevada).——Fig. 17,*6a–b. *R. rotuliformis* (Crick), Mississippian Limestone, upper Tournaisian, Ireland, ×0.7 (Foord, 1903).——Fig. 17,*6c. R. pinyonensis* Gordon, suture, whorl height at 5.8 mm, reversed, Chainman Shale, middle Canyon Formation, Elko County, Nevada, ×5.6 (Gordon, 1986).

Subfamily AMMONELLIPSITINAE Riley, 1996

[Ammonellipsitinae Riley, 1996, p. 69]

Early growth stage widely umbilicate. Ventral lobe with divergent sides. First lateral saddle subacute or acute. *Mississippian (upper Tournaisian–lower Visean [Osagean]).*

Ammonellipsites Parkinson, 1822, p. 164 [**Ellipsolites funatus* Sowerby, 1814, p. 81; SD Schindewolf, 1951b, p. 309] [=*Kaypericyclus* Turner, 1948, p. 51 (type, *Pericyclus kayseri* Schmidt, 1925, p. 554, OD); =*Eurycyclus* Schindewolf, 1951a, p. 86 (type, *Pericyclus kochi* Holzapfel, 1889, p. 35, OD); for extensive discussion see Schindewolf, 1951b, p. 308; Gordon, 1965, p. 172]. Conch form thickly discoidal to globular, with wide or moderately narrow umbilicus. Sculpture with prominent, usually simple ribs; constrictions may be present. Ventral lobe with diverging sides, median saddle elevated to a fourth or a third of entire ventral lobe. First lateral saddle narrowly rounded or subacute. Many species. [No suitable illustrations of the type species are available.] *Mississippian (upper Tournaisian–lowermost Visean [Osagean]):* France, Germany, Ireland, Poland, Russia (North Urals), Spain, Algeria, Morocco, China (Xizang), Kyrgyzstan (Tian Shan), Australia (New South Wales), USA (Kansas).——Fig. 18,*4a–c. A. kochi* (Holzapfel); *a–b,* Liebstein, Erdbach limestone, Rhenish Massif, Germany, upper Tournaisian, ×1 (Holzapfel, 1889); *c,* suture, Casa de la Vega formation, Guadalmez, Sierra Morena, Spain, upper Tournaisian, MGUV 7564, ×2.4 (Pardo Alonso & Kullmann, 2002).

Fascipericyclus Turner, 1948, p. 50 [**Goniatites fasciculatus* McCoy, 1844, p. 13; OD] [=*Schizocyclus* Schindewolf, 1951a, p. 78, obj.]. Sculpture with prominent dichotomous ribs. Ventral lobe with diverging sides, median saddle low. First lateral saddle subacute or acute. Two species. *Mississippian (upper Tournaisian):* Belgium, Great Britain, France, Ireland, Morocco, Kyrgyzstan (Tian Shan), Russia (South Urals).——Fig. 18,*5a–b. *F. fasciculatus* (McCoy), Les Pauquys, north of Waulsort, Calcaire Waulsortien, Belgium, ×1 (Delépine, 1940).

Helicocyclus Schindewolf, 1951a, p. 79 [**Pericyclus (Helicocyclus) gracillimus;* OD]. Conch form discoidal, mostly with wide umbilicus. Sculpture consisting of faint, densely spaced, usually unsplit ribs, crossing flanks and venter radially; no umbilical nodes. Growth lines linear, with weak ventral salient. Ventral lobe with subparallel and slightly sinuous sides, in some species somewhat divergent. Four species. *Mississippian (upper Tournaisian–lower Visean):* Germany, Morocco, *upper Tournaisian;* Great Britain, Russia (North Urals), Kyrgyzstan (Tian Shan), *lower Visean.*——Fig. 18,*3a–b. *H. gracillimus,* holotype, Iberg-Winterberg, Bad Grund, Harz Mountains, Germany, Erdbach limestone, upper Tournaisian, Collection Fuhrmann, Clausthal; *a,* ×4.5 (Schindewolf, 1951a); *b,* suture, ×9 (Schindewolf, 1951a).

Stenocyclus Schindewolf, 1951a, p. 78 [**Pericyclus (Pericyclus) carinatus* Schindewolf, 1926b, p. 81; OD]. Conch form discoidal, with narrow umbilicus, sometimes with keeled venter. Sculpture consisting of faint, regular dichotomous ribs. Ventral lobe with sides diverging orad; first lateral saddle narrowly rounded. Four species. [The type species may be regarded as a juvenile form of *Paraqiannanites;* for discussion, see Kuzina, 2000, p. 18.] *Mississippian (upper Tournaisian–lower Visean):* Belgium, Great Britain, France, Germany, Russia (South Urals), Kyrgyzstan (Tian Shan).——Fig. 18,*1a–c. *S. carinatus* (Schindewolf), holotype, Zadelsdorf, Geodes horizon, Thuringia,

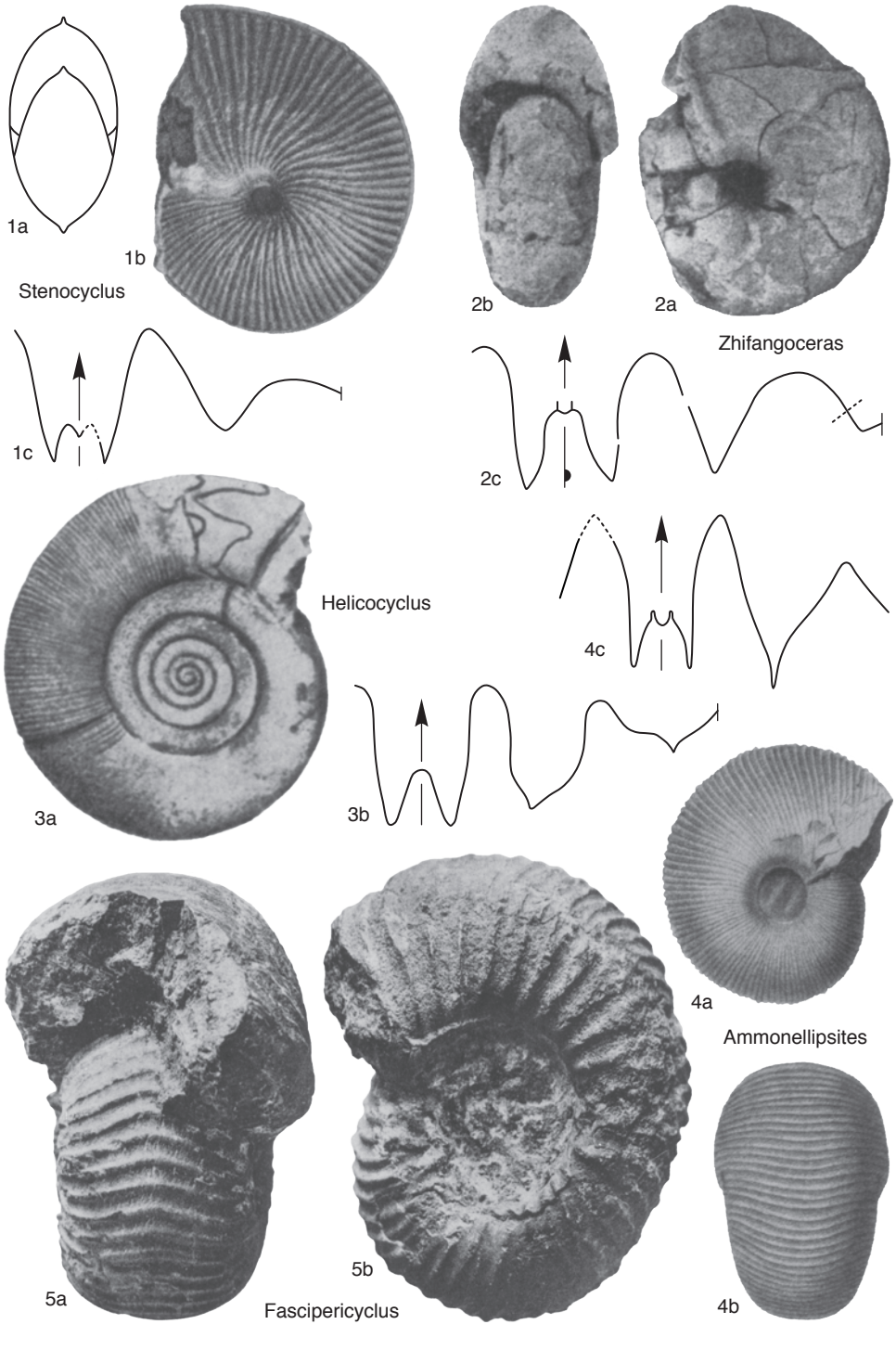

FIG. 18. Pericyclidae (p. 28–30).

Germany, ?middle Tournaisian; *a,* outline of ventral side, ×3 (Schindewolf, 1926b); *b,* side view, ×3.75 (Schindewolf, 1939b); *c,* suture, magnification not stated (Schindewolf, 1926b).

?Zhifangoceras SHENG, 1984, p. 288 [**Z. subglobosum;* OD]. Conch form subdiscoidal, with narrow umbilicus. Surface smooth or with weak and wide ribs or faint wrinkles on living chamber; spiral ornamentation may be present. Suture goniatitic: ventral lobe relatively wide, with apicad acute prongs and median saddle usually less than half as high as entire lobe; ventrolateral saddle acute, subacute, or subangular. Adventitious lobe subtriangular, with almost straight sides. Four species. [The phylogenetic relationship is uncertain; this genus may represent a link between Pericyclidae and Goniatitidae or may even belong to the superfamily Goniatitoidea.] *Mississippian (upper Tournaisian–lower Visean):* China (Xinjiang).——FIG. 18,*2a–b. *Z. subglobosum,* holotype, Donggulu Spring, Zhifang area, East Junggar, Donggulubasitao Formation, upper Tournaisian, no.C3043, ×1 (Sheng, 1984).——FIG. 18,*2c. Z. zhifangense* SHENG, holotype, suture, reversed image, Donggulu Spring, Zhifang area, East Junggar, Donggulubasitao Formation, upper Tournaisian, no.C3045, whorl height at 16.8 mm, whorl width 18.8 mm, ×2.7 (Sheng, 1984).

Family INTOCERATIDAE Kuzina, 1971

[Intoceratidae KUZINA, 1971, p. 39]

Conch form discoidal, involute, with narrow umbilicus; ventral side may be oxycone. Ornamentation consisting of distinct growth lines, rarely with weak lirae in ventrolateral area. Ventral portion of suture primitive; ventral lobe with diverging sides, at its base very narrow, bifid, or with small median lobe. First lateral saddle broadly rounded and wide. Adventitious lobe rounded, in some genera rather small. *Mississippian (middle Tournaisian–lower Visean).*

Intoceras KUZINA, 1971, p. 39 [**I. uralense* KUZINA, 1971, p. 40; OD]. Conch discoidal, small; umbilicus narrow. Growth lines form broad and moderately deep ventral sinus. Constrictions may be present. Ventral lobe extremely narrow at its base; median saddle low, without incision. Adventitious lobe rounded. Five species. *Mississippian (upper Tournaisian–lower Visean):* Russia (North Urals).——FIG. 19,*4a–c. *I. uralense*, holotype, right bank of Kozhim River, Kos'vin Formation, upper Tournaisian, PIN 2775/106; *a–b,* ×1.5; *c,* suture, whorl height at 8 mm, whorl width 8.5 mm, ×2.5 (Kuzina, 1971).

Aquilonites KUZINA, 1974, p. 23 [**A. angustilobatus;* OD]. Conch form discoidal, involute, with very narrow umbilicus. Ornamentation consisting of biconvex growth lines, sometimes with weak lirae. Ventral lobe very narrow, with straight, almost parallel, or slightly sigmoidal sides; adventitious lobe short and broadly rounded. Two species. [This genus may not belong to Intoceratidae because of its advanced suture.] *Mississippian (middle Tournaisian–lower Visean):* Russia (North Urals).——FIG. 19,*2a–c. *A. angustilobatus,* holotype, Kozhim River, Komi, Kos'vin Formation, upper Tournaisian, PIN 2775/190; *a–b*, ×1; *c,* suture, whorl height at 9 mm ,whorl width 9.5 mm (Kuzina, 1974).

Oxintoceras KUZINA, 1974, p. 28 [**O. thaumastum;* OD]. Conch form discoidal, oxycone, involute, with very narrow umbilicus. Ventral lobe extremely wide, with widely diverging sides; median saddle broad, with small median lobe. Adventitious lobe very small and rounded. One species. [Only the holotype is known for this genus.] *Mississippian (lower Visean):* Russia (North Urals).——FIG. 19,*3a–d. *O. thaumastum,* holotype, Kozhim River, Komi, Nortnich Formation, PIN 2775/188; *a–b,* ×1; *c,* outline of last whorl, ×0.9; *d,* suture, whorl height at 25.5 mm, whorl width 10.0 mm, ×3.4 (Kuzina, 1974).

Quasintoceras KUZINA, 1974, p. 25 [**Q. bogoslovskyi* KUZINA, 1974, p. 27; OD]. Conch form discoidal, small, involute, with very narrow umbilicus. Growth lines biconvex. Ventral lobe with extremely diverging sides. Adventitious lobe small, rounded, much less deep than ventral lobe. Two species. *Mississippian (lower Visean):* Russia (North Urals).——FIG. 19,*1a–c. *Q. bogoslovskyi*, holotype, Kozhim River, Komi, Nortnich Formation, PIN 2775/187; *a–b,* ×1.5; *c,* suture, whorl height at 11 mm, whorl width 7.8 mm, ×8.3 (Kuzina, 1974).

Family MUENSTEROCERATIDAE Librovich, 1957

[*nom. transl. et correct.* RUZHENTSEV, 1957, p. 57, *ex* Münsteroceratinae LIBROVICH, 1957, p. 263] [=Kozhimitidae KUZINA, 1974, p. 19; =Furnishoceratidae WORK & NASSICHUK in WORK, NASSICHUK, & RICHARDS, 2000, p. 46]

Conch form discoidal to thickly discoidal, involute, mostly with narrow to closed umbilicus. No prominent sculpture, in general linear to biconvex, simple, rarely crenistriate growth lines, sometimes combined with faint spiral ornamentation. Ventral lobe commonly with parallel or subparallel sides, rarely orad diverging; median lobe and saddle low. First lateral saddle usually rounded, sometimes subacute. [Kozhimitidae was erected for genera with conch form and sculpture similar to Girtyoceratidae but with muensteroceratid sutures. Furnishoceratidae is based on the character of the first lateral lobe, which is unusually

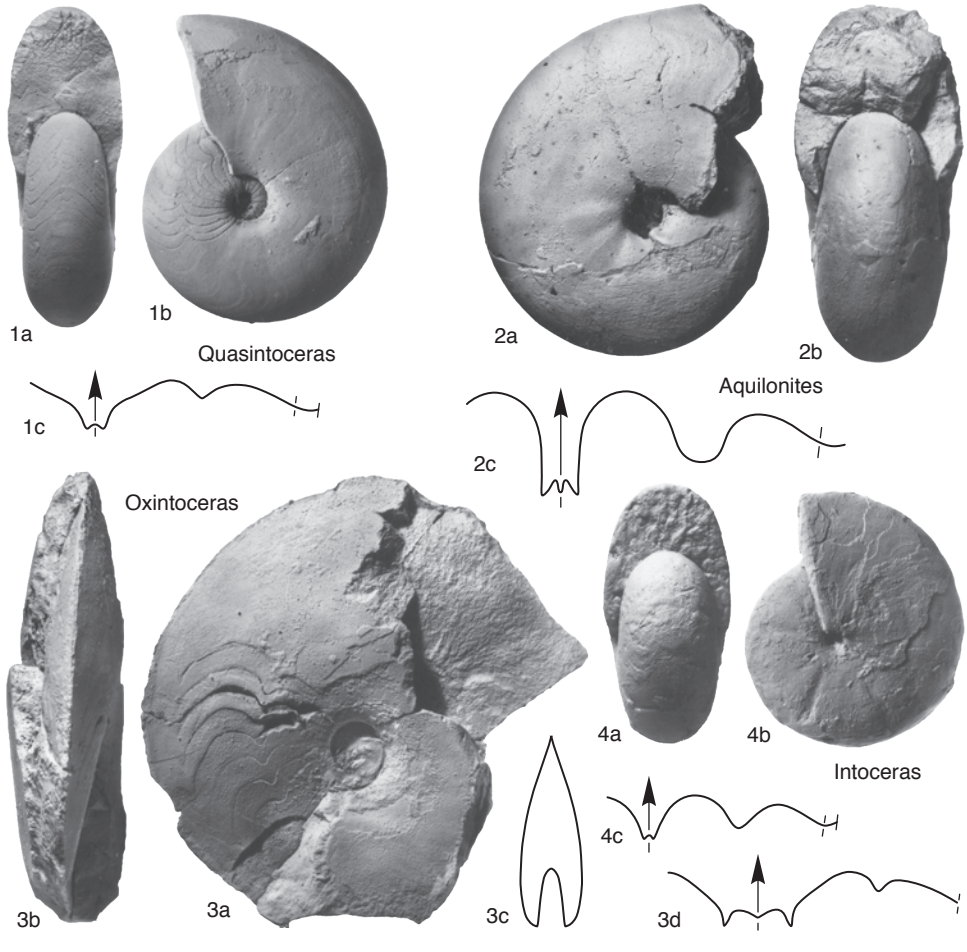

FIG. 19. Intoceratidae (p. 30).

deep and fanglike.] *Mississippian (middle Tournaisian–Serpukhovian [Kinderhookian–Chesterian]).*

Muensteroceras HYATT, 1884 in 1883–1884, p. 326 [**Goniatites Oweni* var. *parallela* HALL, 1860, p. 101; OD] [=*Pronannites* HAUG, 1898, p. 40 (type, *Goniatites inconstans* DE KONINCK, 1880, p. 120, OD, *non* PHILLIPS, 1841, p. 123, =*Muensteroceras koninckianum* SCHINDEWOLF, 1951a, p. 64, *nom. subst.*); =*Karakoramoceras* MILLER, 1931, p. 422 (type, *K. stoliczkai* MILLER, 1931, p. 423, OD); for discussion, see KULLMANN, 1961, p. 258]. Conch form discoidal to thickly discoidal; umbilicus moderately wide to narrow. Growth lines weak to strong, mostly biconvex and with ventrolateral salient. No coarse ornamentation. Ventral lobe narrow or moderately wide, its sides being more or less parallel; median saddle low, median lobe small. Many species, several species poorly known. *Mississippian (middle Tournaisian–lower Visean [Kinderhookian–Osagean]):* Russia (South Urals, North Urals), Kazakhstan (Karaganda), Belgium, Great Britain, Germany, Ireland, ?France, Spain, Algeria, Morocco, Poland, Kazakhstan, Kyrgyzstan (Tian Shan), China (Xinjiang), India (?Kashmir), Australia (New South Wales), USA (Arkansas, Alaska, Illinois, Indiana, ?Iowa, Kentucky, Michigan, Missouri, Virginia).——FIG. 20,*2a–d.* **M. parallelum* (HALL), Rockford, Jackson County, Indiana, Rockford limestone, Osagean; *a–c,* ×1 (Miller, Furnish, & Schindewolf, 1957); *d,* suture, based on small specimen, ×1.5 (Miller & Collinson, 1951; redrawn from Smith, 1903).

Beyrichoceratoides BISAT, 1924, p. 88 [**Goniatites implicatus* PHILLIPS, 1836, p. 235; OD] [?=*Eoglyphioceras* BRÜNING, 1923a, p. 264 (type, *Goniatites truncatus* PHILLIPS, 1836, p. 234, SD KORN, 1988b, p. 39)]. Conch form discoidal, with extremely narrow umbilicus. Growth lines noncrenulate,

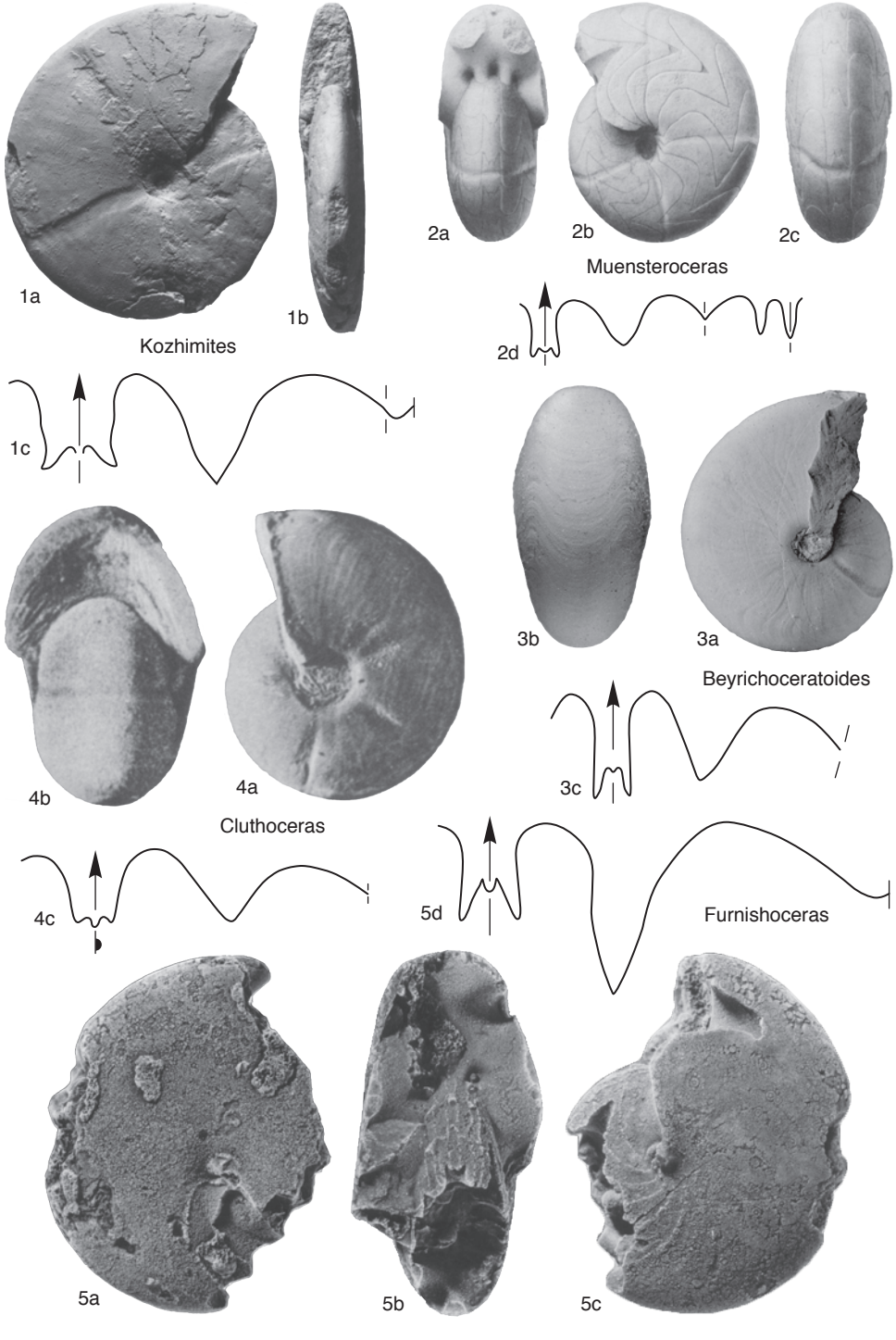

FIG. 20. Muensteroceratidae (p. 31–34).

biconvex, usually fine, with well-developed ventrolateral salient and deep hyponomic sinus; no spiral ornamentation. Constrictions may be present. Ventral lobe relatively narrow, with parallel, straight sides, and moderately low median saddle. First lateral saddle broadly rounded; adventitious lobe deep, almost symmetrical. Eight species. [Some authors regard *Eoglyphioceras* Brüning, 1923b, as being valid, instead of *Beyrichoceratoides* Bisat, 1924. Both genera were established on the basis of identical characteristics and arguments, naming the same species group (*truncatus* and *implicatus*) as being typical for the genus. Brüning (1923b) proposed to replace *Beyrichoceras* and *Muensteroceras* as an amalgamation of the former genera by erecting *Eoglyphioceras* with an unclear diagnosis; for discussion, see Ruzhentsev & Bogoslovskaia, 1971, p. 120; Riley, 1996, p. 31; S. V. Nikolaeva, personal communication, 2004.] *Mississippian (upper Tournaisian–upper Visean):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Poland, Bulgaria, Algeria, Morocco, Russia (North Urals), USA (Kentucky).——Fig. 20,*3a–c. *B. implicatus* (Phillips), Oese, Rhenish Massif, Germany, lower *Goniatites* Zone, upper Visean, WMN 10009; *a–b,* ×2; *c,* suture of holotype *B. truncatus* Phillips, BMNH C240a, Bolland, Yorkshire, England, whorl height at 14.6 mm, ×1.6 (Korn, 1988b).

Cluthoceras Currie, 1954, p. 560 [**C. truemani;* OD]. Conch form small, ellipsoidal, with narrow umbilicus. Ornamentation with faint spirals. Constrictions present. Suture line primitive; sides of ventral lobe subparallel at its base, orad roundly diverging. Median lobe and saddle inconspicuous. More than ten species. [The phylogenetic relationship of *Cluthoceras* is uncertain. Some species may be based on juvenile specimens.] *Mississippian (upper Visean–Serpukhovian):* Great Britain, Poland, Algeria, China (Ningxia, Gansu), USA (Arkansas, Oklahoma).——Fig. 20,*4a–c. *C. truemani*, holotype, Index Limestone Shales, Scotland, *Eumorphoceras* Zone, Serpukhovian; *a–b*, Bishopbriggs, GLAHM 11161, ×3; *c*, suture, reversed, Kirkintilloch, GLAHM 11251, enlarged (Currie, 1954).

Dzhaprakoceras Popov, 1965a, p. 140 [**Muensteroceras tianshanicum* Librovich, 1927, p. 33; OD] [=*Muensteroceratoides* Popov, 1965b, p. 36 (type, *M. aksuensis* Popov, 1965b, p. 37, OD); =*Ouaoufilalites* Korn & others, 2003, p. 83 (type, *O. ouaoufilalensis* Korn & others, 2003, p. 84, OD)]. Conch form discoidal, rarely thickly discoidal, with narrow or very narrow umbilicus. Growth lines fine and biconvex, no spiral ornamentation; constrictions present in several species. Ventral lobe relatively wide, with subparallel or lyrately bent sides, orad slightly narrowed. Adventitious lobe somewhat pouched, pointed, usually larger than ventral lobe. More than ten species. [*Dzhaprakoceras* was placed in the family Maxigoniatitidae by Korn, Klug, and Mapes (1999, p. 348) because of the sinuous shape of the ventral lobe. *Muensteroceratoides* differs in minute details of the shape of the ventral lobe and strength of the growth striae. *Ouaoufilalites* exhibits a ventral lobe with slightly divergent sides and higher median lobe, regarded herein as being of specific significance.] *Mississippian (upper Tournaisian–lower Visean):* Great Britain, Ireland, Germany, Belgium, Russia (Novaia Zemlia, North Urals), Spain, Algeria, Morocco, China (Xinjiang, Yunnan), Mongolia, Iran, Kyrgyzstan (Tian Shan), USA (Arkansas, Kansas, Utah), Canada (British Columbia).——Fig. 21,*1a–c. *D. tianshanicum* (Librovich), upper Tournaisian; *a–b*, Kok-Dzhar, Eastern Moldo-Too, Reef Limestone, Tian Shan, Kyrgyzstan, VSEGEI 2789/86, ×1 (Popov, 1968); *c,* suture, Kaindy-Kardaly River, Dzhapry Formation, VSEGEI 2679/212, whorl height at 14 mm, whorl width 19 mm, enlarged, magnification not stated (Popov, 1968).

Eurites Kuzina, 1973, p. 21 [**E. latus* Kuzina, 1973, p. 22; OD]. Conch form thickly discoidal, with moderately narrow or wide umbilicus; adult whorl width exceeding two-thirds diameter. Ornamentation and suture line similar to *Muensteroceras.* More than ten species. *Mississippian (upper Tournaisian–lower Visean):* Belgium, Germany, Ireland, Wales, Portugal, Spain, Morocco, Algeria, Russia (North Urals), Canada, USA (Alaska).——Fig. 21,*2a. *E. latus,* suture of holotype, Kara River, North Urals, Russia, Kara Formation, upper Tournaisian, PIN 2775/167, whorl height at 11.8 mm, whorl width 28.6 mm, ×1.8 (Kuzina, 1980).——Fig. 21,*2b. E. corpulentissimus* (Schindewolf), Iberg-Winterberg, Bad Grund, Harz Mountains, Erdbach Limestone, Germany, lower Visean, Collection Fuhrmann, Clausthal, ×1.1 (Schindewolf, 1951a).

Furnishoceras Work & Nassichuk in Work, Nassichuk, & Richards, 2000, p. 46 [**F. heterolobatum;* OD]. Conch form subdiscoidal, with closed umbilicus and rounded venter; no constrictions. Ventral lobe with parallel flanks; median saddle almost half as high as entire lobe, prongs bluntly pointed. Ventrolateral saddle broadly rounded. First lateral lobe asymmetric and exceptionally deep, narrowly acuminate; umbilical lobe rounded. One species. *Mississippian (lower Visean [middle Osagean]):* Canada.——Fig. 20,*5a–d. *F. heterolobatum*; *a–c*, holotype, Mount Head Formation, east-central British Columbia, GSC 103227, ×3; *d*, paratype, suture, GSC 103232, diameter at 17 mm, magnification not stated (Work, Nassichuk, & Richards, 2000).

Itimaites Korn & Ebbighausen in Klug & others, 2006, p. 14 [**I. parabolicus* Korn & Ebbighausen in Klug & others, 2006, p. 15; OD]. Juvenile stage of conch pachycone with wide umbilicus, adult stage subdiscoidal with narrow umbilicus. Suture with broadly rounded ventrolateral saddle, median saddle reaching half height of entire ventral lobe, and asymmetric adventitious lobe. One species. [This genus is closely related to *Xinjiangites* and may be its junior synonym.] *Mississippian (?upper Visean):* Morocco.——Fig. 21,*4. *I. parabolicus*, holotype, Zrigat formation, southeastern Tafilalt,

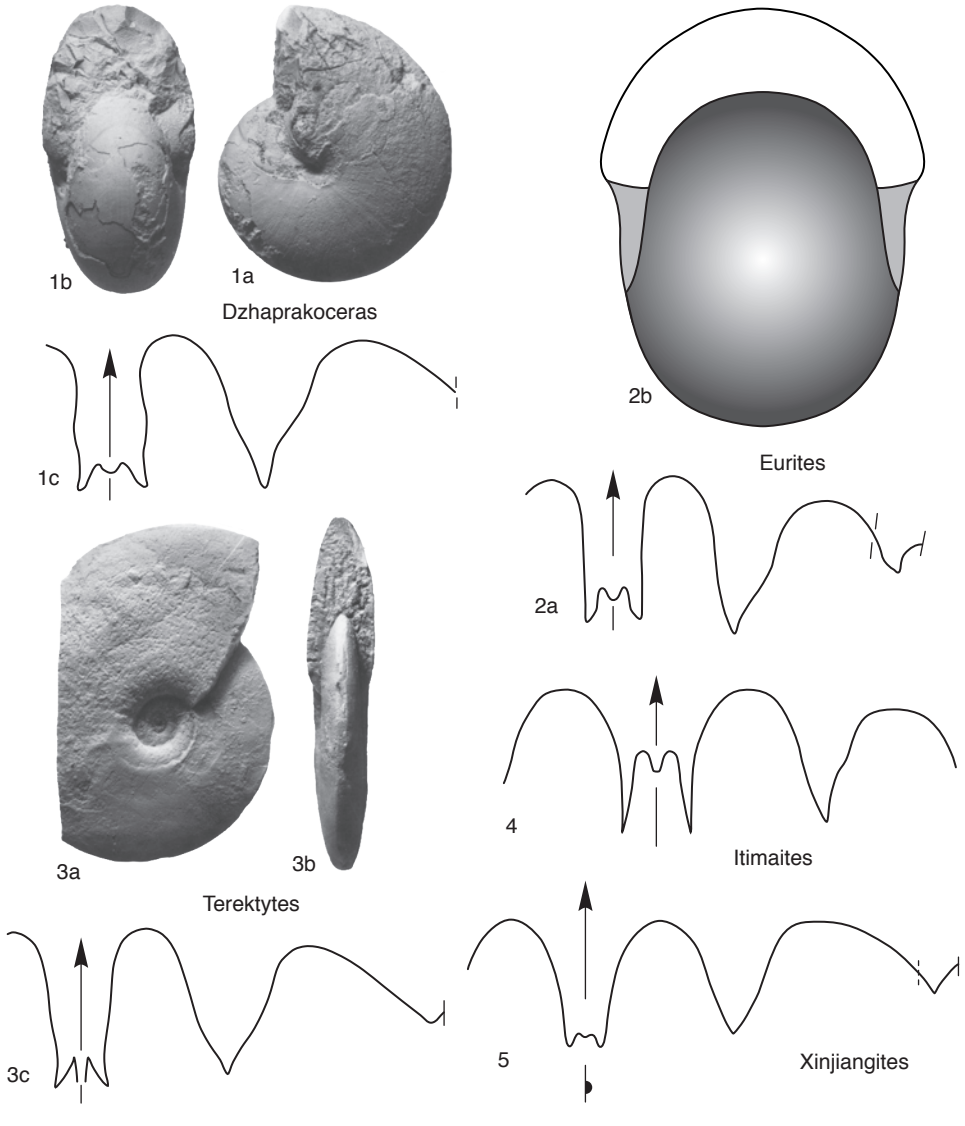

FIG. 21. Muensteroceratidae (p. 33–35).

MB.C.9086.1, diameter at about 55 mm, whorl height 21.5 mm, whorl width 24.8 mm, ×1.4 (Klug & others, 2006).

Kozhimites KUZINA, 1971, p. 43 [**K. planus;* OD]. Conch form discoidal, with very narrow umbilicus. Sculpture consisting of weakly curved lamellae; broad and fairly deep constrictions form unusual, high, ventral salient on internal mold. Ventral lobe wide, with almost parallel, slightly sinuous sides and rather low, broad median saddle. One species, one questionable species. [The phylogenetic relationship is uncertain for this genus, and it may belong to Girtyoceratidae.] *Mississippian (lower Visean):* Russia (North Urals), ?Wales. ——FIG. 20,*1a–c. *K. planus,* holotype, Kozhim River, Kos'vin Formation, North Urals; *a–b*, ×1; *c*, suture, PIN 2775/95, whorl height at 15 mm, whorl width 7.4 mm, ×2.8 (Kuzina, 1971).

?Nautellipsites PARKINSON, 1822, p. 164 [**Ellipsolites ovatus* SOWERBY, 1814, p. 83; M (for discussion of

status, see SPATH, 1934, p. 15)]. [Type species is poorly known. This genus may be a senior synonym of *Muensteroceras* or *Beyrichoceras.* For discussion, see MILLER and GARNER, 1955, p. 144; GORDON, 1965, p. 175. No illustrations of sufficiently preserved material are available for the holotype.] *Mississippian (Visean):* Ireland.

Terektytes LIBROVICH, 1957, p. 263 [**Muensteroceras acutum* LIBROVICH, 1940, p. 112; OD]. Conch form discoidal, with very narrow umbilicus. Ventral side narrowly rounded, later oxycone. Shell surface unknown. Ventral lobe very narrow, with weakly diverging sides and low median saddle. Adventitious lobe same length as ventral lobe. One or questionably two species. *Mississippian (upper Tournaisian):* ?Ireland, Kazakhstan (Karaganda). ——FIG. 21,*3a–c.* **T. acutus* (LIBROVICH), Terekty River, Karaganda, Kazakhstan, Terekty beds, PIN 3111/1; *a–b,* ×1; *c,* suture, whorl height at 15 mm, whorl width 6 mm, ×2.9 (Kuzina, 1971).

Xinjiangites RUAN, 1995b, p. 419 [**X. applanatus;* OD]. Conch form similar to *Muensteroceras,* discoidal and involute, with rounded ventral side and narrow umbilicus. Growth lines weak, convex. No coarse ornament. Ventral lobe narrow, with low median saddle. Sides of ventral lobe divergent and concave. Adventitious lobe V-shaped and acute. Seven species. [This genus is closely related to *Itimaites* and may be its senior synonym.] *Mississippian (middle Tournaisian–lower Visean):* USA (Missouri), Belgium, Great Britain, Ireland, Spain, Russia, China, Australia (New South Wales).——FIG. 21,*5.* **X. applanatus,* holotype, suture, reversed, Xinjiang, Eregennaren Hoboksar, China, Haishantou Formation, middle Tournaisian, Nanjing 108711, whorl width at 15.2 mm, ×2.5 (Ruan, 1995b).

Family MAXIGONIATITIDAE Korn, Klug, & Mapes, 1999

[Maxigoniatitidae KORN, KLUG, & MAPES, 1999, p. 348]

Conch involute, mainly subdiscoidal; ornamentation fine, with biconvex, sometimes crenulated growth lines or fine spiral lines, but no ribbing. Ventral lobe V-shaped, with sinuous flanks and moderately low median saddle; prongs inflexed outward, their apical points diverging apicad. *Mississippian (Tournaisian–Visean).*

Maxigoniatites KORN, KLUG, & MAPES, 1999, p. 350 [**Goniatites maximus saourensis* PAREYN, 1961, p. 146; OD]. Conch large, moderately evolute in early growth stage, involute in adult stage. Four species. *Mississippian (Visean):* Great Britain, Germany, Belgium, Portugal, Spain, Morocco, Algeria, Australia (Queensland).——FIG. 22,*1a–c.* **M. saourensis* (PAREYN), 12 km southeast of Dar Kaoua Oasis, Morocco, ?lower upper Visean; *a–b,* GPIT 1851-26, ×1; *c,* suture, GPIT 1851-25, whorl height at 16.5 mm, whorl width 24.6 mm, ×1.6 (Korn, Klug, & Mapes, 1999).

Beyrichoceras FOORD, 1903, p. 219 [**Goniatites obtusus* PHILLIPS, 1836, p. 234; SD BISAT, 1924, p. 84]. Conch form discoidal, with very narrow umbilicus, similar to *Bollandoceras.* Ornamentation sometimes crenulate, constrictions may be present. Ventral lobe relatively wide, its sides orad divergent, sometimes slightly sinuous. First lateral saddle narrowly rounded to subacute; adventitious lobe V-shaped and symmetrical, with convex sides, pointed. Many species. [*Beyrichoceras* is regarded by some authors as belonging to Muensteroceratidae.] *Mississippian (Visean [Beyrichoceras Zone–lower Goniatites Zone, Meramecian]):* Belgium, Great Britain, Germany, Ireland, Poland, Russia (Novaia Zemlia), South Urals, Iran, Kazakhstan (Karaganda), Portugal, Spain, Algeria, Morocco, USA (Alaska, Missouri).——FIG. 22,*4.* **B. obtusum* (PHILLIPS), suture of holotype, Black Hall, Bolland, Pendleside Limestone, England, lower *Goniatites* Zone, upper Visean, ×3.3 (Bisat, 1924).

Bollandites BISAT, 1952, p. 164 [**Beyrichoceratoides castletonensis* BISAT, 1924, p. 92; OD]. Conch form discoidal to thickly discoidal; umbilicus moderately wide to narrow. Ornamentation consisting of noncrenulate biconvex transverse striae, relatively strong in some species. Constrictions and ventral grove may be present; no spiral ornamentation. Ventral lobe with very low median saddle and rather narrow, at its base as in *Muensteroceras;* sides subparallel in apicad half, diverging orad. Tips of branches of ventral lobe not diverging. First lateral saddle broadly rounded. Adventitious lobe symmetrical and wide, with more or less sinuous sides including a broad angle, lying almost in line with basis of ventral lobe. Twelve species. *Mississippian (Tournaisian–Visean):* Belgium, Germany, England, Wales, Ireland, Portugal, Algeria, Poland, Russia (North Urals), Ukraine, China (Yunnan), Australia (New South Wales, Queensland), USA (Alaska). ——FIG. 22,*3a–b.* **B. castletonensis* (BISAT), upper Visean, upper *Beyrichoceras* Zone, England; *a,* Cracoe Reef Limestone, Elbolton, BGS 53584, ×3 (Bisat, 1934); *b,* suture, diameter at 20 mm, Treak Cliff, Castleton, ×3.6 (Bisat, 1924).

Bollandoceras BISAT, 1952, p. 164 [**Beyrichoceras submicronotum* BISAT, 1934, p. 291; OD; =*Goniatites micronotus* PHILLIPS, 1836, p. 234, subj.]. Conch form discoidal to thickly discoidal; umbilicus narrow to punctiform. Ornamentation consisting of noncrenulate biconvex transverse striae; no spirals. Constrictions present in most species. Ventral lobe rather narrow at its base, with low median saddle. Sides of ventral lobe subparallel at the base as in *Beyrichoceras,* but diverging orad with wide angle; first lateral saddle rounded to spatulate. Adventitious lobe moderately wide and sometimes with small basal nipple. Four species. [This genus is transitional to *Beyrichoceras* but lacks spiral ornamentation. Sufficiently preserved material of the type

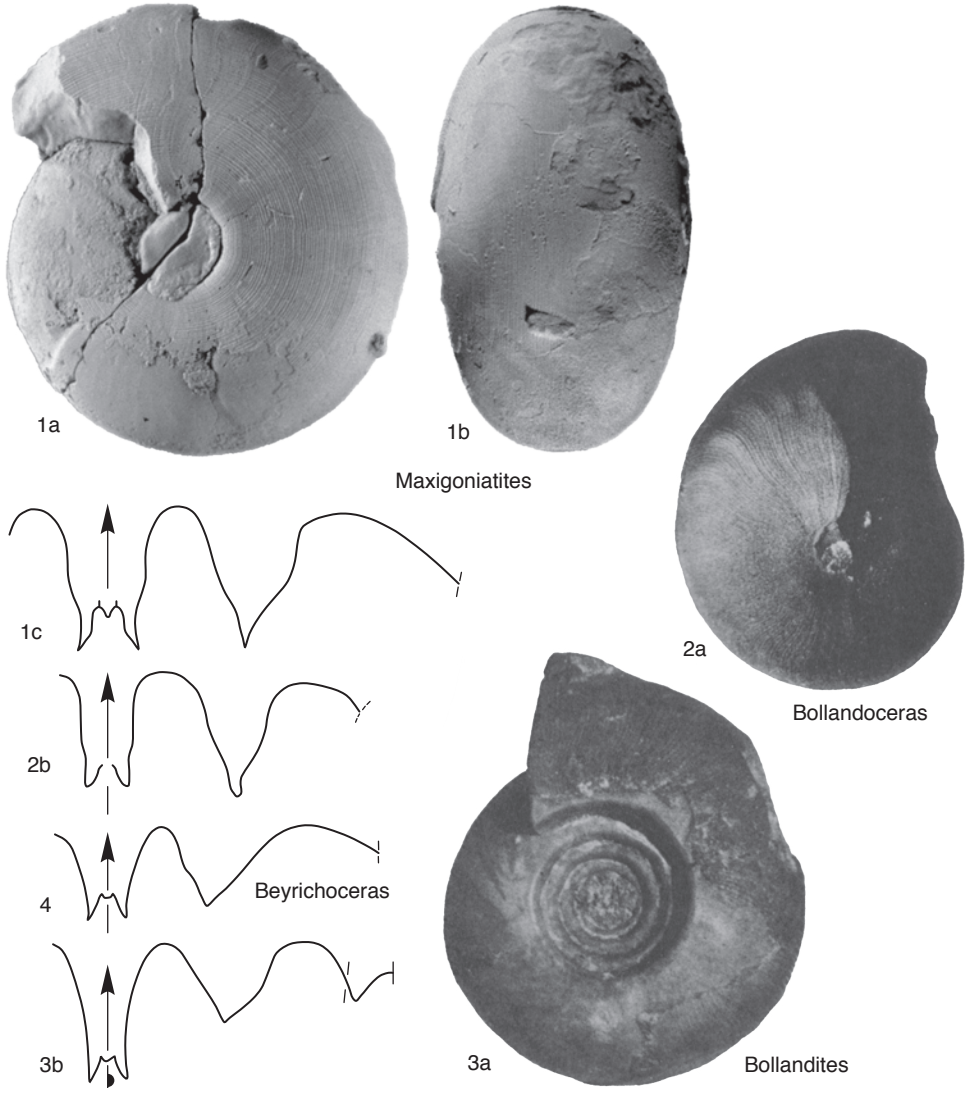

FIG. 22. Maxigoniatitidae (p. 35–36).

species was published after deadline for submission of manuscripts.] *Mississippian (Tournaisian–Visean):* Germany, Russia (North Urals), China (Yunnan), Belgium, Great Britain, Ireland, Morocco, Algeria, Ukraine, Kazakhstan (Karaganda), Kyrgyzstan (Tian Shan), Mongolia, Australia (Queensland), USA (Alaska).——FIG. 22,*2a. B. micronotoide* (BISAT), Grassington, England, upper Visean, upper *Beyrichoceras* Zone, BGS 53531, ×3 (Bisat, 1934).——FIG. 22,*2b. B. hodderense* (BISAT), Ashnott, Crag Beck, England, upper Visean, upper *Beyrichoceras* Zone, BGS Ro5190, suture, whorl height at 12.2 mm, whorl width 13.6 mm, reversed, magnification not stated (Riley, 1996).

NOMISMOCERATOIDEA

JÜRGEN KULLMANN

[University of Tübingen, Germany]

Superfamily NOMISMOCERATOIDEA Librovich, 1957

[*nom. transl.* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 161, *ex* Nomismoceratidae LIBROVICH, 1957, p. 265]

Conch form generally small, thin-discoidal, vermiculate, with wide umbilicus; advanced genera thickly discoidal and rather involute. Some forms with tetragonal or irregular coiling of inner whorls. Shell surface smooth or ornamented with simple or divaricate ribs. Growth lines with ventrolateral salient and well-developed ventral sinus. Longitudinal lirae or ventrolateral grooves may be present. Ventral lobe moderately wide, with rather low median saddle. First lateral saddle and adventitious lobe rounded, rarely pointed. Sutural formula ($E_1E_mE_1$)ALUI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (upper Tournaisian–upper Serpukhovian).*

Family NOMISMOCERATIDAE Librovich, 1957

[Nomismoceratidae LIBROVICH, 1957, p. 265]

Shell surface smooth. No tetragonal coiling of inner whorls. *Mississippian (upper Tournaisian–upper Serpukhovian [Meramecian–Chesterian]).*

Nomismoceras HYATT, 1884 in 1883–1884, p. 330 [**Goniatites spirorbis* PHILLIPS, 1836, p. 237; SD FOORD & CRICK, 1897, p. 212; =*Goniatites vittiger* PHILLIPS, 1836, p. 237, subj.]. Conch form discoidal or lenticular. Ventral side rounded, in adult stage frequently flattened. Umbilicus extremely wide to moderately wide. Ornamentation fine or coarse, prorsiradiate, biconvex, and with long ventrolateral salient. Ventrolateral grooves and constrictions may be present; no spiral ornamentation. Ventral lobe relatively wide and V-shaped, with low median saddle; adventitious lobe symmetrical and deep, usually rounded. Six species. *Mississippian (upper Visean–lower Serpukhovian):* Belgium, Great Britain, Germany, Czech Republic, Ireland, France, Algeria, Poland, Russia (Novaia Zemlia), Ukraine, South Urals, Uzbekistan, China (Xizang), ?Laos, USA (Arkansas).——FIG. 23,*1a–b. *N. vittiger* (PHILLIPS), South Urals, Kazakhstan; *a,* suture, Dombar Hills, upper Visean, PIN 455/5798, whorl height at 4 mm, whorl width 2.4 mm, ×7.8; *b,* cross section, Kzyl-Shin Canyon, lower Serpukhovian, PIN 1721/500, ×5 (Ruzhentsev & Bogoslovskaia, 1971).——FIG. 23,*1c. N. frechi* SCHMIDT, side view, Weitengrund, Rhenish Massif, Germany, upper Visean, ×2 (Schmidt, 1925).

Beleutoceras RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 164 [**B. carinatum* RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 165; OD]. Conch form discoidal, venter on adult stage oxycone. Umbilicus moderately wide. Ornamentation as in *Nomismoceras,* coarse, prorsiradiate, biconvex, and with long ventrolateral salient, but with spiral ornamentation. Ventral lobe relatively wide and V-shaped, with moderately high median saddle; adventitious lobe symmetrical, wide, and acute. One species. *Mississippian (lower Serpukhovian):* Kazakhstan (Karaganda).——FIG. 23,*2. *B. carinatum,* cross section, Zhide river, PIN 2493/6, ×5 (Ruzhentsev & Bogoslovskaia, 1971).

?Cavilentia RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 166 [**C. tenuicula;* OD] [?=*Applanoceras* YANG, 1986, p. 261 (type, *A. epichare,* OD)]. Conch form discoidal, with narrowly rounded venter, umbilicus moderately wide. Ornamentation with fine growth lines, no constrictions, grooves, or spiral lirae. Ventral lobe wide, with low median saddle; first lateral saddle broadly rounded, adventitious lobe deep and rounded. One or two species. [The holotype may be an immature specimen; its relationship is uncertain. *Applanoceras* is also based on very small specimens that differ in their subacute adventitious lobe.] *Mississippian (upper Serpukhovian):* Russia (Novaia Zemlia, South Urals), China (?Ningxia).——FIG. 23,*3a–b. *C. tenuicula,* Verkha Island, Novaia Zemlia, Russia, Verkha limestone, PIN 4279/160; *a,* cross section, ×2.7; *b*, suture, whorl height at 7.0 mm, whorl width 3.6 mm, ×6.5 (Kuzina & Yatskov, 1999).

Eonomismoceras KUZINA, 1974, p. 28 [**E. shevyrevi* KUZINA, 1974, p. 29; OD]. Conch small, discoidal, with wide umbilicus; venter rounded. Growth lines biconvex, with strong ventrolateral salient. Ventral lobe rather narrow, with almost parallel sides. Adventitious lobe deep, almost subacute. Only type species. [This genus is transitional to *Pseudonomismoceras* and *Nomismoceras* and may be a junior synonym of one of these genera.] *Mississippian (lower Visean):* Great Britain, Russia (North Urals).——FIG. 23,*5a–c. *E. shevyrevi*, Kos'vin Formation, Kozhim River, Komi, North Urals; *a–b*, holotype, PIN 2775/349, ×1.5; *c*, suture, PIN 2775/348, whorl height at 3.0 mm, whorl width 3.1 mm, ×9.9 (Kuzina, 1974).

Pseudonomismoceras FRECH, 1899, p. 285 [**P. silesiacus* FRECH, 1899, p. 310; M]. Conch form thin-discoidal, vermicular, with extremely wide umbilicus. Strong growth lines, with ventrolateral salient crossing venter without ventral sinus; weak

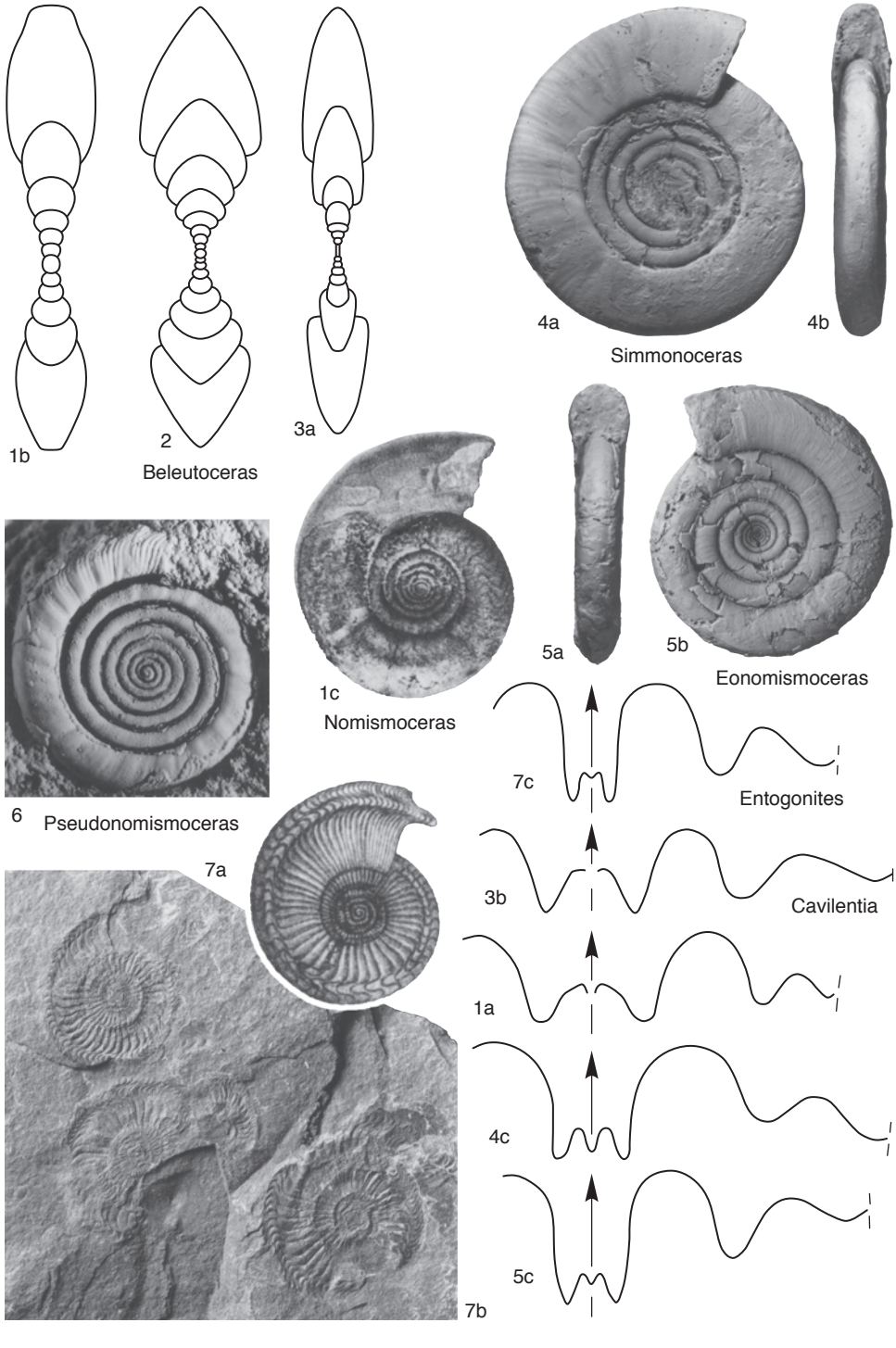

FIG. 23. Nomismoceratidae and Entogonitidae (p. 37–39).

ribbing on flanks of last whorl. Three species. [The type species is poorly known: the holotype, the only known specimen, measures 8 mm in diameter; the suture is only partly known.] *Mississippian (upper Tournaisian–Visean):* Germany, Poland, Australia (Queensland).——Fig. 23,*6. *P. silesiacus*, holotype, Hausdorf, Lower Silesia, Poland, upper Visean, ×5 (Weyer, new).

Simmonoceras Kuzina, 1974, p. 29 [**S. atratum* Kuzina, 1974, p. 30; OD]. Conch discoidal, moderately involute, with rather wide umbilicus. Sculpture consisting of weak riblets; constrictions present. Ventral lobe relatively wide, but not deep, with rounded sides. Adventitious lobe very small and rounded. [Only the holotype of the type species is known for this genus.] *Mississippian (?upper Tournaisian):* Russia (North Urals).——Fig. 23,*4a–c. *S. atratum,* holotype, Tschernyi river basin, Komi, Nortrich Formation, PIN 2775/356; *a–b,* ×1.5; *c,* suture, whorl height at 5.5 mm, whorl width 4.2 mm, ×5.9 (Kuzina, 1974).

Family ENTOGONITIDAE Ruzhentsev & Bogoslovskaia, 1971

[Entogonitidae Ruzhentsev & Bogoslovskaia, 1971, p. 166]

Shell surface with prominent dichotomizing ribs. Inner whorls tetragonal. *Mississippian (upper Visean).*

Entogonites Kittl, 1904b, p. 322, *nom. nov. pro Tetragonites* Kittl, 1904a, p. 677, *non* Kossmat, 1895, p. 131 [**Tetragonites grimmeri* Kittl, 1904a, p. 677; M] [=*Kittliella* Frech, 1906, p. 41, *nom. nov. pro Tetragonites* Kittl, 1904a, p. 677, *non* Kossmat, 1895, p. 131, *nom. van.;* =*Brannerоceratoides* Kullmann, 1962, p. 88 (type, *Gastrioceras (B.) tetragonum,* OD)]. Conch form thin-discoidal, evolute, with moderately wide umbilicus; venter well rounded. Inner whorls tetragonal. Sculpture consisting of prominent ribs, dichotomizing on flanks or ventrolateral, with ventrolateral salient and deep ventral sinus. Ventral lobe relatively narrow and parallel sided, with a low median saddle and roundly diverging sides; first lateral saddle broadly rounded. Adventitious lobe small and deep, narrowly rounded. Three species. [The suture of the type species is unknown for this genus.] *Mississippian (upper Visean):* Bosnia, Serbia, Great Britain, Ireland, Germany, Czech Republic, Poland, Morocco, USA (Alaska, Utah).——Fig. 23,*7a–b. *E. grimmeri* (Kittl), Prača, Sarajewo, Bosnia, lower upper Visean; *a,* side view (Kittl, 1904a); *b,* slab with specimens, MGBW 1900H, ×1.8 (Kullmann, new).——Fig. 23,*7c. E. borealis* Gordon, suture, Alapah limestone, Kirktagiak River, Brooks Range, Alaska, Meramecian, USNM 118984, diameter at 12 mm, ×6 (Gordon, 1957).

DIMORPHOCERATOIDEA

Jürgen Kullmann

[University of Tübingen, Germany]

Superfamily DIMORPHOCERATOIDEA Hyatt, 1884

[*nom. transl. et correct.* Miller & Furnish, 1954, p. 687, *ex* Dimorphocerae Hyatt, 1884 in 1883–1884, p. 330]

Conch form in general thickly discoidal to discoidal, rarely lenticular; umbilicus moderately narrow or closed. Ventral lobe wide, with relatively narrow prongs; height of median saddle rarely exceeding half the height of entire ventral lobe. Branches of ventral and adventitious lobes may be subdivided or denticulate, but not tridentate. *Mississippian (upper Tournaisian)–Pennsylvanian (Moscovian).*

Family DIMORPHOCERATIDAE Hyatt, 1884

[*nom. correct.* Miller & Furnish, 1954, p. 687, *ex* Dimorphocerae Hyatt, 1884 in 1883–1884, p. 330]

Conch completely involute. Sculpture consisting only of growth lines, sometimes with delicate spiral ornamentation. Ventral lobe becoming extremely wide by subdivision. Adventitious lobe simple (subfamily Dimorphoceratinae) or subdivided (subfamily Glyphiolobinae). *Mississippian*

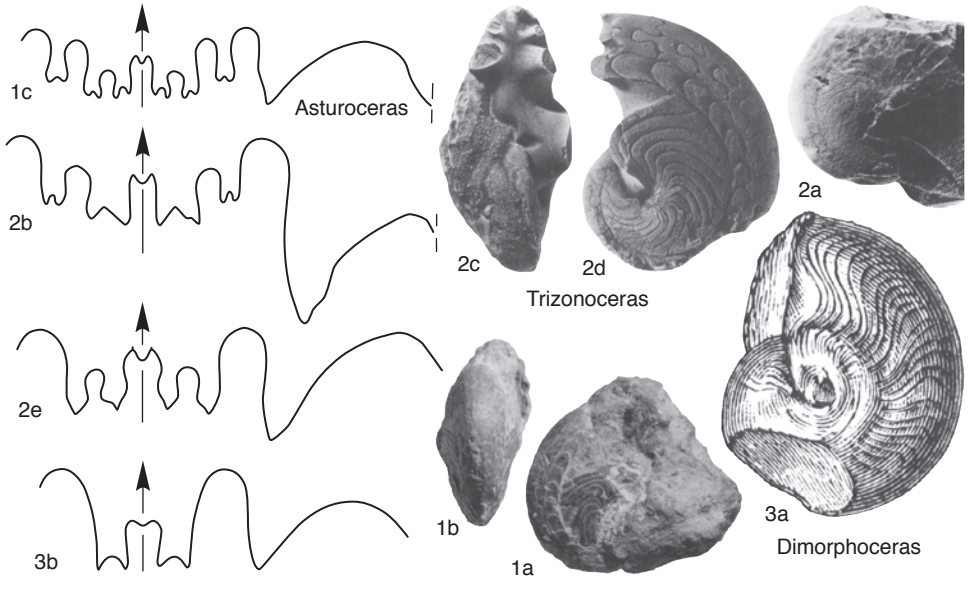

FIG. 24. Dimorphoceratidae (p. 40).

(?upper Tournaisian, Visean)–Pennsylvanian (Moscovian).

Subfamily DIMORPHOCERATINAE Hyatt, 1884

[*nom. transl. et correct.* RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 60, *pro* Dimorphocerae HYATT, 1884 in 1883–1884, p. 330]

Only ventral lobe subdivided. Adventitious lobe simple, pointed. *Mississippian (?upper Tournaisian, Visean–Serpukhovian).*

Dimorphoceras HYATT, 1884 in 1883–1884, p. 331 [**Goniatites Gilbertsoni* PHILLIPS, 1836, p. 236; SD FOORD & CRICK, 1897, p. 219]. Ventral lobe with bidentate branches. Five species. *Mississippian (?upper Tournaisian, Visean):* Germany, USA (Alaska), ?Belgium, Great Britain, Ukraine, Algeria, Morocco.——FIG. 24,*3a–b.* **D. gilbertsoni* (PHILLIPS); *a,* holotype, Yorkshire, England, ?upper Visean, Gilbertson Collection BMNH, ×2 (Foord & Crick, 1897); *b,* suture, Bowland Shales, upper Visean, ×2.8 (Moore, 1930).

Asturoceras RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 60 [**Trizonoceras subdivisum* KULLMANN, 1962, p. 29; OD]. Similar to *Trizonoceras*, but ventral lobe consisting of six bifid branches. Sutural formula: ($E_{1d}E_{1vd}E_{1v2}E_mE_{1v2}E_{1vd}E_{1d}$)AL:UI [German], $V_{1.1}(V_{1.2.1}V_{1.2.1}V_{1.2.1})V_{1.1}$LU:ID [Russian]. Two species. *Mississippian (upper Serpukhovian):* Great Britain, Spain.——FIG. 24,*1a–c.* **A. subdivisum* (KULLMANN), holotype, Perlora, Tudela Veguín quarry, grey limestones, Arnsbergian, Spain, GPIT 1206/99; *a–b*, ×1; *c*, suture, ×3 (Kullmann, 1962).

Trizonoceras GIRTY, 1909, p. 70 [**T. typicale;* OD]. Similar to *Dimorphoceras*, but ventral lobe developing four branches regularly; ventrad ones always bifid, dorsad elements may be bifid. Basic sutural formula: ($E_{1d}E_{1v}E_mE_{1v}E_{1d}$)AL:UI [German], ($V_{1.1}V_{1.2}V_{1.2}V_{1.1}$)LU:ID [Russian]. Many species. *Mississippian (upper Visean–Serpukhovian):* Ireland, Algeria, Russia (Novaia Zemlia), Kazakhstan (South Urals), Tajikistan, China (Guangxi, Ningxia), USA (Arkansas, Oklahoma).——FIG. 24,*2a–b.* **T. typicale*, holotype, Caney Shales, Antler, Oklahoma, middle Chesterian, USNM 119598; *a*, side view, ×6; *b*, suture, diameter at 8.4 mm, ×9 (Manger & Pareyn, 1979).——FIG. 24,*2c–d. T. horreitense* MANGER & PAREYN, holotype, Ain el Mizab Formation, Djebel Horreit, Algeria, UA 77-217-1, ×3 (Manger & Pareyn, 1979).——FIG. 24,*2e. T. kathleenae* (MOORE), suture, northeastern slope of Dough Mountain, 3.2 km south-southwest of Kiltyclogher, County Leitrim, Ireland, upper Visean, GSM Z1.5643, corrected by RUZHENTSEV & BOGOSLOVSKAIA (1969a, fig. 1b), ×3.3 (Moore, 1958).

Subfamily GLYPHIOLOBINAE Ruzhentsev & Bogoslovskaia, 1969

[Glyphiolobinae RUZHENTSEV & BOGOSLOVSKAIA, 1969a, p. 61]

Conch thickly discoidal to subglobose. Not only ventral lobe, but also adventitious lobe subdivided. Subdivisions sometimes irregular or denticulate. *Mississippian (upper Visean)–Pennsylvanian (Moscovian).*

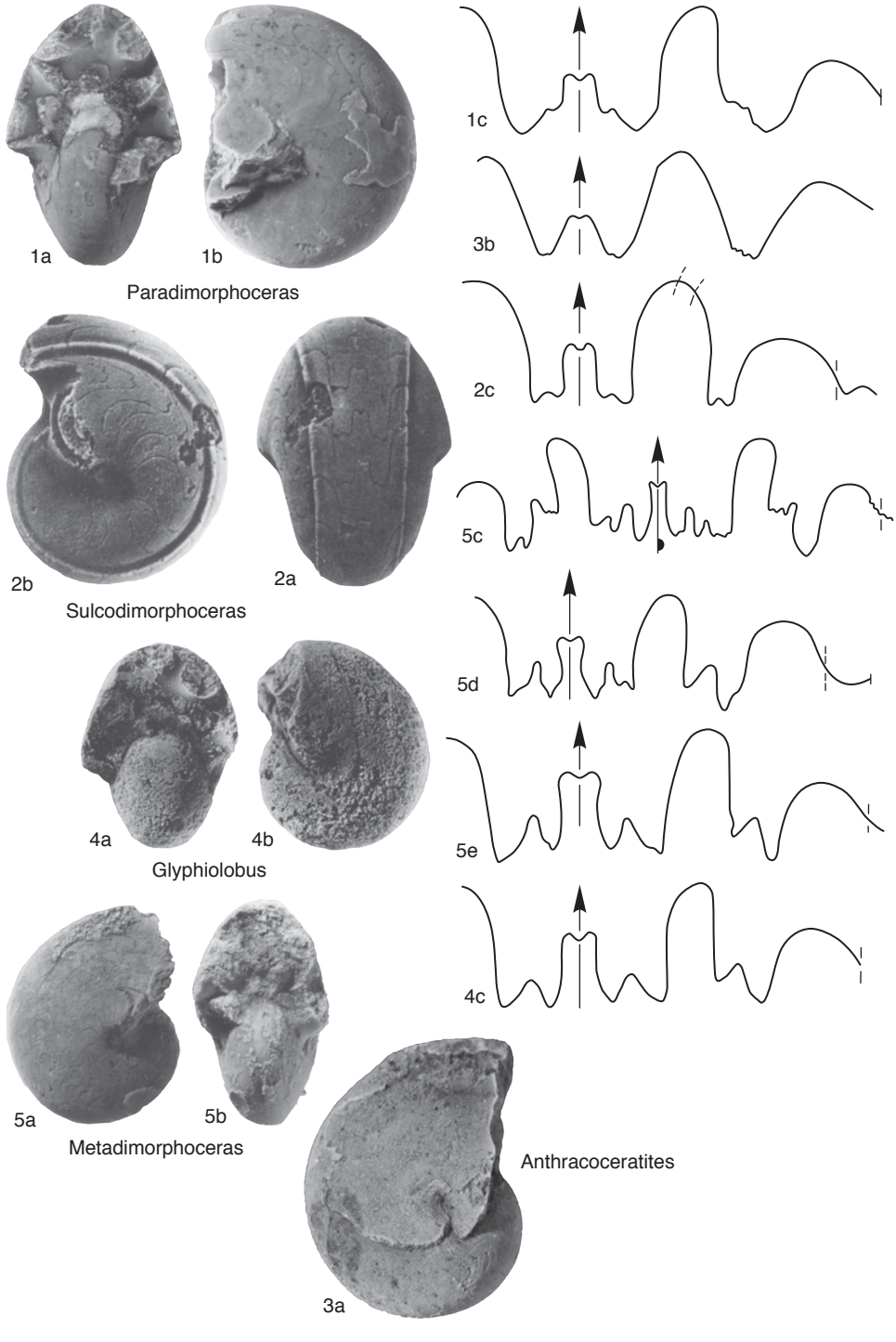

FIG. 25. Dimorphoceratidae (p. 42).

Glyphiolobus GORDON, 1965, p. 280 [**Trizonoceras lepidum* GIRTY, 1909, p. 71; OD] [=*Currieoceras* MANGER, 1988, p. 32 (type, *Dimorphoceras marioni* MOORE, 1939, p. 120, OD)]. Ventral and adventitious lobes both twice subdivided; no denticulation. Sutural formula: $(E_{1d}E_{1v}E_mE_{1v}E_{1d})(A_vA_d)$L:UI [German], $(V_{1.1}V_{1.1}V_{1.1}V_{1.1})(L_2L_1)$U:ID [Russian]. Many species. [This genus is transitional to *Metadimorphoceras* and may be its junior synonym; for discussion, see MANGER and QUINN, 1972, p. 305. *Currieoceras* was established for species with bifid ventral prongs and lateral lobe, in which the subdivisions are low and restricted to the tips of sutural elements; these characters are regarded herein as being of specific rather than generic significance.] *Mississippian (upper Visean)–Pennsylvanian (lower Bashkirian [Yeadonian]):* Belgium, Czech Republic, Great Britain, Ireland, Germany, Poland, Ukraine, Portugal, Russia (South Urals, Novaia Zemlia), China (Gansu, Xinjiang, Ningxia), Kazakhstan (South Urals), Tajikistan, Uzbekistan, USA (Arkansas, Kentucky, Nevada, Oklahoma).——FIG. 25,*4a–c. *G. lepidus* (GIRTY), holotype, Caney Shale, Oklahoma, upper Chesterian, GSNM 119599; *a,* apertural view, ×9.7; *b,* side view, ×10.2; *c,* suture, diameter at 6.3 mm, ×7.8 (Manger, new).

Anthracoceratites RAMSBOTTOM, 1970, p. 57 [**A. deansi;* OD]. Growth lines biconvex; rather prominent ventrolateral salient on flanks. Lobes have tendency to become denticulate. Eight species. [The assignment of this genus to the family Dimorphoceratidae is questionable; for discussion, see RUZHENTSEV and BOGOSLOVSKAIA, 1978, p. 129.] *Pennsylvanian (Bashkirian–Moscovian [Duckmantian]):* Belgium, Great Britain, Germany, Netherlands, Portugal, Russia (South Urals), Ukraine (Donets), Algeria, Morocco, Uzbekistan.——FIG. 25,*3a–b. *A. deansi; a,* holotype, side view, Rombalds Moor, England, Yorkshire, borehole depth 140 m, IGSL LZ 3597, Marsdenian, ×4; *b,* suture of holotype, diameter at 10 mm, magnification not stated (Ramsbottom, 1970).

Metadimorphoceras MOORE, 1958, p. 222 [**Goniatites splendidus* BROWN, 1841, p. 215; OD]. Similar to *Glyphiolobus*, but with tertiary subdivision of ventrad and dorsad portions of ventral lobe. Many species. Adventitious lobe deeper than ventral lobe. [Some authors (e.g., RUZHENTSEV & BOGOSLOVSKAIA, 1971, p. 192; RUAN, 1981b, p. 208) regard *Metadimorphoceras* as a junior synonym of *Paradimorphoceras* RUZHENTSEV, 1947a.] *Mississippian (upper Visean [Arnsbergian])–Pennsylvanian (lower Bashkirian [Kinderscoutian]):* Great Britain, Belgium, Germany, Ireland, Portugal, Algeria, Morocco, Czech Republic, Poland, Russia (Novaia Zemlia), Russia and Kazakhstan (South Urals), China (Gansu, Guangxi, Guizhou, Ningxia), Tajikistan (Pamirs), Uzbekistan, USA (Arkansas).——FIG. 25,*5a–c. *M. splendidum* (BROWN), holotype, lower Bashkirian, Kinderscoutian, Millstone Grit, R_1, Manchester Museum L10242, England; *a–b,* ×3 (Manger, new); *c,* suture, diameter at 9.7 mm, magnification not stated (Manger, 1988).——FIG. 25,*5d. M. wiswellense* (MOORE), suture, upper Fayetteville Shale, Town Branch, Fayetteville, Arkansas, Chesterian, SUI 35058, ×5.3 (Manger & Quinn, 1972).——FIG. 25,*5e. M. pseudodiscrepans* (MOORE), Batesville, Arkansas, Ruddel Member, Moorefield Shale, Chesterian, SUI 35065, suture, diameter at 8.9 mm, ×6 (Manger & Quinn, 1972).

?Paradimorphoceras RUZHENTSEV, 1947a, p. 522 [**Goniatites looneyi* PHILLIPS, 1836, p. 236; OD]. Conch form similar to *Anthracoceras*. Branches of ventral lobe bifid; adventitious lobe irregularly subdivided. Adventitious lobe never deeper than ventral lobe. One species, one questionable. [Judging from the neotype, selected by MOORE, 1939, p. 123 and officially confirmed by MOORE, 1958, p. 222, the type species may have closer affinities to anthracoceratids than to dimorphoceratids (W. L. MANGER, personal communication, 1985)]. *Mississippian (Serpukhovian):* Belgium, Great Britain, China (?Xinjiang).——FIG. 25,*1a–c. *P. looneyi* (PHILLIPS), lectotype (MOORE, 1958, p. 222), Crimsworth Dean near Hebden Bridge, Yorkshire, England, Millstone grit, Kinderscoutian, IGS (GSM) 70235; *a–b,* ×6; *c,* suture, ×10 (Manger, new).

Sulcodimorphoceras MANGER & PAREYN, 1979, p. 663 [**S. sedraense;* M]. Conch form subglobular, with very small umbilicus. Sculpture consisting of two ventrolateral sulci separated by a narrow, rounded ridge. Ventral lobe with shallowly bifid ventral prongs and bifid adventitious lobe. One species. [Only the holotype is known and is an immature specimen 5.4 mm in diameter.] *Mississippian (lower Serpukhovian):* Algeria.——FIG. 25,*2a–c. *S. sedraense,* holotype, Ain el Mizab Formation, Gadet Sedra, Cirque d'El Guelmouna, UA 77-217-3; *a–b,* ×7.5; *c,* suture, diameter at 5 mm, ×9.2 (Manger & Pareyn, 1979).

Family GIRTYOCERATIDAE Wedekind, 1918

[*nom. transl.* RUZHENTSEV, 1957, p. 57, *ex* Girtyoceratinae WEDEKIND, 1918, p. 139, *nom. nov. pro* Adelphoceratidae WEDEKIND, 1914, p. 10, *nom. oblit.*]

Conch form subdiscoidal to subglobular, moderately to completely involute, with moderately wide to small umbilicus. Sculpture variable within wide range: transverse striae prominent or weak, usually with ventrolateral salient and ventral sinus. Constrictions common. Longitudinal lirae or ventrolateral grooves may be present. Ventral lobe moderately wide to wide, with diverging sides; first lateral saddle usually well rounded, rarely pointed. Sutural formula: $(E_1E_mE_1)$AL:UI [German], (V_1V_1)LU:ID [Russian]. *Mississippian (upper Tournaisian)–Pennsylvanian (lower Bashkirian).*

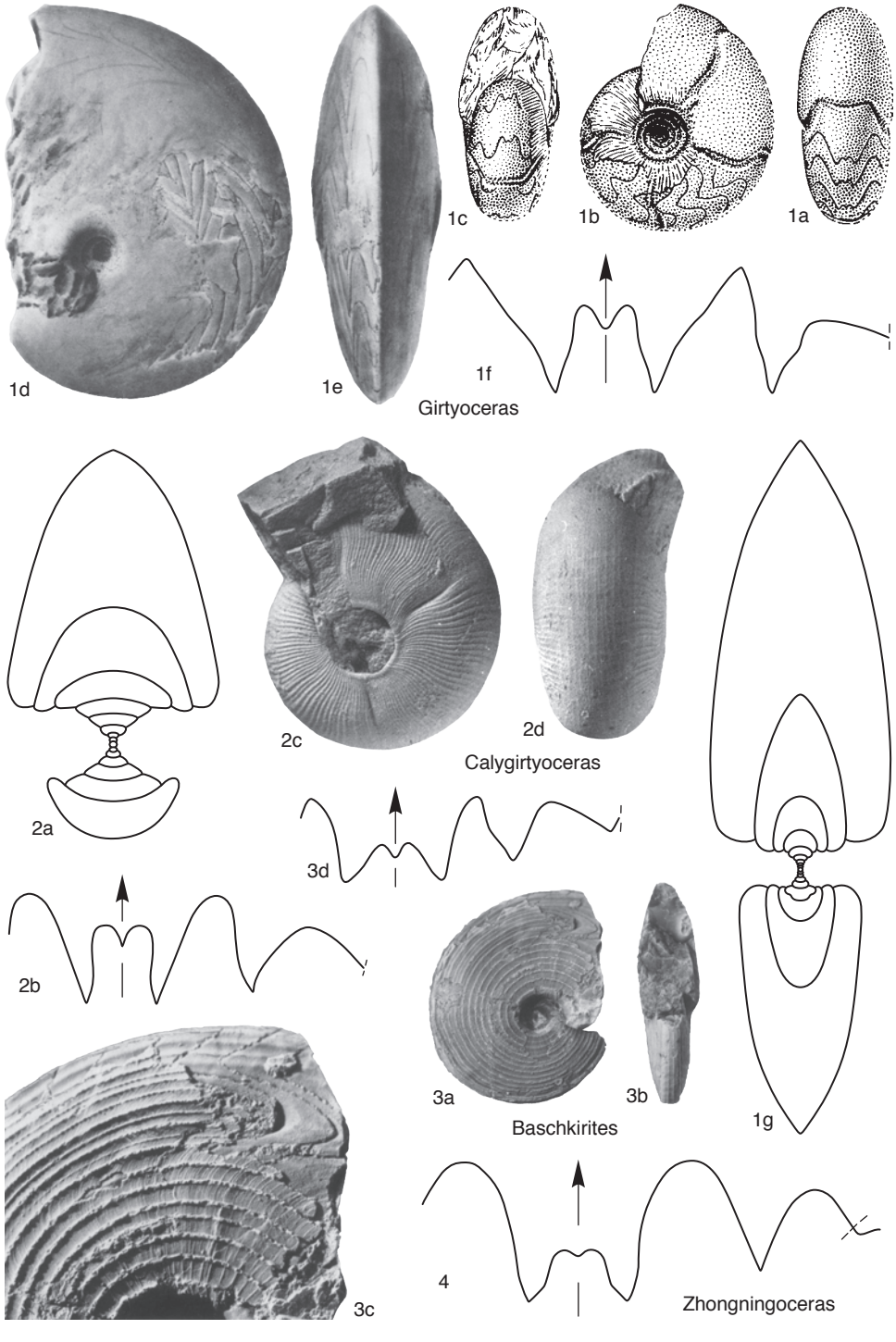

FIG. 26. Girtyoceratidae (p. 44–48).

Subfamily GIRTYOCERATINAE Wedekind, 1918

[Girtyoceratinae Wedekind, 1918, p. 139] [=Baschkiritinae Ruzhentsev, 1960d, p. 204]

Ventral lobe with widely diverging sides, in advanced genera generally wide. Adventitious lobe pointed, asymmetric. [Baschkiritinae comprise advanced genera with moderately involute shell form and subacute or acute sutural elements.] *Mississippian (upper Tournaisian)–Pennsylvanian (lower Bashkirian).*

Girtyoceras Wedekind, 1918, p. 140, *nom. nov. pro Adelphoceras* Girty, 1909, p. 64, *non* Hyatt, 1883–1884, p. 285 [**Adelphoceras meslerianum* Girty, 1909, p. 66; OD] [=*Sagittoceras* Hind, 1918, p. 446 (type, *S. acutum,* M), for discussion, see Gordon, 1965, p. 227; =*Dryochoceras* Morgan, 1924, p. 185 (type, *D. brainerdi,* M), for discussion, see Miller, 1934b, p. 31; =*Cowdaleoceras* Bisat, 1952, p. 166 (type, *C. difficile,* OD, *teste* Riley, 1990a, p. 152); =*Jeminayceras* Wang, 1983, p. 520 (type, *J. heishantouense,* OD)]. Conch form in young stages with wide umbilicus and low whorl section, later with small umbilicus; tendency to form an acute venter in relatively young stages. Shell surface in young stages commonly smooth, later temporarily ribs or umbilical nodes; constrictions may be present. No ventrolateral grooves. Ventral lobe wide, with rounded or straight diverging sides; median saddle reaching about half height of ventral lobe. First lateral saddle narrowly rounded, sometimes spatulate. Adventitious lobe moderately deep, pointed, and relatively wide. Many species. [*Cowdaleoceras* was erected for forms with a moderately high ventral lobe, its sides being subparallel at the base, but with a diverging orad with wide angle; the first lateral saddle is spatulate, with subacute tip. These characters are regarded herein as being of specific significance. *Jeminayceras* is based on two small, poorly preserved specimens that exhibit a relatively high umbilical shoulder.] *Mississippian (upper Visean–lower Serpukhovian):* Great Britain, Belgium, France, Germany, Czech Republic, Poland, Russia (Novaia Zemlia, North Urals), Spain, Portugal, Algeria, Morocco, Ukraine, South Urals, Kazakhstan (Karaganda), China (Yunnan, Ningxia, Xinjiang), Australia (New South Wales), USA (Alaska, Arkansas, Georgia, Montana, Nevada, Oklahoma, Texas, Utah).——Fig. 26,*1a–g.* **G. meslerianum* (Girty); *a–c,* Chesterian, Oklahoma, USA, ×2.5; *d–e,* Chesterian, Texas, USA, ×0.8 (Miller, Furnish, & Schindewolf, 1957); *f,* suture, Caney Formation, Delaware Creek Member, Oklahoma, SUI 10932, diameter at 81 mm, ×0.8; *g,* cross section, Caney Formation, Delaware Creek Member, Wapanucka, Oklahoma, SUI 10932, ×1 (McCaleb, Quinn, & Furnish, 1964).

Baschkirites Librovich, 1957, p. 250 [**B. discoidalis* Librovich, 1957, p. 251; OD]. Conch discoidal, with narrow umbilicus in adult stage. Growth lines fine, prorsiradiate, with long ventrolateral salient; ventrolateral grooves common. Simple, sometimes granose spiral ornamentation on entire shell. Ventral lobe wide and V-shaped, with moderately high median saddle; first lateral saddle rounded or subacute, adventitious lobe deep and acute. Seven species. [Some authors (e.g., Bogoslovskaia, Kuzina, & Leonova, 1999) assign *Baschkirites* to Nomismoceratoidea.] *Pennsylvanian (lower Bashkirian):* Great Britain, Belgium, Germany, Ireland, Portugal, Russia (South Urals), Uzbekistan, USA (Arkansas).——Fig. 26,*3a–d.* **B. discoidalis,* holotype, Malaia Ik River, Bashkortostan, Russia; *a–b,* ×1.5; *c,* ×4; *d,* suture, whorl height at 11 mm, ×1.9 (Librovich, 1957).

Calygirtyoceras Korn, Klug, & Mapes, 1999, p. 353 [**C. darkaouaense* Korn, Klug, & Mapes, 1999, p. 354; OD]. Early stage widely umbilicate, with sharp umbilical margin forming a calyx, intermediate stage with rounded flanks and venter. Adult conch large and oxyconic. No ventrolateral grooves. Median saddle of ventral lobe exceeding half the entire height, ventrolateral saddle broadly rounded, adventitious lobe deep and acute. Four species. [This genus is similar to *Pseudogirtyoceras* Wagner-Gentis and may be its junior synonym.] *Mississippian (upper Visean):* Great Britain, Germany, Morocco, China (Yunnan), USA (Alaska).——Fig. 26,*2a–b.* **C. darkaouaense*, southeast of Dar Kaoua Oasis, Morocco, upper Visean; *a,* cross section, GPIT 1851-88, ×1.5; *b,* suture, GPIT 1851-89, ×1 (Korn, Klug, & Mapes, 1999).——Fig. 26,*2c–d. C. moorei* (Nicolaus), Hillershausen, Rhenish Massif, Germany, Goniatitenknollen, *Goniatites* Zone alpha 2, upper Visean, WMN 11047, ×2.5 (Korn, 1990).

Cousteauceras Korn, 1988b, p. 73 [**Sagittoceras costatum* Ruprecht, 1937, p. 271; OD]. Conch form small, discoidal, umbilicus closed. Ornamentation fine, with radiate and biconvex growth lines, partly forming riblets. Ventrolateral grooves present. Two or three species. *Mississippian (upper Visean–lower Serpukhovian [Pendleian]):* Great Britain, Germany, Ireland.——Fig. 27,*1.* **C. costatum* (Ruprecht), lectotype, Frenkhausen, Rhenish Massif, Germany, Go γ 2, uppermost Visean, GÖT 423-12, side view of internal mold, ×2.5 (Korn, 1988b).

Edmooroceras Elias, 1956, p. 132 [**Eumorphoceras plummeri* Miller & Youngquist, 1948, p. 665; OD]. Conch form and ornamentation similar to *Eumorphoceras*, but with a subangular and nodose umbilical edge; umbilicus usually narrow, rarely moderately wide. Many species. [This genus is closely related to *Eumorphoceras* and *Girtyoceras* and is probably a junior synonym of the former genus. For discussion, see Saunders, 1973, p. 44.] *Mississippian (upper Visean–lower Serpukhovian):* Great Britain, Germany, Ireland, Czech

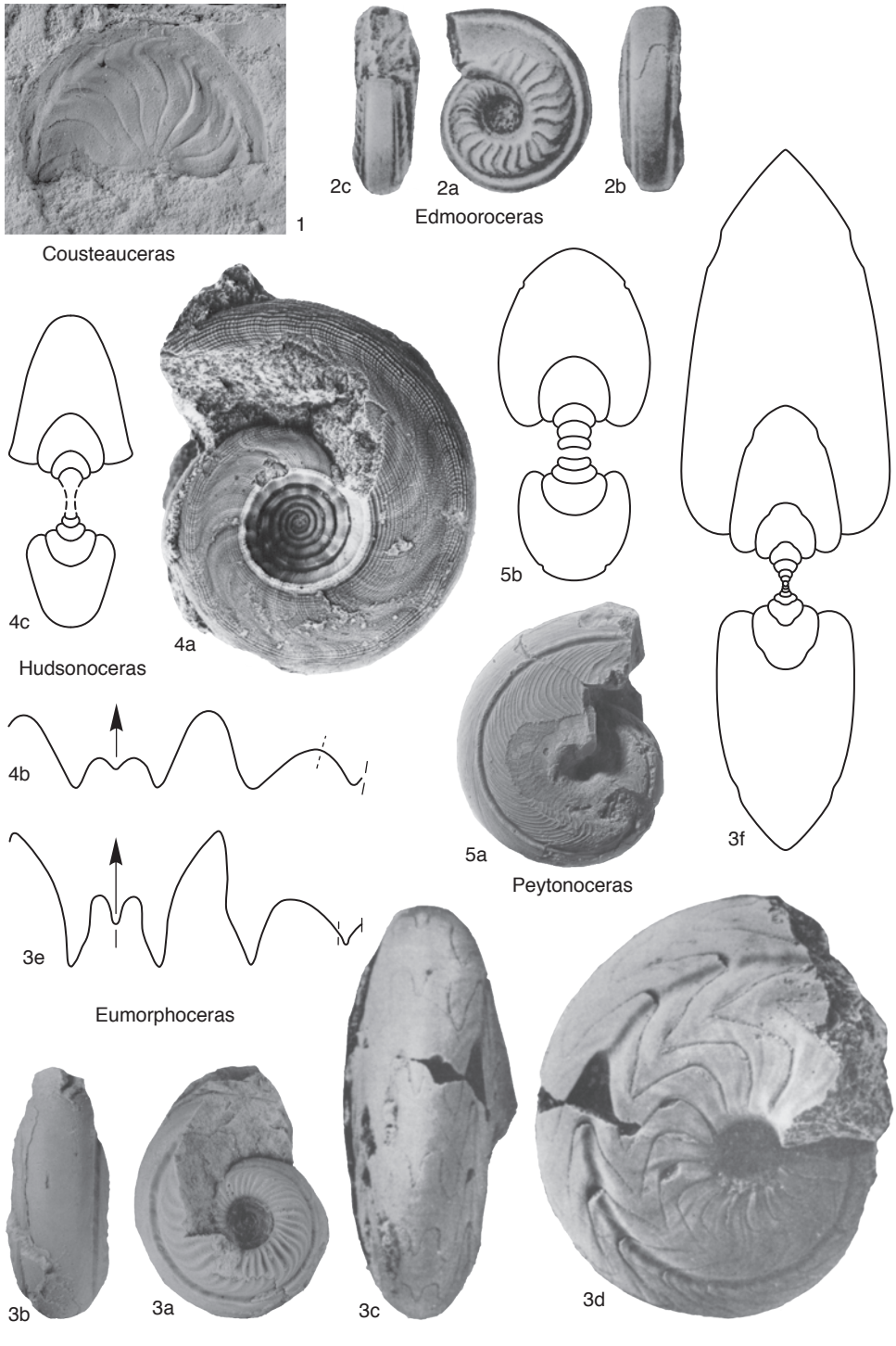

FIG. 27. Girtyoceratidae (p. 44–46).

Republic, Kazakhstan (South Urals), Algeria, China (Guangxi, Ningxia), USA (Arkansas, Oklahoma, Texas).——Fig. 27,*2a–c*. **E. plummeri* (Miller & Youngquist), south-southeast of San Saba, Barnett Shale, Chesterian, Texas; *a–b*, holotype; *c*, side view of paratype, east of San Saba, ×2 (Miller & Youngquist, 1948).

Eumorphoceras Girty, 1909, p. 67 [**E. bisulcatum* Girty, 1909, p. 68; OD] [=*Mediologoceras* Kullmann, 1962, p. 23 (type, *M. mediolobum,* OD)]. Conch form similar to *Girtyoceras*, but acute venter appearing at a late stage; ventrolateral grooves always present. Strong ribs beginning usually at second whorl, late stage smooth; no spiral ornamentation. Suture line often with subacute first lateral saddle; lateral lobe deep and acute. Many species. [*Mediologoceras* was erected for forms with narrowly rounded venter, acute saddles, and a deep median lobe.] *Mississippian (Serpukhovian):* Belgium, Great Britain, Ireland, Germany, Poland, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), Spain, Algeria, China (Gansu, Guangxi), Tajikistan, Uzbekistan, USA (Arkansas, California, Nevada, Oklahoma, Texas, Utah).——Fig. 27,*3a–f*. **E. bisulcatum,* Caney Shale, Sandy Creek, Johnson County, Oklahoma, USA, upper Chesterian; *a–b,* holotype, USNM 119596, ×3 (Gordon, 1965); *c–d,* Leslie, Searcy County, Arkansas, USA, upper Chesterian, SUI 11523, ×2; *e,* suture, ×0.4; *f,* cross section, ×1.2 (McCaleb, Quinn, & Furnish, 1964).

Hudsonoceras Moore, 1946, p. 433, *non* Flower, 1955, p. 352 [**Goniatites proteus* Brown, 1841, p. 217; OD]. Conch form discoidal, evolute on early stages, later with narrow umbilicus. Sculpture consisting of delicate spiral ornamentation and transverse striae; crossing of both produces reticulate pattern. Ventrolateral grooves may be present. Ventral lobe wide, with relatively low median saddle; first lateral saddle rounded. Adventitious lobe deep and acute. Two or three species. [The phylogenetic relationship of this genus is uncertain. Some authors (e.g., Bogoslovskaia, Kuzina, & Leonova, 1999) assign *Hudsonoceras* to the family Nomismoceratidae.] *Pennsylvanian (lower Bashkirian):* Great Britain, Wales, Ireland, Belgium, France, Russia (South Urals), USA (Arkansas).——Fig. 27,*4a–c*. **H. proteus* (Brown); *a,* side view, Clare Shale near Roadford, Clare County, Ireland, Kinderscoutian, SUI 320005, ×3 (Quinn & Saunders, 1968); *b,* suture of lectotype, Lob Mill, Todmorden, Yorkshire, England, MM L11797b, diameter at 8 mm, ×8.3; *c,* cross section of original syntype, Lob Mill, Todmorden, Yorkshire, England, MM L11797a, ×3.7 (Moore, 1946).

Peytonoceras Saunders, 1966, p. 43 [**P. ornatum* Saunders, 1966, p. 45; OD]. Conch with extremely narrow umbilicus. Lateral ribs delicate and closely spaced, sinuous; spiral lirae crossed by growth lines forming reticulate pattern. One ventrolateral groove well pronounced. One species. [The adult suture is not known for this genus.] *Mississippian (lower Serpukhovian [Arnsbergian]):* USA (Arkansas).——Fig. 27,*5a–b*. **P. ornatum,* holotype, Peyton Creek beds, upper Chesterian, UA L114-10; *a,* side view, ×3 (Saunders, 1973); *b,* cross section, ×6.8 (Saunders, 1966).

?Pseudogirtyoceras Wagner-Gentis in Higgins & Wagner-Gentis, 1982, p. 346 [**P. villabellacoi* Wagner-Gentis in Higgins & Wagner-Gentis, 1982, p. 347; OD]. Conch involute, with moderately narrow umbilicus and oxycone ventral side at adult stage; early whorls evolute. Surface of test almost smooth, on ventral side with faint undulations of growth lines; two to four constrictions on last whorl. Median saddle of ventral lobe slightly higher than half the entire lobe. Ventrolateral saddle narrowly rounded and asymmetric. One species. [Type species is insufficiently known. Similar suture line and conch form suggest a close relationship with *Zhifangoceras* Sheng, 1984 (Pericyclidae) and *Calygirtyoceras* Korn, Klug, & Mapes, 1999; the latter genus may be a junior synonym provided a calyx stage of the inner whorls can be proven.] *Mississippian (lowermost Visean):* Spain.——Fig. 28,*4*. **P. villabellacoi,* suture of holotype, Villabellaco, Palencia, Villabellaco Formation, BMNH C.82323, ×5 (Higgins & Wagner-Gentis, 1982).

Sulcogirtyoceras Ruzhentsev, 1960d, p. 204 [**Eumorphoceras burhennei* Brüning, 1923a, p. 265; OD]. Conch form and suture line similar to *Girtyoceras*. Acute venter only at last whorl. Shell surface in young stage smooth, rarely with ribs, later temporarily ribs or umbilical nodes. Constrictions typical, and numerous forming biconvex transversal sulci. Ventrolateral grooves always present. Four species. [For discussion, see Kullmann, Korn, & Pitz, 1983, p. 545.] *Mississippian (upper Visean):* Germany, Czech Republic, Portugal, Kazakhstan (South Urals), USA (Arkansas, Kentucky, Texas).——Fig. 28,*3a–b*. **S. burhennei* (Brüning), Herdringen, Rhenish Massif, *Goniatites striatus* Zone, Germany; *a,* lectotype, GPIM 3478, side view, ×2; *b*, suture of lectotype, diameter at 24 mm, ×2.7 (Kullmann, Korn, & Pitz, 1983).

Sundernites Korn, 1993b, p. 49 [**S. horni;* OD]. Conch form small, early whorls thickly discoidal, later stages discoidal; umbilicus moderately wide. Umbilical ribs, irregularly spaced, forming ventrolateral salient. Growth lines biconvex, no ventrolateral grooves. Two species. *Mississippian (lower Serpukhovian [Pendleian]):* Great Britain, Germany.——Fig. 28,*1a–b*. **S. horni,* holotype, Sundern-Hellefeld, Hangende Alaunschiefer, Rhenish Massif, Germany, lowermost Serpukhovian, WMN P18247, ×5 (Korn, 1993b).

Torulites Kuzina & Yatskov, 1987, p. 106 [**T. septentrionalis;* OD]. Conch form involute, in young stages with wide umbilicus, later with small umbilicus; ventral side relatively broadly rounded. Ornamentation consisting of biconvex growth lines and irregularly bifurcated ribbing; three or four constrictions present. Ventral lobe relatively narrow, with low median saddle and widely divergent sides. Adventitious lobe symmetric and with slightly sinuous sides. One species. *Mississippian*

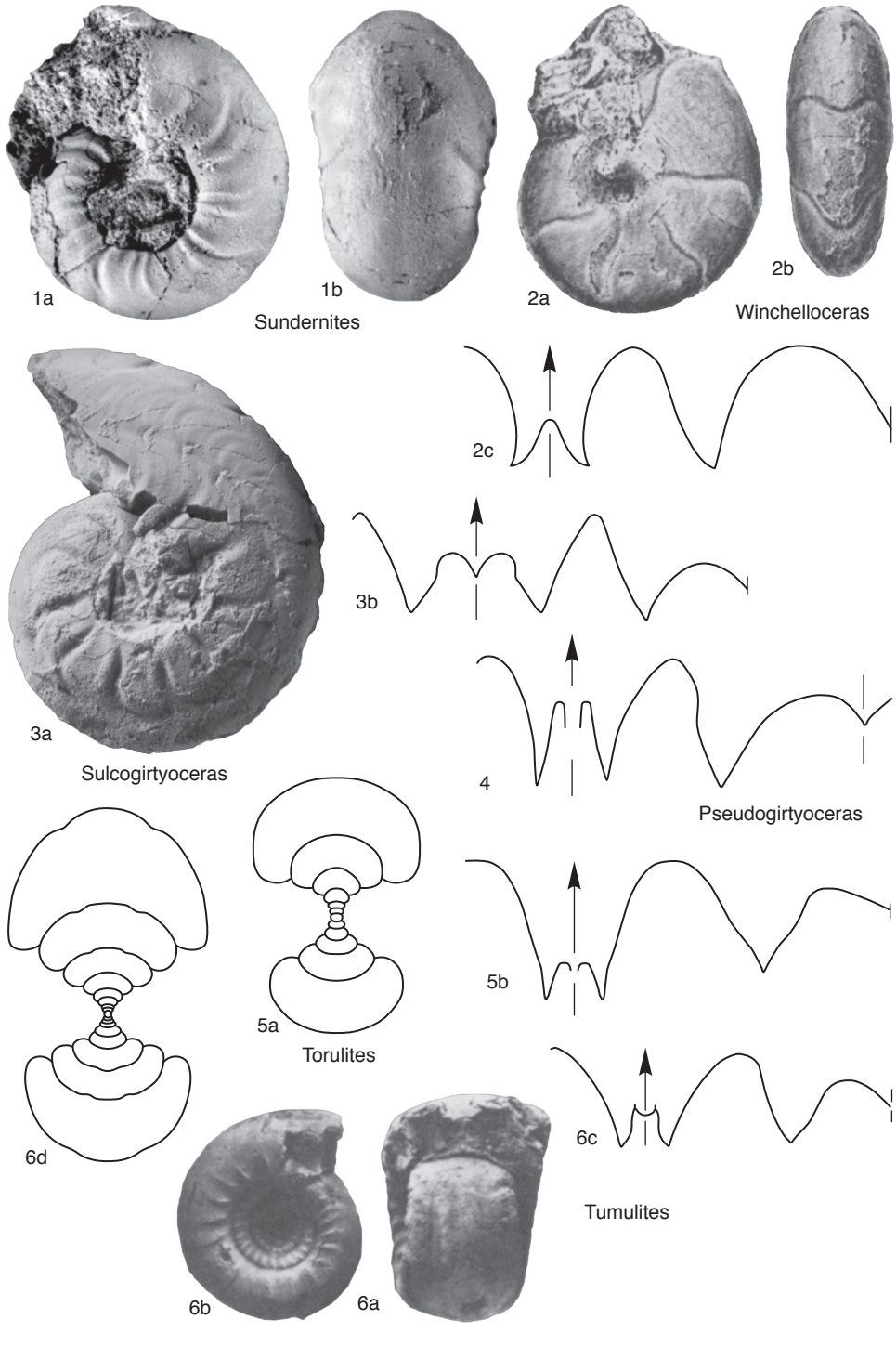

FIG. 28. Girtyoceratidae (p. 46–48).

(lower Visean): Russia (Novaia Zemlia).——Fig. 28,*5a–b. *T. septentrionalis,* Milin Formation, Olenii rivulet, Severnaia Tainaia basin; *a*, cross section, PIN 4006/476, ×4.3; *b*, holotype, suture, PIN 4006/478, ×8 (Kuzina & Yatskov, 1987).

Tumulites McCaleb, Quinn, & Furnish, 1964, p. 28 [**T. varians* McCaleb, Quinn, & Furnish, 1964, p. 30; OD]. Conch thickly discoidal to subglobose, moderately involute, usually with narrow umbilicus. Umbilical ribs forming ventrolateral salient and rounded sinus on venter. Ventrolateral grooves always present. First lateral saddle broadly rounded. Five species. *Mississippian (Serpukhovian):* Belgium, Great Britain, Germany, Ireland, Poland, Russia (South Urals), China (Gansu, Ningxia), USA (Arkansas, Texas).——Fig. 28,*6a–d. *T. varians; a–b,* paratype, Batesville, Fayetteville Shale, Arkansas, USA, upper Chesterian, SUI 11531, ×3.75; *c*, suture of holotype, Fayetteville Formation, Town Branch bed, Arkansas, UA L-119-TB-5, diameter at 15 mm, ×3.4; *d*, cross section of paratype, SUI 11536, ×2 (McCaleb, Quinn, & Furnish, 1964).

Winchelloceras Ruzhentsev, 1965, p. 9 [**Goniatites allei* Winchell, 1862, p. 363; OD]. Conch discoidal, involute, with very narrow umbilicus; venter broadly rounded, rarely oxycone. Growth lines fine or coarse, with deep hyponomic sinus. Constrictions may be present; no spiral ornamentation. Ventral lobe with relatively low median saddle. Adventitious lobe deep and acute, symmetrical, sometimes bell shaped, usually smaller than ventral lobe. Seven species. *Mississippian (upper Tournaisian–lower Visean [Osagean]):* ?Spain, Algeria, Russia (North Urals), Kyrgyzstan (Tian Shan), USA (Michigan).——Fig. 28,*2a–c. *W. allei* (Winchell), hypotype, Coldwater Shale, 2 km southwest of Coldwater, Michigan, USA, Osagean, UM 30703c; *a–b,* ×2; *c,* suture, UM 30704, ×2.6 (Miller & Garner, 1955).

?Zhongningoceras Yang, 1986, p. 262 [**Z. bellum;* OD]. Conch form small, involute, with moderately wide umbilicus. Sculpture consisting of fine concave-convex growth lines that form long salient and deep hyponomic sinus, and fine simple ribs on flanks; umbilical tubercles present. Several strong constrictions present; on venter one shallow groove partly exposed. Ventral lobe rather wide, with moderately low median saddle; adventitious lobe V-shaped and much less deep than ventral lobe. Two species. [Type specimens are very small and possibly immature.] *Mississippian (lower Serpukhovian [Arnsbergian]):* China (Ningxia).——Fig. 26,*4. *Z. bellum,* suture of paratype, reversed, Zhongning, diameter at 11.2 mm, ×8.8 (Yang, 1986).

Family BERKHOCERATIDAE Librovich, 1957

[Berkhoceratidae Librovich, 1957, p. 265]

Conch completely involute. Ventral lobe quadripartite, with simple, cuneate branches. Adventitious lobe simple, deep, and acute. Sutural formula: $(E_1E_2E_mE_2E_1)$ AL:UI [German], $(V_{1.1}V_{1.2}V_{1.2}V_{1.1})$LU:ID [Russian]. *Mississippian (upper Visean–Serpukhovian).*

Kazakhoceras Ruzhentsev, 1947a, p. 521 [**K. yanshini* Ruzhentsev, 1947a, p. 522; OD; =?*Neodimorphoceras hawkinsi* Moore, 1930, p. 168; Ruzhentsev & Bogoslovskaia, 1971, p. 197, subj.] [=*Berkhoceras* Librovich, 1938, p. 48, *nom. nud.; =Berkhoceras* Librovich, 1957, p. 259 (type, *B. boreale* Librovich, 1957, p. 260, OD)]. Conch form lenticular and almost oxycone. Growth lines crossed sometimes by fine spiral lirae. Five species. *Mississippian (upper Visean–Serpukhovian):* Great Britain, Belgium, Ireland, Germany, Spain, Poland, Russia (Novaia Zemlia, South Urals), Kazakhstan (Karaganda), China (Guangxi, Gansu, Ningxia), Kyrgyzstan, Tajikistan, Uzbekistan.——Fig. 29,*4a–c. *K. yanshini,* Nocedo, Cantabrian Mountains, Spain, Arnsbergian; *a–b,* GPIT 1494/1226, ×1 (Kullmann, new); *c,* suture, Perlora, Cantabrian Mountains, Spain, lower Serpukhovian, GPIT 1268/68, whorl height at 22 mm, whorl width at 15 mm, ×1.5 (Kullmann, 1962).

Family EOGONIOLOBOCERATIDAE Ruzhentsev & Bogoslovskaia, 1978

[Eogoniloboceratidae Ruzhentsev & Bogoslovskaia, 1978, p. 83]

Conch form subdiscoidal, evolute on early whorls; umbilicus of adult forms very narrow. No prominent sculpture; spiral ornamentation and constrictions may be present. Ventral lobe wide, with strongly divergent sides; median saddle broad and half as high as entire ventral lobe, also with strongly divergent sides. First lateral saddle narrowly rounded, subacute or acute, adventitious lobe pointed. [This family is similar to Goniolobocerati dae, but the phylogenetic relationship is uncertain.] *Mississippian (upper Visean–Serpukhovian), Pennsylvanian (?lower Bashkirian [?Yeadonian]).*

Eogonioloboceras Librovich, 1957, p. 249 [**Goniolobocera*s *asiaticum* Librovich, 1940, p. 117; OD] [=*Atratoceras* Librovich, 1957, p. 249 (type, *Goniolobocera*s *(Milleroceras) atratum* Librovich, 1940, p. 183, OD); for discussion, see Ruzhentsev & Bogoslovskaia, 1971, p. 201]. Ventral lobe angular, median saddle about half as high as entire lobe. First lateral saddle subacute or narrowly rounded. Adventitious lobe acute and deep. Five species. [*Atratoceras* was erected for forms with constrictions and less angularity of the lobes.] *Mississippian (upper Visean–Serpukhovian), Pennsylvanian*

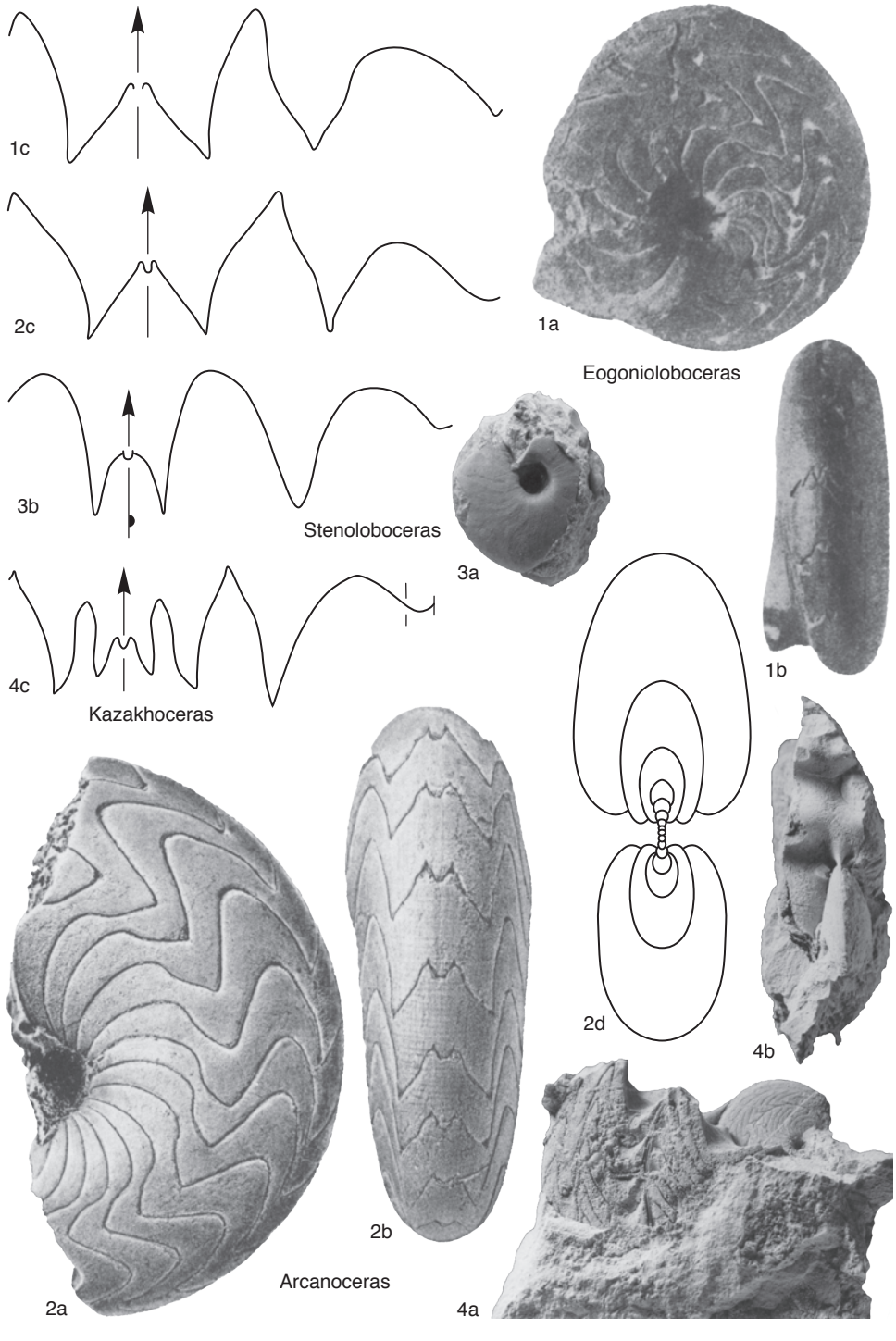

FIG. 29. Berkhoceratidae and Eogonioloboceratidae (p. 48–50).

(?lower Bashkirian [?Yeadonian]): Russia (South Urals), Kazakhstan (Karaganda), China (Guangxi), *upper Visean–Serpukhovian;* China (Guangxi), *?lower Bashkirian [?Yeadonian].*——Fig. 29,*1a–c.* **E. asiaticum* (Librovich), holotype, Verkhnii Sokur basin, Kazakhstan, upper Visean, CNIGR 168/5450; *a–b,* ×1.5 (Librovich, 1940); *c,* suture, enlarged, magnification not stated (Bogoslovskii, Librovich, & Ruzhentsev, 1962).

Arcanoceras Ruzhentsev, 1965, p. 10 [**Girtyoceras burmai* Miller & Downs, 1950b, p. 576; OD]. Conch form as in *Eogonioloboceras,* but with extremely evolute early whorls; at fifth whorl rapid increase of involution. Adult whorl with very narrow umbilicus. Biconvex growth lines crossed by fine spiral ornamentation. Suture line as in *Eogonioloboceras,* but even more angular; first lateral saddle pointed. Adventitious lobe almost triangular, with concave sides. Six species, two questionable. *Mississippian (upper Visean–Serpukhovian [Pendleian, ?Arnsbergian]):* Spain, Russia (Novaia Zemlia, South Urals), Kazakhstan (South Urals), China (Guangxi, Ningxia), USA (Texas).——Fig. 29,*2a–d.* **A. burmai* (Miller & Downs); *a–b,* holotype, San Saba, Texas, Barnett Formation, upper Chesterian, SUI 2642, ×6 (Miller & Downs, 1950b); *c*, suture, Dombar Hills, South Urals, Kazakhstan, uppermost Visean, PIN 455/6998, ×1.3; *d*, cross section, Zhaksy Kargaly River, South Urals, Kazakhstan, lower Serpukhovian, PIN 455/6962, ×3 (Ruzhentsev & Bogoslovskaia, 1971).

Stenoloboceras Ruan, 1981b, p. 213[227] [**S. stenolobatum;* OD]. Conch form discoidal, with narrowly rounded venter on early whorls, becoming slightly acute later. Growth lines biconvex. Ventral lobe moderately wide, with roundly diverging sides. Median saddle broad and less than half as high as entire lobe; prongs of ventral lobe rather narrow. First lateral saddle high and rounded, adventitious lobe asymmetric and V-shaped. One species. *Mississippian (Serpukhovian):* China (Guangxi).——Fig. 29,*3a–b.* **S. stenolobatum,* holotype, Qixu, upper Locheng Formation, NIGP 48933; *a*, side view, ×1; *b*, suture, reversed, ×3.9 (Ruan, 1981b).

Family ANTHRACOCERATIDAE Plummer & Scott, 1937

[Anthracoceratidae Plummer & Scott, 1937, p. 321]

Conch form discoidal, involute. Growth lines delicate, with ventrolateral salient and ventral sinus. Suture relatively primitive; ventral lobe commonly wide, with divergent sides. [The phylogenetic relationship of this family is uncertain and may be an artificial grouping.] *Mississippian (upper Visean [upper Namurian])–Pennsylvanian (Moscovian).*

Anthracoceras Frech, 1899, p. 285 [**Nomismoceras (Anthracoceras) discus* Frech, 1899, p. 337; M]. Conch form subdiscoidal, with narrow, almost closed umbilicus. Growth lines with ventral sinus and strong salients forming a lingua on ventrolateral shoulder; second salient weak on flanks. Faint longitudinal ornamentation in some species. Ventral lobe wide, with strongly divergent sides. First lateral saddle broadly rounded. Adventitious lobe rounded during ontogeny, pointed at maturity. Many species, several questionable species. [The type species material is insufficiently preserved]. *Mississippian (Serpukhovian)–Pennsylvanian (Moscovian):* Belgium, Great Britain, France, Germany, Ireland, Netherlands, Czech Republic, Poland, Spain, Algeria, Morocco, China (Guangxi, Gansu, Xinjiang, Ningxia), USA (Arkansas, Missouri, Oklahoma).——Fig. 30,*4a. A. glabrum* Bisat, side view, Throstle Nest, Silsden, Airedale, Sabden Shales, Arnsbergian, ×3.4 (Currie, 1954).——Fig. 30,*4b. A. paucilobum* (Phillips), suture, Thornliebank, Renfrewshire, Scotland, Orchard Limestone, Arnsbergian, RSM 1911.62.493a, ×3 (Currie, 1954).

?Anthracoceratoides Ramsbottom, 1970, p. 54 [**A. cornubiensis;* OD]. Early whorls widely umbilicate, later with narrow umbilicus. Growth lines on young stages more or less linear, later with slight ventrolateral salient and ventral sinus. First lateral saddle almost subacute, adventitious lobe pointed. One species. [The type species for this genus is poorly known; Ruzhentsev and Bogoslovskaia (1978, p. 166) regarded it as a synonym of *Schartymites.*] *Pennsylvanian (Moscovian [Langsettian]):* Great Britain.——Fig. 30,*3.* **A. cornubiensis,* paratype, suture, nodule in Bude Sandstone, Sandimouth, Cornwall, IGSL HR2156, diameter at 8 mm, magnification not stated (Ramsbottom, 1970).

Cathranoceras Nikolaeva, 1990, p. 109 [**C. badavense;* OD]. Conch form similar to *Anthracoceras;* ornamentation with transversal riblets. Ventral lobe with subparallel sides and relatively low median saddle. Ventrolateral saddle broadly rounded, adventitious lobe half as long as ventral lobe, acute. One species from one locality. [The type material for this genus is poorly known.] *Pennsylvanian (lower Bashkirian [Homoceras Zone]):* Uzbekistan.——Fig. 30,*1a–c.* **C. badavense,* Aksu-Vakhshivardara, Surkhantau Range; *a–b,* paratype, PIN 4372/2, ×4; *c,* suture of holotype, PIN 4372/1, whorl height at 4.4 mm, whorl width 4.1 mm, ×12 (Nikolaeva, 1990).

?Ningxiaceras Yang, 1987, p. 158[171] [**N. brevilobatum*; OD]. Conch thinly lenticular with narrowly rounded or acute venter; umbilicus narrow. Ventral lobe with rounded prongs, median saddle reaching a third of entire lobe. Adventitious lobe at diameter of 10 mm deep and broadly rounded. [The holotype for this genus is insufficiently known, and its systematic position is uncertain.] *Pennsylvanian (Bashkirian):* China (Ningxia).——Fig. 30,*2a–b.* **N. brevilobatum,* holotype, Xiaoyuchuan, Zhongwei, no. 855; *a,* ×2; *b,* suture, diameter at 10 mm, ×6.3 (Yang, 1987).

Sudeticeras Patteisky, 1929, p. 274 [**Homoceratoides hoeferi* Patteisky in Patteisky & Fohlbrecht,

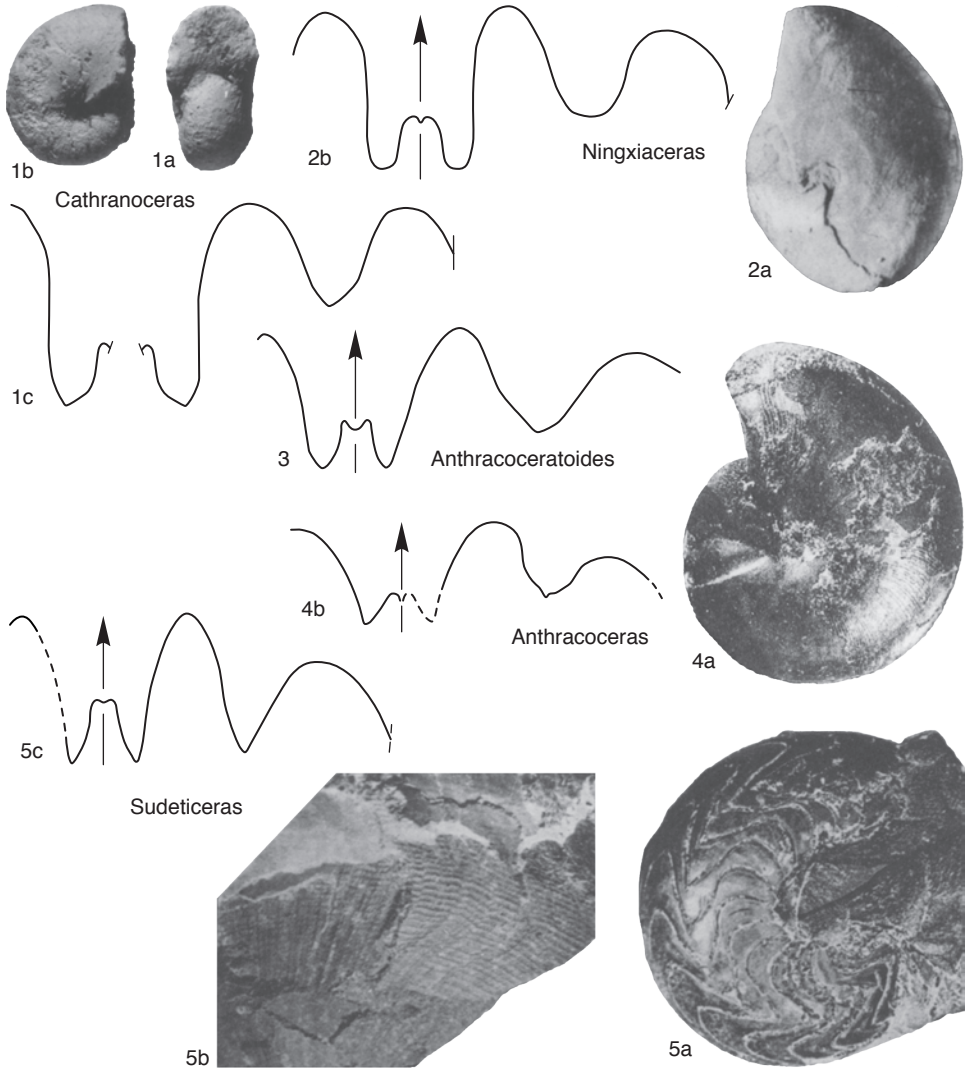

FIG. 30. Anthracoceratidae (p. 50–51).

1928, p. 63; OD] [=*Glyphioceratoides* KNOPP, 1931, p. 15, M, obj., *nom. van.;* =*Cravenites* BISAT, 1950, p. 16 (type, *C. varians* BISAT, 1950, p. 18, OD)]. Conch with very narrow umbilicus; venter rounded. Growth lines fine, nearly linear on flanks, biconvex, with shallow salient on ventrolateral shoulder and with marked ventral sinus. Ornamentation weak, crenistriate, in some forms with spiral pattern. Constrictions present in many species. Ventral lobe relatively narrow at base, with median saddle about or little less than half as high as entire lobe. First lateral saddle asymmetrically rounded; adventitious lobe relatively large, with almost straight sides. Many species. [The type species material is insufficiently preserved.] *Mississippian (upper Visean–Serpukhovian):* Great Britain, Ireland, Belgium, Germany, Czech Republic, Poland, Portugal, Spain, Algeria, Morocco, Poland, Russia and Kazakhstan (South Urals), Russia (Novaia Zemlia), Kazakhstan (Karaganda), China (Guangxi, Ningxia), USA (Arkansas, Alaska).——FIG. 30,*5a–c. S. splendens* (BISAT); *a,* side view, Hilly Clough Farm, Barnoldswick, Yorkshire, Bollandian, upper Visean, GSM GSL83593, ×1.3; *b,* ornamentation of test, River Ribber, Dinkley, Lancashire, GSM GSL83587, ×2.5; *c,* suture, Hilly Clough Farm, GSM GSL83593, diameter at 33 mm, ×1.8 (Moore, 1950).