RETICULARIOIDEA

J. L. Carter and Rémy Gourvennec

[retired from Carnegie Museum of Natural History; and Université de Bretagne Occidentale]

Superfamily RETICULARIOIDEA Waagen, 1883

[*nom. correct.* Gourvennec & Carter in Carter & others, 1994, p. 353, *pro* Reticulariacea Pitrat, 1965, p. 717, *nom. transl. ex* Reticulariinae Waagen, 1883a, p. 538]

Subequally biconvex; outline generally transversely subovate to equidimensional; hinge line short, lateral extremities rounded; fold and sulcus generally present, generally weakly developed; ribbing absent or weak, rarely multicostate; microornament often lamellose, commonly with fine spines or granules. *Silurian (upper Llandovery)–Permian.*

Family RETICULARIIDAE Waagen, 1883

[*nom. transl.* Ivanova, 1959, p. 56, *ex* Reticulariinae Waagen, 1883a, p. 538]

Lateral slopes usually smooth, rarely plicate; fold and sulcus, if present, smooth; microornament concentrically arranged, consisting of growth lamellae and generally uniramous spinules or tubercles; dental adminicula generally present, true ventral septum absent but median ridge or myophragm present in some genera. *Silurian (upper Llandovery)–Permian.*

Subfamily RETICULARIINAE Waagen, 1883

[Reticulariinae Waagen, 1883a, p. 538]

[Materials for this subfamily prepared by J. L. Carter & Rémy Gourvennec]

Generally pauciplicate; lacking delthyrial plates, delthyrial ridges, or any kind of apical thickening; commonly lacking crural plates. *Lower Devonian (upper Pragian)–Permian.*

Reticularia M'Coy, 1844, p. 142 [**Terebratula? imbricata* Sowerby, 1822 in 1821–1822, p. 40; SD Davidson, 1882, p. 80]. Medium to large; unequally biconvex; fold and sulcus weakly to strongly developed; cardinal extremities well rounded; ornament of narrow, imbricate, growth lamellae fringed with fine, uniramous spines; exfoliated surfaces radially striated; ventral interior with dental adminicula and median ridge; dorsal interior with crural bases not touching valve floor; spiralia directed posterolaterally. *Carboniferous (Visean–Namurian):* Europe, Asia.——Fig. 1229,*2a–d.* **R. imbricata* (Sowerby), Visean, England; lectotype, dorsal, ventral, lateral, and anterior views, ×1 (George, 1932).

Georgethyris Minato, 1953, p. 68 [**Reticularia alexandri* George, 1932, p. 553; OD]. Fold and sulcus strongly developed; ventral interior seemingly lacking median ridge; otherwise similar to *Reticularia. Carboniferous (Visean):* British Isles.——Fig. 1229,*1a–d.* **G. alexandri* (George); holotype, dorsal, ventral, lateral, and anterior views, ×1 (George, 1932).

Parareticularia Li & Gu, 1976, p. 298 [**P. spiriferiformis;* OD]. Small to medium size; outline transversely spiriferoid with widely extended lateral extremities; ventral interarea moderately high; delthyrium wide, open; fold and sulcus strongly developed; lateral slopes with pair of wide shallow sulci; ornament consisting of lamellose growth lamellae fringed with numerous fine, uniramous, radial spines; ventral interior with short dental adminicula and long median ridge; dorsal interior lacking median ridge or septum. *Permian (Cisuralian):* China.——Fig. 1229,*3a–e.* **P. spiriferiformis;* ventral, dorsal, anterior, posterior, and lateral views, ×1 (Li & Gu, 1976).

Squamularia Gemmellaro, 1899, p. 189 [**S. rotundata;* OD]. Medium size; almost equally biconvex; outline subovate; ventral umbonal region broad, beak incurved; ventral interarea indistinct; ornament lamellose with widely spaced, undulating, squamose growth lamellae fringed with closely spaced, fine, uniramous spines; ventral interior simple, dental adminicula and septa absent; spiralia directed posterolaterally. *Permian (Lopingian):* Sicily.——Fig. 1229,*4a–f.* **S. rotundata; a–e,* topotype, ventral, dorsal, anterior, posterior, and lateral views, ×1; *f,* microornament, ×10 (new).

?Undispirifer Havlíček, 1957b, p. 439 [**Spirifer undiferus* Roemer, 1844, p. 73; OD] [=*Nakazatothyris* Minato & Kato, 1977, p. 623 (type, *Undispirifer (Nakazatothyris) vandercammeni* Minato & Kato, 1977, p. 623, OD); ?*Gerolsteinites* Struve, 1990, p. 268 (type, *Spirifera gerolsteinensis* Steininger, 1853, p. 76, OD)]. Medium to large size, transverse, with catacline to apsacline interarea and rounded cardinal extremities; narrow, well-developed fold and sulcus; flanks with 5 to 8 low

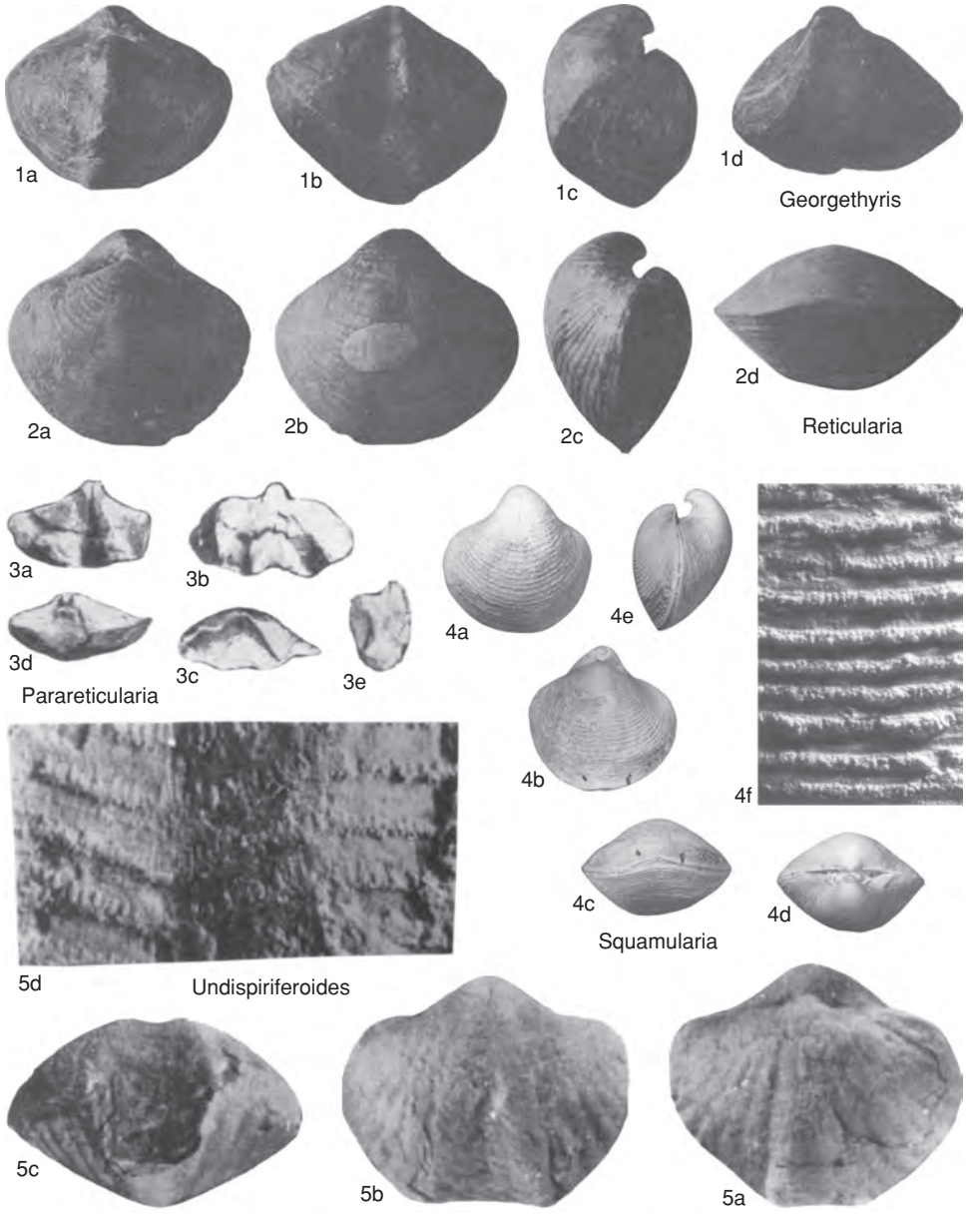

FIG. 1229. Reticulariidae (p. 1848–1850).

plications; microornament of concentric growth lamellae and marginal spines; dental plates long; crural plates short or lacking; ctenophoridium present. [The genus *Undispirifer* is here accepted with a broad definition, awaiting revision of the undispiriferoid stock(s), especially interiors, in Germany and immediate environs. *?Gerolsteinites* STRUVE, 1990, was diagnosed as having stronger ribs and a narrower ventral interarea than *Undispirifer.* After revision it might be revived as a subgenus of *Undispirifer,* or it could be a synonym of the genus *Corylispirifer* GOURVENNEC, 1989, to which it is also similar.] *Lower Devonian (upper Pragian)–Upper Devonian (Frasnian):* cosmopolitan.——FIG. 1230*a–f.* **U. undiferus* (ROEMER); dorsal, ventral, anterior, lateral views, lower

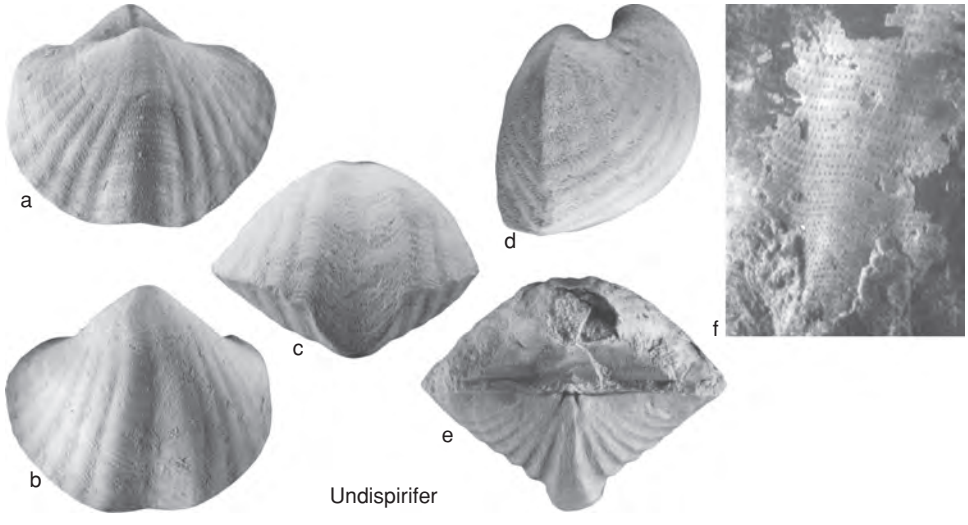

FIG. 1230. Reticulariidae (p. 1848–1850).

Givetian, Moravia, Czech Republic, ×1.8 (new); *e,* posterior view of internal mold, Givetian, Eifel, Germany, ×1.5; *f,* ornament, Givetian, Eifel, Germany, ×5 (Johnson, 1974).

?Undispiriferoides XIAN in XIAN & JIANG, 1978, p. 330 [**U. huishuiensis;* OD]. Medium to large size, subcircular; cardinal extremities rounded; sulcus and fold distinct, smooth; lateral costae low; microornament of concentric lamellae with 2 or 3 rows of spines; dental plates thin; crural bases platelike. [The interior of this genus is poorly known and has never been illustrated.] *Middle Devonian (Givetian):* southern China.——FIG. 1229,*5a–d.* **U. huishuiensis; a–c,* dorsal, ventral, anterior views, ×1; *d,* ornament, ×10 (Xian & Jiang, 1978).

Subfamily RETICULARIOPSINAE Gourvennec, 1994

[Reticulariopsinae GOURVENNEC in CARTER & others, 1994, p. 355]

[Materials for this subfamily prepared by Rémy Gourvennec]

Generally pauciplicate; lacking delthyrial plates, delthyrial ridges, or any kind of apical thickening; dental plates, crural plates, and ctenophoridium present. *Silurian (Wenlock)–Middle Devonian (Givetian).*

Reticulariopsis FREDERIKS, 1916, p. 17 [**Spirifer (Reticularia) dereimsi* OEHLERT, 1901, p. 236; SD FREDERIKS, 1918a, p. 87] [=*Tingella* GRABAU, 1931b, p. 406 (type, *T. reticularioides,* OD)]. Small to medium size, slightly transverse, with rounded cardinal angles; low, short, gently curved, apsacline interarea; weak, narrow, well-delimited fold and sulcus; flanks smooth or with 3 to 4 incipient, low plications; microornament of concentric growth lamellae and marginal spines; dental plates high, rather short; ctenophoridium and long crural plates. *Silurian (Wenlock)–Middle Devonian (Givetian):* cosmopolitan.——FIG. 1231,*4a–h.* **R. dereimsi* (OEHLERT), Emsian; *a–e,* dorsal, ventral, anterior, posterior, lateral views, Spain, ×2; *f,* posterior view of internal mold, Spain, ×3; *g–h,* ornament, unweathered spines, Massif Armoricain, France, ×10 (Gourvennec, 1994b).

Corylispirifer GOURVENNEC, 1989, p. 191 [**C. monicae;* OD]. Medium to large size, moderately transverse, with moderately high, slightly curved ventral interarea; cardinal angles rounded; fold and sulcus well marked, smooth; flanks bearing 2 to 5 rather low, wide, rounded plications; microornament of concentric, regularly spaced growth lamellae and closely spaced, marginal, uniramous spine bases; dental plates long, divergent, posteriorly thickened; ctenophoridium and long crural plates. *Lower Devonian (Pragian–Emsian):* western France, Spain.——FIG. 1231,*1a–g.* **C. monicae,* Pragian, Massif Armoricain, western France; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1.5; *f,* ornament, ×10; *g,* posterior view of decorticated shell showing internal characters, ×3 (Gourvennec, 1989).

Kymatothyris STRUVE, 1970, p. 533 [**K. kroemmelbeini;* OD] [=*Fallaxispirifer* SU, 1976, p. 226 (type, *Spirifer pseudofallax* KHALFIN, 1935, p. 18, OD)]. Large, transverse, with rounded cardinal angles; ventral interarea apsacline, high, curved; sulcus and fold well expressed, wide; dorsal valve with 2 to 5 low, wide, lateral plications weakening anteriorly; plications of ventral valve commonly

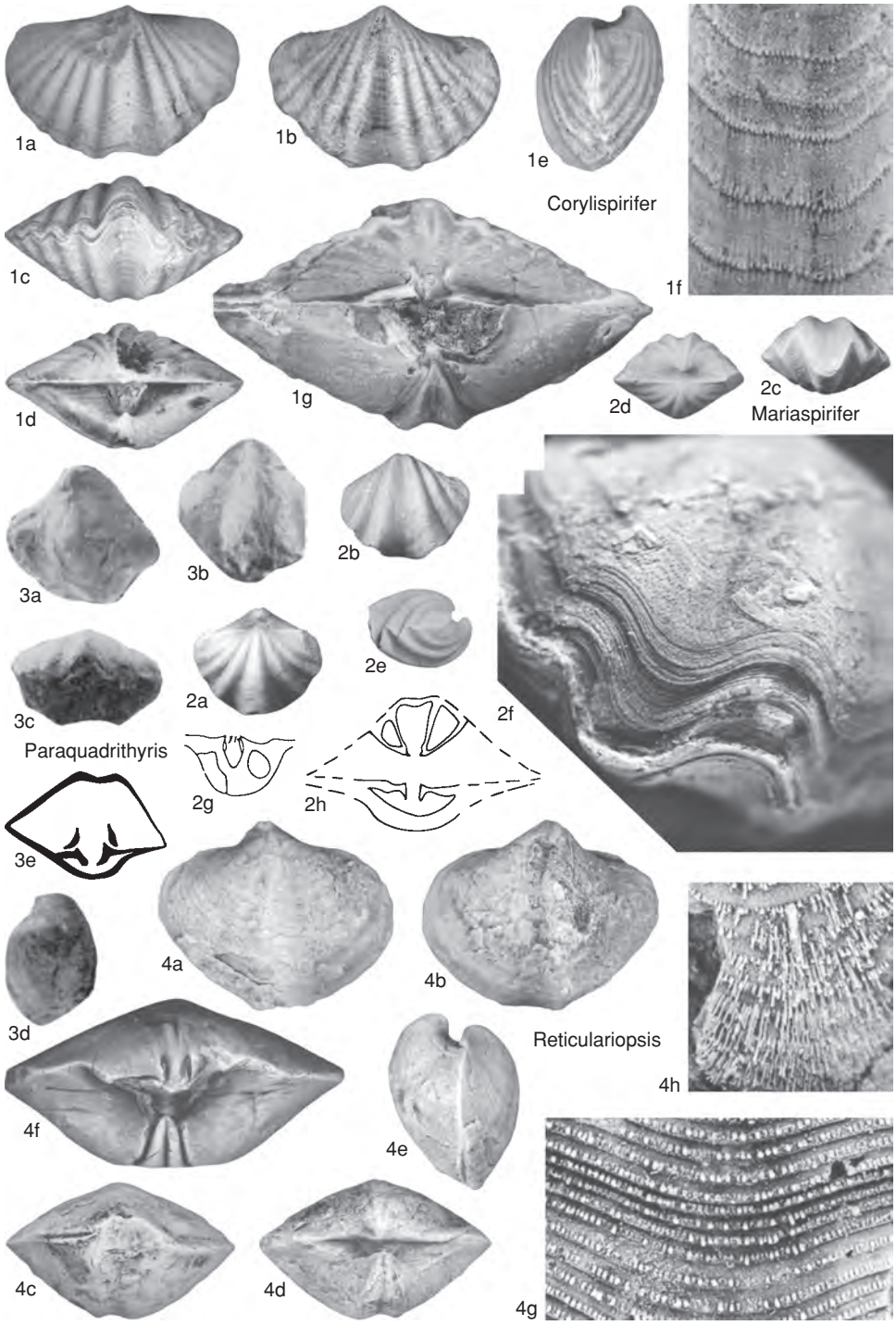

FIG. 1231. Reticulariidae (p. 1850–1852).

weaker or absent; microornament of concentric growth lines and simple spine bases; dental plates long, thin, slightly divergent to subparallel; crural plates short. *Lower Devonian (?upper Pragian, Emsian)–Middle Devonian (Eifelian):* Germany. ——FIG. 1232,*1a–c. *K. kroemmelbeini,* Eifelian, Salmerwald Mulde; dorsal, ventral, posterior views, ×0.7 (Struve, 1970).——FIG. 1232,*1d–f. K. bornicensis* (FUCHS), lower Emsian, Hunsrück; lateral, posterior views, interior of ventral valve, ×0.7 (Struve, 1970).

Mariaspirifer CHERKESOVA, 1991, p. 97 [**M. dolganensis;* OD]. Small size, equidimensional to slightly transverse with low, curved interarea; delthyrium with possible deltidial plate; fold and sulcus well marked; flanks commonly with 2 narrow plications; spinose microornament; dental plates short; massive ctenophoridium on cardinal platform and long crural plates. *Lower Devonian (lower Emsian):* Taimyr.——FIG. 1231,*2a–h. *M. dolganensis; a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1; *f,* ornament, ×5; *g–h,* serial sections, magnification unknown (Cherkesova, 1991).

?Paraquadrithyris YANG in ZHANG & others, 1983, p. 367 [**P. kashgarensis;* OD]. Medium size, with rhomboidal outline; sulcus and fold present, smooth; lateral plications few (1 to 2), low, and wide; microornament of growth lines and marginal spine bases; dental plates long, thin. [Poorly known genus, possibly synonym of *Reticulariopsis.*] *Middle Devonian:* China.——FIG. 1231,*3a–e. *P. kashgarensis,* Xingjiang; *a–d,* dorsal, ventral, anterior, lateral views, ×1; *e,* transverse section, ×2 (Zhang & others, 1983).

Pavdenia BREIVEL & BREIVEL, 1988, p. 114 [**Spirifer (?Eospirifer) pavdensis* SHTREIS, 1951, p. 242; OD]. Medium to large size, equidimensional to slightly transverse, with widely rounded cardinal extremities; ventral interarea high, gently curved, apsacline; sulcus and fold sharply delimited from flanks in mature specimens; entire shell smooth; microornament of closely spaced growth lamellae bearing radially aligned marginal spines; dental plates long, thin; crural plates short. *Silurian (Wenlock):* Urals.——FIG. 1232,*2a–f. *P. pavdensis* (SHTREIS); *a–d,* dorsal, ventral, anterior, lateral views, ×1; *e,* ornament, ×5; f, transverse section, ×2 (Breivel & Breivel, 1988).

Prosserella GRABAU in GRABAU & SHERZER, 1910, p. 138 [**P. modestoides;* SD BASSLER, 1915, p. 1,102]. Small to medium size, equidimensional to slightly transverse, with short, relatively high, gently curved ventral interarea; fold and sulcus absent or moderately developed, smooth; flanks smooth or bearing 4 to 5 low, rounded plications on anterior half of shell; rectimarginate to uniplicate commissure; microornament of growth lines only; dental lamellae long, thin, parallel, closely spaced; ctenophoridium with short, closely spaced crural plates. *Lower Devonian (?upper Emsian), Middle Devonian (Eifelian):* eastern North America.——FIG. 1232,*3a–f. *P. modestoides,* ?upper Emsian, lower Eifelian, Ontario, Canada; *a–b,* dorsal, lateral views, ×3; *c,* anterior view, ×2; *d,* posterior view of internal mold showing crural plates, cardinal process, and short myophragm, ×2; *e,* interior of ventral valve showing closely spaced dental plates, ×1.3; *f,* ventral interior of costate morphotype, ×2 (Fagerstrom, 1971).

Yeothyris STRUVE, 1992, p. 582 [**Tingella bicollina* STRUVE, 1961, p. 332; OD]. Large size, equidimensional to transverse, with well-delimited, wide, ventral interarea; cardinal extremities rounded; fold and sulcus small, well defined; flanks smooth; microornament of growth lines and marginal spines; dental plates long, moderately divergent, strong; ctenophoridium with short crural plates. *Middle Devonian (middle Eifelian):* Germany, Belgium.——FIG. 1232,*4a–g. *Y. bicollina* (STRUVE), Eifel, Germany; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1 (Struve, 1970); *f,* ornament, ×10 (Struve, 1961); *g,* posterior view of internal mold, ×1 (Struve, 1970).

Subfamily RHENOTHYRIDINAE Gourvennec, 1994

[Rhenothyridinae GOURVENNEC in CARTER & others, 1994, p. 355]

[Materials for this subfamily prepared by Rémy Gourvennec]

With delthyrial plate, ridge, or ventral apical thickening; dental plates and ctenophoridium present. *Silurian (upper Llandovery)–Upper Devonian (Frasnian).*

Rhenothyris STRUVE, 1970, p. 460 [**R. rhenana;* OD]. Large size, transverse, with low ventral interarea; deltidial plates joining apically in a short deltidium; cardinal extremities rounded; fold and sulcus wide, high to strongly developed; entire shell devoid of plications; regularly spaced growth lamellae with marginal spines; dental plates long, divergent; ctenophoridium and long, thick crural plates. *Lower Devonian (upper Emsian)–Middle Devonian (lower Eifelian, ?Givetian):* Germany, Belgium, ?northern Africa, ?Kazakhstan.——FIG. 1233,*1a–h. *R. rhenana,* lower Eifelian, Eifel, Germany; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×0.7; *f,* ornament, ×5.75; *g,* posterior view of steinkern showing internal structures, ×1.3; *h,* section showing delthyrial plate, ×3 (Struve, 1970).

Deltospirifer WANG & RONG, 1986, p. 208 [263] [**Elytha transversa* WANG, 1956, p. 378; OD]. Medium to large size, transverse to equidimensional, with slightly acute to rounded cardinal extremities; low, curved, apsacline ventral interarea; delthyrium entirely covered by deltidium; fold and sulcus well defined; anterior commissure uniplicate; lateral plications few (1 to 3), low and weakening anteriorly; microornament of growth lamellae and marginal spine bases; dental plates long, thin; ctenophoridium without crural plates. *Lower Devonian*

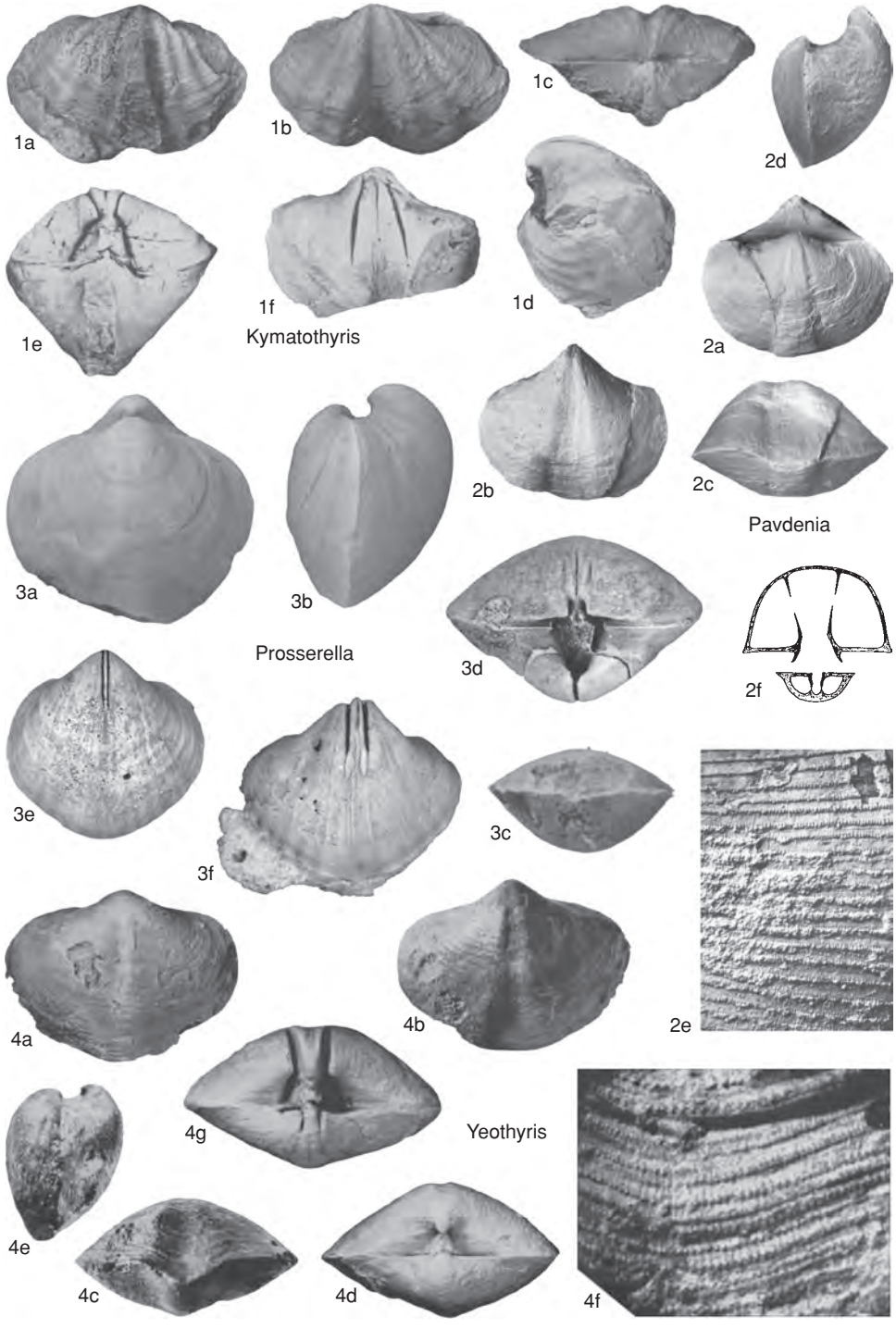

FIG. 1232. Reticulariidae (p. 1850–1852).

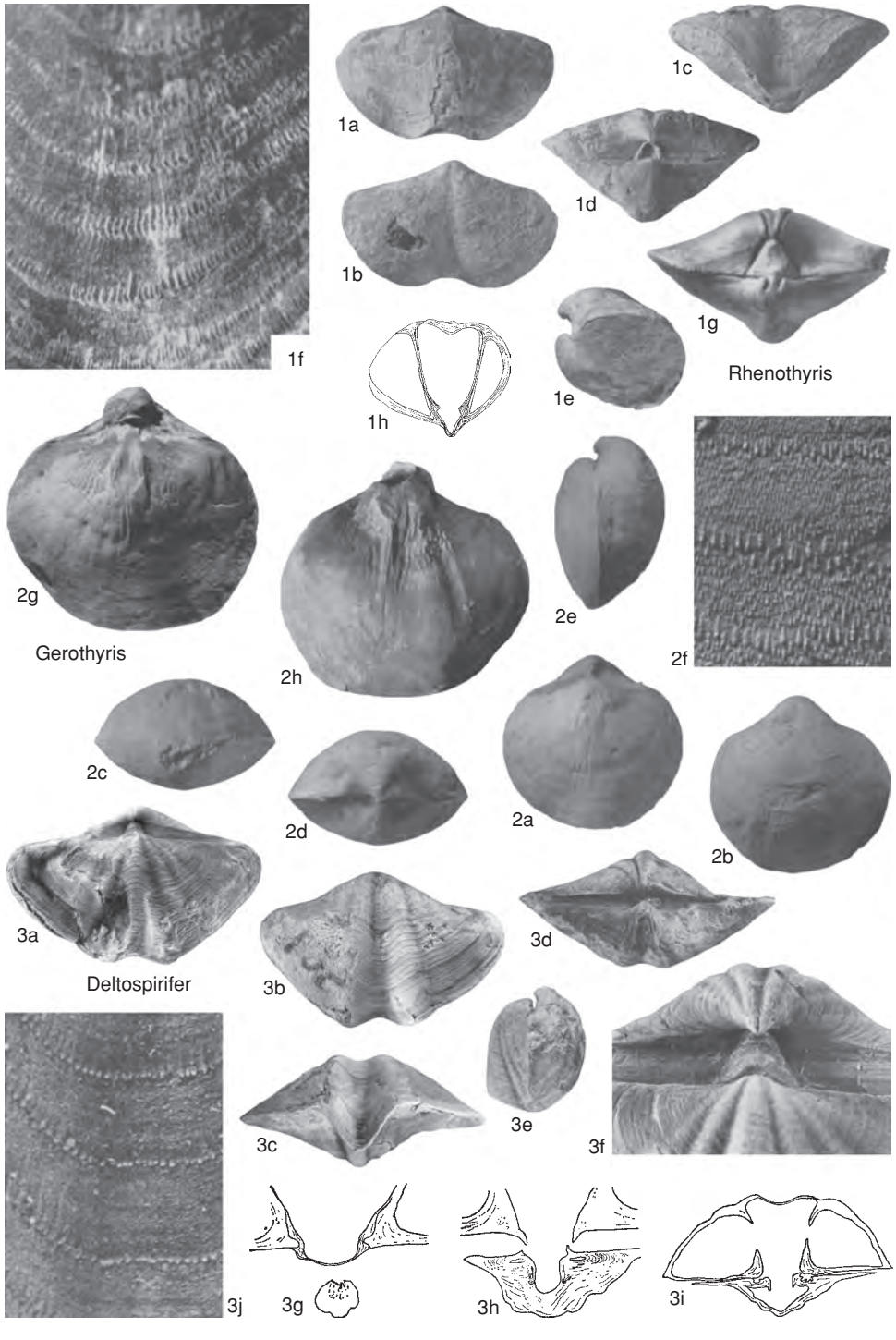

FIG. 1233. Reticulariidae (p. 1852–1855).

(Emsian)–Middle Devonian (Eifelian): China.——Fig. 1233,*3a–i.* **D. transversus* (Wang), Emsian, Guangxi; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1; *f,* detail of deltidial cover, ×3; *g–h,* serial sections, ×3.8; *i,* serial section, ×1.5 (Wang & Rong, 1986).——Fig. 1233,*3j. D. ovatus* (Wang), Emsian; ornament, ×6 (Wang & Rong, 1986).

?Eohowellella Lopushinskaia, 1976, p. 79 [**Eomartiniopsis(?) minimus* Lopushinskaia, 1965, p. 30; OD]. Very small, unequally biconvex, equidimensional, with rounded cardinal angles; ventral interarea relatively high; sulcus narrow and shallow; fold well delimited by wide sulci; microornament of growth lines and radial striae; dental plates uniting in rudimentary septum (spondylium?); crural plates. [The definition of *Eohowellella* is imprecise and not in accordance with the original illustrations. For example, the so-called ventral septum recorded in the diagnosis is absent on the serial sections; if such a septum is really present, *Eohowellella* would better be assigned to the Quadrithyridinae. The comparison with *Howellella* suggests that a ctenophoridium is present although not reported in the diagnosis. The mention of a finely punctate shell in the description is probably erroneous; such a character would necessitate removal of *Eohowellella* from the Reticularioidea.] *Silurian (upper Llandovery–lower Ludlow):* Siberian Platform.——Fig. 1234,*1a–c.* **E. minima* (Lopushinskaia), Wenlock; dorsal, ventral, anterior views, ×1.5 (Lopushinskaia, 1976).

Gerothyris Struve, 1970, p. 537 [**Spirifer laevigatus eiflianus* Quenstedt, 1871 in 1868–1871, p. 514; OD]. Medium size, equidimensional to slightly transverse, with widely rounded cardinal angles; ventral interarea short, low, orthocline to catacline; sulcus and fold lacking but anterior commissure slightly uniplicate; flanks smooth; microornament of growth lines obscure or lacking and roughly concentric rows of papillae alternating with smaller, randomly distributed papillae; dental plates short, thickened with apical callosity and excavated muscle field; ctenophoridium and long, thin crural plates. *Middle Devonian (Eifelian):* Germany, Belgium.——Fig. 1233,*2a–h.* **G. eifliana* (Quenstedt), Eifel, Germany; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1; *f,* ornament, ×10; *g–h,* dorsal, ventral views of internal mold, ×1.5 (Struve, 1970).

Grebenella Modzalevskaia & Beznosova, 1992, p. 8 [**Spirifer parvulus* Chernyshev & Iakovlev, 1898, p. 352; OD]. Small, rounded to slightly transverse, with high, apsacline, curved, ventral interarea; cardinal extremities rounded to acutely rounded; fold and sulcus well defined, weak; flanks with 2 to 3 low plicae; microornament of growth lamellae only; dental plates strong, long, and small delthyrial plate or ridges; well-developed crural plates and ctenophoridium; dorsal apical thickening of shell. *Silurian (Pridoli):* northeastern Russia (Arctic Islands).——Fig. 1234,*2a–g.* **G. parvula* (Chernyshev & Iakovlev); *a–c,* dorsal, ventral, anterior views, ×3.5 (Modzalevskaia & Beznosova, 1992); *d–e,* posterior, lateral views, ×3.5 (new); *f,* transverse section showing short delthyrial plate, ×3 (Modzalevskaia & Beznosova, 1992); *g,* transverse section showing crural plates, ×2 (Modzalevskaia, 1981).

?Nordella Liashenko, 1973, p. 135 [**Elytha orbiculata* Liashenko, 1959, p. 142; OD]. Medium to large size, equidimensional, subcircular; ventral interarea low and short, with delthyrium mostly covered by convex deltidium; fold and sulcus poorly expressed, smooth; anterior commissure slightly uniplicate; flanks smooth or bearing 4 to 10 very weak, wide plications near anterolateral commissure; microornament of growth lines bearing marginal spine bases; dental plates long, divergent; crural plates lacking. [A ctenophoridium is not reported in the diagnosis of *Nordella,* but the comparison with *Elita* suggests close analogies in the internal structures, and we admit the presence of a ctenophoridium; should this not be the case, *Nordella* would be better placed in the Eoreticulariinae.] *Upper Devonian (lower Frasnian):* Russia (Siberia).——Fig. 1234,*5a–g.* **N. orbiculata* (Liashenko), Russian Platform; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×0.7; *f,* ornament, ×10; *g,* transverse section, magnification unknown (Liashenko, 1973).

Pseudoundispirifer Zhang, 1987a, p. 144 [**P. yiwaensis;* OD]. Small, equidimensional to slightly transverse, with curved ventral interarea; fold and sulcus weak; lateral plications rare, low; microornament of growth lamellae and marginal spines; dental plates long, thin, and well-developed delthyrial plate; crural plates and ctenophoridium on cardinal platform. [This poorly known genus is probably a synonym of *Eoreticularia.*] *Middle Devonian (Givetian):* China.——Fig. 1234,*4a–h.* **P. yiwaensis; a–d,* dorsal, ventral, anterior, lateral views, ×1; *e–h,* serial sections, ×3 (Zhang, 1987a).

?Puanospirifer Jiang in Xian & Jiang, 1978, p. 329 [**P. guanziyaoensis;* OD]. Medium size, triangular in outline; flanks smooth or with weak plications; microornament with marginal spines; short dental plates and ventral apical thickening; crural plates lacking. [This genus is poorly known and is possibly a synonym of *Deltospirifer.*] *Lower Devonian (Emsian):* southern China.——Fig. 1234,*3a–b.* **P. guanziyaoensis,* Guizhou; dorsal, ventral views, ×0.7 (Xian & Jiang, 1978).——Fig. 1234,*3c–e. P. transversus* Jiang, Guizhou; anterior, posterior, lateral views, ×1 (Xian & Jiang, 1978).

Spirinella Johnston, 1941, p. 161 [**S. caecistriata;* OD] [=*Ectatoglossa* Chu, 1974, p. 419 (type, *E. biplicata,* OD)]. Medium size; equidimensional to slightly transverse, smooth, inequivalve with apsacline, curved ventral interarea; cardinal angles rounded; fold and sulcus smooth, very low, poorly defined except near weakly uniplicate commissure; flanks lacking plications; numerous closely spaced growth lamellae with marginal spine bases or papillae; moderately long, divergent dental plates, short delthyrial plate, and variably impressed muscle field; ctenophoridium and short crural plates.

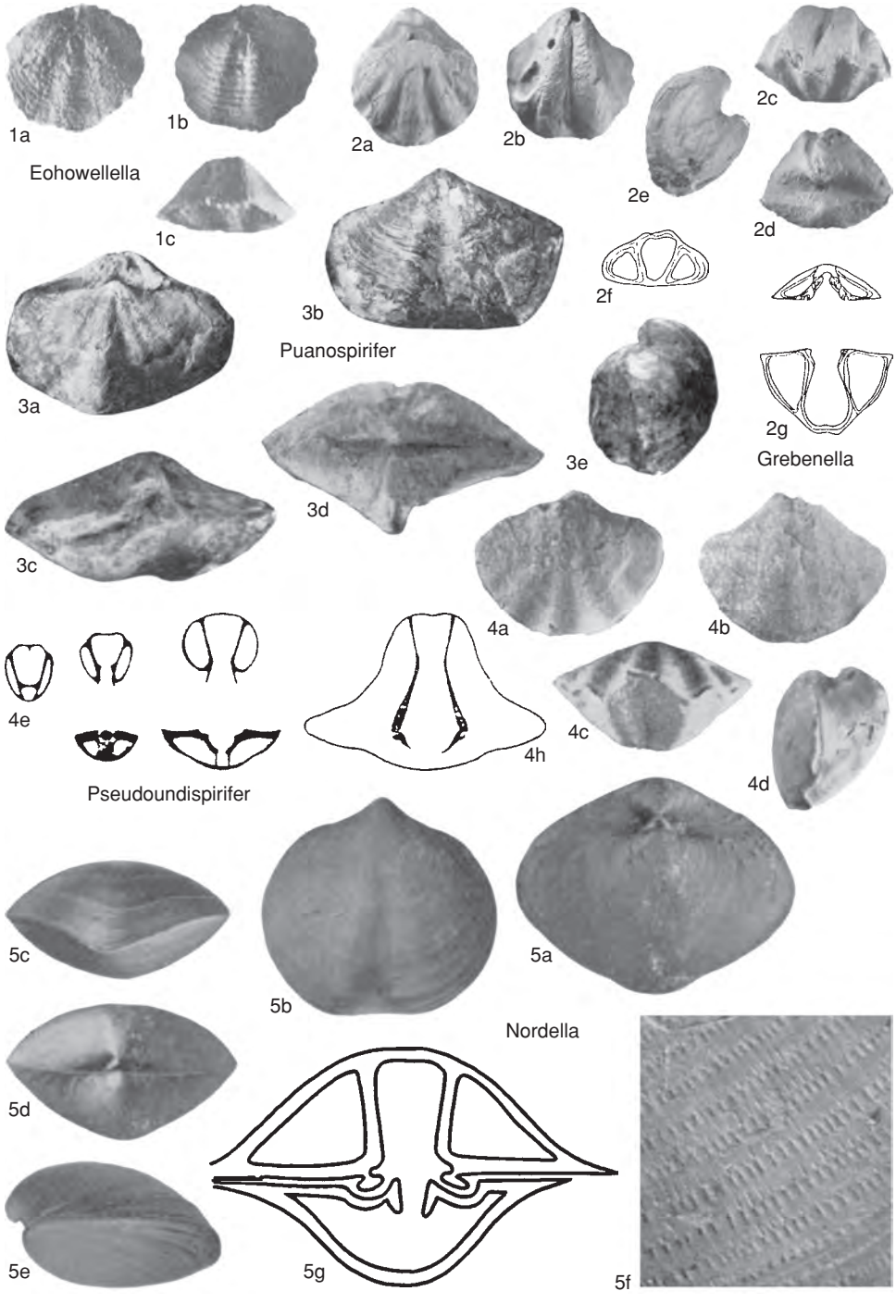

FIG. 1234. Reticulariidae (p. 1855).

Silurian (upper Llandovery)–Lower Devonian (upper Emsian): Australia, western North America, Altai, China, Czech Republic.——Fig. 1235,*1a–j. *S. caecistriata,* lower Ludlow, New South Wales, Australia; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1.5; *f,* ornament, ×16 (Strusz, 1984); *g,* detail of cardinalia, ×5 (Strusz, 1985); *h–j,* dorsal, ventral, posterior views of internal mold, ×1.5 (new).

Uexothyris Struve, 1992, p. 572 [**U. convergens;* OD]. Medium size, transverse to equidimensional, with rounded cardinal extremities; low to moderately high, wide ventral interarea; sulcus and fold lacking or very weak; flanks smooth; microornament of marginal papillae; dental plates possibly lacking or short; strongly excavated muscle field; closely spaced, short crural plates and ctenophoridium. [No satisfactory illustrations are available for this genus.] *Middle Devonian (Eifelian):* Germany.

Warrenella Crickmay, 1953a, p. 596 [**W. eclectea;* OD] [=*Minatothyris* Vandercammen, 1957, p. 178 (type, *Spirifer euryglossus* Schnur, 1851, p. 11, OD)]. Medium to large, elongate; low, curved, apsacline ventral interarea; apex of delthyrium with short deltidium; cardinal angles rounded; fold and sulcus poorly expressed but generally distinct; closely spaced growth lamellae with marginal spine bases; strong apical callus; closely spaced, subparallel dental plates and deeply impressed muscle field; ctenophoridium and highly variable crural plates. *Lower Devonian (upper Pragian)–Upper Devonian (Frasnian).*

W. (Warrenella). Lateral plications lacking or incipient near commissure. *Lower Devonian (upper Pragian)–Upper Devonian (Frasnian):* cosmopolitan.——Fig. 1235,*2a–g. *W. eclectea,* Frasnian, Alberta, Canada; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1.5 (Crickmay, 1953); *f–g,* ventral, posterior views of internal mold, ×1.5 (new).

W. (Warrenellina) Brice, 1982b, p. 103 [**W. (W.) extensa;* OD]. Medium size, with 0 to 5 low, obsolescent plications in vicinity of commissure; uncommonly with 1 faint median rib in sulcus and corresponding groove on fold. *Lower Devonian (Emsian)–Upper Devonian (Frasnian):* western and arctic North America.——Fig. 1235,*3a–h. *W. (W.) extensa,* Eifelian, Northwest Territories, Canada; *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1; *f,* ornament, ×4; *g–h,* serial sections, ×2 (Brice, 1982b).

Subfamily OBESARIINAE Gourvennec, 1994

[Obesariinae Gourvennec in Carter & others, 1994, p. 356]

[Materials for this subfamily prepared by Rémy Gourvennec]

Smooth; lacking dental plates and ctenophoridium; apical thickening in ventral valve. *Silurian (upper Wenlock)–Middle Devonian (Eifelian), Carboniferous (?Mississippian).*

Obesaria Havlíček, 1957b, p. 438 [**Spirifer indifferens* var. *obesa* Barrande, 1848, p. 159; OD] [=*Obessaria* Havlíček, 1957b, p. 438, obj., *lapsus calami*]. Medium size, slightly transverse, with rounded cardinal angles; short, low, ventral interarea; fold absent; sulcus narrow and shallow near umbo, rapidly deepening and widening anteriorly; anterior commissure strongly uniplicate; flanks smooth; microornament of faint growth lines and concentric, radial rows of minute granules; deeply impressed ventral muscle field, lacking dental plates; strong apical callosity; crural plates and ctenophoridium lacking. [In the original publication by Havlíček (1957b), the new genus is spelled *Obessaria* nov. gen., but in the remaining parts of the text and in the English summary it is spelled *Obesaria.*] *Middle Devonian (Eifelian):* Czech Republic.——Fig. 1236,*1a–g. *O. obesa* (Barrande); *a–e,* dorsal, ventral, anterior, posterior, lateral views, ×1.5; *f,* ornament, ×10; *g,* internal mold showing muscle field and lack of dental plates, ×1 (Havlíček, 1959).

Alaskospira Kirk & Amsden, 1952, p. 61 [**A. dunbari;* OD] [=*Proreticularia* Havlíček, 1957a, p. 247 (type, *Spirifer carens* Barrande, 1879, p. 218, OD)]. Medium size, equidimensional to slightly transverse, with apsacline, curved ventral interarea; cardinal angles rounded; fold and sulcus ill defined except near anterior commissure; shell surface smooth; microornament of closely spaced growth lines and radial rows of spines; dental plates lacking; strong apical thickening; muscle field deeply impressed, divided by a median ridge extending nearly to anterior margin; ctenophoridium and crural plates lacking; low myophragm. *Silurian (upper Wenlock)–Lower Devonian (Emsian):* USA (Alaska), Czech Republic, Urals, Australia (New South Wales).——Fig. 1236,*2a–i. *A. dunbari,* upper Wenlock, Alaska, USA; *a–d,* dorsal, ventral, posterior, lateral views, ×2; *e,* ornament, ×6; *f–i,* serial sections, ×1.5 (Kirk & Amsden, 1952).

Echinocoeliopsis Hamada, 1968b, p. 17 [**E. sculpta;* OD]. Very small to small, strongly inequivalve, equidimensional with rounded cardinal angles; low and short interarea; sulcus obscure; fold distinctly separated from flanks by wide sulci; commissure rectimarginate; flanks smooth; microornament of growth lamellae and marginal spine bases; dental plates and crural plates lacking; cardinal process bifid. *?Upper Devonian, Carboniferous (?Mississippian):* Malaysia.——Fig. 1236,*4a–e. *E. sculpta; a,* dorsal valve showing ornament, ×8; *b,* ventral valve, approximately ×3; *c,* anterior view of ventral valve, ×3; *d,* lateral view of ventral valve, ×5; *e,* interior of dorsal valve, ×5 (Hamada, 1968b).——Fig. 1236,*4f. E. ladjioidea* Hamada; interior of ventral valve, ×3 (Hamada, 1968b).

Quasimartinia Havlíček, 1959, p. 179 [**Q. rectimarginata;* OD] [=*Candispirifer* Havlíček,

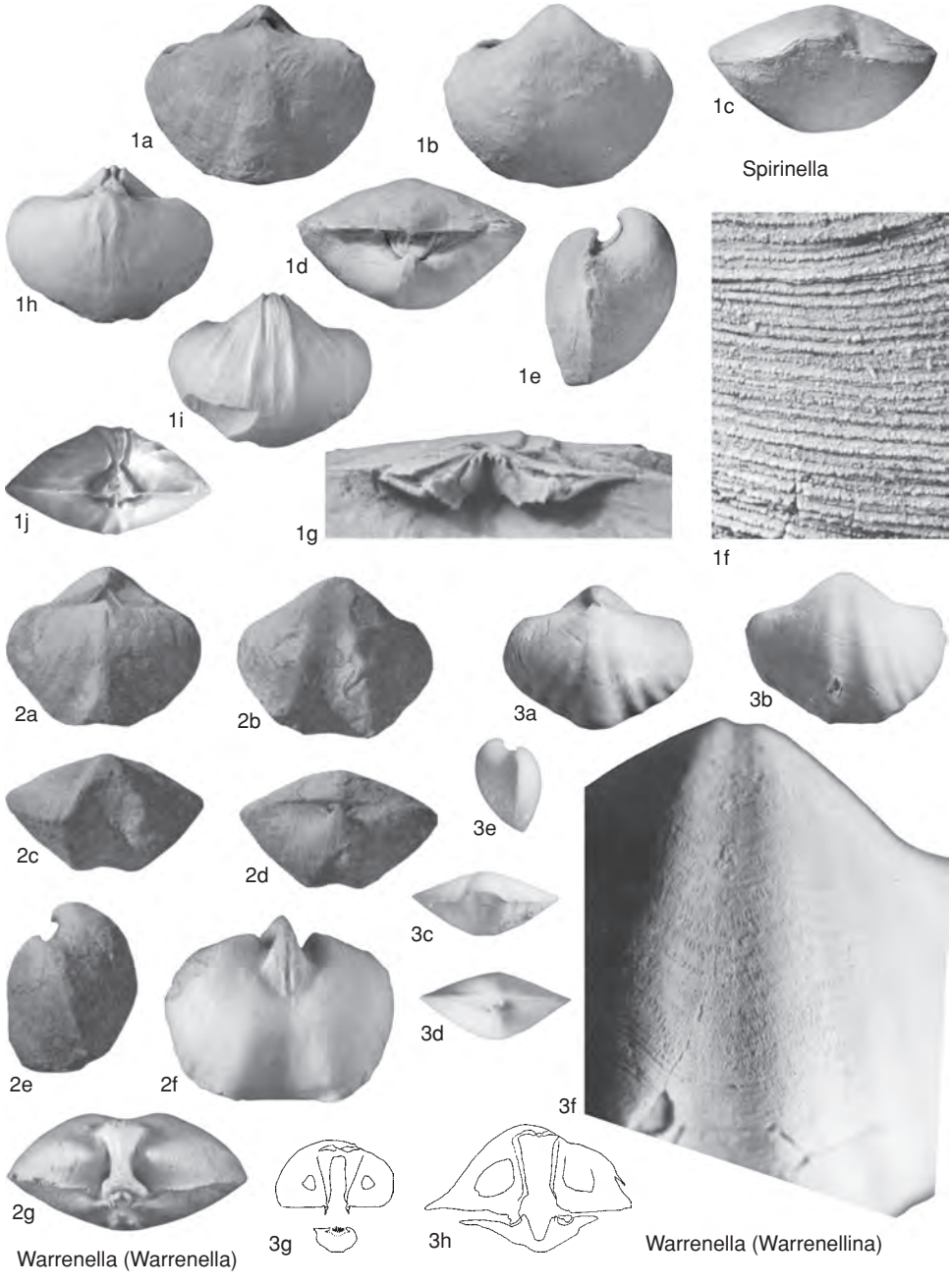

FIG. 1235. Reticulariidae (p. 1855–1857).

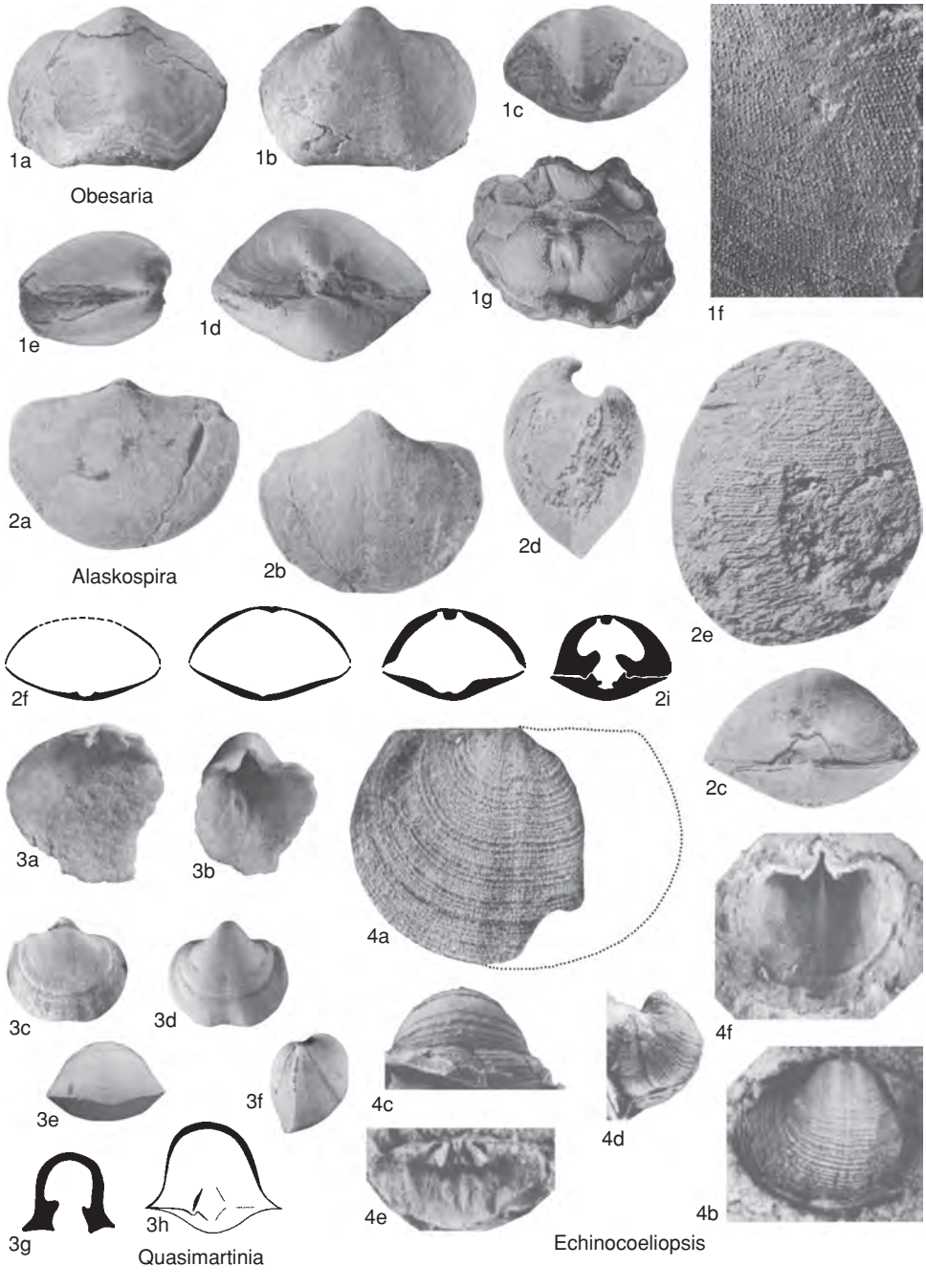

FIG. 1236. Reticulariidae (p. 1857–1860).

1971, p. 26 (type, *Proreticularia candida* Havlíček, 1959, p. 155, OD)]. Small size, equidimensional, strongly inequivalve; ventral valve high with low, curved, apsacline interarea and strong beak; cardinal angles rounded; fold and sulcus absent or scarcely marked near anterior commissure; entire shell smooth; microornament lacking; dental plates, septum, and crural plates lacking; cardinal process bilobed. *Lower Devonian (Pragian)–Middle Devonian (Eifelian):* Czech Republic.——Fig. 1236,*3a–b.* **Q. rectimarginata,* Pragian; interior of dorsal valve, interior of ventral valve, ×3.5 (Havlíček, 1959).——Fig. 1236,*3c–h. Q. candida* (Havlíček), Pragian; *c–f,* dorsal, ventral, anterior, lateral views, ×1.5; *g–h,* serial sections, ×3 (Havlíček, 1959).

Subfamily EORETICULARIINAE Gourvennec, 1994

[Eoreticulariinae Gourvennec in Carter & others, 1994, p. 356]

[Materials for this subfamily prepared by Rémy Gourvennec]

Smooth; with cardinal platform or septalium; lacking ctenophoridium. *Silurian (Wenlock)–Upper Devonian (Frasnian).*

Eoreticularia Nalivkin in Frederiks, 1924, p. 314 [**Spirifer indifferens* Barrande, 1848, p. 159; OD]. Medium to large, equidimensional to slightly transverse, with rounded cardinal extremities; low, curved ventral interarea; fold obscure, sulcus shallow, deepening anteriorly and producing uniplicate commissure; lateral plications generally lacking or very faintly expressed; microornament of growth lamellae and minute granules arranged in radial rows, lacking spines; long, thin dental plates and delthyrial plate or ridge; short crural plates joining median septum or ridge; cardinal process smooth. *Silurian (Ludlow)–Upper Devonian (Frasnian):* Czech Republic, Poland, Germany, Kazakhstan, Urals, China, Morocco, Algeria, Mauritania.——Fig. 1237,*1a–e.* **E. indifferens* (Barrande), Emsian, Czech Republic; *a–d,* dorsal, ventral, anterior, lateral views, ×1.5; *e,* transverse section of dorsal valve, ×3 (Havlíček, 1959).——Fig. 1237,*1f. E. fraterna* (Barrande), Emsian, Czech Republic; transverse section showing delthyrial plate, ×3 (Havlíček, 1959).

Chnaurocoelia Johnson, Boucot, & Murphy, 1976, p. 95 [**C. transversa;* OD]. Very small to small, slightly transverse, with apsacline ventral interarea; cardinal angles acutely rounded; very shallow sulcus and obscure fold; 5 to 6 low, ill-defined plications on each flank; microornament unknown; dental lamellae short, thin; ctenophoridium and crural plates lacking. *Silurian (Ludlow):* USA (Nevada).——Fig. 1237,*3a–g.* **C. transversa; a–e,* dorsal, ventral, anterior, posterior, lateral views; *f,* interior of dorsal valve; *g,* interior of ventral valve, ×5 (Johnson, Boucot, & Murphy, 1976).

?Protoreticularia Su, 1980, p. 323 [**P. fimbriata;* OD]. Small, subpentagonal, with rounded cardinal extremities and high, curved ventral interarea; lateral plications, fold and sulcus lacking or shallow median depression on ventral valve; microornament of growth lamellae and marginal spines; interior poorly investigated, with short, thin dental plates, lacking crural plates. [Apparently this genus lacks crural plates, but the interior is poorly known and needs further investigation for a solid assignment to the subfamily.] *Silurian (Ludlow):* China.——Fig. 1237,*2a–d.* **P. fimbriata,* northeastern China; *a–c,* dorsal valve, ventral, posterior views of ventral valve, ×3; *d,* ornament, ×10 (Su, 1980).

Vadum Strusz, 1982, p. 136 [**V. coppinsense;* OD]. Very small, slightly transverse, with rounded cardinal extremities; high, catacline ventral interarea; fold and sulcus distinct or very subdued; flanks lacking plications; growth lamellae few, bearing both radially and concentrically arranged papillae; dental plates thin, moderately long; crural plates short, cardinal process bilobed. *Silurian (Wenlock):* Australia.——Fig. 1237,*4a–e.* **V. coppinsense,* New South Wales; *a–b,* dorsal, ventral views, ×5; *c,* lateral view, ×8; *d,* detail of cardinalia, ×12; *e,* internal mold of ventral valve, ×6 (Strusz, 1982).

Family XENOMARTINIIDAE Havlíček, 1971

[Xenomartiniidae Havlíček, 1971, p. 24]

[Materials for this subfamily prepared by Rémy Gourvennec]

With ventral median septum. *Silurian (upper Wenlock)–Middle Devonian (Givetian).*

Subfamily XENOMARTINIINAE Havlíček, 1971

[*nom. transl.* Gourvennec in Carter & others, 1994, p. 357, *ex* Xenomartiniidae Havlíček, 1971, p. 24]

Smooth; lacking dental plates and ctenophoridium. *Lower Devonian (Pragian)–Middle Devonian (Eifelian).*

Xenomartinia Havlíček, 1953, p. 6 [**X. monosepta;* OD] [=*Sinothyris* Minato, 1953, p. 68 (type, *S. maureri,* OD, =*Reticularia maureri sensu* Grabau, 1931b, p. 394, *non* Holzapfel, 1896)]. Small, equidimensional, biconvex; short, moderately high ventral interarea; fold and sulcus lacking; anterior commissure slightly uniplicate; entire shell smooth; microornament of concentric lamellae crossed by fine radial capillae; ventral median septum; lacking

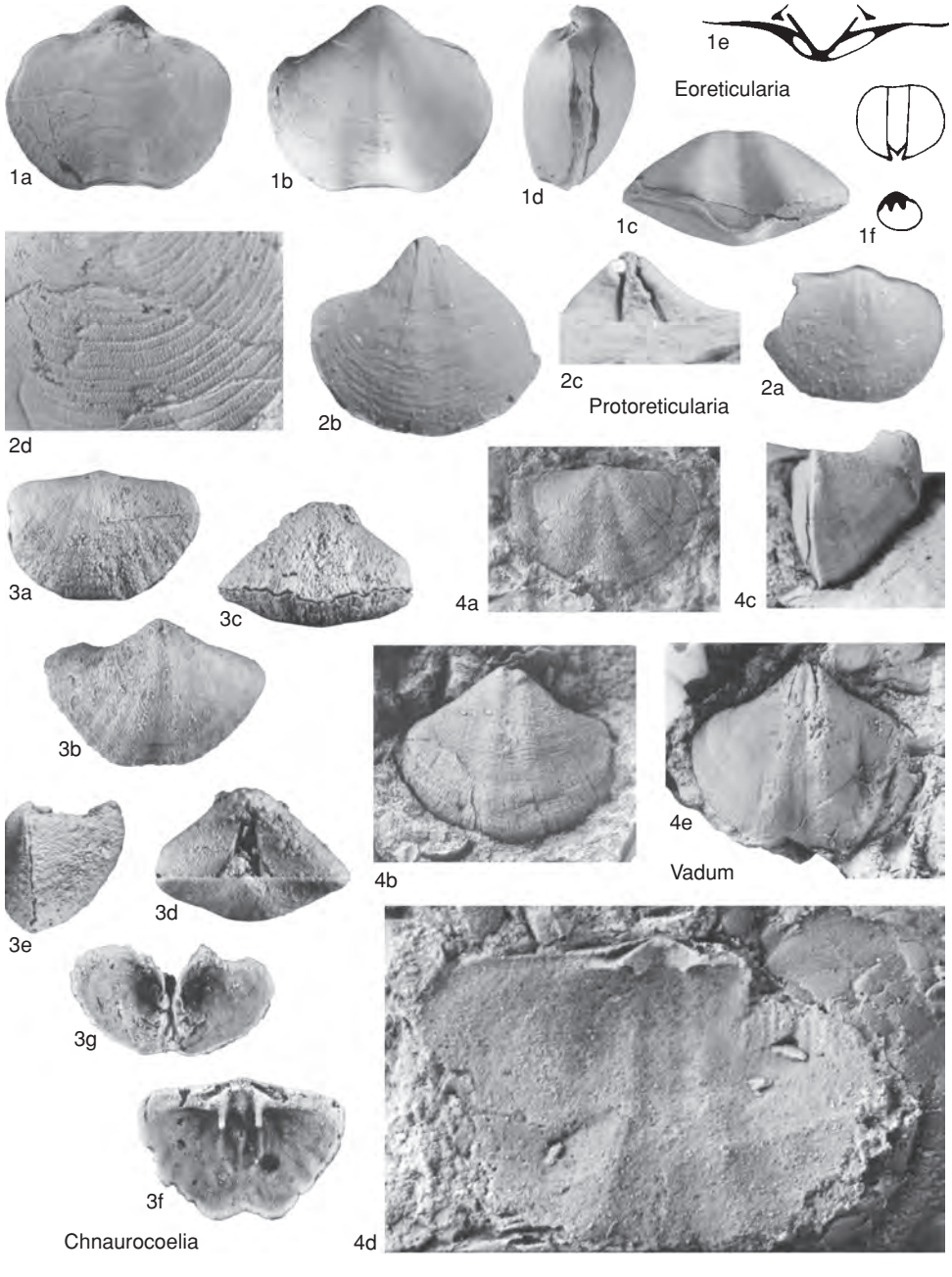

FIG. 1237. Reticulariidae (p. 1860).

dental plates; crural plates lacking; cardinal process trilobed. *Lower Devonian (Pragian)–Middle Devonian (Eifelian):* Czech Republic, Turkestan, China.——FIG. 1238,*1a–f. *X. monosepta,* Pragian, Czech Republic; *a–d,* dorsal, ventral, anterior, lateral views, ×2; *e–f,* dorsal interior, ventral interior, ×3 (Havlíček, 1959).——FIG. 1238,*1g. X. monoseptoides* HAVLÍČEK, ?upper Emsian, Czech Republic; transverse section, ×2.5 (Havlíček, 1959).

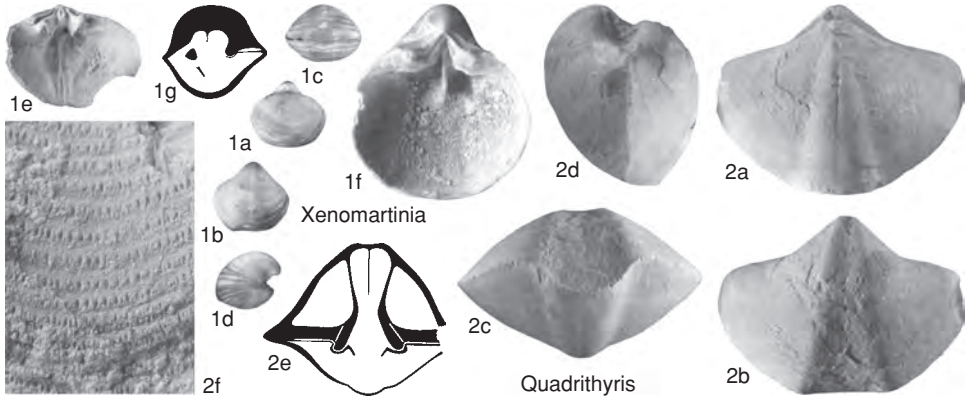

FIG. 1238. Xenomartiniidae (p. 1860–1864).

Subfamily BOJOTHYRIDINAE Havlíček, 1990

[*nom. transl.* GOURVENNEC in CARTER & others, 1994, p. 357, *ex* Bojothyrididae HAVLÍČEK in HAVLÍČEK & KUKAL, 1990, p. 186]

Dental plates converging to median septum, commonly producing spondylium or spondylium-like structure. *Silurian (upper Ludlow)–Middle Devonian (Eifelian).*

Bojothyris HAVLÍČEK, 1959, p. 147 [**B. nikiforovae;* OD]. Small, transverse-oval, with low, curved, apsacline interarea; cardinal angles rounded; fold and sulcus indistinct, developed anteriorly, smooth; flanks lacking plications; surface with fine, concentric growth lines; thin dental plates forming spondylium supported and pierced by median septum; crural plates lacking. *Lower Devonian (Emsian)–Middle Devonian (Eifelian):* Czech Republic.——FIG. 1239,*4a–e. *B. nikiforovae,* Eifelian; *a–c,* dorsal, ventral, anterior views; *d,* damaged shell showing ventral septum, ×3 (new); *e,* transverse section showing spondylium, ×3 (Havlíček, 1959).

Altajella KULKOV, 1962, p. 653 [**A. contorta;* OD]. Small, transverse-oval to equidimensional, with high, curved, apsacline interarea; cardinal angles rounded; fold and sulcus prominent, smooth; flanks with 1 or 2 strong, rounded plications; surface with fine, concentric growth lines; thin dental plates forming spondylium supported and pierced by median septum; short crural plates and ctenophoridium on incipient notothyrial platform. *Silurian (upper Ludlow)–Lower Devonian (Lochkovian):* Altai, Salair.——FIG. 1239,*3a–f. *A. contorta,* Lochkovian; *a–d,* dorsal, ventral, anterior, lateral views, Altai, ×1 (Kulkov, 1963); *e–f,* serial sections, Salair, approximately ×2 (Alekseeva & others, 1970).

Quadrithyrina HAVLÍČEK, 1959, p. 136 [**Q. ivanovae;* OD]. Small or medium size, slightly transverse, with rounded cardinal extremities and almost catacline, high ventral interarea; fold and sulcus well developed, smooth; lateral plications lacking; microornament of concentric growth lines and radial capillae; high, narrow, ventral median septum and apical callus, lacking dental plates; crural plates short or obsolescent; ctenophoridium lacking. [Despite its strong affinities with the Xenomartiniinae, *Quadrithyrina* is assigned here because of the presence of rudimentary dental ridges converging toward the median septum.] *Lower Devonian (Pragian)–Middle Devonian (Eifelian):* Czech Republic, Turkestan, Australia (New South Wales, Queensland).——FIG. 1239,*1a–e. *Q. ivanovae,* upper Emsian, Czech Republic; *a–d,* dorsal, ventral, anterior, lateral views, ×3; *e,* transverse section, ×2 (Havlíček, 1959).

Spondylothyris SU, 1980, p. 324 [**S. pinguis;* OD]. Small, subglobular, with rounded cardinal extremities; ventral valve subpyramidal with high, catacline interarea; fold and sulcus well developed; flanks smooth or with 1 to 2 low, broad plications; microornament of densely crowded, concentric growth lamellae and marginal spines; dental plates joining high median septum to form spondylium; crural plates joining together on valve floor in a septalium-like structure; ctenophoridium present. *Lower Devonian (Emsian):* northeastern China.——FIG. 1239,*5a–f. *S. pinguis; a–d,* dorsal, anterior, posterior, lateral views of internal mold, ×2; *e,* posterior view of dorsal internal mold showing cardinalia, ×2; *f,* transverse section, magnification unknown (Su, 1980).

Uralospirifer HAVLÍČEK, 1959, p. 142 [**Spirifer (Delthyris) mansy* KHODALEVICH, 1951, p. 96; OD]. Medium size, slightly transverse, with curved, apsacline interarea; cardinal angles rounded; fold and sulcus prominent, smooth; flanks with 3 to 4 strong, rounded plications; fimbriate ornament, with closely spaced growth lines; thick tooth tracks forming shallow spondylium, supported posteriorly by median septum; crural plates lacking. *Lower Devonian (Emsian), Middle Devonian (?Eifelian):* northern Urals.——FIG. 1239,*2a–e. *U. mansy* (KHODALEVICH), upper Emsian or ?lower Eifelian; *a–d,* dorsal, ventral, anterior, lateral views, ×1

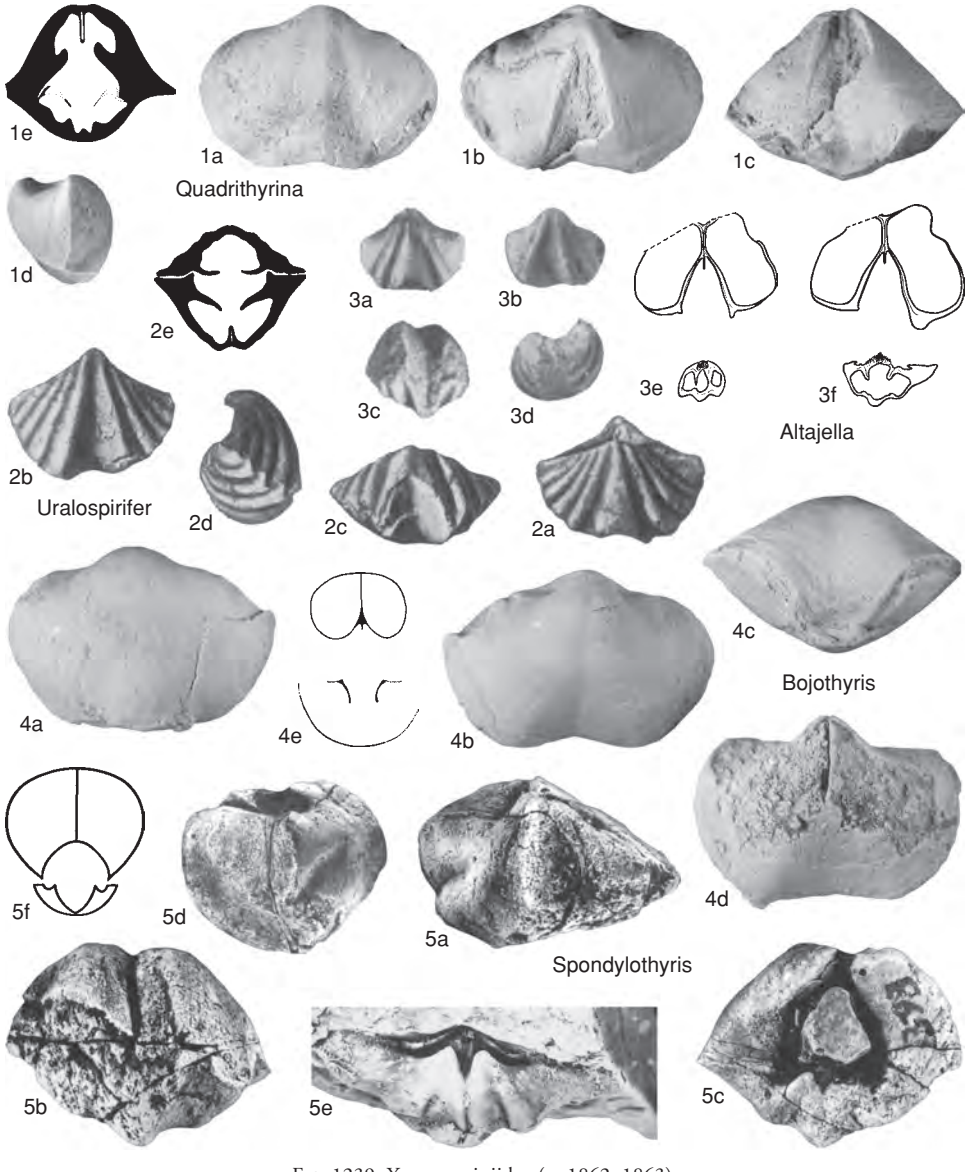

FIG. 1239. Xenomartiniidae (p. 1862–1863).

(Khodalevich, 1951); *e,* transverse section, magnification unknown (Havlíček, 1959).

Subfamily QUADRITHYRIDINAE Gourvennec, 1994

[Quadrithyridinae GOURVENNEC in CARTER & others, 1994, p. 358]

With divergent or subparallel dental plates. *Silurian (upper Wenlock)–Middle Devonian (Givetian).*

Quadrithyris HAVLÍČEK, 1957b, p. 437 [**Spirifer robustus* BARRANDE, 1848, p. 162; OD]. Size variable, medium to large, slightly transverse, with rounded cardinal angles; apsacline to catacline, gently curved ventral interarea; sulcus and fold distinctly marked, smooth; flanks generally smooth, occasionally bearing 1 to 3 low, wide, rounded plications; microornament of growth lamellae and marginal spine bases; dental plates and high median septum; ctenophoridium with crural plates lacking. *Silurian (upper Wenlock)–Middle Devonian (Givetian):* cosmopolitan.——FIG. 1238,*2a–e.* **Q. robusta* (BARRANDE), Pragian, Czech Republic; *a–d,* dorsal, ventral, anterior, lateral views, ×1.5; *e,* transverse section, ×2 (Havlíček, 1959).——FIG.

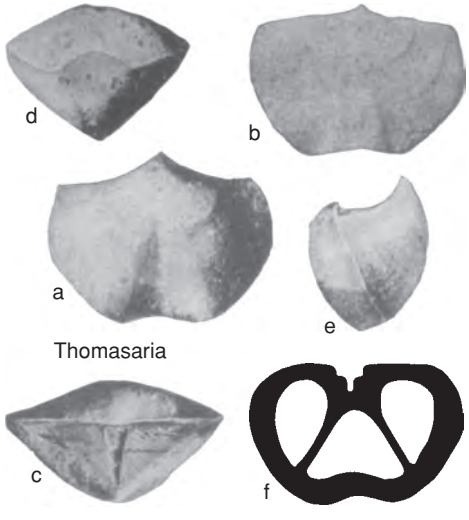

FIG. 1240. Thomasariidae (p. 1864).

1238,*2f. Q. falco* (BARRANDE), Pragian, Czech Republic; ornament, ×10 (Havlíček, 1971).

Family THOMASARIIDAE Cooper & Dutro, 1982

[Thomasariidae COOPER & DUTRO, 1982, p. 102]

[Materials for this family prepared by J. G. Johnson]

Small, hemipyramidal, with strong, long dental plates and pair of conjunct apical plates; ctenophoridium present, crural plates lacking; surface with fine spines. *Upper Devonian (Frasnian).*

Thomasaria STAINBROOK, 1945, p. 57 [**T. altumbona* STAINBROOK, 1945, p. 58; OD]. Small, ventribiconvex, equidimensional; cardinal angles acute or at right angles; ventral interarea high, flat to slightly curved, steeply apsacline to catacline; delthyrium partially closed by apical plates that join below level of interarea; fold and sulcus smooth; flanks smooth or weakly pauciplicate; dental plates divergent. *Upper Devonian (Frasnian):* midcontinental and western North America.——FIG. 1240*a–f.* **T. altumbona;* ventral, dorsal, posterior, anterior, lateral, and ventral section, ×1 (Stainbrook, 1945).

Family ELYTHIDAE Frederiks, 1924

[*nom. transl.* PITRAT, 1965, p. 721, *ex* subfamily Elythinae FREDERIKS, 1924, p. 304]

[Materials for this family prepared by J. L. Carter]

Lateral slopes smooth or with low plications; fold and sulcus, if present, usually weakly developed; microornament of fine, biramous spines. *Lower Devonian (Pragian)–Permian (Lopingian).*

Subfamily ELYTHINAE Frederiks, 1924

[Elythinae FREDERIKS, 1924, p. 304]

Spines biramous but not elaborate; ventral interior with dental adminicula and median ridge; dorsal interior with ctenophoridium. *Lower Devonian–Carboniferous (Tournaisian).*

Elita FREDERIKS, 1918a, p. 87 [**Delthyris fimbriata* CONRAD, 1842, p. 263; OD] [=*Elytha* FREDERIKS, 1924, p. 304, *nom. van.; Elyta* IVANOVA, 1960, p. 277, *nom. null.*]. Medium to large, transverse, with rounded cardinal extremities and apsacline ventral interarea; fold and sulcus well delimited, rounded, smooth; lateral slopes with 5 to 7 low, rounded, simple plicae; microornament of well-marked growth lamellae and moderately coarse marginal biramous spines; ventral interior with long dental adminicula and septum; dorsal interior with massive, inconsistently bilobed ctenophoridium on cardinal platform, short or absent crural plates, and generally strong myophragm. *Lower Devonian (Pragian)–Upper Devonian (Frasnian, ?Famennian):* Western Hemisphere, Russia.——FIG. 1241,*1a–c.* **E. fimbriata* (CONRAD), Hamilton, Middle Devonian, New York; *a–b,* dorsal and lateral views, ×1 (Cooper, 1944); *c,* microornament, approximately ×4 (Hall & Clarke, 1894).

Kitakamithyris MINATO, 1951, p. 374 [**Torynifer (Kitakamithyris) tyoanjiensis* MINATO, 1951, p. 374; OD]. Small to medium size; moderately transverse to subovate; cardinal extremities well rounded; ventral sulcus very weak and shallow, dorsal fold absent; lateral slopes smooth; interior surfaces of valves finely radially grooved; dorsal interior with small ctenophoridium and weak myophragm; some species possibly with very short crural plates or small apical callus. *Carboniferous (Tournaisian):* Japan, Russia, Australia, North America.——FIG. 1241,*5a–b.* **K. tyoanjiensis* (MINATO), Japan; *a,* posterior view, ×1; *b,* microornament, ×2 (Minato, 1952).

Subfamily MARTINOTHYRIDINAE Carter, 1994

[Martinothyridinae CARTER in CARTER & others, 1994, p. 358]

Ventral interior with dental adminicula; ventral median ridge absent; spines elaborate. *Carboniferous (Mississippian)–Permian (Cisuralian).*

Martinothyris MINATO, 1953, p. 70 [**Terebratula? lineata* SOWERBY, 1822 in 1821–1822, p. 39; OD; =*Conchyliolites (Anomites) lineatus* MARTIN, 1809, pl. 36,*3,* ICZN Opinion 420, 1956a, p. 132]. Ven-

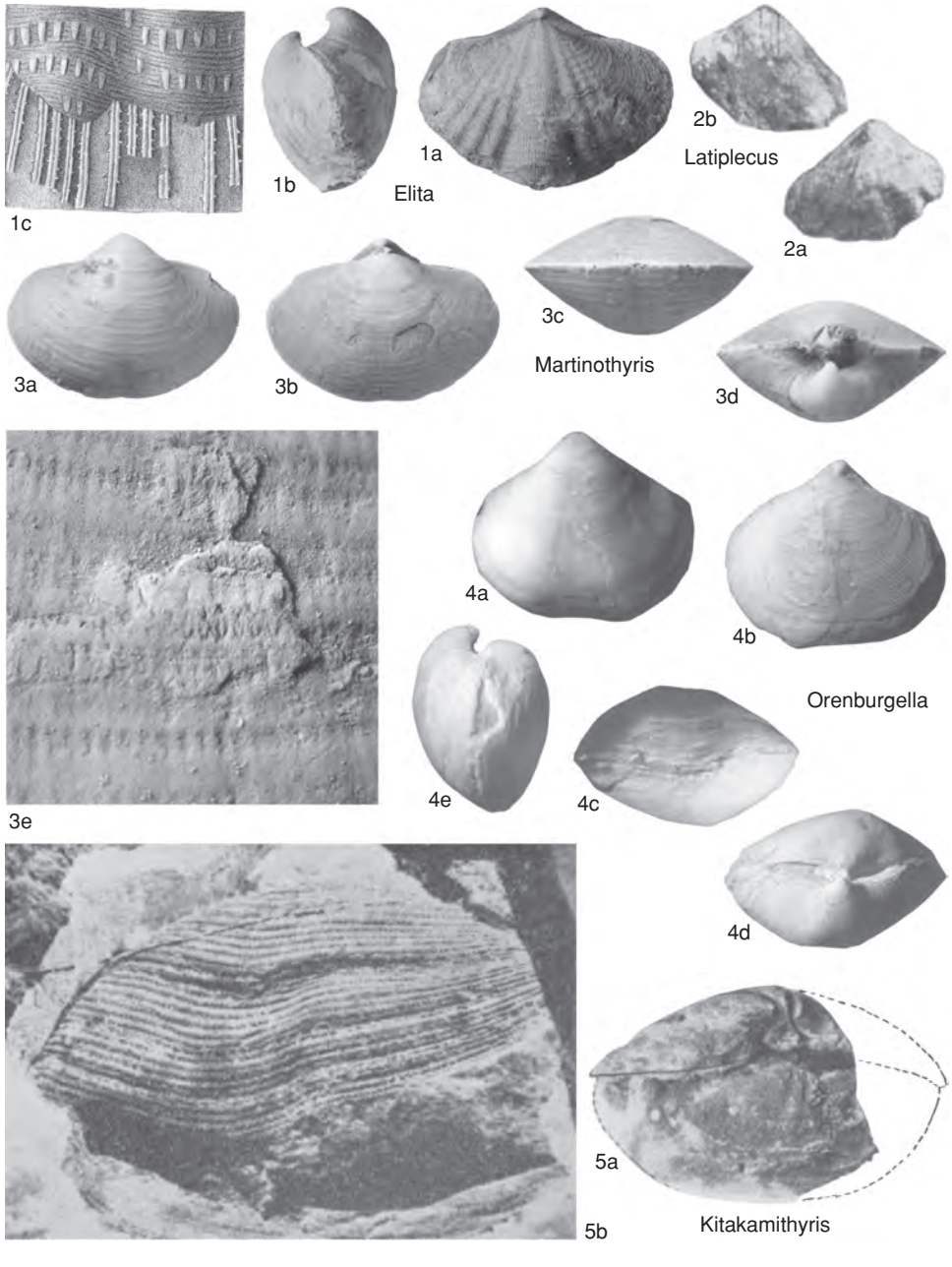

FIG. 1241. Elythidae (p. 1864–1866).

tral valve interior with short dental adminicula; dorsal interior possibly with short adminicula or crural plates; otherwise similar to *Phricodothyris. Carboniferous (Mississippian):* British Isles.——FIG. 1241,*3a–e. *M. lineata* (SOWERBY); *a–d,* lectotype, ventral, dorsal, anterior, posterior views, ×1; *e,* microornament, ×10 (new).

Latiplecus LI & GU, 1976, p. 299 [**L. typicus;* OD]. Small to medium size; outline transversely subovate to subtrigonal; fold and sulcus moderately developed; lateral slopes with 2 pair of broad low plicae; ventral interior with long, parallel dental adminicula; dorsal interior with cardinal process. *Permian (Cisuralian):* China.——FIG. 1241,*2a–b.*

******L. typicus;* dorsal and ventral views, ×1 (Li & Gu, 1976).

Orenburgella Pavlova, 1969, p. 76 [**O. uralica;* OD]. Both valves with umbonal thickening; deltidial plates absent; dorsal interior with discrete crural bases not touching valve floor; otherwise similar to *Martinothyris. Carboniferous (Visean):* Russia (southern Urals).——Fig. 1241,*4a–e.* **O. uralica;* holotype, ventral, dorsal, anterior, posterior, and lateral views, ×1 (new).

Subfamily PHRICODOTHYRIDINAE Caster, 1939

[*nom. correct.* Carter in Carter & others, 1994, p. 359, *pro* Phricodothyriinae Caster, 1939, p. 145]

Lacking dental adminicula and ventral median ridge; spines elaborate. *Carboniferous (Mississippian)–Permian (Lopingian).*

Phricodothyris George, 1932, p. 524 [**P. lucerna;* OD] [=*Neophricadothyris* Likharev, 1934, p. 211 (type, *Squamularia asiatica* Chao, 1929, p. 91, OD); *Condrathyris* Minato, 1953, p. 69 (type, *Spirifer perplexa* McChesney, 1860, p. 43, OD)]. Small to medium size; unequally biconvex; outline subovate; fold and sulcus absent; anterior commissure rectimarginate; ribbing absent; ventral interarea well delimited, finely vertically striated only in primary layer; short flat deltidial plates nearly at right angle to interarea; ventral interior with very low dental flanges; dorsal interior with dental sockets nearly parallel to cardinal margin; crural bases broad, flattened, directed dorsomedially; sometimes forming short crural plates; dorsal septum and adminicula absent, low myophragm present in some species; minute bulbous ctenophoridium present in at least some species; microornament including very fine interspinous pustules or spinules; spiralia directed slightly posterolaterally. *Carboniferous (Mississippian)–Permian:* cosmopolitan.——Fig. 1242,*1a–d.* **P. lucerna,* Visean, Great Britain; holotype, dorsal, ventral, lateral, and anterior views, ×1 (George, 1932).——Fig. 1242,*1e–f. P. verecunda* George; dorsal and ventral interiors, ×4 (Brunton, 1984).

Astegosia Cooper & Grant, 1969, p. 16 [**Squamularia guadalupensis subquadrata* Girty, 1909, p. 369; OD]. Ventral interarea narrow, poorly defined; pseudodeltidium or deltidial plates not present; ventral interior with well-developed, concave dental flanges medially converging to fuse with short, apical, subdelthyrial plate; dorsal interior with finely striate, bosslike ctenophoridium; otherwise similar to *Phricodothyris. Permian (Guadalupian):* USA (Texas).——Fig. 1242,*4a–g.* **A. subquadrata* (Girty), western Texas; *a–e,* dorsal, ventral, lateral, posterior, and anterior views, ×1; *f–g,* dorsal and ventral interiors, ×2 (Cooper & Grant, 1976a).

Bajkuria Ustritskii in Ustritskii & Cherniak, 1963, p. 116 [**B. dorsosinuata* Ustritskii in Ustritskii & Cherniak, 1963, p. 117; OD]. Dorsal interior with short adminicula; dorsal muscle scars delineated by low ridges; otherwise similar to *Phricodothyris. Permian (Lopingian):* Arctic Siberia.——Fig. 1242,*2a–d.* **B. dorsosinuata;* holotype, ventral, dorsal, posterior, and lateral views, ×1 (Ustritskii & Cherniak, 1963).

Bullarina Jin & Sun, 1981, p. 153 [**Neophricadothyris bullata* Cooper & Grant, 1976a, p. 2,248; OD]. Medium size for family; longitudinally to transversely subovate or guttate; weak fold and sulcus usually developed; anterior commissure usually weakly uniplicate; spiralia directed posterolaterally; cardinal process bulbous; otherwise similar to *Phricodothyis. Permian (Lopingian):* USA (Texas), China.——Fig. 1242,*3a–d.* **B. bullata* (Cooper & Grant), lower Guadalupian, Texas; dorsal, ventral, posterior, and anterior views, ×1 (Cooper & Grant, 1976a).

Nebenothyris Minato, 1953, p. 72 [**N. lineatus;* OD]. With median ridges or septa in both valves; otherwise similar to *Phricodothyris. Carboniferous (Mississippian)–Permian:* Western Europe, Japan, *Mississippian;* China, Russia, *Permian.*——Fig. 1243,*2. **N. lineata,* Mississippian, Japan; ventral valve, ×1 (Nebe, 1911).

Permophricodothyris Pavlova, 1965, p. 134 [**P. ovata* Pavlova, 1965, p. 135*;* OD]. Medium to large; umbonal regions often broad; dorsal interior with very long, subparallel crura and elongated, posteriorly directed spiralia with numerous whorls; otherwise similar to *Phricodothyris. Permian (Lopingian):* Sicily, Armenia, Iran, Mongolia, Timor, Indochina, China, Salt Range, Caucasus Mountains.——Fig. 1243,*1a–e.* **P. ovata,* Djulfian, Caucasus Mountains; ventral, dorsal, anterior, posterior, and lateral views, ×1 (new).

Subfamily TORYNIFERINAE Carter, 1994

[Toryniferinae Carter in Carter & others, 1994, p. 359]

Dental adminicula and low median ridge present in ventral valve; ctenophoridium generally absent; spines elaborate. *Carboniferous (Mississippian)–Permian.*

Torynifer Hall & Clarke, 1894, p. 943, pl. 84 [**T. criticus;* OD; =*Spirifer pseudolineatus* Hall, 1858, p. 645]. Small to large; fold and sulcus variably developed; outline transversely subovate; spine-bearing growth lamellae broadly spaced; lacking interspinous pustules or spinules; ventral interior with well-developed, long, diverging dental adminicula, short delthyrial plate and long, low median ridge; dorsal interior with long, complete hinge plate with apical pit supported by variably strong median septum; spiralia directed posterolaterally. *Carboniferous*

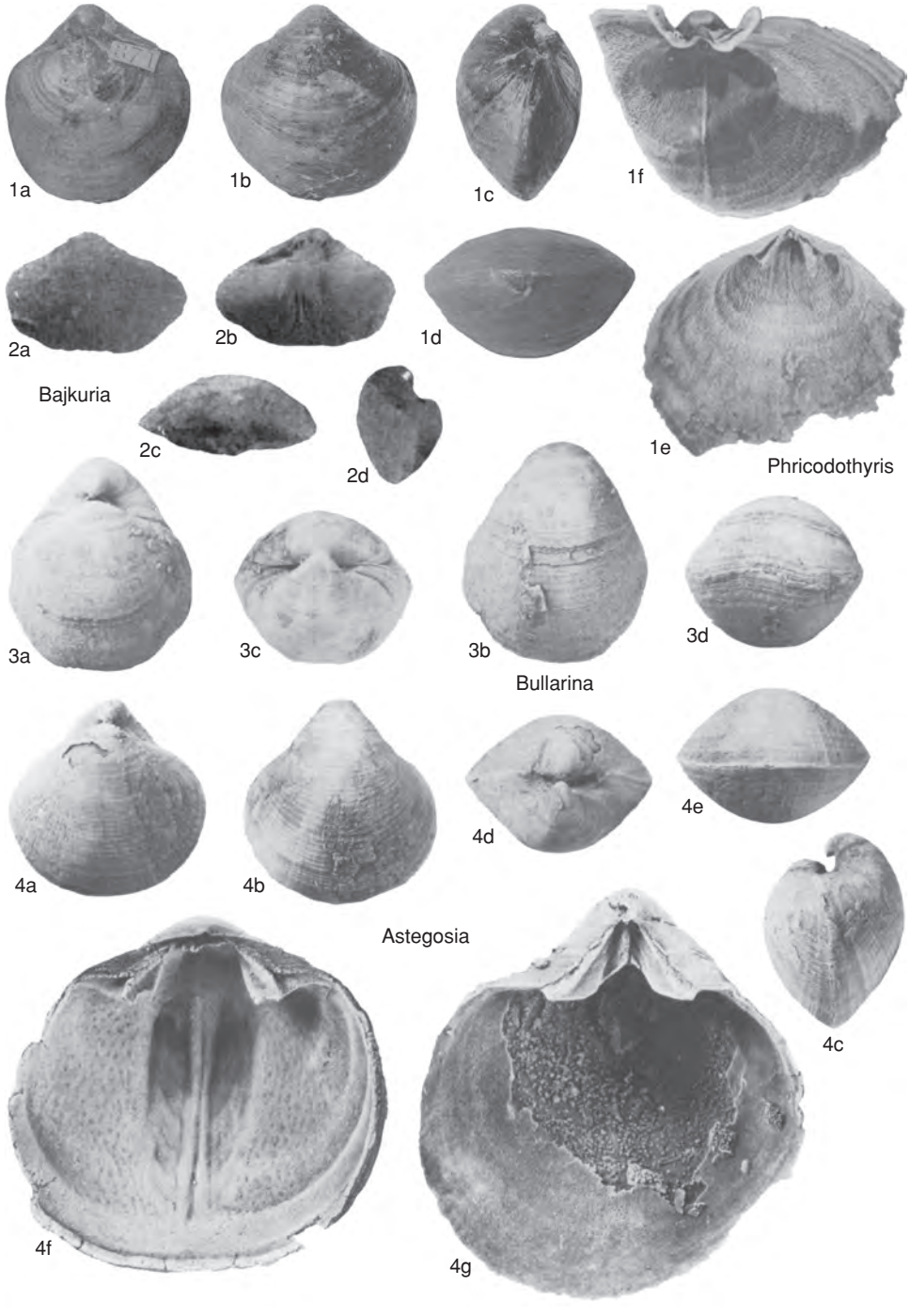

FIG. 1242. Elythidae (p. 1866).

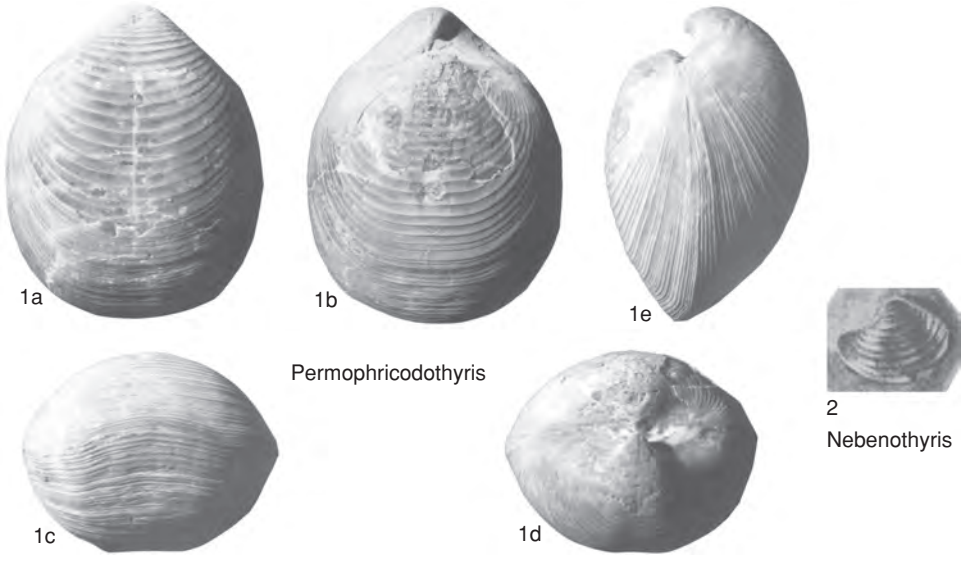

FIG. 1243. Elythidae (p. 1866).

(Mississippian): cosmopolitan.——FIG. 1244,*3a–g.* **T. pseudolineatus* (HALL), upper Tournaisian, Iowa, USA; *a–b,* ventral and dorsal interiors, ×2 (Cooper, 1944); *c–g,* ventral, dorsal, posterior, anterior, and lateral views, ×1 (Weller, 1914).

Plicotorynifer ABRAMOV & SOLOMINA in ABRAMOV, 1970, p. 153 [**P. simakovi;* OD]. Lateral slopes with 1 or 2 shallow, broad plicae; ventral interior with stout median septum; dorsal interior with short median septum and short adminicula; otherwise similar to *Taimyrella. Carboniferous (Moscovian–Kasimovian):* Siberia.——FIG. 1244,*6.* **P. simakovi;* holotype, ventral valve, ×1 (Abramov, 1970).

Spirelytha FREDERIKS, 1924, p. 304 [**S. pavlovae* ARCHBOLD & THOMAS, 1984a, p. 313; OD; *nom. nov. pro Spirifer scheii* CHERNYSHEV in CHERNYSHEV & STEPANOV, 1916b, p. 45, *non* MEYER, 1913]. Fold and sulcus variably developed; lateral slopes lacking plications; ventral interior with dental adminicula and median ridge; dorsal interior with delicate myophragm, adminicula absent or weakly developed; otherwise similar to *Torynifer. Permian:* Arctic.——FIG. 1244,*5a–c.* **S. pavlovae* ARCHBOLD & THOMAS, Arctic Siberia; lectotype, ventral, lateral, and posterior views, ×1 (Chernyshev & Stepanov, 1916b).

Stepanoviina ZAVODOVSKII, 1968b, p. 170 [**Neophricodothyris(?) larini* ZAVODOVSKII, 1958, p. 134; OD]. Large; weak but distinct fold and sulcus present; ventral interior with dental adminicula and low median ridge; dorsal valve interior with low median ridge; otherwise similar to *Spirelytha. Permian (Cisuralian):* northeastern Asia.——FIG. 1244,*4a–b.* **S. larini* (ZAVODOVSKII), Russia; dorsal and ventral valves, ×1 (Zavodovskii, 1968b).

Taimyrella USTRITSKII in USTRITSKII & CHERNIAK, 1963, p. 115 [**Martiniopsis (?) pseudodarwini* EINOR, 1946, p. 55; OD]. Each lateral slope with single, broad, rounded, sulcuslike depression on each side of fold-sulcus; ventral valve interior with low median ridge; otherwise similar to *Spirelytha. Permian (Cisuralian):* northern Siberia.——FIG. 1244,*2a–b.* **T. pseudodarwini* (EINOR), Taimyr; dorsal and ventral valves, ×1 (new).

Toryniferella WEYER, 1967, p. 435 [**Kitakamithyris globosa* MAXWELL, 1961, p. 101; OD]. Dorsal valve with very thin, complete, unsupported hinge plate; dorsal median septum absent; otherwise similar to *Torynifer. Carboniferous (upper Visean):* Australia (Queensland).——FIG. 1244,*1a–f.* **T. globosa* (MAXWELL); *a–b,* holotype, posterior and dorsal views, ×1; *c–f,* transverse sections, approximately ×2 (Maxwell, 1961).

Subfamily ANOMALORIINAE Cooper & Grant, 1976

[*nom. transl.* CARTER in CARTER & others, 1994, p. 359, *ex* Anomaloriidae COOPER & GRANT, 1976a, p. 2,260]

Delthyrium covered with convex pseudodeltidium; ventral interior with converging, thickened dental flanges that fuse apically; dorsal interior with notothyrial

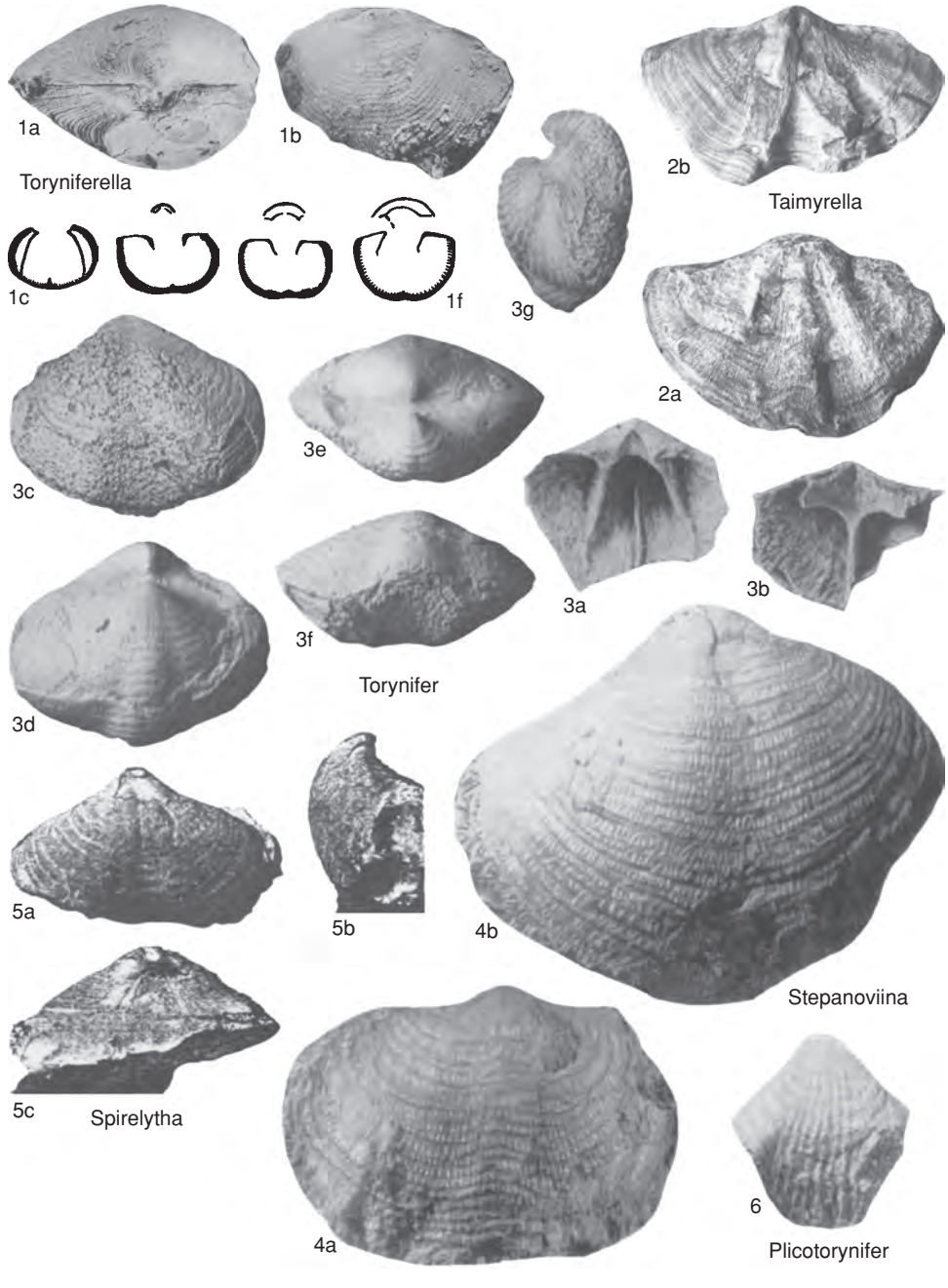

FIG. 1244. Elythidae (p. 1866–1868).

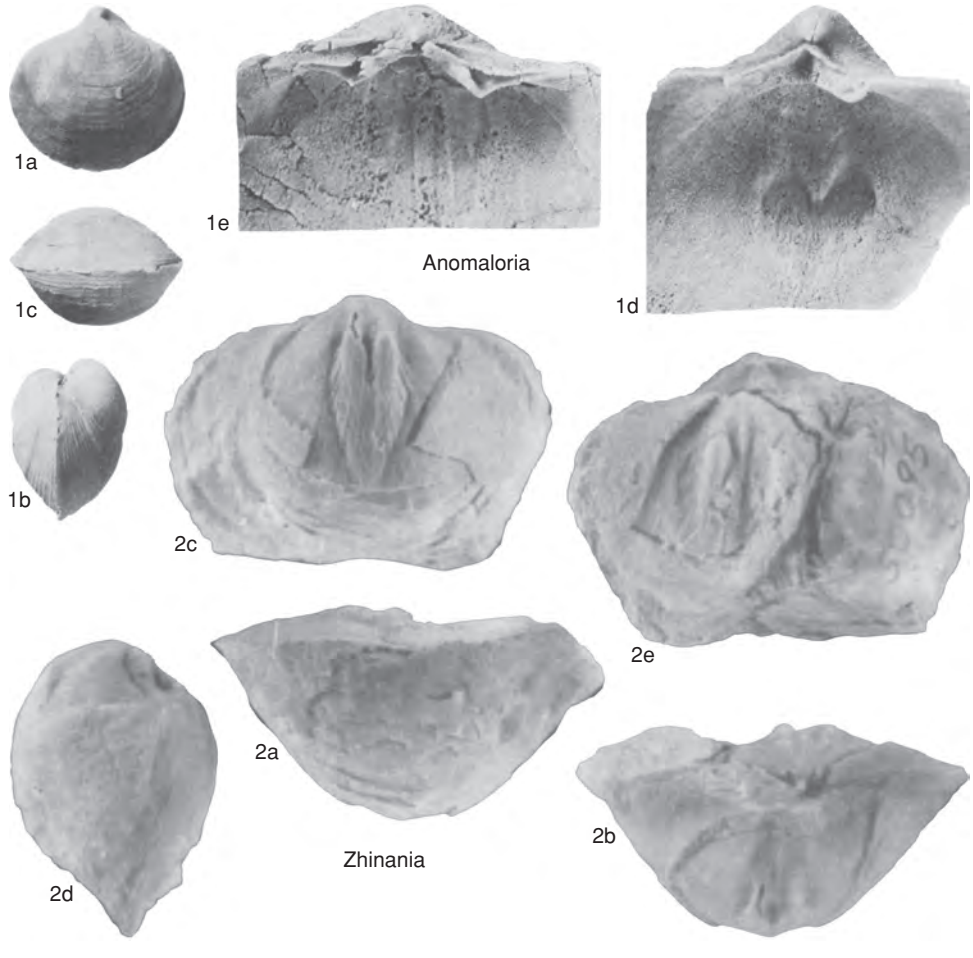

FIG. 1245. Elythidae (p. 1870).

flanges fused to inner socket ridges that partially obscure sockets medially. *Permian (Guadalupian).*

Anomaloria COOPER & GRANT, 1969, p. 16 [**A. anomala;* OD]. Medium size; outline subovate; both valves strongly and nearly equally inflated; dorsal interior with narrow socket ridges; crural bases indistinct; cardinal process absent, replaced by apical pit. *Permian (Guadalupian):* Texas.——FIG. 1245,*1a–e. *A. anomala; a–c,* holotype, dorsal, lateral, and anterior views, ×1; *d–e,* ventral and dorsal interiors, ×3 (Cooper & Grant, 1976a).

Zhinania LIANG, 1990, p. 308 [473] [**Z. eximiusa;* OD]. Medium size; outline transversely subovate to subquadrate; unequally biconvex, dorsal valve flattened and much thinner than opposite; dorsal interior with small, thin cardinal process; presence of apically fused dental flanges and notothyrial flanges not known. *Permian (Guadalupian):* China (Zhejiang).——FIG. 1245,*2a–e. *Z. eximiusa;* anterior, posterior, ventral, lateral, and dorsal views, ×1.5 (Liang, 1990).

UNCERTAIN

PATRICK R. RACHEBOEUF

[Université de Bretagne Occidentale]

INTRODUCTION

Representatives of the superfamily Plicanoplitacea *sensu* GARRATT (1980) cannot be definitely or clearly assigned to any of the brachiopod orders. It is evident that they can no longer be considered as members of the Chonetoidea as GARRATT (1980) thought: they lack hinge spines and anderidia, and they exhibit a peculiar ornament. These small, paedomorphic shells can be divided into two morphological groups, however, based on their dorsal valve internal features, almost corresponding respectively to the families Notanopliidae and Plicanoplitidae *sensu* GARRATT, 1980. The first group is highly enigmatic; it could possibly be allied to the Orthida or to some orthotetidine-like *?Fardenia,* while the second group might be related to the Anoplothecidae.

Most of the materials are decalcified, preserved as internal and external molds, or silicified, both preservations that preclude any reliable microstructural analysis of the shell structure. Some well-preserved specimens of *Serrulatrypa* from Germany, however, have an impunctate shell with fibrous secondary shell microstructure (F. LANGENSTRASSEN, written communication, 1992), which suggests a close relationship with the Spiriferida. Moreover, internal characters, such as the development of inner peripheral ridges in one or both valves of several genera, are reminiscent of the Thecideida.

These minute Siluro-Devonian shells for now are regarded as a taxonomically uncertain group.

SUBORDER UNCERTAIN

Boucotia GILL, 1969, p. 1,227 [**Anoplia australis* GILL, 1942, p. 38; OD]. Shell small, subcircular; ventral interarea apsacline; surface smooth or finely capillate; crested septa in both ventral and dorsal valves or in ventral valve only. *Lower Devonian (Lochkovian–Emsian):* southeastern Australia, Argentine Precordillera.——FIG. 1246,*1a–d.* **B. australis* (GILL), Humevale Formation; *a–b,* exterior, interior of articulated shell; *c,* ventral valve interior; *d,* dorsal valve interior, ×8 (Gill, 1969).

Callicalyptella BOUCOT & JOHNSON, 1972, p. 301 [**C. empelia;* OD]. Shell subcircular, convexoconcave; ventral interarea absent; surface with faint radial costae; ventral interior multiseptate; dorsal interior with only median septum. *Lower Devonian (Lochkovian):* USA (Nevada).——FIG. 1246,*2a–d.* **C. empelia,* Roberts Mountains Formation; *a,* ventral valve exterior; *b,* dorsal valve exterior; *c,* ventral, dorsal valve interiors; *d,* ventral valve interior, ×5 (Boucot & Johnson, 1972).

Costanoplia XU, 1977a, p. 65 [**C. faceta;* OD]. Differs from *Notanoplia* in the development of strong radial costate ornament only. *Lower Devonian (upper Emsian)–Middle Devonian (Eifelian):* southern China.——FIG. 1247,*1a–b.* **C. faceta,* Tangxiang Formation, Eifelian, Guangxi; ventral valve external mold, internal mold of both valves, ×5 (Xu, 1977a).

Guixiella XIAN, 1987, p. 74 [**G. lamellosa;* OD]. Shell small, subcircular to subquadrate, gently convexoconcave; hinge wide; fold, sulcus absent; radial ornament of narrow costae with wide, flat interspaces; interior of both valves with long, narrow median septum; no lateral septa but well-differentiated brachial ridges in dorsal valve interior. [No suitable figures are available for illustration.] *Lower Devonian (Emsian):* western Guangxi, China.

Hollardiella DROT, 1967, p. 877 [**H. akkaensis;* OD]. Very small shell, subquadrate or slightly elongate; planoconvex or subbiconvex posteriorly, concavoconvex anteriorly; ventral interarea apsacline; dorsal interarea anacline; ventral valve sulcate; radial ornament of narrow, low, thin, numerous costellae with wide, flat interspaces; ventral valve interior with three stout septa; dorsal valve interior with well-developed peripheral ridge, median septum. *Lower Devonian (Emsian)–Middle Devonian (Eifelian):* Morocco, Spain.——FIG. 1246,*3a–d.* **H. akkaensis,* Formation de Timrhanrhart, lowermost Eifelian, Morocco; *a–b,* articulated shell, ventral, dorsal views; *c,* juvenile ventral valve; *d,* anterior view, ×8 (Drot, 1967).——FIG. 1246,*3e–g. H. drotae* RACHEBOEUF, Tamajoso Formation, Emsian, southwestern Spain; ventral valve exterior, ventral valve internal mold, dorsal valve interior, ×5 (Racheboeuf & Robardet, 1986).

Jacetanella RACHEBOEUF, FERRER BATET, & MAGRANS, 1994, p. 9 [**J. bruguesensis;* OD]. Shell plano- to concavoconvex; ventral interior with median

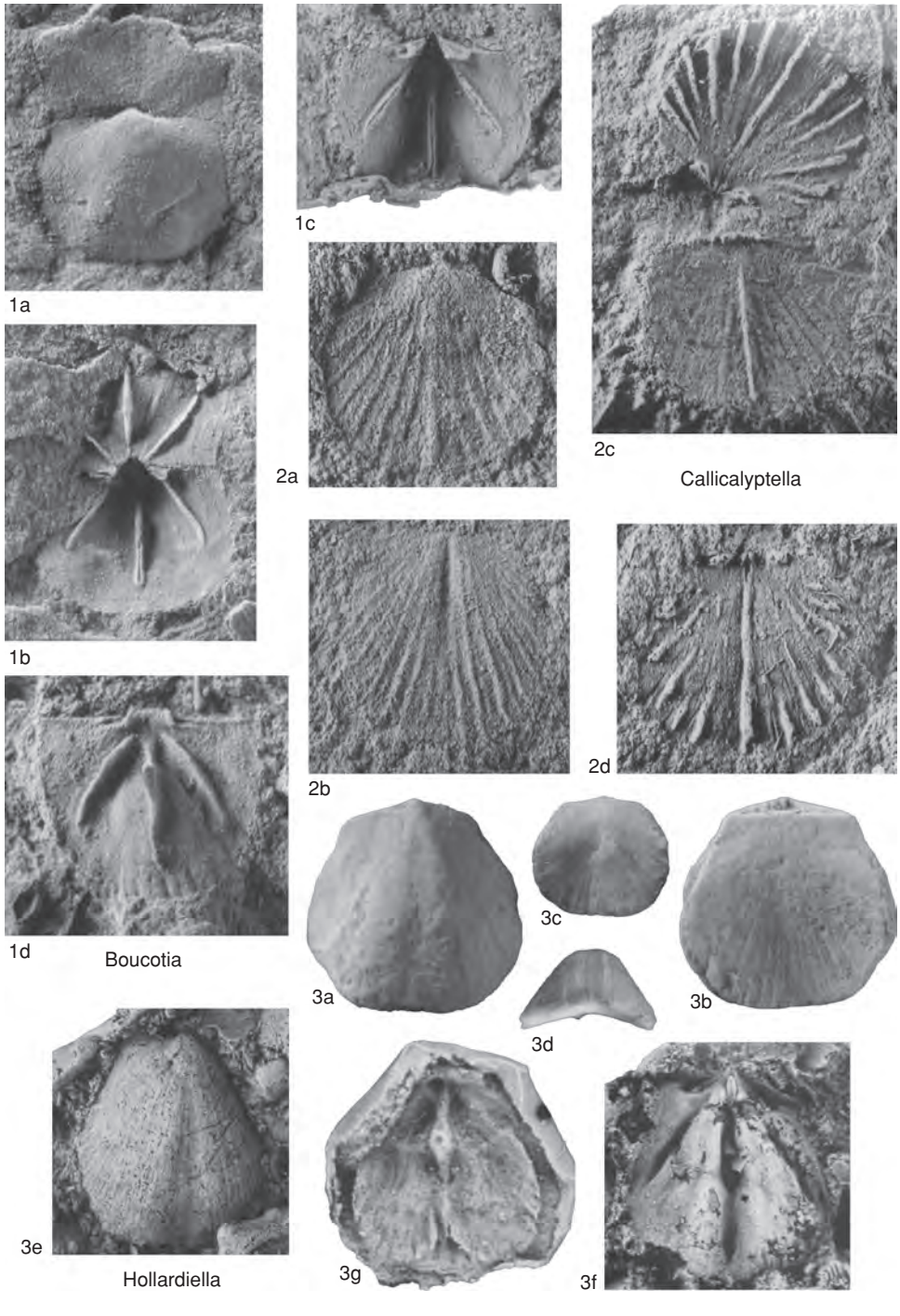

FIG. 1246. Uncertain (p. 1871).

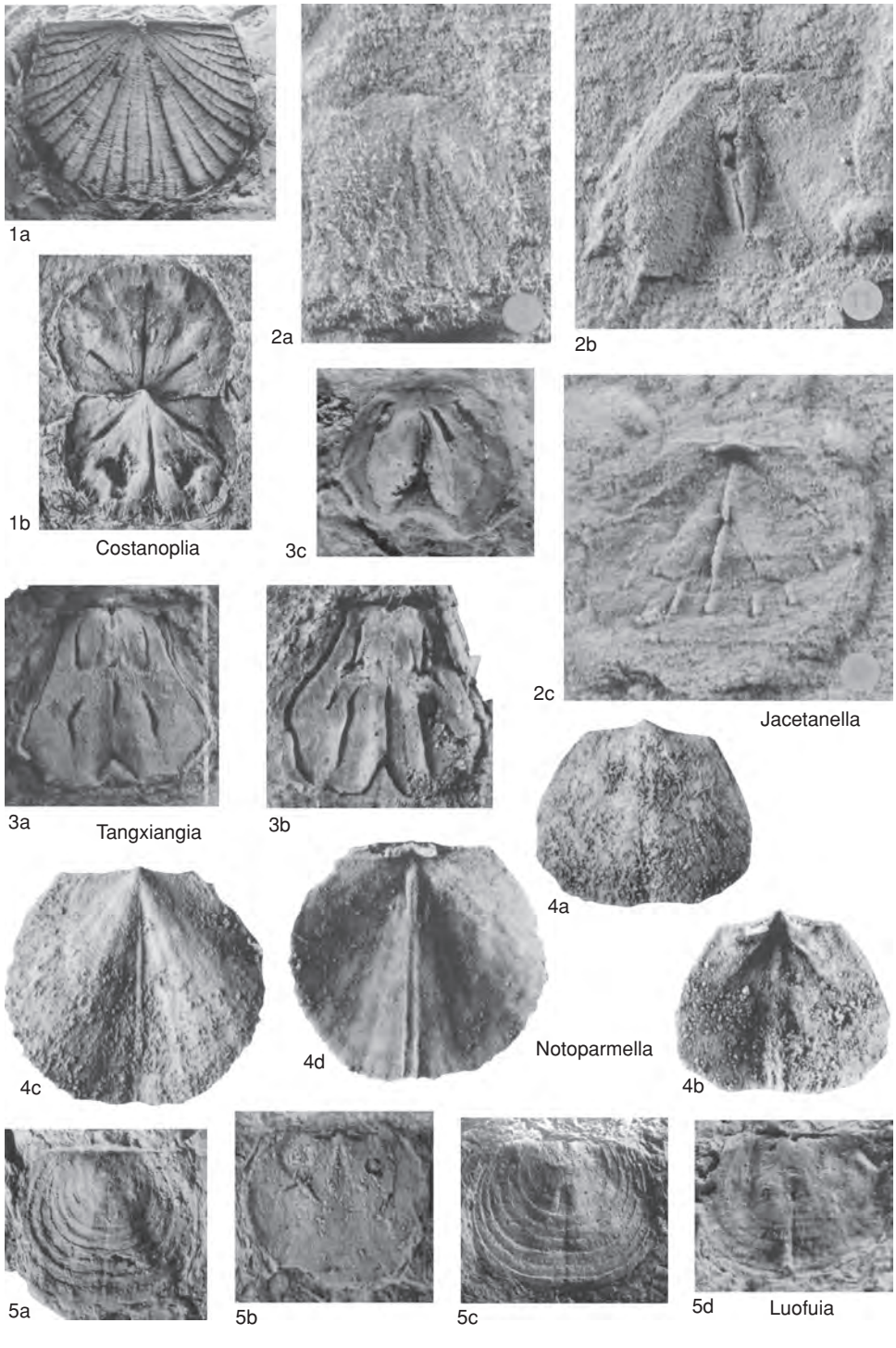

FIG. 1247. Uncertain (p. 1871–1876).

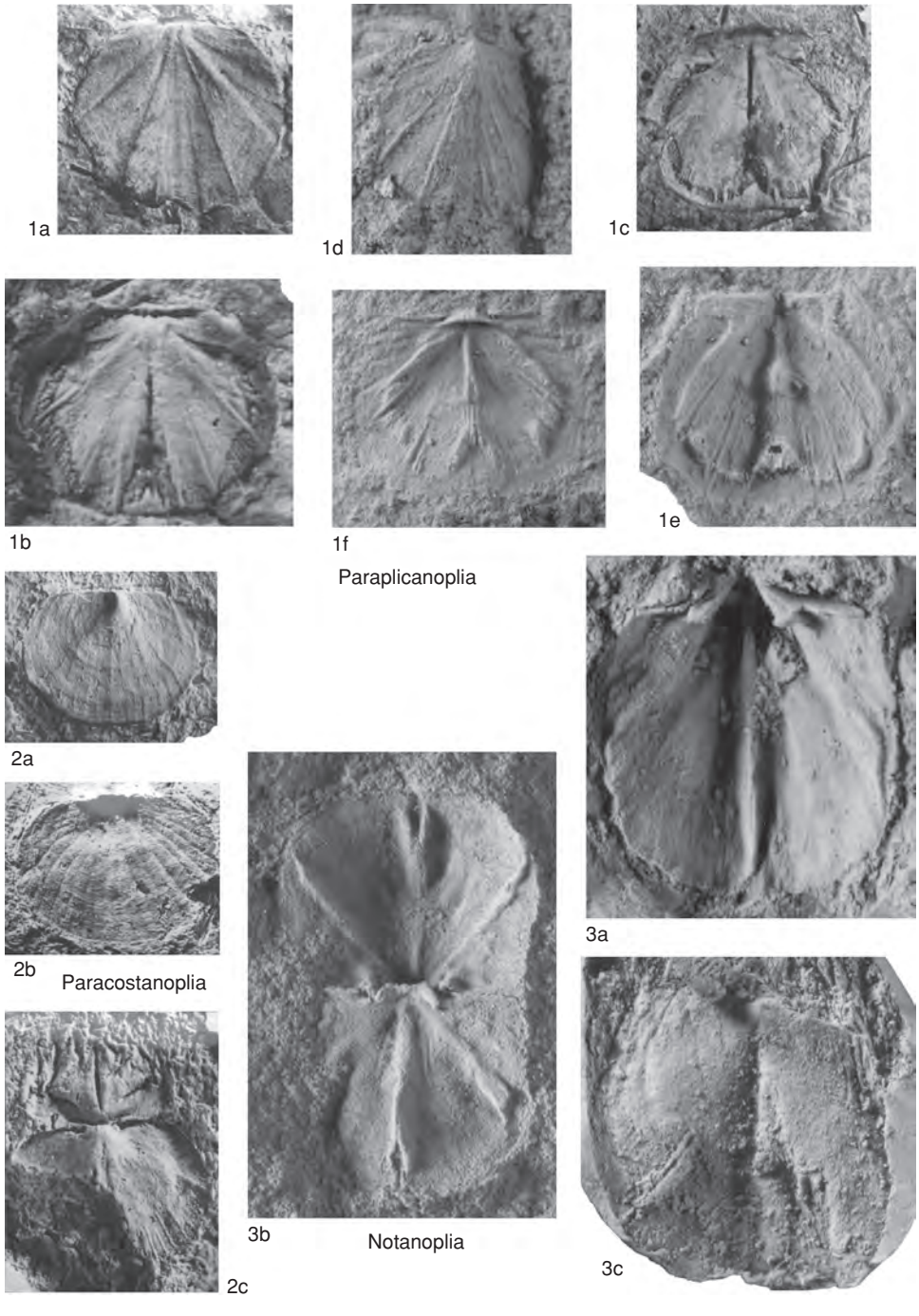

FIG. 1248. Uncertain (p. 1875).

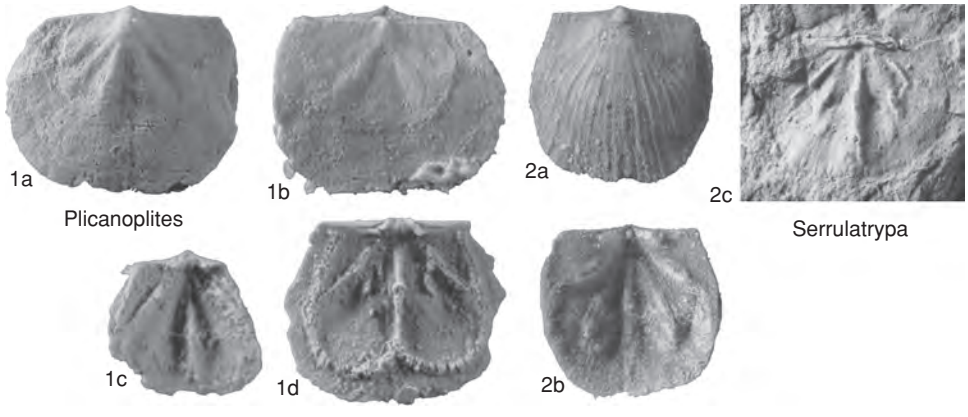

FIG. 1249. Uncertain (p. 1875–1876).

septum, pair of brevisepta; dorsal interior with long median septum, three to four pairs of brevisepta; radial ornament with median costa, one or two pairs of anteriorly divergent lateral costae. *Lower Devonian (Lochkovian):* northeastern Spain.——FIG. 1247,*2a–c. *J. bruguesensis,* Catalonia; ventral valve exterior, ventral valve interior, dorsal valve interior, ×8 (Racheboeuf, Ferrer Batet, & Magrans, 1994).

Luofuia XU, 1977a, p. 66 [**L. delicata;* OD]. Shell planoconvex; surface without radial ornament, but with dense concentric lamellae; interior of both valves without septa. [The concentric external ornament as well as the lack of septa in both valve interiors make *Luofuia* a peculiar genus within this group of brachiopods.] *Middle Devonian (Eifelian):* southern China.——FIG. 1247,*5a–d. *L. delicata,* Tangxiang Formation, Guangxi; *a–b,* dorsal valve exterior, latex external mold; *c–d,* ventral valve interior, dorsal valve interior, ×5 (Xu, 1977a).

Notanoplia GILL, 1950, p. 250 [**N. pherista;* OD]. Exterior smooth to finely costellate; ventral interarea apsacline; periphery of ventral interior with more or less developed radial costae; interiors with bladelike, not crested septa. *upper Silurian (Pridoli)–Lower Devonian (Pragian):* southeastern Australia.——FIG. 1248,*3a–c. *N. pherista,* Bell Shale, Pragian; ventral valve interior, interior of both valves, dorsal valve exterior, ×6 (Gill, 1950).

Notoparmella JOHNSON, 1973b, p. 1,026 [**N. gilli;* OD]. Thin-shelled, shield-shaped concavoconvex shell; no interarea, but sometimes pair of flat apsacline plates; radial ornament of very low, faint costae, or finely costellate; ventral valve with variably developed median furrow; dorsal valve with threadlike median rib; interiors aseptate; ventral diductors impressed; simple, discrete pair of socket plates. *upper Silurian (Ludfordian)–Lower Devonian (lower Lochkovian):* USA (Nevada), Canadian Arctic Archipelago, eastern Australia, far eastern Russia.——FIG. 1247,*4a–d. *N. gilli,* Windmill Limestone, lower Lochkovian, central Nevada; *a,* ventral valve exterior; *b,* ventral valve interior; *c,* dorsal valve exterior; *d,* dorsal valve interior, ×5 (Johnson, 1973b).

Paracostanoplia XU, 1977a, p. 65 [**P. mirabilis;* OD] [=*Paranotanoplia* XU, 1977a, pl. 3,*10,* obj.]. Differs externally from *Costanoplia* in having weak radial costellae instead of well-developed, rounded, anteriorly widening costellae; differs internally in its lack of ventral septa. *Middle Devonian (Eifelian):* southern China.——FIG. 1248,*2a–c. *P. mirabilis,* Tangxiang Formation, Guangxi; ventral valve exterior, ventral valve external mold, internal mold of both valves, ×5 (Xu, 1977a).

Paraplicanoplia XU, 1977a, p. 67 [**P. nana;* OD] [=*Imatrypa* HAVLÍČEK, 1977, p. 300 (type, *I. infima,* OD)]. Very small shell, subquadrate or slightly elongate; planoconvex or subbiconvex posteriorly, concavoconvex anteriorly; ventral interarea apsacline; dorsal interarea anacline; ventral valve variably sulcate; radial ornament of narrow costae with wide, flat interspaces; interior of both valves with well-developed peripheral ridge, median septum. *Lower Devonian (upper Pragian)–Middle Devonian (lower Eifelian):* Bohemia, China.——FIG. 1248,*1a–c. *P. nana,* Tangxiang Formation, lower Eifelian, Guangxi, southern China; dorsal valve exterior, ventral valve interior; dorsal valve interior, ×10 (Xian, 1987).——FIG. 1248,*1d–f. P. infima* (HAVLÍČEK), Chotec Limestone, lower Eifelian, Bohemia; ventral valve exterior, ventral valve interior, dorsal valve interior, ×7 (Havlíček, 1977).

Plicanoplites HAVLÍČEK, 1974, p. 170, *nom. nov. pro Plicanoplia* HAVLÍČEK, 1973, p. 337, obj., *non* BOUCOT & HARPER, 1968 [**Plicanoplia peculiaris* HAVLÍČEK, 1973, p. 338; OD]. Shell very small, subpolygonal; apsacline, low ventral interarea; steeply anacline, very low dorsal interarea; internally, shell almost similar to *Hollardiella,* but with pair of dorsal, variably developed septa oblique to lateral branches of peripheral ridge; differs externally by presence of wide, rounded, radially arranged ribs instead of radial costae; ribs sometimes

bifurcating or intercalating. *Lower Devonian (Pragian–Emsian):* Bohemia.——Fig. 1249,*1a–d.* **P. peculiaris* (Havlíček), Dvorce-Prokop Limestone, Pragian; *a–b,* articulated shell, ventral, dorsal sides; *c,* ventral valve interior; *d,* dorsal valve interior, ×7 (Havlíček, 1973).

Septaparmella Su, 1976, p. 184 [**S. sinica;* OD]. Differs from *Notoparmella* in development of ventral interarea; ventral valve smooth with median furrow developed posteriorly, bearing median rib; dorsal exterior parvicostellate, with wide, ill-defined sinus; interior of both valves with long median septum only. [No suitable figures are available for illustration.] *Lower Devonian (Pragian):* southern China.

Serrulatrypa Havlíček, 1977, p. 299 [**Boucotia incognita* Langenstrassen, 1972, p. 49; OD]. Differs externally from *Boucotia* by development of narrow, rounded radial costae, not deflected posteriorly; interior of both valves with five crested septa. *Middle Devonian (Eifelian):* Germany, Bohemia.——Fig. 1249,*2a–c.* **S. incognita* (Langenstrassen), Stöppeler Tonschiefer, Sauerland, Germany; ventral valve exterior, ventral valve interior, dorsal valve interior, ×4 (Havlíček, 1977).

Tangxiangia Xu, 1977a, p. 68 [**T. delicata;* OD]. Shell surface without radial ornament but with thin, weak, concentric lamellae; ventral peripheral ridge deeply bilobate anteriorly; dorsal interior with median septum not fusing anteriorly with peripheral ridge, pair of septa subparallel to lateral branches of peripheral ridge. *Middle Devonian (Eifelian):* southern China.——Fig. 1247,*3a–c.* **T. delicata,* Tangxiang Formation, Guangxi; *a–b,* ventral valve interiors; *c,* dorsal valve interior, ×10 (Xu, 1977a).

SPIRIFERINIDA

J. L. Carter and J. G. Johnson

[retired from Carnegie Museum of Natural History; and deceased, formerly of Oregon State University]

Order SPIRIFERINIDA Ivanova, 1972

[*nom. transl.* Carter & Johnson in Carter & others, 1994, p. 359, *ex* Spiriferinidina Ivanova, 1972, p. 41] [=Spiriferinida Cooper & Grant, 1976b, p. 2,666]

Hinge line strophic; commonly transverse and biconvex; flanks ribbed, rarely smooth; ventral valve inflated and thicker than dorsal valve; ventral interarea commonly well developed; brachidium, where present, spiraliform, spiralia directed laterally or posterolaterally; jugum generally present; shell punctate. *Lower Devonian (Lochkovian)–Lower Jurassic.*

INTRODUCTION

J. L. Carter and Rémy Gourvennec

[retired from Carnegie Museum of Natural History; and Université de Bretagne Occidentale]

This group of 116 genera comprises all of the punctate spiriferids formerly classified within the impunctate order Spiriferida and includes the syringothyridids and licharewiidines, which are now known to be punctate (Erlanger, 1989). They appeared near the Siluro-Devonian boundary and disappeared in the Early Jurassic. Many of these shells resemble the impunctate Spiriferida in external growth form and in having a calcified spiral brachidium. In addition to different shell structure, however, this group differs in generally having a jugum (Fig. 1250) in the oldest genera (and in many younger genera); and, unlike most of the Spiriferida, most punctate genera have structures to shorten the length of the ventral adductors. These structures may take the form of a ventral septum, a depressed delthyrial plate or syrinx, or a spondylium or false spondylium (the functional equivalent of a spondylium but with the dental adminicula simulated by callus deposits).

The typical spiriferinide is smaller than its impunctate counterpart, transverse, with coarse plications on the flanks, a high to very high flattened apsacline to procline ventral interarea, a smooth fold and sulcus, and a jugum uniting the primary lamellae of the spiralia. Punctae are coarse and easily detected in some genera or fine and very difficult to detect in others, often requiring complex preparation techniques for observation. Unlike many large impunctate spiriferides, which probably lay freely on the sea floor, these animals seem to have been attached always by means of a pedicle. In general, these shells are much less common in Paleozoic faunas than are the impunctate spiriferides.

All spiriferinides seem to have lived either attached to the substrate or to each other by means of a muscular pedicle. They are found in many normal marine sedimentary rocks of shallow to moderately deep origin. They are rare or absent in most deep basinal sediments such as black shales and were cosmopolitan in distribution throughout most of their stratigraphic range, occurring in many normal marine biotas.

The origin of the punctate spiriferinides is uncertain. *Cyrtina*, the earliest genus, first appeared near the Silurian-Devonian boundary with several complex internal structures, a fully punctate shell, and no complex microornament, although there are a few scattered spinules in some species. *Cyrtina* bears a ventral spondylium with

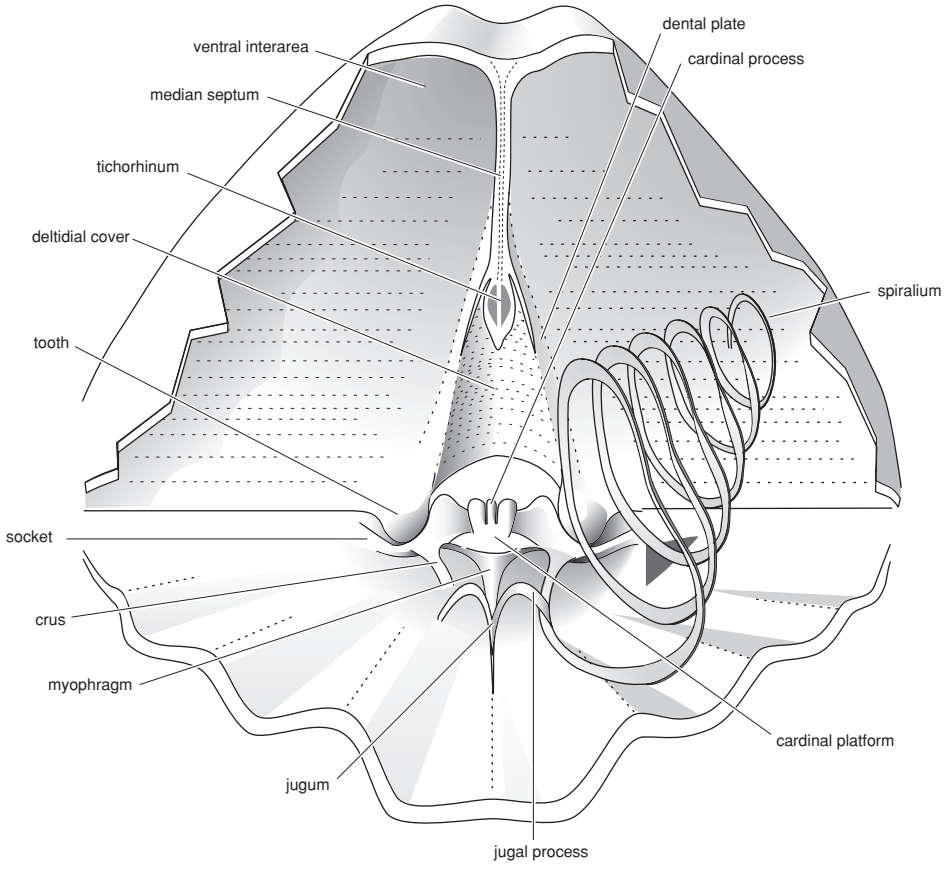

FIG. 1250. Diagrammatic representation of morphology of the cyrtinid shell: anterior view of the interior with ventral valve up, dorsal valve down (new).

tichorhinum (Fig. 1250) in the ventral valve, a knoblike or striated cardinal process situated on a low platform, and a jugum connecting the primary lamellae of the spiralium in the dorsal valve. The impunctate genera *Cyrtinopsis* and *Kozlowskiellina* are somewhat similar to *Cyrtina* both externally and internally but differ significantly, in addition to having different shell structure, in having a more complex microornament and in lacking a jugum or tichorhinum. The simultaneous appearance of endopunctation, a complete jugum, a tichorhinum, and the loss of delthyridine microornament in *Cyrtinopsis*, characters needed in order to produce *Cyrtina*, seems unlikely. It does, however, seem likely that *Cyrtina* is much too morphologically complex to have been the first of the Spiriferinida.

Two other possibilities for the origin of the punctate spirifers are 1) derivation by parallel or convergent evolution from some unknown punctate orthid by acquisition of calcareous spiralia, and 2) derivation from some unknown transverse endopunctate retzioid by acquisition of interareas and loss of the rostrate growth form and the complex jugum in the dorsal valve. There is no fossil evidence for either of these possibilities. Figure 1251 indicates the general evolutionary path of the Spiriferinida.

This order is composed of two suborders, the Cyrtinidina and Spiriferinidina, each with three superfamilies. The Cyrtinidina are

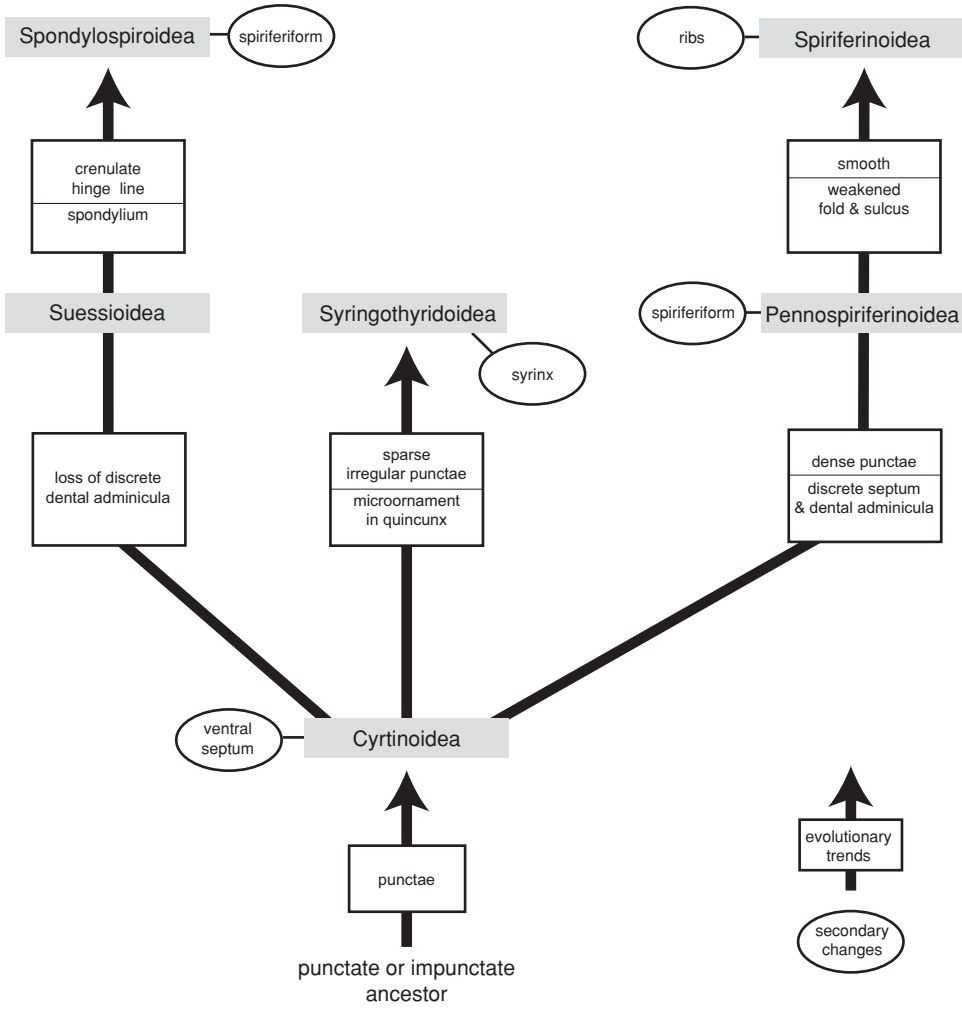

FIG. 1251. General evolutionary path within the Spiriferinida with indication of primary and secondary innovations or changes (new).

characterized by having a spondylium or spondylium-like structure in the ventral valve and the Spiriferinidina by having only a delthyrial plate, syrinx, or ventral septum for adductor attachment. The cyrtinidines ranged from near the Siluro-Devonian boundary beds to the Lower Jurassic, giving rise in the Famennian to the spiriferinidines, which also ranged through the Lower Jurassic (see Fig. 1102).

In the Devonian the cyrtinidines evolved slowly, producing only five additional genera, one of which, *Komiella*, gave rise in the Middle or Late Devonian to the lineage that produced the large superfamilies Syringothyridoidea and Pennospiriferinoidea, both of which appeared at about the same time in the late Famennian. The main cyrtinidine lineage evolved very slowly in the Late Devonian and late Paleozoic, producing a sparse stratigraphic record. Only three cyrtinidine genera are known from rocks of this age, but one of these, *Eolaballa* from the upper Permian of China and Sicily, is clearly an antecedent of the Mesozoic cyrtinidines of the superfamily Suessioidea.

The Suessioidea were probably derived from the cyrtinoids in the early Carboniferous, but there is no undoubted fossil record of this lineage before that of *Eolaballa* in the upper Permian. Except for this long apparent hiatus in occurrences, the startling external and internal similarity of this group with the cyrtinioids could justify combining these groups, as has been done by other authors.

The Spondylospiroidea appeared in the Middle Triassic with a unique innovation, the development of crenulate interareas and an interlocking hinge line. Many of these unusual genera are otherwise similar to the suessioid family Laballidae, and it is assumed that their ancestry was within that stock. After a brief evolutionary radiation that produced 14 genera, the group disappeared at the end of the Triassic.

Two stocks of the suborder Spiriferinidina appeared at nearly the same time in the Upper Devonian (upper Famennian). One lineage, the Syringothyridoidea, is characterized by its large size, wide and high procline ventral interarea, subdelthyrial plate or syrinx within the ventral valve, and distinctive microornament. This superfamily flourished in the Carboniferous and early Permian but became extinct by the end of the Permian.

The other stock, the Pennospiriferinoidea, lacks a delthyrial plate or syrinx but achieved the same effect of shortening the adductor muscles by using a high apical ventral median septum. This lineage evolved slowly in the early part of the Carboniferous but produced four new families and a number of new genera starting in the Visean. There is no record of this order in the Lower Triassic, but a final radiation commenced in the Middle Triassic and culminated in the Late Triassic.

In the Middle Triassic a pennospiriferinoid stock gave rise to the Spiriferinoidea, the last of the spiriferinidine superfamilies. This group mimics the Paleozoic reticularioids in having an ovate outline, weakly developed fold-sulcus, and weak or absent ribbing. Only five cyrtinidine and spiriferinidine genera occur in the Lower Jurassic, after which the entire order became extinct.

CYRTINIDINA

J. L. CARTER and J. G. JOHNSON

[retired from Carnegie Museum of Natural History; and deceased, formerly of Oregon State University]

Suborder CYRTINIDINA Carter & Johnson, 1994

[Cyrtinidina CARTER & JOHNSON in CARTER & others, 1994, p. 360]

Lateral slopes plicate or smooth; ventral valve high, subconical or hemipyramidal in early forms, variable in later ones; delthyrium commonly covered in early genera, variably covered in late genera; ventral interior generally with complex, elevated adductor attachment structures. *Lower Devonian (Lochkovian)–Lower Jurassic.*

CYRTINOIDEA

J. G. JOHNSON

[deceased, formerly Oregon State University]

Superfamily CYRTINOIDEA Frederiks, 1911

[*nom. correct.* JOHNSON in CARTER & others, 1994, p. 360, *pro* superfamily Cyrtinacea JOHNSON, 1966a, p. 177, *nom. transl. ex* Cyrtininae FREDERIKS, 1911, p. 5]

Ventral valve hemipyramidal, with high interarea; dorsal valve flat or weakly convex; surface nonfimbriate and noncapillate; with ventral median septum. *Lower Devonian (Lochkovian)–Carboniferous (Visean).*

Family CYRTINIDAE Frederiks, 1911

[*nom. transl.* STEHLI, 1954, p. 350, *ex* Cyrtininae FREDERIKS, 1911, p. 5]

Deltidium stout, apically perforated; spondylium and divided tichorhinum present; with bilobed, commonly nonstriate cardinal process, but ctenophoridium may form in older growth stages. *Lower Devonian (Lochkovian)–Carboniferous (Visean).*

Cyrtina DAVIDSON, 1859 in 1858–1863, p. 66 [**Calceola heteroclita* DEFRANCE, 1828b, p. 156; SD OEHLERT, 1887a, p. 40] [=*Spinocyrtina* FREDERIKS, 1916, p. 18 (type, *Cyrtina lachrymosa* HALL & CLARKE, 1895, p. 362, SD FREDERIKS, 1918b, p. 145, =*Cyrtia hamiltonensis* HALL, 1857, p. 166); *Cyrtinaellina* FREDERIKS, 1926, p. 414 (type, *Cyrtia acutirostris* SHUMARD, 1855, p. 204, OD); *Trochalocyrtina* WRIGHT, 1975, p. 175 (type, *T. flemingi* WRIGHT, 1975, p. 175, OD)]. Flanks plicate; fold and sulcus smooth; with or without prominent growth lines and, rarely, with fine pustules; cardinal platform present; jugum with prominent median process. [PITRAT (1965, p. 678) suggested that the "first unequivocal designation of the type-species" for *Cyrtina* was that of HALL and CLARKE (1893, p. 44), but this is subsequent to the designation of *C. heteroclita* by OEHLERT (1887a, p. 40). In 1916, FREDERICKS designated two species for the genus *Spinocyrtina* (*S. lachrimosa* HALL & CLARKE and *S. hamiltonensis* HALL), neither of them being clearly designated as type species. Later, in 1918b and 1926, FREDERICKS designated different type species. In 1918b (p. 145), the type species is listed as *C. lachrimosa* HALL & CLARKE. In 1926 (p. 413), the type species is listed as *C. hamiltonensis* HALL. The species that should be retained is *lachrimosa,* which does not appear in the body of FREDERICKS's 1918b paper but in an appendix at the end of the volume entitled "Diagnoses generum et speciorum novorum"; nevertheless this designation seems valid.] *Lower Devonian (lower Lochkovian)–Carboniferous (Visean):* cosmopolitan.——FIG. 1252,*1a–e.* **C. heteroclita* (DEFRANCE), Middle Devonian, western Europe; *a–c,* ventral, posterior and lateral views, ×1.5 (Davidson, 1864); *d,* ventral interior, ×3; *e,* section of ventral valve, approximately ×2 (Oehlert, 1901).

Cyrtinaella FREDERIKS, 1916, p. 18 [**Cyrtia biplicata* HALL, 1857, p. 165; OD]. Entire surface smooth, or with incipient plications bounding sulcus; ventral valve transverse, wider than high. *Lower Devonian (Lochkovian)–Middle Devonian:* North America.——FIG. 1252,*2a–c.* **C. biplicata* (HALL), Lower Devonian, USA; ventral, anterior, and posterior views, ×1 (Hall, 1867b).——FIG. 1252,*2d–i.*

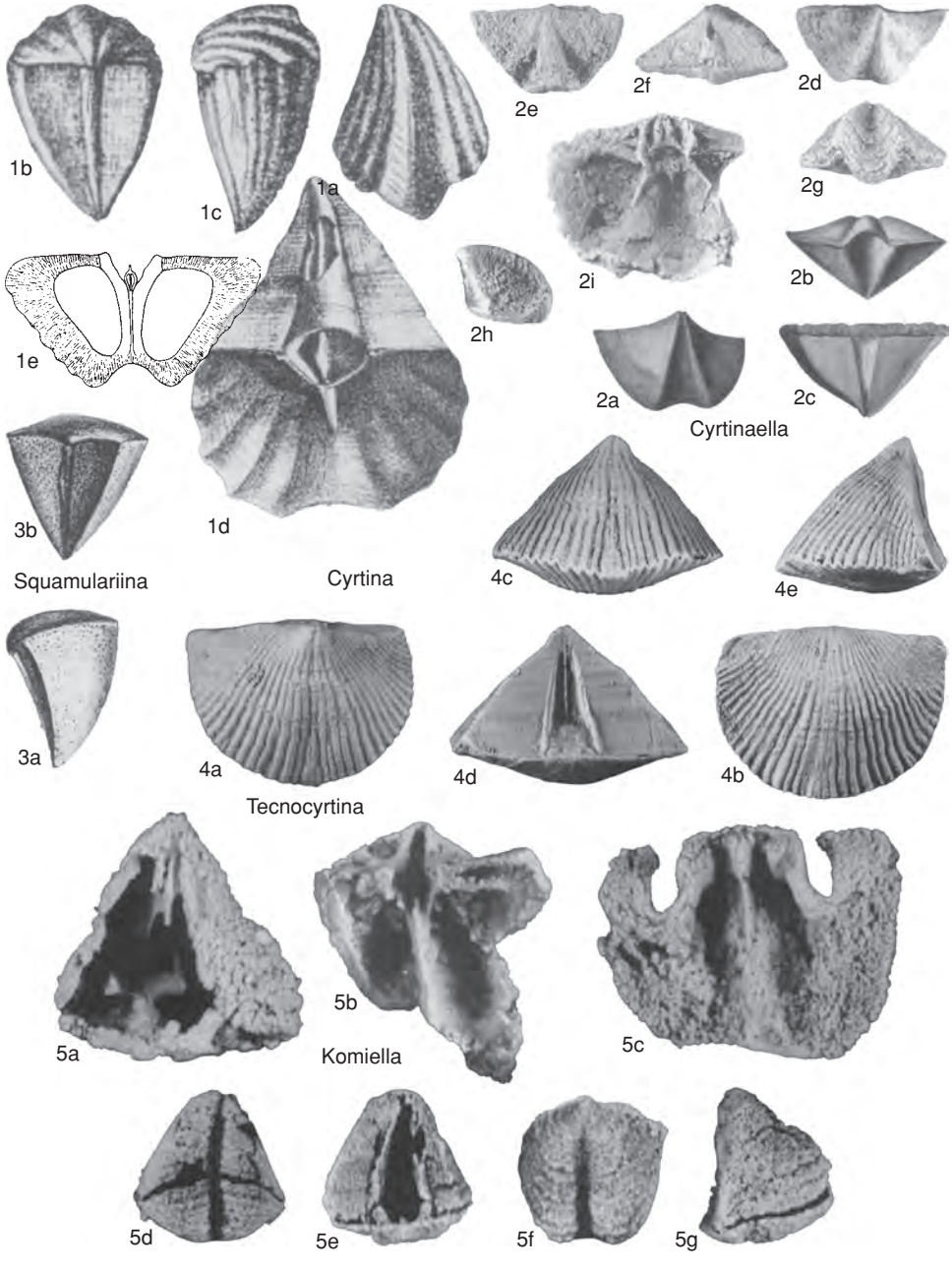

FIG. 1252. Cyrtinidae and Komiellidae (p. 1881–1883).

C. causa JOHNSON, Pragian, Nevada, USA; *d–h,* ventral, dorsal, posterior, anterior, and lateral views, ×1.5; *i,* dorsal interior, ×3 (Johnson, 1970).

Squamulariina FREDERIKS, 1916, p. 19 [**Cyrtina parva* GÜRICH, 1896, p. 266; OD] [=*Pyramidalia* NALIVKIN, 1947, p. 124 (type, *Spirifera simplex* PHILLIPS, 1841, p. 71, OD)]. Entire surface smooth; width less than height of ventral interarea. *Middle Devonian:* Europe, south Fergana, Salair, China (Guizhou).——FIG. 1252,*3a–b*. **S. parva* (GÜRICH), Poland; lateral and posterior views, ×2.5 (Gürich, 1896).

Tecnocyrtina JOHNSON & NORRIS, 1972, p. 566 [**Cyrtina billingsi* MEEK, 1868, p. 97; OD]. Entire surface plicate, commonly multiplicate. *Middle Devonian (upper Givetian)–Upper Devonian (lower Frasnian):* North America, Europe.——FIG. 1252,*4a–e.* **T. billingsi* (MEEK), upper Givetian, Alberta, Canada; ventral, dorsal, anterior, posterior, and side views, ×2.5 (Johnson & Norris, 1972).

Family KOMIELLIDAE Johnson & Blodgett, 1993

[Komiellidae JOHNSON & BLODGETT, 1993, p. 952]

Spondylium incomplete, or dental flanges and median septum not connected, and lacking a tichorhinum; cardinal process simple, nonstriate; jugum sessile. *Lower Devonian (Emsian)–Upper Devonian (Frasnian).*

Komiella LIASHENKO, 1985, p. 14 (BARKHATOVA, 1970, p. 62, *nom. nud.*) [**K. devonica;* OD]. Entire surface smooth; bisulcate; teeth and sockets widely spaced. [No satisfactory illustration of the type is available.] *Lower Devonian (Emsian)–Upper Devonian (Frasnian):* western USA (Alaska, Nevada), western Canada (Yukon Territory), Timan.——FIG. 1252,*5a–c. K. gilberti* JOHNSON & BLODGETT, lower Eifelian, west-central Alaska; posterior showing jugum, ventral interior, and dorsal interior views, ×10 (Johnson & Blodgett, 1993).——FIG. 1252,*5d–g. K. stenoparva,* upper Givetian, Nevada; anterior, posterior, dorsal, and side views, ×10 (Johnson & Blodgett, 1993).

SUESSIOIDEA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

Superfamily SUESSIOIDEA Waagen, 1883

[*nom. correct.* CARTER in CARTER & others, 1994, p. 361, *pro* Suessiacea PITRAT, 1965, p. 675, *nom. transl. ex* Suessiinae WAAGEN, 1883a, p. 498]

Usually cyrtiniform; ventral valve usually hemipyramidal to subconical with high interarea; ventral median septum present, discrete dental adminicula absent; endopunctae or so-called hemipunctae obscure in some genera. *Carboniferous (Mississippian)–Lower Jurassic.*

Family DAVIDSONINIDAE Ivanova, 1972

[Davidsoninidae IVANOVA, 1972, p. 41]

Lateral slopes ribbed; ventral interior with false spondylium composed of median septum and high dental flanges; ventral adminicula absent; shell substance punctate, but punctae possibly not penetrating primary layer (hemipunctate); jugum and jugal processes absent; brachidium unknown, possibly absent. *Carboniferous (Mississippian).*

Davidsonina SCHUCHERT in SCHUCHERT & LEVENE, 1929a, p. 120, *nom. nov. pro Cyrtinopsis* FREDERIKS, 1916, p. 17, *non* SCUPIN, 1896; *nom. nov. pro Davidsonella* FREDERIKS, 1926, p. 413, *non* MUNIER-CHALMAS, 1880, *nec* WAAGEN, 1885 [**Spirifera septosa* PHILLIPS, 1836, p. 216; OD]. Medium to very large; outline variable; ventral valve strongly inflated and evenly convex; interarea high, flattened to concave, apsacline; deltidial plates rarely preserved; sulcus narrow, shallow; dorsal valve much less convex or flattened; dorsal interior lacking septa or plates; ornament consisting of numerous uniform, rounded costae with frequent bifurcations and narrow interspaces over entire surface; microornament unknown. *Carboniferous (Mississippian):* Eurasia.——FIG. 1253,*1a–b.* **D. septosa* (PHILLIPS), Visean, British Isles; *a,* holotype, ventral valve; *b,* transverse section of ventral valve, ×1 (Davidson, 1858 in 1858–1863).——FIG. 1253,*1c–e. D. carbonaria* (M'COY); dorsal, ventral, and ventral interiors, ×1 (Davidson, 1858 in 1858–1863).

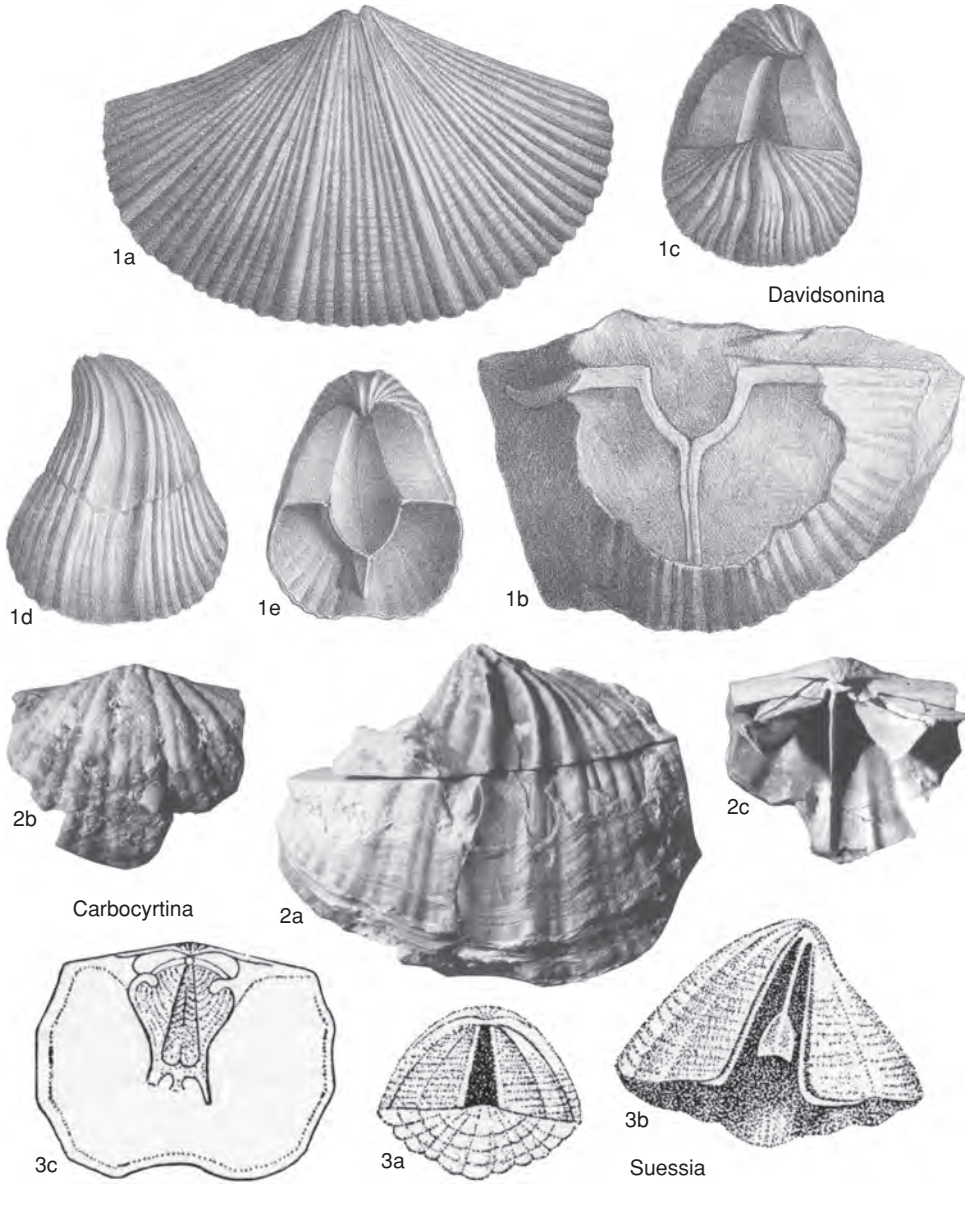

FIG. 1253. Davidsoninidae and Suessiidae (p. 1883–1890).

Carbocyrtina IVANOVA, 1975, p. 81 [**C. triplicata;* OD]. Medium size; transverse; ventral interarea high, irregular, concave; delthyrium with convex deltidium; ornament consisting of several rounded plications with fasciculate costae on flanks; fold and sulcus smooth, or with 1 prominent plication, or with several weak ribs; microornament consisting of very fine, recumbent papillae that may produce fimbriate growth lamellae; dorsal valve interior with small, weakly striate ctenophoridium, diverging crural bases, and thin, high median septum; otherwise similar to *Davidsonina. Carboniferous (Visean):* Russia (Moscow basin).——FIG. 1253,*2a–c. *C. triplicata; a,* holotype, ventral valve; *b–c,* dorsal valve exterior and interior, ×1 (new).

Family LABALLIDAE Dagys, 1962

[*nom. transl.* Dagys, 1965, p. 91, *ex* Laballinae Dagys, 1962, p. 49]

Cyrtiniform; spondylium bisected by high median septum. *Permian (Changhsingian)–Upper Triassic.*

Subfamily LABALLINAE Dagys, 1962

[Laballinae Dagys, 1962, p. 49]

Fold and sulcus well defined; lateral slopes smooth or with 1 or 2 faint plicae; delthyrium open. *Permian (Changhsingian)–Upper Triassic.*

Laballa Moisseev, 1962, p. 51 [**Spiriferina suessi* Winkler, 1859, p. 22; OD]. Medium size; outline subtrigonal to subpentagonal; strongly ventribiconvex, subpyramidal; ventral umbonal region elongated, beak straight or slightly incurved; ventral interarea high, flattened or slightly concave, weakly apsacline to catacline; delthyrum open; fold and sulcus moderately well developed, rounded, smooth; lateral slopes smooth or very gently folded; microornament of short spinules; ventral interior with very high, short median septum bisecting high, shallow, anteriorly free spondylium; dorsal interior with ctenophoridium and long, high, subparallel dorsal adminicula; jugum free, flattened, fimbriate. *Upper Triassic:* Tethys, northeastern Siberia, New Zealand, New Caledonia.——Fig. 1254,*3a–j.* **L. suessi* (Winkler), Rhaetian, eastern Alps; *a–b,* dorsal and lateral views, ×1 (new); *c–g, h–j,* transverse sections of 2 specimens, ×2 (Dagys, 1963).

Eolaballa Liao & Meng, 1986, p. 86 [94] [**E. pristina;* OD]. Medium size; lateral slopes with 1 or 2 very weak, low, undulating plicae; ventral interarea very narrow with much wider, false interareas laterally, strongly apsacline in adults, catacline in juveniles; jugum unknown; otherwise similar to *Laballa. Permian (Changhsingian):* China (Hunan), Sicily.——Fig. 1254,*1a–e.* **E. pristina,* Hunan; ventral, dorsal, anterior, posterior, and lateral views, ×2 (new).

Pseudolaballa Dagys, 1974, p. 145 [**Laballa bittneri* Dagys, 1965, p. 93; OD]. Medium size; transversely subovate to subquadrate in outline; ventribiconvex; ventral valve subpyramidal; cardinal extremities rounded; ventral interarea high, flattened, smooth, catacline to procline; fold and sulcus well defined, variably wide, rounded, smooth; lateral slopes smooth or obscurely plicate; microornament unknown; ventral interior with moderately deep high spondylium bisected by median septum; dorsal interior with apical callus, low ctenophoridium, and thin, low ridges bounding adductor field; jugum unknown. *Upper Triassic (Carnian):* northeastern Siberia, New Zealand, New Caledonia.——Fig. 1254,*2a–f.* **P. bittneri* (Dagys), northeastern Siberia; *a–c,* paratype, ventral, posterior, and lateral views, ×1 (new); *d–f,* transverse sections, ×1 (Dagys, 1965).

Subfamily SPINOLEPISMATININAE Carter, 1994

[Spinolepismatininae Carter in Carter & others, 1994, p. 362]

Lateral slopes distinctly plicate; fold and sulcus smooth; microornament densely spinulose. *Upper Triassic.*

Spinolepismatina Dagys, 1974, p. 147 [**Lepismatina rara* Dagys, 1963, p. 97; OD]. Small to medium sized; ventral valve subconical; ventral interarea high, flattened, smooth; fold and sulcus smooth; lateral slopes with several rounded plicae; ventral interior with elevated spondylium; dorsal interior with jugum supported by sessile net. *Upper Triassic:* Caucasus Mountains.——Fig. 1255,*4a–g.* **S. rara* (Dagys); *a–d,* holotype, posterior, ventral, dorsal, and lateral views, ×1; *e–g,* transverse sections, approximately ×2 (Dagys, 1963).

Klipsteinella Dagys, 1974, p. 150 [**Spirifer calceola* Klipstein, 1845, p. 227; OD]. Small; strongly ventribiconvex, ventral valve acutely extended and very high, dorsal valve flattened or concave; ventral interarea high, flattened, delthyrium closed by convex deltidium with small apical foramen; fold and sulcus very narrow but well defined, smooth; lateral slopes with few rounded plicae; microornament of small spinules; dorsal interior unknown. *Upper Triassic (Carnian):* western Tethys.——Fig. 1255,*1a–d.* **K. calceola* (Klipstein), southern Alps; dorsal, ventral, lateral, and posterior views, ×3 (Dagys, 1974).

Klipsteinelloidea Sun, 1981, p. 209 [**K. tibetica;* OD; =*K. xizangensis* Sun, 1981, p. 210]. Small; outline subovate; profile subtrigonal; ventral valve very high, subconical, with high, flat, catacline or slightly procline interarea; beak acute, straight; delthyrium narrow, open; dorsal valve thinly convex; fold and sulcus narrow, smooth, poorly defined; cardinal extremities rounded, maximum width attained anterior to hinge line; lateral slopes with few rounded, coarse plicae; microornament unknown; dorsal interior with posteriorly sessile low ctenophoridium; dorsal adminicula short, slightly divergent; jugum unknown. *Upper Triassic:* China.——Fig. 1255,*2a–h.* **K. tibetica,* Tibet; *a–d,* anterior, posterior, lateral, and ventral views, ×3 (new); *e–h,* transverse sections, approximately ×2 (Sun, 1981).

Subfamily PARALEPISMATININAE Carter, 1994

[Paralepismatininae Carter in Carter & others, 1994, p. 362]

Fold and sulcus poorly developed; entirely ribbed; microornament absent. *Middle Triassic (Anisian).*

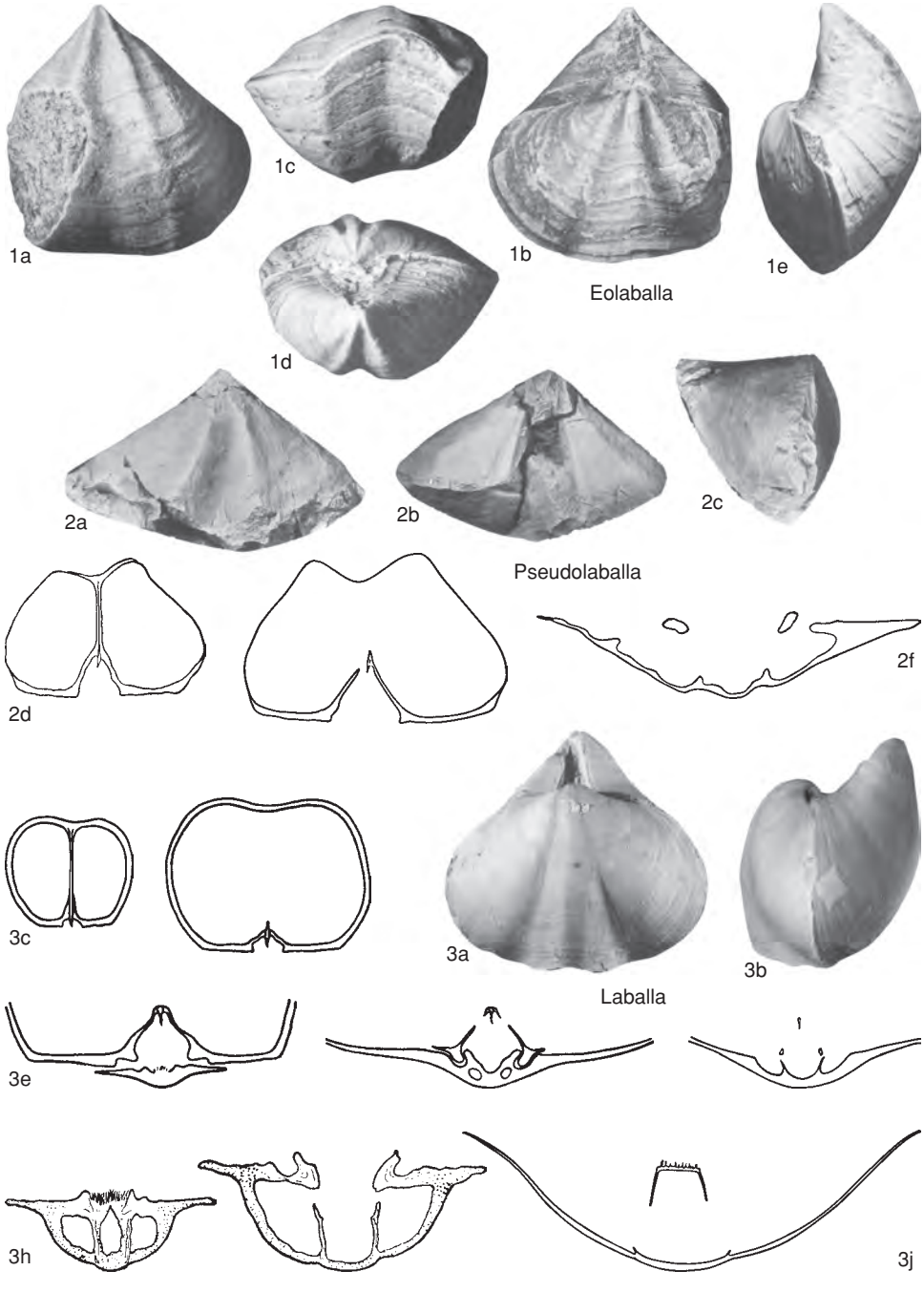

FIG. 1254. Laballidae (p. 1885).

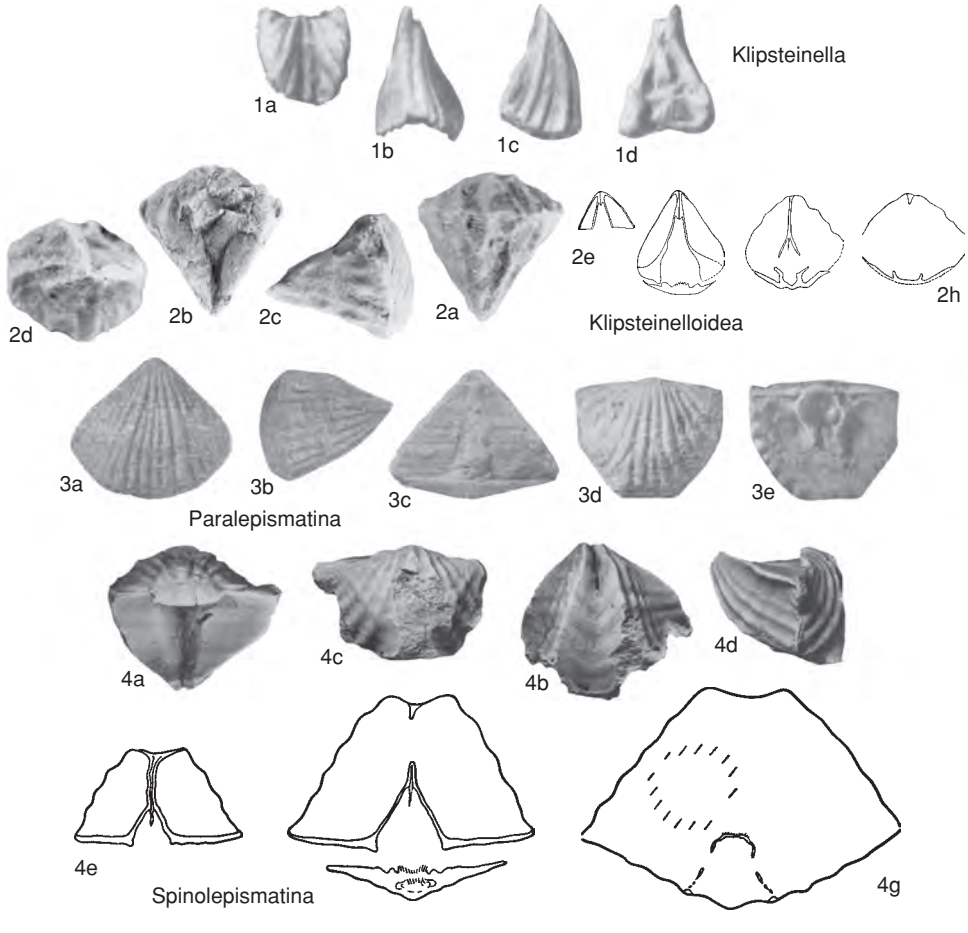

FIG. 1255. Laballidae (p. 1885–1887).

Paralepismatina YANG & XU, 1966, p. 38 [**P. semiconica;* OD]. Small; strongly ventribiconvex, ventral valve subconical, dorsal valve weakly convex; cardinal extremities angular, maximum width at hinge line; ventral beak straight, acute; ventral interarea high, flattened, nearly catacline; delthyrium narrow, open; fold and sulcus absent or very poorly developed; entire surfaces of valves with fine, rounded, simple costellae and fine, regular growth lamellae; microornament seemingly absent; ventral interior with short spondylium supported by high, long median septum; ctenophoridium present; jugum unknown. *Middle Triassic (Anisian):* China (Guizhou).——FIG. 1255,*3a–e. *P. semiconica; a–c,* paratype, ventral, lateral, and posterior views; *d–e,* exterior and interior views of dorsal valve, ×2 (Yang & Xu, 1966).

Family BITTNERULIDAE Schuchert, 1929

[*nom. transl.* CARTER in CARTER & others, 1994, p. 362, *ex* Bittnerulinae SCHUCHERT, 1929, p. 21] [=Thecocyrtellinae DAGYS, 1965, p. 105]

Cyrtiniform; dental adminicula and spondylium absent; ventral septum and dental flanges fused by apical callus or short transverse plate. *Middle Triassic–Upper Triassic.*

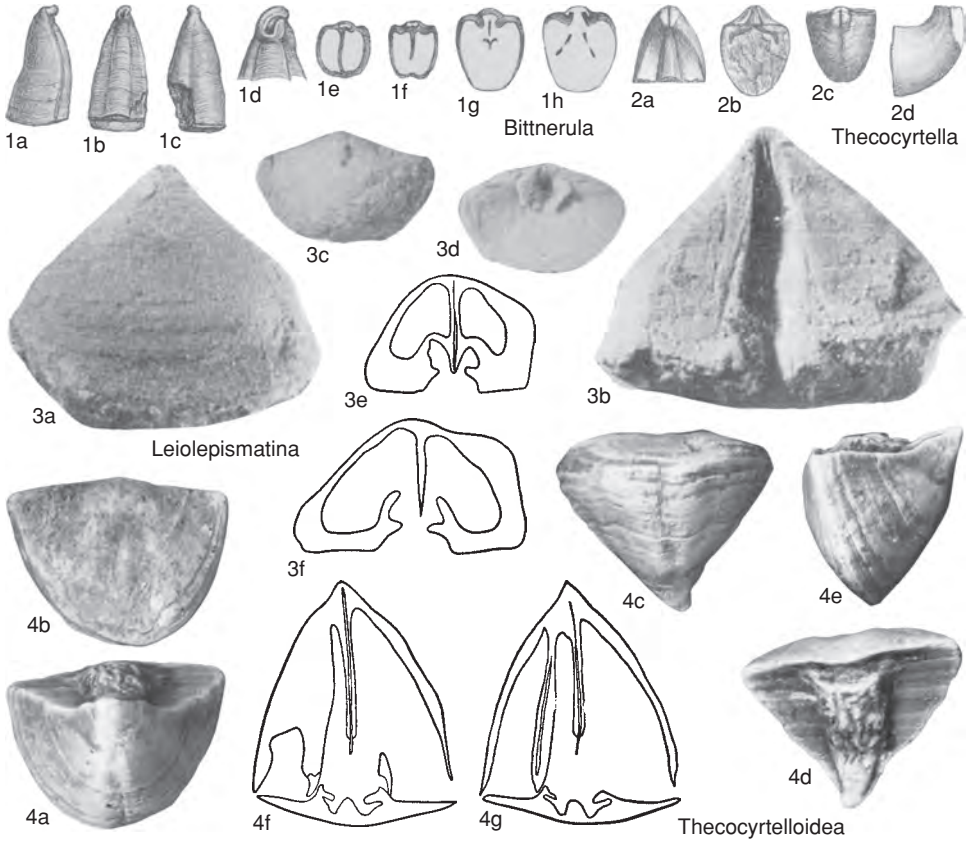

FIG. 1256. Bittnerulidae (p. 1888–1889).

Subfamily BITTNERULINAE Schuchert, 1929

[Bittnerulinae SCHUCHERT, 1929, p. 21]

Smooth or obscurely ribbed; fold and sulcus absent or very weak; delthyrium closed by convex deltidium. *Middle Triassic–Upper Triassic.*

Bittnerula HALL & CLARKE, 1894, p. 764 [**Cyrtina zitteli* BITTNER, 1890, p. 117; OD]. Small; very strongly inequivalved; ventral valve very high, subconical; dorsal valve weakly convex; ventral beak twisted, asymmetrical; ventral interarea very high, flattened, catacline; delthyrium covered by convex deltidium (possible symphytium) pierced by tiny apical foramen; cardinal extremities subangular, maximum width anterior to hinge line, at midlength in type species; lateral slopes of ventral valve rounded in type species, flattened in some species; weak sulcus present; microornament of fine, dense spinules in some species; interior with high median septum fused to dental flanges by thin transverse plate or callus; dorsal interior in type species with complete jugum bearing short anterior process; short dorsal adminicula and jugal net present in some species. *Upper Triassic (Carnian):* western Tethys.——FIG. 1256,*1a–h. *B. zitteli* (BITTNER), southern Alps; *a–d,* lateral, posterior, anterior, and enlarged ventral beak; *e–h,* longitudinal sections, ×1 (Bittner, 1892).

Leiolepismatina YANG & XU, 1966, p. 39 [**L. semiconula;* OD]. Small; transversely subsemicircular in outline; strongly ventribiconvex, ventral valve high, subconical, dorsal valve moderately convex; cardinal extremities rounded; ventral interarea very high, flat, catacline; delthyrium open; fold and sulcus absent; shell lacking macro- or microornament; high median septum connected to dental flanges by bisected transverse band of callus; presence of functional spondylium not certain; dorsal interior with small ctenophoridium; jugum unknown. *Middle Triassic:* China (Guizhou).——FIG. 1256,*3a–f. *L. semiconula; a–b,* ventral and posterior views of ventral valve, ×4; *c–d,* exterior and

interior views of dorsal valve, ×2; *e–f,* transverse sections, approximately ×4 (Yang & Xu, 1966).

Thecocyrtella Bittner, 1892, p. 15, *nom. nov. pro Cyrtotheca* Bittner, 1890, p. 116, *non* Hicks, 1872 [**Cyrtotheca ampezzana* Bittner, 1890, p. 116; OD]. Very small; strongly ventribiconvex; ventral valve high, symmetrical, beak incurved; dorsal valve probably slightly concave; widest at hinge line, cardinal extremities angular; ventral interarea well defined, concave; delthyrium completely closed by convex deltidium; fold and sulcus absent; microornament of fine growth lines only; ventral interior with long median septum; other internal details unknown. *Upper Triassic:* western Tethys.——Fig. 1256,*2a–d.* **T. ampezzanaa* (Bittner), Alps; holotype, posterior, dorsal (showing part of brachidium), ventral, and lateral views, ×3 (Bittner, 1890).

Thecocyrtelloidea Yang & Xu, 1966, p. 58 [**T. tubulosa;* OD]. Small, ventribiconvex, ventral valve strongly subconical, dorsal weakly convex; ventral beak commonly asymmetrical; ventral interarea high, flattened, weakly convex or concave, catacline to procline; deltidium widely convex with numerous fine tubules; semicircular pedicle foramen seemingly present proximally; fold and sulcus narrow, very weakly developed; microornament unknown; ventral interior with long median septum; ventral adminicula possibly absent or very short; spondylium absent; dorsal interior with broad, bilobed ctenophoridium; jugum unknown. *Middle Triassic (Anisian):* China (Guizhou).——Fig. 1256,*4a–g.* **T. tubulosa; a–e,* topotype, ventral, dorsal, anterior, posterior, and lateral views, ×4 (new); *f–g,* transverse sections, approximately ×3 (Yang & Xu, 1966).

Subfamily HIRSUTELLINAE Xu & Liu, 1983

[Hirsutellinae Xu & Liu, 1983a, p. 82]

Lateral slopes ribbed; fold and sulcus weakly to moderately developed; delthyrium open or partially occluded by various plates. *Middle Triassic–Upper Triassic (Carnian).*

Hirsutella Cooper & Muir-Wood, 1951, p. 195, *nom. nov. pro Hirsutina* Kirchner, 1933, p. 106, *non* Tutt, 1909 [**Spirifer? hirsutus* Alberti, 1864, p. 156; OD]. Small to medium size; outline transversely subovate; usually strongly ventribiconvex; ventral valve subpyramidal, dorsal valve flattened or weakly convex; cardinal extremities subangular to rounded; ventral interarea high, catacline; fold and sulcus weakly developed; entire surface covered with moderately numerous, rounded, simple costae; microornament unknown; ventral interior with high median septum laterally fused to valve wall and dental flanges by callus; dorsal interior with stout, thick ctenophoridium supported by thick callus; jugum unknown. *Middle Triassic:* western Tethys.——Fig. 1257,*1a–b.* **H. hirsuta* (Alberti), Germany; exterior and interior views of ventral valve, ×1 (Kirchner, 1933).——Fig. 1257,*1c–g. H. multicostata* Yang & Yin; dorsal, ventral, lateral, anterior, and posterior views, ×1 (Xu & Liu, 1983a).

Flabellocyrtia Chorowicz & Termier, 1975, p. 235 [**F. flabellum;* OD]. Small; strongly ventribiconvex; ventral valve high, subconical; dorsal valve flattened; ventral interarea high, slightly concave, smooth, catacline; delthyrium completely closed by deltidium; fold and sulcus weakly developed, narrow; lateral slopes with few rounded plicae, sulcus with weak median rib; microornament unknown; dorsal interior with fine, radiating grooves anteriorly; jugum unknown. *Middle Triassic (Ladinian):* Yugoslavia.——Fig. 1257,*3a–e.* **F. flabellum; a–c,* lateral, dorsal, and ventral views, ×5.3; *d,* ventral interior, ×5.45; *e,* dorsal interior, ×7.3 (Chorowicz & Termier, 1975).

Neocyrtina Yang & Xu, 1966, p. 62 [**N. mixodeltidiumosa;* OD]. Small, with subconical ventral valve and weakly convex dorsal valve; maximum width at hinge line, cardinal extremities angular; ventral interarea high, flattened, catacline to procline; delthyrial cover bipartite with imbricating plates proximally and irregular solid nodules or tubules apically; fold and sulcus weakly delimited, smooth; fold with medial depression; lateral slopes with few plicae; growth lamellae closely imbricate, other microornament absent; punctae fine; ventral interior with thick callus uniting dental flanges and high, strong median septum; dorsal interior with short, broad ctenophoridium; jugum unknown. *Middle Triassic:* China (Guizhou).——Fig. 1257,*2a–i.* **N. mixodeltidiumosa; a,* holotype, posterior view; *b,* dorsal interior, ×4; *c–f,* dorsal, ventral, lateral, and posterior views, ×2; *g–i,* transverse sections, approximately ×4 (Yang & Xu, 1966).

Spiriferinoides Tokuyama, 1957, p. 101 [**S. sakawanus* Kobayashi & Tokuyama in Tokuyama, 1957, p. 101; OD]. Small; outline transversely subovate to subsemicircular; ventribiconvex; ventral valve strongly convex, dorsal valve flattened, weakly convex; cardinal extremities rounded; ventral interarea moderately high, concave, apsacline; ventral beak moderately incurved; fold and sulcus well developed, rounded, smooth; lateral slopes with few rounded, simple plicae; microornament of dense, fine spinules; internally similar to *Hirsutella;* jugum unknown. *Upper Triassic (Carnian):* Japan, Primorye (Siberia).——Fig. 1257,*4a–d.* **S. sakawanus* (Kobayashi & Tokuyama); holotype, dorsal, ventral, posterior, and lateral views, ×2 (Tokuyama, 1957).

Family SUESSIIDAE Waagen, 1883

[*nom. transl.* Pitrat, 1965, p. 679, *ex* Suessiinae Waagen, 1883a, p. 498]

Entirely plicate; delthyrium open; dental adminicula and spondylium absent; large,

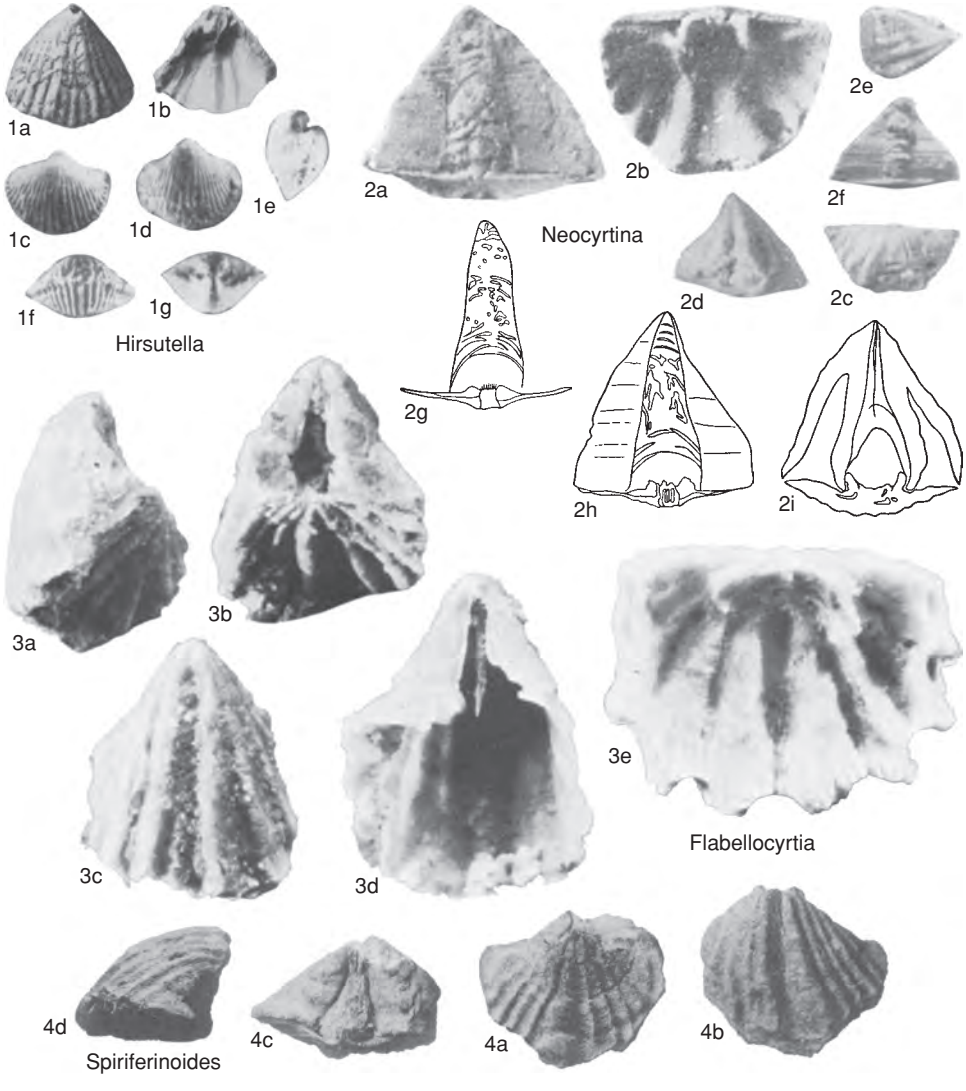

FIG. 1257. Bittnerulidae (p. 1889).

elongate hinge plate bearing adductors. *Lower Jurassic.*

Suessia EUDES-DESLONGCHAMPS, 1855, p. 6 [**S. costata;* SD DAVIDSON, 1854, p. 28]. Strongly ventribiconvex; ventral valve high, strongly convex; dorsal valve much less convex; ventral interarea high, concave; fold and sulcus present; microornament unknown; ventral interior with high median septum horizontally expanded at posterodorsal margin; dorsal interior with complete jugum, bearing anterior process. *Lower Jurassic:* Europe.——FIG. 1253,*3a–c. *S. costata;* posterior, ventral valve posterior, and dorsal interior views, magnification unknown (Hall & Clarke, 1894).

SPONDYLOSPIROIDEA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

Superfamily SPONDYLOSPIROIDEA Hoover, 1991

[*nom. transl.* CARTER in CARTER & others, 1994, p. 363, *ex* Spondylospiridae HOOVER, 1991, p. 75]

Spiriferiform to cyrtiniform; hinge line partially to completely crenulate; dental adminicula converging or forming spondylium; punctation well developed. *Middle Triassic (Ladinian)–Upper Triassic (Rhaetian).*

Family SPONDYLOSPIRIDAE Hoover, 1991

[Spondylospiridae HOOVER, 1991, p. 75]

Cyrtiniform to globose; lateral slopes ribbed; spondylium bisected by high median septum; jugum complete, supported by sessile jugal net. *Upper Triassic (Carnian–Rhaetian).*

Subfamily SPONDYLOSPIRINAE Hoover, 1991

[Spondylospirinae HOOVER, 1991, p. 80]

Dental adminicula and ventral interarea complete, not pierced by paired pedicle foramena. *Upper Triassic (Carnian–Rhaetian).*

Spondylospira COOPER, 1942, p. 232 [**S. reesidei;* OD]. Medium size; strongly ventribiconvex, ventral valve high, subconical, dorsal gently convex; hinge line less than maximum width; ventral interarea high, flattened, apsacline to procline, vertically grooved, commonly covered with multipartite punctate cover (cooperculum); entire hinge line crenulate; delthyrium open or partially closed by disjunct deltidial plates leaving apical foramen; fold and sulcus well developed; valves entirely costate, costae increasing by bifurcation, those on fold-sulcus weakest; microornament unknown; spondylium high, short; sessile jugum supported by net; ctenophoridium present. *Upper Triassic (Carnian–Norian):* western North America, western South America.——FIG. 1258,*3a–i.* **S. reesidei,* Norian, Idaho, USA; *a–e,* lectotype, lateral, dorsal, ventral, posterior, and anterior views; *f–g,* dorsal and ventral views; *h,* dorsal interior; *i,* ventral interior, ×1 (Hoover, 1991).

Phenacozugmayerella HOOVER, 1991, p. 89 [**P. mimuncinata;* OD]. Medium size; ventral valve high, subpyramidal; ventral interarea high, flattened to moderately concave, entirely crenulate; delthyrium long, narrow, open; fold and sulcus moderately well developed, subangular, smooth; lateral slopes with 3 to 5 coarse subangular plicae; microornament very finely cancellate with fine capillae and slightly lamellose growth lamellae; spondylium bisected by long, high median septum; jugum unknown. *Upper Triassic (upper Carnian–middle Norian):* USA (Alaska, Nevada, Oregon).——FIG. 1258,*2a–e.* **P. mimuncinata;* middle Norian, Nevada; paratype, anterior, posterior, dorsal, ventral, and lateral views, ×1 (Hoover, 1991).

Vitimetula HOOVER, 1991, p. 85 [**V. parva;* OD]. Small; extremely ventribiconvex; ventral valve very high, subconical; dorsal valve much thinner, moderately convex; ventral interarea high, flattened, narrow, catacline, entirely crenulate; delthyrium very narrow, open; fold and sulcus weakly developed, narrow, smooth, fold sometimes absent; lateral slopes with few very weak ribs; microornament unknown; spondylium shallow; jugum unknown. *Upper Triassic (Norian):* USA (Idaho).——FIG. 1258,*1a–g.* **V. parva; a–e,* holotype, anterior, posterior, dorsal, ventral, and lateral views; *f–g,* dorsal and ventral interiors, ×3 (Hoover, 1991).

Yanospira DAGYS, 1977, p. 11 [**Y. bychkovi;* OD]. Medium size; ventribiconvex; cardinal extremities rounded; ventral interarea orthocline to slightly apsacline, bipartite, outer part smooth, inner part vertically grooved; hinge line partially crenulate; fold and sulcus well defined, moderately developed, smooth; lateral slopes with few rounded plicae; microornament absent; spondylium deep; dorsal interior with ctenophoridium supported by short, thick median septum or callus; low adductor platform bounded by lateral ridges present; jugum unknown. *Upper Triassic (Norian):* northeastern Siberia.——FIG. 1258,*5a–g.* **Y. bychkovi; a–d,* holotype, dorsal, ventral, posterior, and lateral views, ×1; *e–g,* transverse sections, ×2.7 (Dagys, 1977).

Zugmayerella DAGYS, 1963, p. 99 [**Spiriferina koessenensis* ZUGMAYER, 1882, p. 354; OD]. Medium size; ventral valve subconical; ventral interarea high, slightly concave, vertically grooved; hinge line entirely crenulate; delthyrium partially closed by deltidium with apical foramen; fold and sulcus well developed, rounded, smooth, or with weak, low median rib; lateral slopes with few rounded plicae; microornament of short spinules; spondylium elevated; jugum sessile. *Upper Triassic (Norian–*

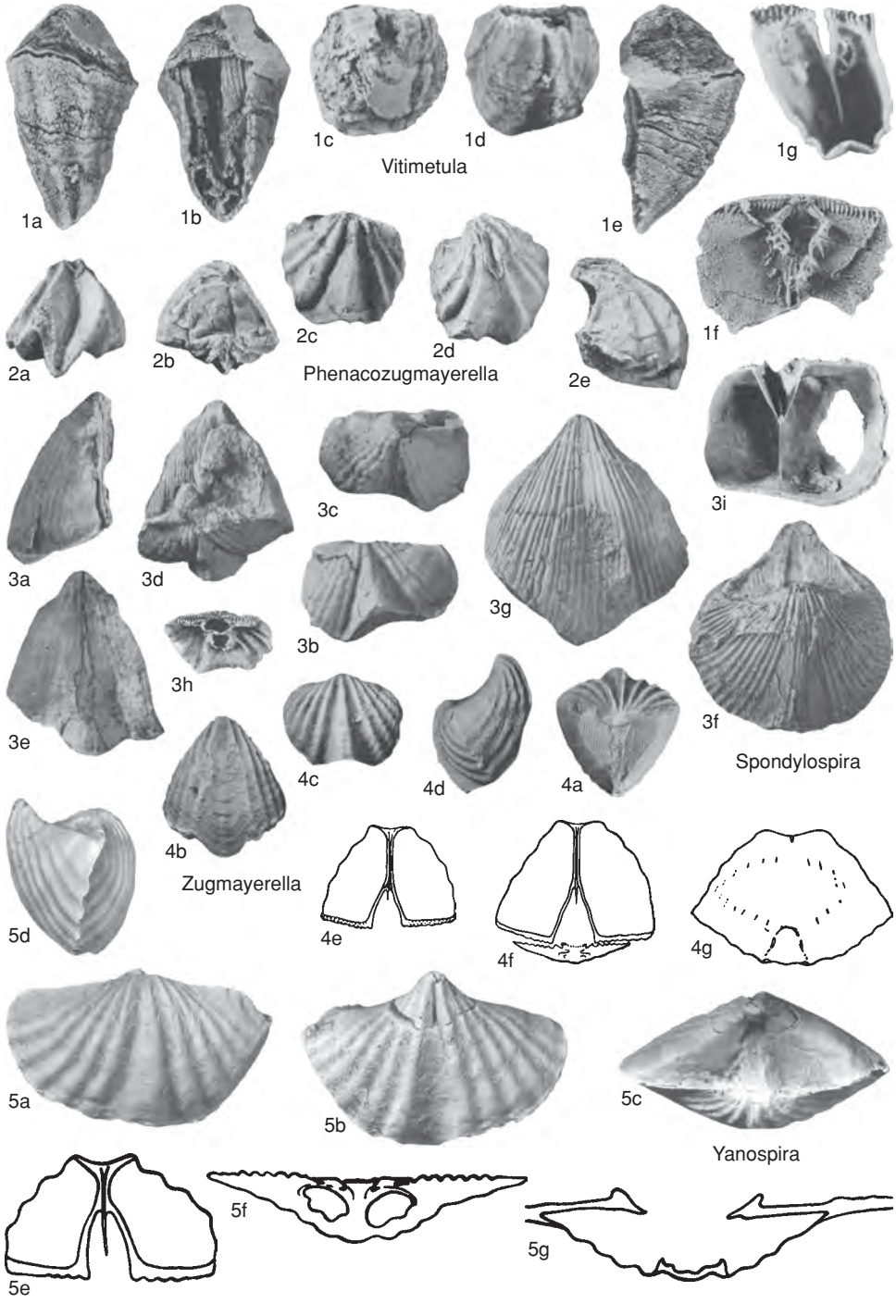

FIG. 1258. Spondylospiridae (p. 1891–1893).

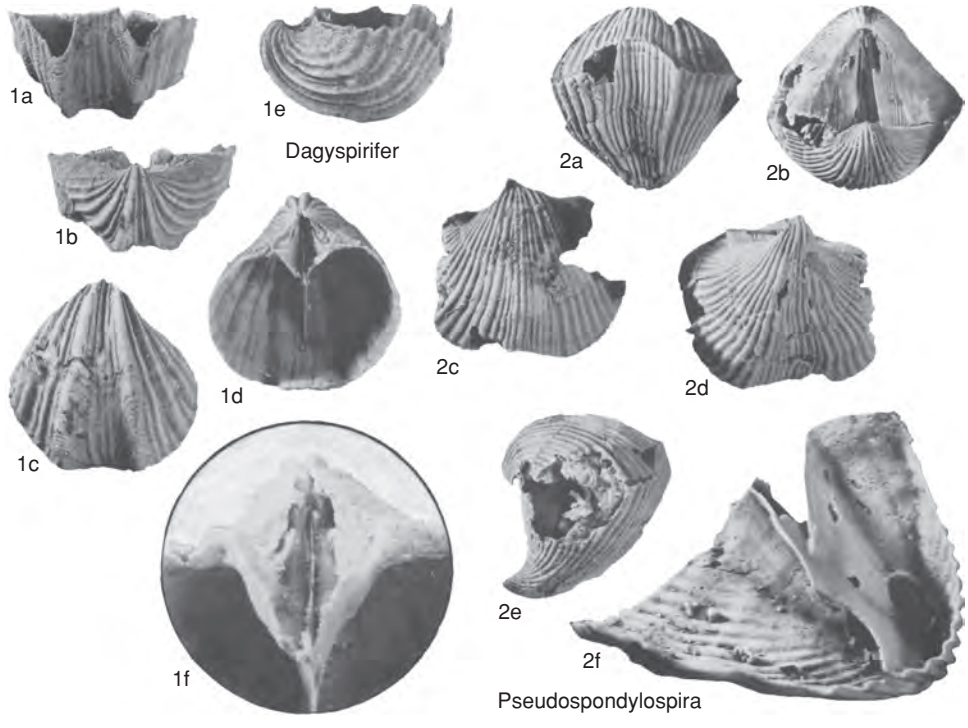

FIG. 1259. Spondylospiridae (p. 1893).

Rhaetian): Tethyan seaway, northeastern Siberia, South America.——FIG. 1258,*4a–g. *Z. koessenensis* (ZUGMAYER); *a–d,* posterior, ventral, dorsal, and lateral views, ×1; *e–g,* transverse sections, approximately ×2 (Dagys, 1963).

Subfamily DAGYSPIRIFERINAE Hoover, 1991

[Dagyspiriferinae HOOVER, 1991, p. 77]

Globose to cyrtiniform; entirely ribbed; apex of spondylium and ventral interarea pierced by paired elongate foramena. *Upper Triassic (Carnian–Norian).*

Dagyspirifer HOOVER, 1991, p. 77 [**D. fascicostata;* OD]. Medium size; spiriferoid with subglobose, arched ventral valve and incurved umbo; dorsal valve unknown; cardinal extremities well rounded, hinge line much less than maximum width; ventral interarea narrow, concave, partially crenulate; delthyrium possibly with narrow deltidial plates; sulcus moderately wide and deep, well delimited by strong bounding plicae; entire surface with several coarse ribs, each with bundles of several much finer, fasciculate costae; microornament finely pustulose; dental adminicula long and close set, bisected by long, high median septum. *Upper Triassic (lower Norian):* USA (Alaska).——FIG. 1259,*1a–f. *D. fascicostata; a–e,* anterior, posterior, ventral, ventral interior, and lateral views, ×1; *f,* enlargement of apical portion of ventral interior, ×3 (Hoover, 1991).

Pseudospondylospira HOOVER, 1991, p. 78 [**P. perplexa;* OD]. Medium size, cyrtinoid; ventral valve high, subpyramidal, beak slightly incurved; dorsal valve moderately convex; cardinal extremities rounded, maximum width posterior to midlength; ventral interarea high, flattened but apically concave, partially crenulate, apically pierced by foramena; delthyrium long and narrow, with very narrow deltidial plates; fold and sulcus moderately developed and delineated; entire surface with numerous simple and bifurcating costae; microornament unknown; ventral interior with delicate spondylium; dorsal interior with bilobate ctenophoridium and jugum supported by jugal net. *Upper Triassic (Carnian–Norian):* USA (Alaska, Nevada, Oregon).——FIG. 1259,*2a–f. *P. perplexa,* lower Carnian, Alaska; *a–e,* holotype, anterior, posterior, dorsal, ventral, and lateral views, ×1; *f,* oblique view of ventral interior, ×3 (Hoover, 1991).

Family RASTELLIGERIDAE Carter, 1994

[Rastelligeridae CARTER in CARTER & others, 1994, p. 364]

Spiriferiform; usually transverse; fold and sulcus smooth; lateral slopes usually plicate;

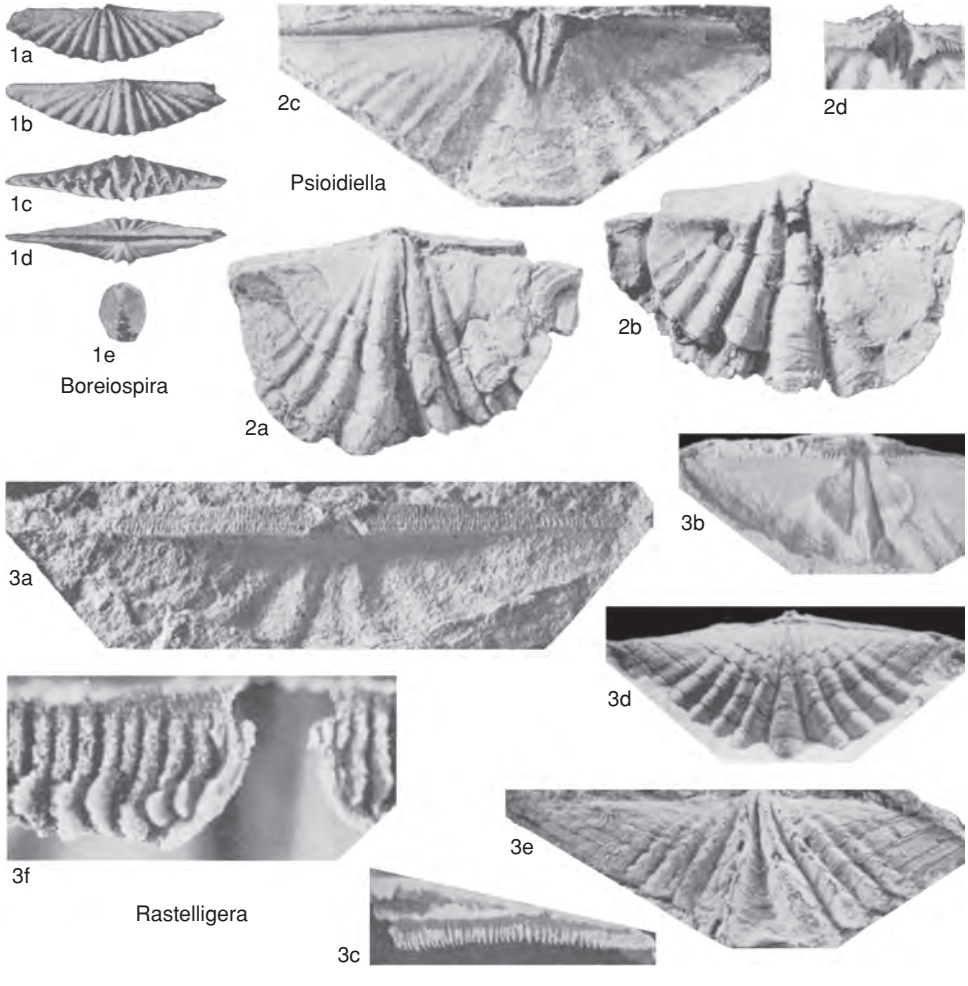

FIG. 1260. Rastelligeridae (p. 1894–1895).

dental adminicula subparallel or convergent. *Middle Triassic (Ladinian)–Upper Triassic (Rhaetian).*

Subfamily RASTELLIGERINAE Carter, 1994

[Rastelligerinae CARTER in CARTER & others, 1994, p. 364]

Strongly transverse; cardinal extremities extended; lateral slopes strongly plicate; dental adminicula convergent or forming sessile spondylium. *Middle Triassic (Ladinian)–Upper Triassic (Rhaetian).*

Rastelligera HECTOR, 1879, p. 538 [**R. elongata* HECTOR in THOMSON, 1913, p. 50; SD THOMSON, 1913, p. 50]. Medium to large; transverse, cardinal extremities alate to mucronate; subequally biconvex, moderately inflated; fold and sulcus well defined, smooth; both interareas vertically grooved; hinge line almost entirely crenulate; flanks strongly plicate; microornament not pustulose; ventral interior with dental adminicula convergent but not meeting median septum to form spondylium; teeth, dental adminicula, and socket ridges lost in some younger species; median septum low, thin; muscle field large, well defined in species lacking dental adminicula; dorsal interior with small, sessile, diamond-shaped ctenophoridium; jugum complete,

simple. *Upper Triassic (Carnian–Rhaetian):* New Zealand.——Fig. 1260,*3a–c.* **R. elongata,* Rhaetian; *a,* holotype, cast of ventral valve; *b,* cast of ventral interior, ×1; *c,* ventral interarea, ×2 (J. D. Campbell, 1968).——Fig. 1260,*3d–f. R. malingi* Campbell; *d–e,* dorsal and ventral views, ×1; *f,* ventral interarea, ×10 (J. D. Campbell, 1968).

Boreiospira Dagys, 1974, p. 126 [**Spiriferina lundgreni* Boehm, 1903, p. 13; OD]. Medium size; much wider than long, outline transversely subtrigonal; cardinal extremities alate; both valves weakly and subequally convex; ventral umbonal region poorly differentiated, beak inconspicuous; ventral interarea low, apsacline or nearly orthocline; entire hinge line crenulate; fold and sulcus poorly delineated, rounded, slightly wider than lateral ribbing; lateral slopes with few strong, rounded plicae separated by slightly narrower, subangular interspaces; microornament of densely spaced spinules; ventral interior with very short dental adminicula that converge toward long, stout median septum at umbo; spondylium absent; jugum probably incomplete. *Middle Triassic (Ladinian)–Upper Triassic (Carnian):* Spitzbergen, Arctic Canada, Siberia (Medvezhi Islands, Yakutia).——Fig. 1260,*1a–e.* **B. lundgreni* (Boehm), Ellesmere Island; dorsal, ventral, anterior, posterior, and lateral views, ×1 (Logan, 1967).

Psioidiella Campbell, 1968, p. 33 [**Spiriferina otamitensis* Trechmann, 1918, p. 225; OD]. Medium to large, alate to mucronate, cardinal extremities acute; moderately and subequally biconvex; fold and sulcus narrow, rounded; flanks with several strong, rounded plications; microornament apparently absent; both interareas partially crenulate near delthyium and notothyrium; ventral interior with sessile spondylium; median septum high anteriorly; dorsal interior with well-developed sockets and low ctenophoridium; jugum unknown. *Upper Triassic (Carnian–Rhaetian):* New Zealand, New Caledonia.——Fig. 1260,*2a–b.* **P. otamitensis* (Trechmann); holotype, ventral and dorsal views, ×2 (J. D. Campbell, 1968).——Fig. 1260,*2c–d. P. drotae* Campbell; ventral internal mold and ventral interarea, ×1 (J. D. Campbell, 1968).

Subfamily DENTOSPIRIFERININAE Carter, 1994

[Dentospiriferininae Carter in Carter & others, 1994, p. 364]

Cardinal extremities subangular to rounded; lateral slopes smooth or with few weak plicae; dental adminicula subparallel to convergent. *Upper Triassic (Carnian–Norian).*

Dentospiriferina Dagys, 1965, p. 109 [**D. pepeliaevi;* OD]. Medium size; outline subovate; subequally biconvex; cardinal extremities well rounded, hinge line narrower than maximum width; ventral umbonal region broad, beak slightly incurved; ventral interarea moderately high, bipartite, outer area smooth, inner area marked with coarse vertical grooves; hinge line crenulate medially, noncrenulate laterally; fold and sulcus well delineated, moderately developed, smoothly rounded; lateral slopes with weak or obscure plicae; microornament of fine, dense, regularly arranged spinules; ventral interior with stout, long, dental adminicula, median septum, and thick apical callus; jugum complete. *Upper Triassic (Carnian):* northeastern Siberia.——Fig. 1261,*1a–g.* **D. pepeliaevi; a–d,* holotype, dorsal, ventral, lateral, and anterior views, ×1; *e,* posterior view of ventral valve, ×3; *f–g,* transverse sections, approximately ×1.5 (Dagys, 1965).

Canadospira Dagys, 1972a, p. 40 [**Spiriferina (Psioidia) canadensis* Logan, 1967, p. 26; OD]. Medium size; outline transversely subovate; strongly ventribiconvex; ventral valve strongly inflated, subpyramidal; cardinal extremities rounded, maximum width near midlength; ventral interarea high, moderately concave, strongly apsacline to catacline, vertically grooved; hinge line entirely crenulate; fold and sulcus rounded, strongly developed, moderately wide, well defined by strong ventral bounding plicae and deep dorsal interspaces; lateral slopes with few low, rounded plicae separated by wide, rounded interspaces; microornament unknown; ventral interior with long, subparallel dental adminicula and long, high median septum; ctenophoridium supported by short, thin median septum; jugum complete. *Upper Triassic (Carnian):* Arctic Canada.——Fig. 1261,*3a–g.* **C. canadensis* (Logan); *a–e,* holotype, ventral, dorsal, anterior, posterior, and lateral views, ×1; *f–g,* transverse sections, ×2 (Logan, 1967).

Orientospira Dagys, 1965, p. 101 [**O. gregaria;* OD]. Medium size; moderately transverse to slightly elongate; outline subquadrate to subovate; subequally biconvex, ventral valve usually more convex than dorsal, both valves moderately inflated; hinge line slightly less than maximum width, cardinal extremities subangular; ventral umbonal region broad, beak incurved; ventral interarea low, apsacline, vertically grooved; hinge line almost entirely crenulate; fold and sulcus well defined, moderately wide, rounded; lateral slopes with few coarse plicae separated by narrow interspaces; microornament absent; both valves much thickened by callus posteriorly; ventral interior with converging dental adminicula fused to median septum near floor of valve, forming low spondylium; jugum sessile anteriorly, supported by elongate ridges and net. *Upper Triassic (Norian):* northeastern Siberia.——Fig. 1261,*4a–f.* **O. gregaria; a–c,* holotype, dorsal, ventral, and lateral views, ×1 (new); *d–f,* transverse sections, approximately ×1.5 (Dagys, 1965).

Psioidea Hector, 1879, p. 538 [*Spiriferina suessi* var. *australis* Trechmann, 1918, p. 225; SD Thomson,

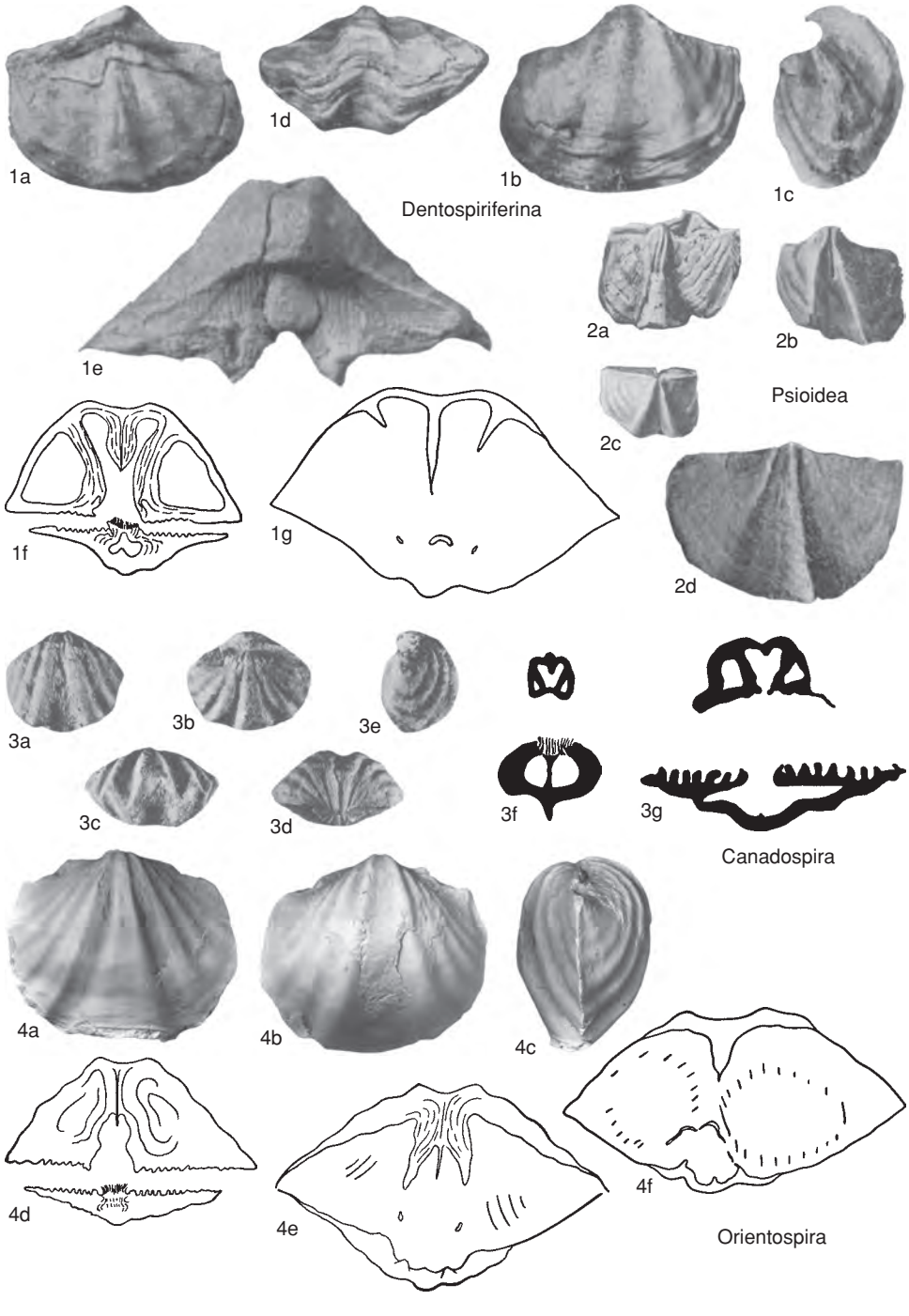

FIG. 1261. Rastelligeridae (p. 1895–1897).

1919, p. 413]. Medium size; nonalate; cardinal extremities angular, maximum width attained at or anterior to hinge line; ventral interarea bipartite with vertically grooved crenulate portions bordering delthyrium and smooth lateral portions; dorsal umbo overhanging hinge line; lateral slopes smooth; fold and sulcus narrow, rounded, sharply defined; microornament unknown; ventral interior with spondylium; jugum unknown. *Upper Triassic (Carnian):* New Zealand.——FIG. 1261,*2a–d. *P. australis* (TRECHMANN); *a–b,* dorsal and ventral views of steinkern; *c,* cast of ventral valve, ×1 (Trechmann, 1918); *d,* mold of dorsal valve, ×1.5 (Marwick, 1953).

SPIRIFERINIDINA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

Suborder SPIRIFERINIDINA Ivanova, 1972

[Spiriferinidina IVANOVA, 1972, p. 41] [=Spiriferinidina COOPER & GRANT, 1976b, p. 2,666]

Subequally biconvex; lateral slopes generally well ribbed, especially in early forms, ribbing weak or absent in youngest forms; ventral interarea high, planar in early forms, low, concave in later genera; ventral beak generally incurved; ventral adductor-raising structures simple, generally consisting only of delthyrial plate or median septum. *Upper Devonian (upper Famennian)–Lower Jurassic.*

Superfamily SYRINGOTHYRIDOIDEA Frederiks, 1926

[*nom. correct.* CARTER in CARTER & others, 1994, p. 365, *pro* Syringothyridacea IVANOVA, 1972, p. 40 [319], *nom. imperf., nom. transl. ex* Syringothyrinae FREDERIKS, 1926, p. 411]

Outline usually spiriferiform; moderately to strongly transverse; generally strongly ventribiconvex; fold and sulcus invariably developed; lateral slopes with simple ribbing; microornament of fine, short, radial striae with fine, elongate pustules or spinules arranged in quincunx between striae, producing textilelike appearance; dental adminicula present; ventral septum generally lacking; cardinalia usually stout and wide; punctae highly variable in size, commonly sparsely or irregularly distributed. *Upper Devonian (upper Famennian)–Permian.*

Family SYRINGOTHYRIDIDAE Frederiks, 1926

[*nom. correct.* PITRAT, 1965, p. 691, *pro* Syringothyridae IVANOVA, 1959, p. 55, *nom. imperf., nom. transl. ex* Syringothyrinae FREDERIKS, 1926, p. 411]

Cardinal extremities subangular to slightly rounded; lateral slopes with moderately numerous simple ribs; interspaces narrow and subangular to moderately broad; fold and sulcus smooth medially; ventral interarea high to very high; perideltidial areas present. *Upper Devonian (upper Famennian)–Permian.*

Subfamily SYRINGOTHYRIDINAE Frederiks, 1926

[*nom. correct.* PITRAT, 1965, p. 692, *pro* Syringothyrinae FREDERIKS, 1926, p. 411]

Delthyrial plate and syrinx present. *Upper Devonian (upper Famennian)–Carboniferous (Mississippian, ?Pennsylvanian).*

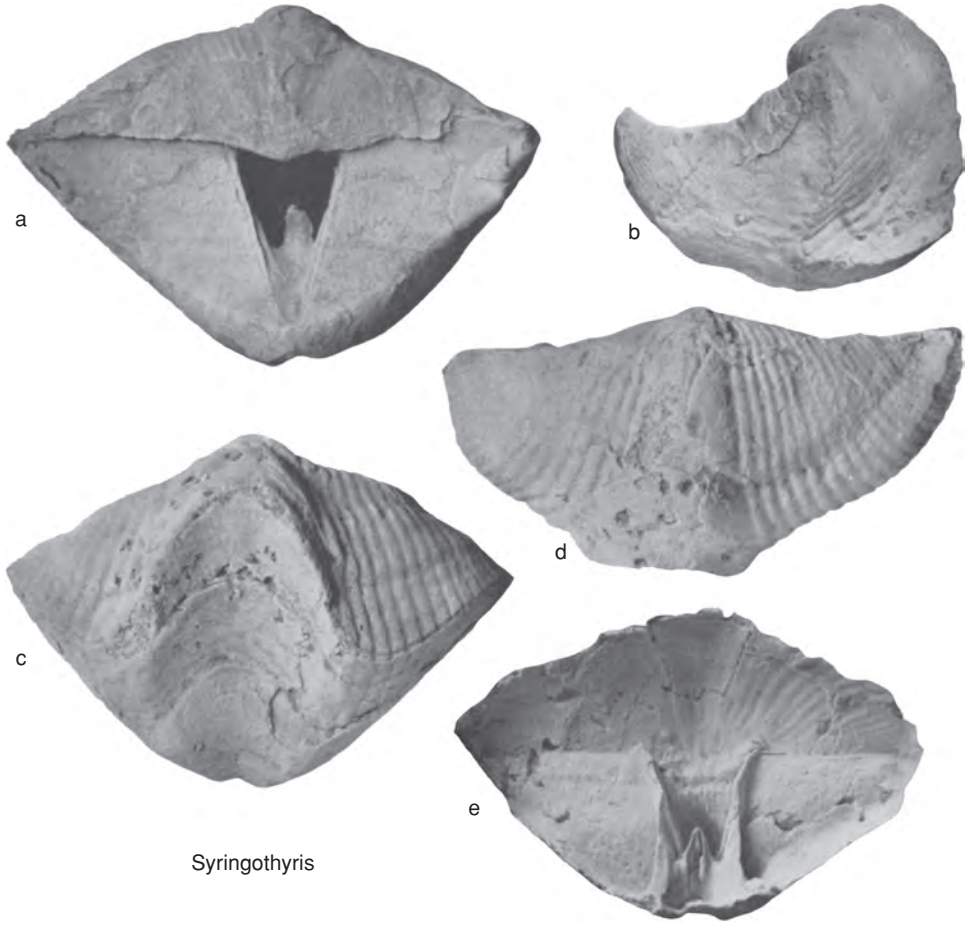

FIG. 1262. Syringothyrididae (p. 1898).

Syringothyris WINCHELL, 1863, p. 6 [**S. typa;* SD ICZN Opinion 100, 1928, p. 12; =*Spirifer carteri* HALL, 1857, p. 170] [=*Syringopleura* SCHUCHERT, 1910, p. 224 (type, *Spirifer randalli* SIMPSON, 1890, p. 441, OD); *Prosyringothyris* FREDERIKS, 1916, p. 51 (type, *P. northi,* OD); *Protosyringothyris* FREDERIKS, 1918a, p. 88, *nom. null.*]. Dental adminicula long, subparallel; pedicle valve often subconical or hemipyramidal with high, flattened interarea; beak straight or rarely slightly incurved; delthyrium largely covered by stegidial plates, forming tubular foramen in some species; perideltidial areas well developed. *Upper Devonian (upper Famennian)–Carboniferous (Mississippian):* cosmopolitan.——FIG. 1262*a–d. *S. carteri* (HALL), upper Tournaisian, Iowa, USA; posterior, lateral, anterior, and dorsal views, ×1 (Weller, 1914). ——FIG. 1262*e. S. bedfordensis* HYDE, upper Famennian, Ohio, USA; ventral interior, ×1 (Hyde, 1953).

Subfamily SEPTOSYRINGOTHYRIDINAE Termier & Termier, 1974

[*nom. transl.* CARTER in CARTER & others, 1994, p. 365, *ex* Septosyringothyrididae LEGRAND-BLAIN, 1974, p. 120, *nom. correct. pro* Septosyringothyridae TERMIER & TERMIER in MASSA, TERMIER, & TERMIER, 1974, p. 168]

Median septum and syrinx present in ventral valve. *Carboniferous (Mississippian).*

Septosyringothyris VANDERCAMMEN, 1955, p. 2 [**S. demaneti;* OD]. Syrinx suspended between delthyrial plate and floor of valve by bifid median septum; otherwise similar to *Syringothyris. Carboniferous (Mississippian):* Europe, South America.——FIG. 1263,*1a–d. *S. demaneti,* Tournaisian, Belgium; *a–b,* holotype, ventral and posterior views, ×1; *c–d,* transverse sections of ventral valves, ×4.5 (Vandercammen, 1955).

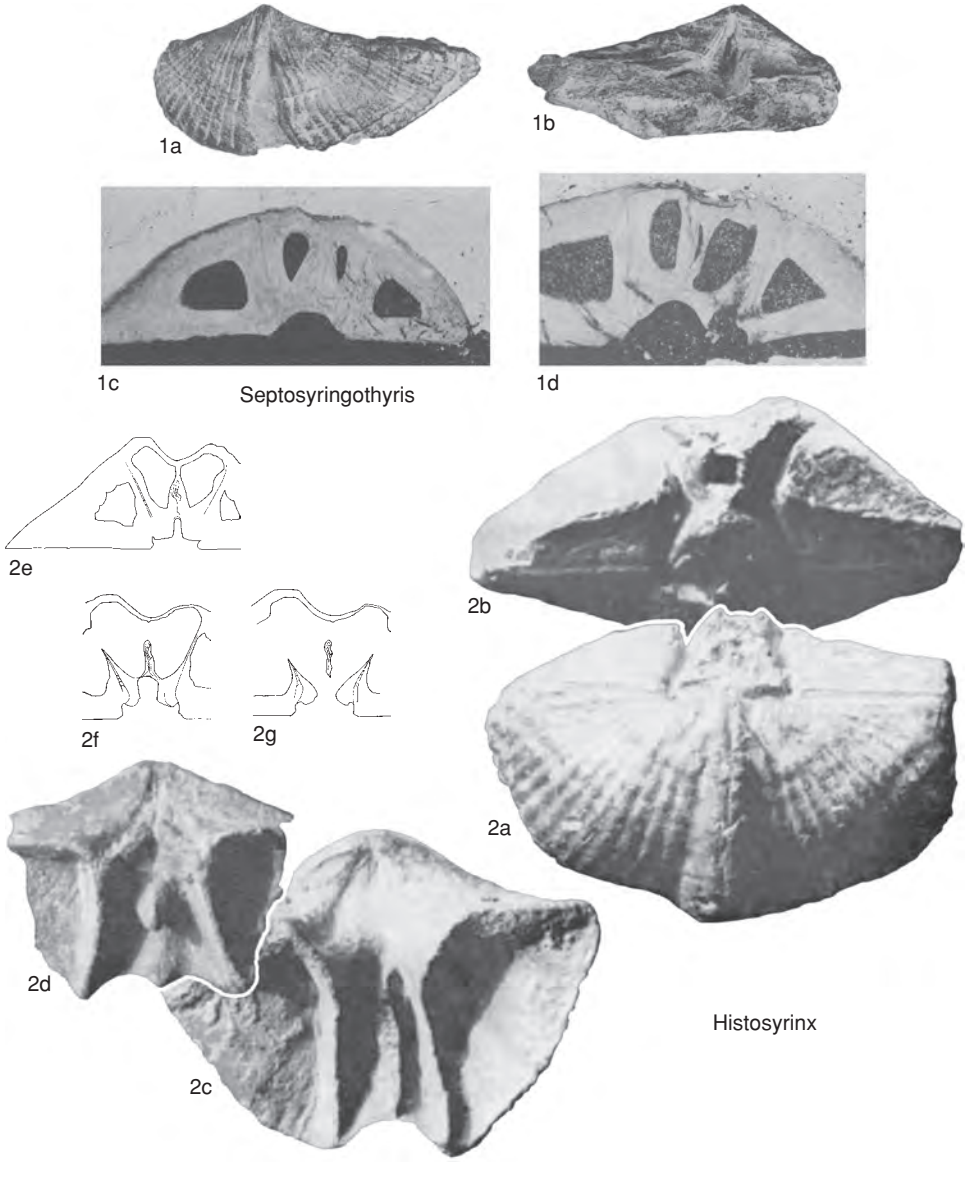

FIG. 1263. Syringothyrididae (p. 1898–1899).

Histosyrinx TERMIER & TERMIER in MASSA, TERMIER, & TERMIER, 1974, p. 168 [**H. vautrini;* OD]. Dental adminicula greatly thickened by callus deposits that converge to simulate delthyrial plate; syrinx supported by short, stout median septum; otherwise similar to *Septosyringothyris. Carboniferous (upper Tournaisian):* Libya.——FIG. 1263,*2a–g.* **H. vautrini; a–b,* syntype, dorsal and posterior views, ×1.33; *c,* ventral interior, ×1.2; *d,* ventral interior, ×1.36 (Massa, Termier, & Termier, 1974); *e–g,* transverse sections, ×1 (Legrand-Blain, 1974).

Subfamily PERMASYRINXINAE Waterhouse, 1986

[Permasyrinxinae WATERHOUSE, 1986b, p. 3]

Syrinx absent. *Carboniferous (lower Tournaisian)–Permian.*

Permasyrinx WATERHOUSE, 1983b, p. 155 [**Subansiria procera* ARMSTRONG, 1970a, p. 149; OD]. Moderately transverse with rounded cardinal extremities;

ventral interarea moderately high, concave, apsacline; beak incurved in some species; fold and sulcus smooth; flanks with moderately numerous plicae; dental adminicula short; delthyrial plate well developed; adductor field on floor of valve. *Carboniferous (Kasimovian)–Permian (upper Artinskian):* Australia.——Fig. 1264,*1a–d. *P. procera* (Armstrong), ?Aktastinian, Cisuralian, Queensland; holotype, ventral, dorsal, posterior, and anterior views, ×1 (Armstrong, 1970a).

Asyrinxia Campbell, 1957, p. 80 [**Spirifera lata* M'Coy, 1847, p. 233; OD]. Strongly transverse; moderately high ventral interarea with well-defined perideltidial areas; ventral interior with parallel dental adminicula; delthyrial plate absent. *Carboniferous (upper Tournaisian):* Australia (New South Wales).——Fig. 1265,*2a–c. *A. lata* (M'Coy); *a,* lectotype, ventral mold; *b,* ventral interarea, ×1; *c,* dorsal view, ×0.9 (Campbell, 1957).

Cyrtella Frederiks, 1924, p. 312 [**Cyrtia kulikiana* Frederiks, 1916, p. 43; OD] [=*Asyrinx* Hudson & Sudbury, 1959, p. 46 (type, *A. haushensis,* OD); *Punctocyrtella* Plodowski, 1968, p. 252 (type, *P. spinosa,* OD); ?=*Kungaella* Solomina, 1988, p. 44 (type, *Pseudosyringothyris inopinatus* Solomina, 1970, p. 101, OD)]. Strongly transverse; ventral interarea moderately high, flattened; perideltidial areas well developed; flanks with moderately numerous ribs; delthyrial plate absent but simulated by thick callus; dental adminicula short, widely divergent; dorsal fold with distinctive median furrow. *Permian (Cisuralian):* Russia, Afghanistan.——Fig. 1266,*2a–e. *C. kulikiana* (Frederiks), Russia; ventral, dorsal, anterior, posterior, and lateral views of large syntype, ×1 (new).

Myodelthyrium Thomas, 1985, p. 164 [**Pseudosyringothyris dickensi* Thomas, 1971, p. 140; OD]. Large; ventral interior with short, divergent dental adminicula and well-developed delthyrial plate; underside of delthyrial plate with pair of elongate oval muscle scars separated by median longitudinal ridge; substantial apical callosity present; dorsal cardinalia massive; otherwise similar to *Pseudosyrinx. Permian (Sakmarian–Artinskian):* Western Australia.——Fig. 1265,*1a–e. *M. dickensi* (Thomas); *a–c,* holotype, anterior, dorsal, and posterior views, ×1; *d,* dorsal interior, ×1.5; *e,* posterior view showing perideltidial areas, ×1 (Thomas, 1971).

Primorewia Likharev & Kotljar, 1978, p. 71 [**P. reshetnikov;* OD]. Large, very transverse, moderately biconvex; cardinal extremities alate; umbonal region narrow, short; ventral interarea moderately high, weakly concave; delthyrium wide; lateral slopes with few wide, simple, rounded plicae; sulcus smooth, fold with distinct median furrow; ventral interior with moderate apical callus, moderately long, diverging dental adminicula, delthyrial plate and short, stout median ridge in apical portion of ventral muscle field; otherwise similar to *Cyrtella. Permian (Kungurian–Roadian):* northeastern Siberia.——Fig. 1264,*2a–e. *P. reshetnikov; a–d,* holotype, ventral, dorsal, anterior, and posterior views; *e,* natural mold of ventral interior, ×1 (new).

Pseudosyringothyris Frederiks, 1916, p. 51 [**P. karpinskii;* OD]. Delthyrial plate with median longitudinal thickening; otherwise similar to *Cyrtella.* [Grigor'eva (1977) states that the validity of *P. karpinskii,* and hence of this genus, is in doubt because intensive collecting for topotypes has failed to produce specimens internally similar to Frederiks's description of the type.] *Permian (Cisuralian):* Russia.——Fig. 1266,*1a–b. *P. karpinskii; a,* ventral interarea, ×0.7; *b,* transverse section of ventral valve, ×2 (Frederiks, 1916).

Pseudosyrinx Weller, 1914, p. 404 [**P. missouriensis;* OD]. Medium to large; externally similar to *Syringothyris;* ventral interarea high, flattened, usually procline, more rarely catacline to slightly apsacline; delthyrial plate large, slightly below plane of interarea, syrinx absent; position of adductor attachment unknown. *Carboniferous (upper Tournaisian–lower Visean):* cosmopolitan.——Fig. 1267,*1a–e. *P. missouriensis,* upper Tournaisian, Missouri, USA; holotype, anterior, posterior, lateral, ventral, and dorsal views, ×1 (Weller, 1914).

Subansiria Sahni & Srivastava, 1956, p. 212 [**S. ranganensis;* OD]. Valves subequally biconvex with low, strongly concave, apsacline ventral interarea; syrinx lacking; delthyrial plate near inner valve surface; otherwise similar to *Cyrtella. Carboniferous (?Pennsylvanian):* India.——Fig. 1267,*3a–b. *S. ranganensis;* holotype, dorsal and ventral views, ×1 (Sahni & Srivastava, 1956).

Sulcicosta Waterhouse, 1983b, p. 156 [**Pseudosyrinx plicata* Armstrong, 1970a, p. 142; OD]. Medium size; outline variable from transverse to elongate; ventribiconvex; ventral interarea moderately high, apsacline; broad, shallow sulcus moderately well defined; narrow fold well defined; fold and sulcus bearing several low but distinct ribs on sides; fold with median furrow; lateral slopes with few strong, simple ribs; interspaces narrow; ventral interior with short delthyrial plate that bears lateral ridges along sides of dental adminicula; dental adminicula high, very thin, moderately long, divergent; callus deposits absent; dorsal valve with low median ridge; otherwise similar to *Cyrtella. Permian:* eastern Australia.——Fig. 1267,*2a–d. *S. plicata* (Armstrong); holotype, dorsal, ventral, posterior, and anterior views, ×1 (Armstrong, 1970a).

Verkhotomia Sokolskaya, 1963, p. 280 [**V. plenoides;* OD]. Medium to large, strongly inflated, subequally biconvex; ventral interarea moderately low, moderately concave, apsacline; lateral slopes with few to moderately numerous simple ribs with

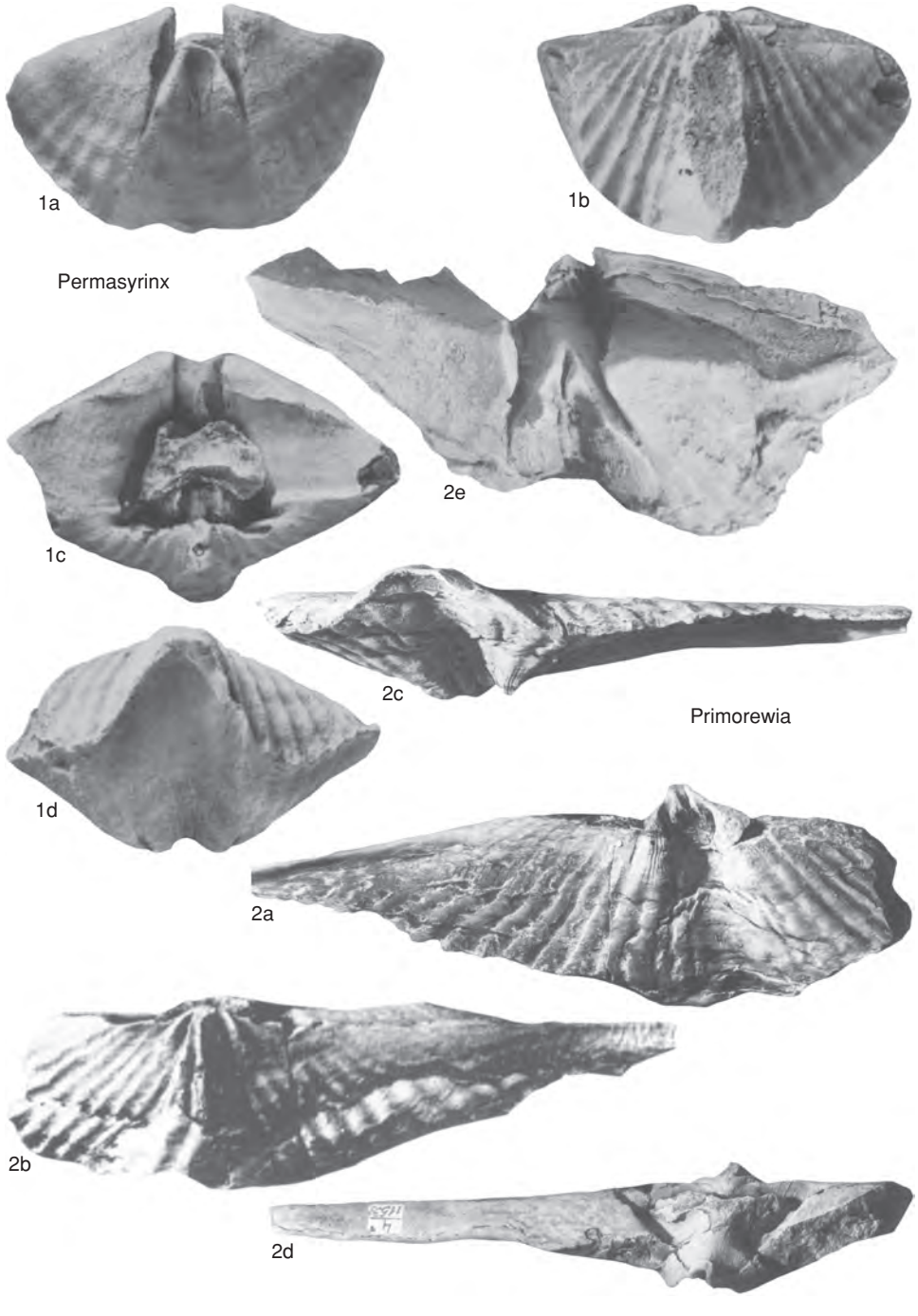

FIG. 1264. Syringothyrididae (p. 1899–1900).

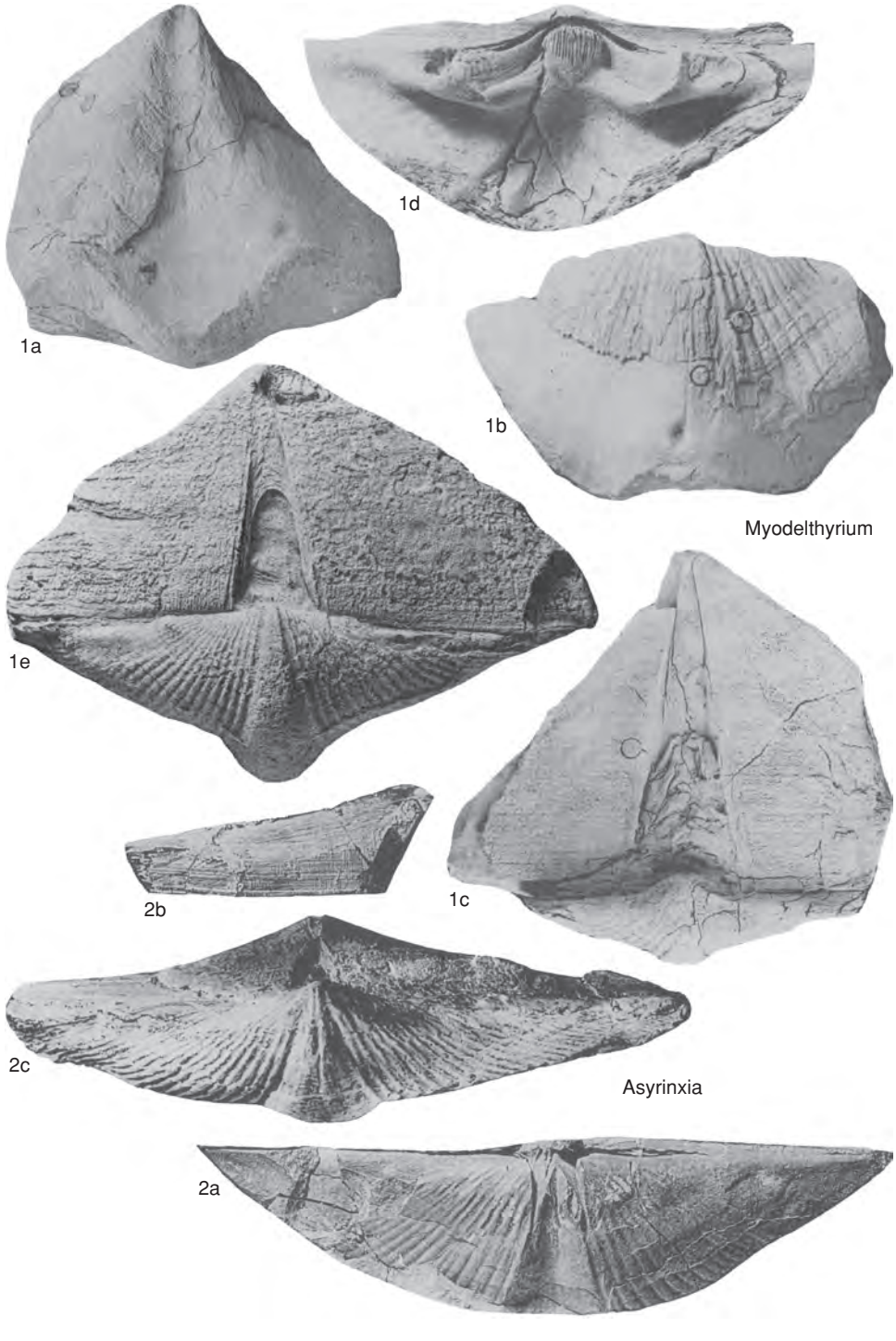

FIG. 1265. Syringothyrididae (p. 1900).

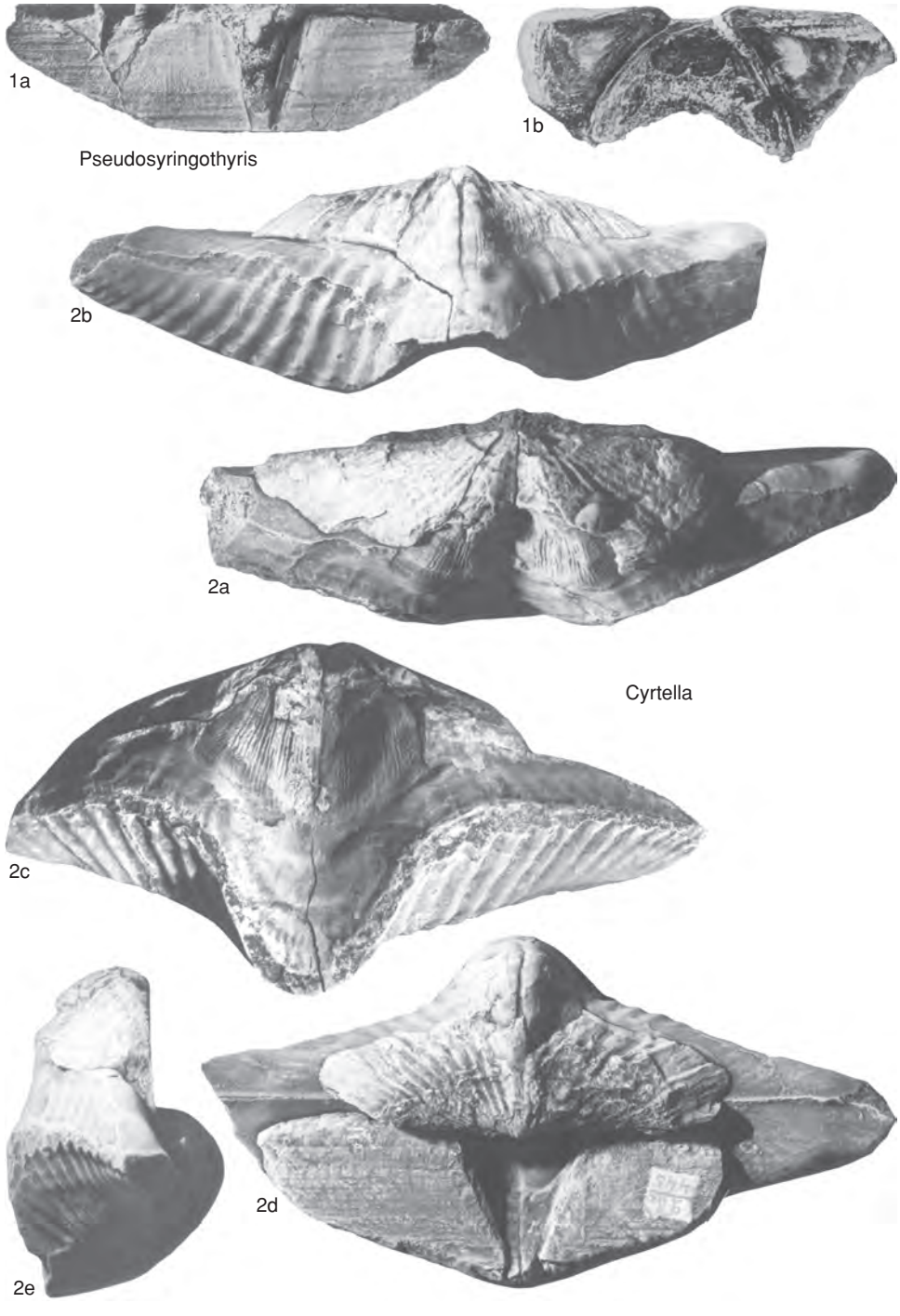

Fig. 1266. Syringothyrididae (p. 1900).

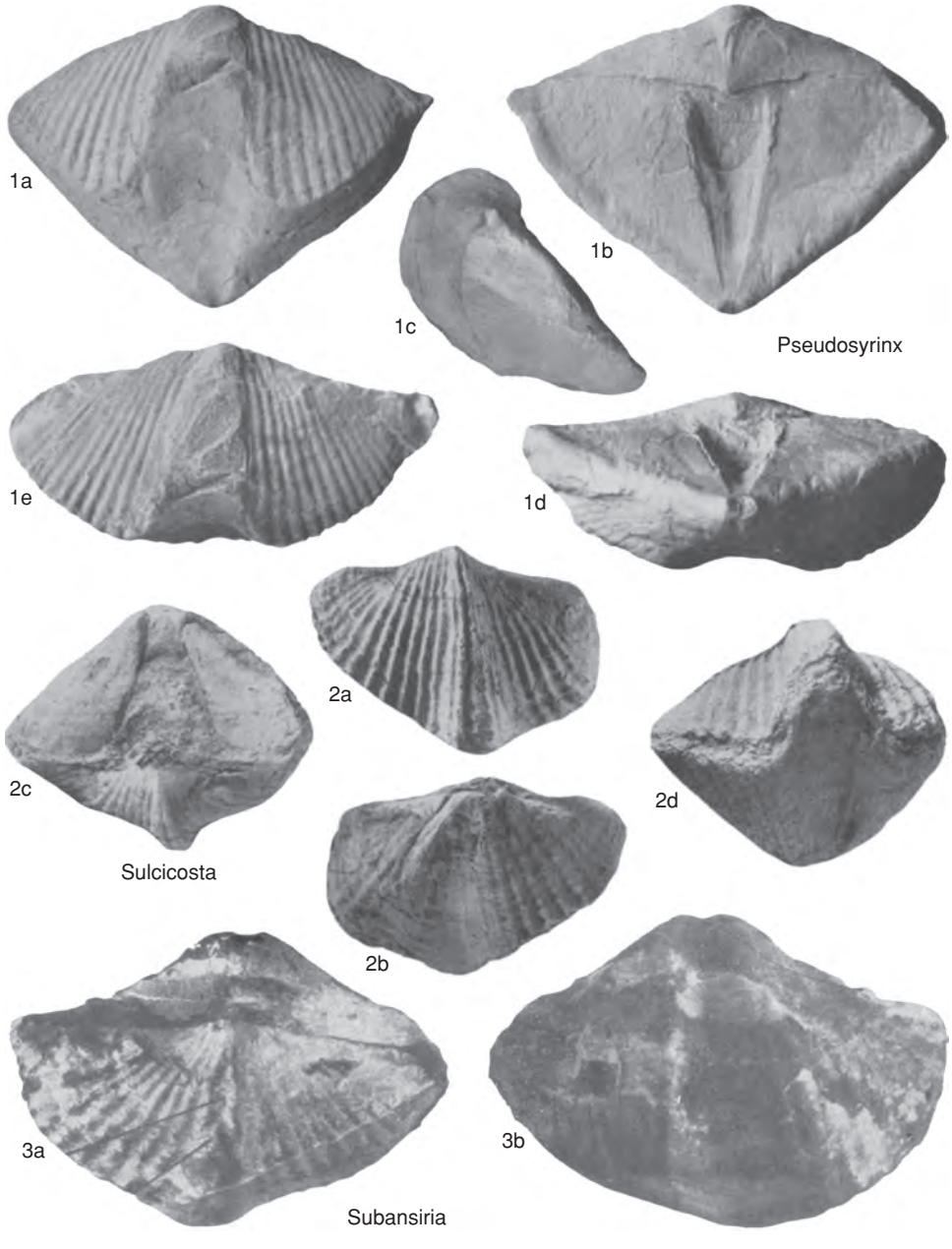

FIG. 1267. Syringothyrididae (p. 1900).

narrow interspaces; sulcus commonly with few weak ribs on sides; fold smooth or weakly ribbed; dental adminicula long, thick; delthyrial plate moderately long; adductor scars on floor of valve; cardinal process supported by long, low median ridge or septum. *Carboniferous (lower Tournaisian–Visean):* Russia, North America.——FIG. 1268*a–d.* **V. plenoides,* Visean, Kuznets basin, Siberia; *a–c,* ventral, dorsal, and lateral views, ×1 (new); *d,* ventral interior, ×1 (Sokolskaya, 1963).

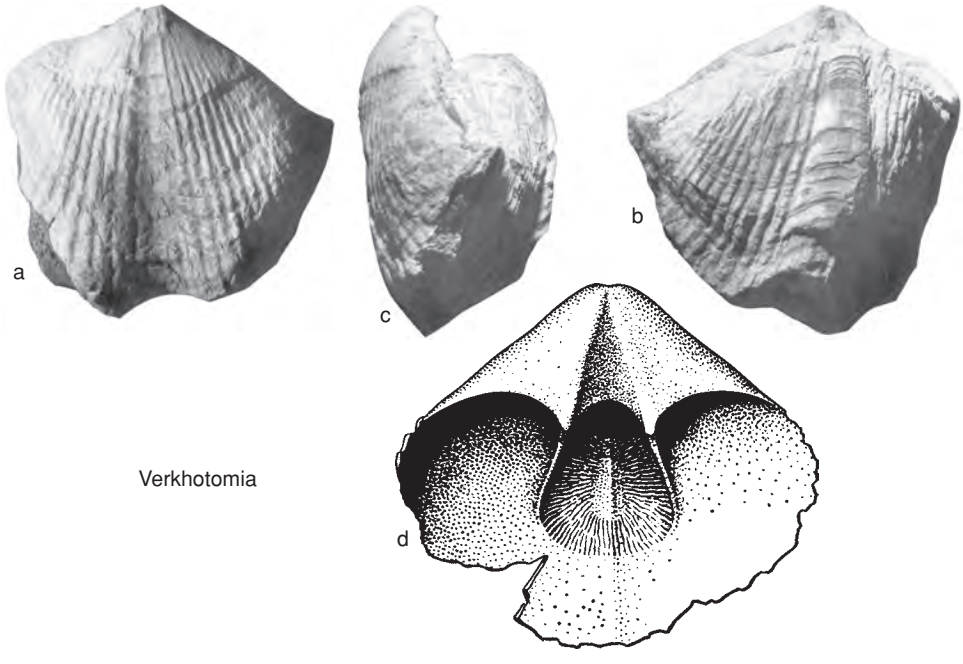

FIG. 1268. Syringothyrididae (p. 1900–1904).

Family DIMEGELASMIDAE Carter, 1994

[Dimegelasmidae CARTER in CARTER & others, 1994, p. 366]

Cardinal extremities well rounded; ventral interarea low to moderately high; lateral slopes with few plications separated by broad, rounded interspaces; sulcus sparsely plicate or costate; perideltidial areas present; syrinx absent; delthyrial plate small or absent; shell substance thin. *Upper Devonian (upper Famennian)–Carboniferous (Visean).*

Dimegelasma COOPER, 1942, p. 232 [**Spirifer neglectus* HALL, 1858, p. 643; OD] [?=*Doescherella* ABRAMOV & GRIGOR'EVA, 1987, p. 121, *nom. nov. pro Crassispirifer* ABRAMOV & GRIGOR'EVA, 1986, p. 162, *non* ARCHBOLD & THOMAS, 1985 (type, *C. grandicostatus,* OD)]. Medium to large, strongly biconvex, subovate in outline; hinge line much less than maximum width; beak ridges absent; ventral interarea moderately high, concave, apsacline, consisting essentially of narrow perideltium and laterally rounded, poorly defined, false interareas; fold and sulcus moderately well developed; sulcus with broad median plica and often with pair of weaker lateral plicae; fold usually well rounded; lateral slopes with few broad plicae; delthyrial plate short, thin; dental adminicula very long, slender, slightly diverging; cardinalia wide, elevated, supported by low, stout median septum. *Carboniferous (Visean):* North America, northeastern Siberia.——FIG. 1269,*1a–f.* **D. neglecta* (HALL), Iowa, USA; *a–d,* ventral, lateral, dorsal, and anterior views, ×1 (Weller, 1914); *e–f,* ventral and dorsal interiors, ×0.7 (Cooper, 1944).——FIG. 1269,*1g. D. grandicostatus* (ABRAMOV & GRIGOR'EVA); holotype, ventral valve, ×1 (new).

Guilinospirifer XU & YAO, 1988, p. 306 [**G. obscurus;* OD]. Small, subequally biconvex, outline transversely subovate, lateral extremities well rounded; fold and sulcus poorly developed; flanks with 3 to 5 simple, flattened plications, with sulcus-bounding plications notably stronger than other lateral ribs; sulcus simple or with very broad median and 2 narrower, lateral sulcal plications; delthyrial plate absent; dental adminicula long. *Upper Devonian (upper Famennian)–Carboniferous (lower Tournaisian):* China (Guilin Province).——FIG. 1269,*3a–c.* **G. obscurus; a,* holotype, dorsal valve interior; *b–c,* two dorsal valve exteriors, ×1 (new).——FIG. 1269,*3d. G. peregrinus* XU & YAO; ventral valve, ×1.5 (Xu & Yao, 1988).

Zeugopleura CARTER, 1988, p. 71 [**Spirifer jeffersonensis* WELLER, 1906, p. 444; OD]. Small to medium size, with pair of simple costae in sulcus that rarely bifurcate; lateral extremities rounded; ventral interarea moderately high, concave, procline; perideltidial areas large; lateral slopes with

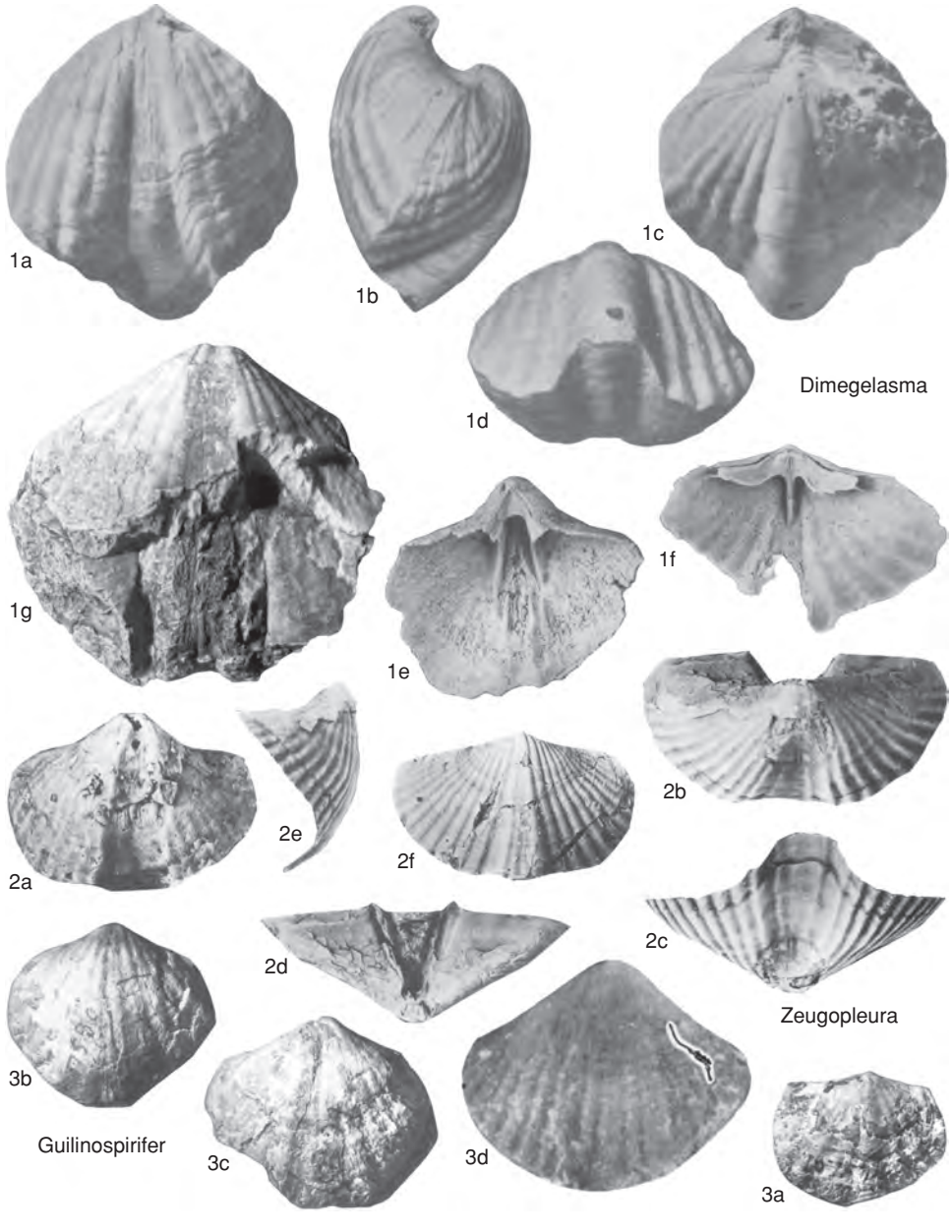

FIG. 1269. Dimegelasmidae (p. 1905–1906).

moderately numerous flattened plicae; ventral interior with very small, apical delthyrial plate and slender, moderately long dental adminicula. *Carboniferous (lower Tournaisian):* North America.——FIG. 1269,*2a–f. *Z. jeffersonensis* (WELLER); *a,* lectotype, ventral valve; *b–e,* ventral, anterior, posterior, and lateral views of large ventral valve; *f,* dorsal valve, ×1.5 (new).

Family LICHAREWIIDAE Sliusareva, 1958

[*nom. transl.* SOLOMINA, 1988, p. 44, *ex* Licharewiinae SLIUSAREVA, 1958, p. 582]

Perideltidial areas absent; syrinx absent; moderate to thick callus deposits in ventral

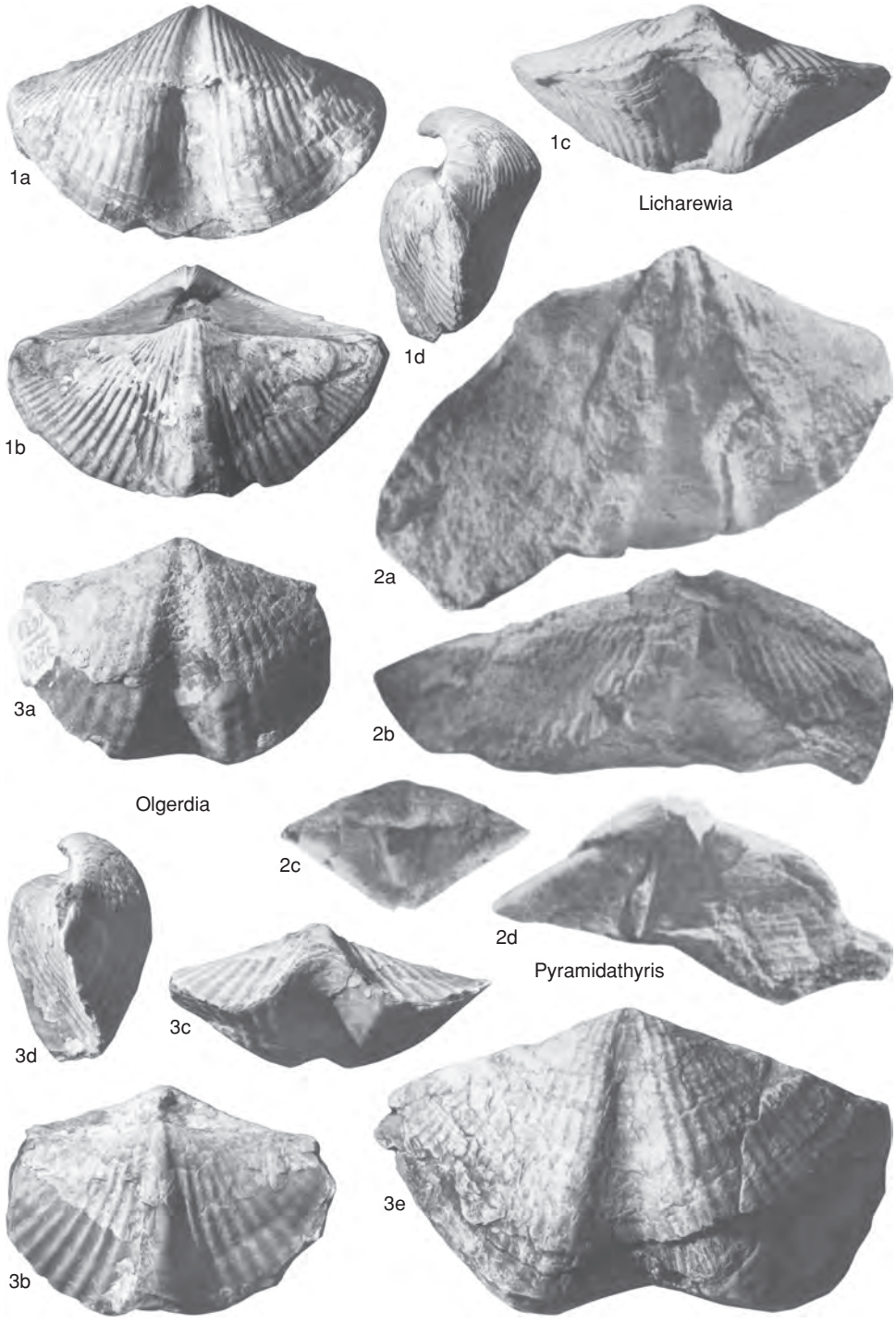

FIG. 1270. Licharewiidae (p. 1908).

umbonal region commonly present. *Carboniferous (Pennsylvanian)–Permian (Lopingian).*

Licharewia Einor, 1939, p. 69 [**Spirifer stuckenbergi* Nechaev, 1900, p. 18; OD] [=*Rugulatia* Sokolskaya, 1952, p. 187 (type, *Spirifer rugulatus* Kutorga, 1842, p. 22, OD)]. Medium size; usually transverse with greatest width at or near hinge line; umbonal region moderately inflated and defined; cardinal extremities subangular to rounded; ventral beak moderately incurved; ventral interarea low to moderately high, concave, apsacline to orthocline; floor of sulcus smooth, sides of sulcus sometimes with weak ribs; fold smooth; flanks with moderately numerous rounded, simple, or very rarely bifurcating costae; microornament of short, weak striae crudely arranged in quincunx; dental adminicula stout, curved, diverging, much thickened by layered callus deposits, simulating delthyrial plate; sparsely punctate. *Permian (Lopingian):* Russia.——Fig. 1270,*1a–d. *L. stuckenbergi* (Nechaev); holotype, ventral, dorsal, anterior, and lateral views, ×1 (new).

Olgerdia Grigor'eva, 1977, p. 50 [**O. zavodowskii;* OD]. Outline transversely oval or rounded to widely triangular; width usually exceeding length; subequally biconvex; ventral interarea nearly orthocline, flattened to evenly concave; fold and sulcus distinct, smooth; lateral slopes with moderately numerous simple ribs; ventral interior with curved dental adminicula, obscurely seen in transverse section, buried in very thick, seemingly nonlayered callus in adults; dental flanges medially arcuate in transverse section; thick, archlike callus simulates delthyrial plate in adults; otherwise similar to *Licharewia. Permian (Lopingian):* northeastern Russia.——Fig. 1270,*3a–e. *O. zavodowskii;* paratype, ventral, dorsal, anterior, and lateral views, large ventral valve, ×1 (new).

Orulgania Solomina & Cherniak, 1961, p. 61 [**O. naumovi;* OD]. Medium size; outline variable, usually transverse; umbonal region broad, poorly delineated, beak slightly incurved; sulcus smooth to weakly ribbed; fold usually with median furrow; lateral slopes with moderately numerous flattened, simple ribs; ventral interarea moderately high, flattened to moderately concave, apsacline; ventral interior with very long, straight, evenly thickened dental adminicula; delthyrial plate recessed well below plane of ventral interarea; umbonal callus moderate. *Carboniferous (Pennsylvanian):* Russia.——Fig. 1271,*1. *O. naumovi;* holotype, ventral view, ×1 (new).

Penzhinella Solomina, 1985, p. 119 [**Licharewia micluchomaclayi* Zavodovskii in Zavodovskii & Stepanov, 1971, p. 136; OD]. Medium size; transversely subovate to subpentagonal; subequally biconvex; umbonal region of both valves narrow and extended with moderately incurved beaks; ventral interarea moderately high, flattened or concave, delthyrium occluded in umbonal region by true delthyrial plate; fold and sulcus well delineated; fold smooth, sulcus smooth or with weak ribs on sides of sulcus; flanks with few coarse, simple ribs; ventral interior with short, arcuately curved dental adminicula thickened by callus; muscle field poorly distinguished, with oval diductors and short narrow adductors separated by myophragm; dorsal interior unknown. *Permian (Lopingian):* northeastern Russia.——Fig. 1271,*2a–d. *P. micluchomaclayi* (Zavodovskii), Siberia; ventral, dorsal, lateral, and posterior views, ×1 (Solomina, 1985).

Permospirifer Kulikov, 1950, p. 5 [**Spirifer keyserlingi* Nechaev, 1911, p. 84; OD]. Medium size; ventral umbo reduced, poorly defined; beak tiny, scarcely incurved; ventral interarea moderately high, flattened or weakly concave, strongly apsacline to orthocline; microornament pustulose; otherwise similar to *Licharewia. Permian (Lopingian):* Russia.——Fig. 1271,*4a–d. *P. keyserlingi* (Nechaev); *a–b,* syntype, exterior and interior views of large ventral valve; *c–d,* dorsal and lateral views of crushed specimen, ×1 (new).

Pyramidathyris Hu, 1983, p. 106 [**P. aliensis;* OD]. Small to medium size; outline semipyramidal; presence or absence of perideltidial areas unknown; delthyrium narrow; externally similar to small *Syringothyris;* microornament of concentrically arranged, fine pustules; lacking delthyrial plate, syrinx, or median ridge; dental adminicula long, thin, subparallel. *Permian (Cisuralian):* China.——Fig. 1270,*2a–d. *P. aliensis;* ventral, dorsal, and posterior views, ×1 (Hu, 1983).

Tumarinia Solomina & Grigor'yeva in Grigor'eva & Solomina, 1973, p. 35 [**T. orientalis* Grigor'eva in Grigor'eva & Solomina, 1973, p. 36; OD]. Medium to large; transversely subpentagonal in outline; both valves moderately inflated; ventral umbonal region rounded, beak incurved; ventral interarea high, concave, apsacline, or nearly catacline; fold and sulcus well defined, smooth or with faint costae on sides; lateral slopes with few simple, flattened ribs; dental adminicula long, straight, divergent; delthyrial plate slightly below plane of interarea; delthyrium covered by slightly concave, rugose stegidium that may be in contact with delthyrial plate; presence or absence of perideltidial areas not determined; otherwise similar to *Licharewia. Permian (Lopingian):* Russia.——Fig. 1271,*3a–d. *T. orientalis* Grigor'eva; *a–c,* holotype, ventral, posterior, and lateral views; *d,* posterior view of ventral valve, ×1 (new).

Tuotalania Hu, 1983, p. 105 [**T. rostrata;* OD]. Medium to large; moderately transverse; delthyrium very wide; otherwise externally similar to *Syringothyris;* ventral interior with long, low median ridge; delthyrial plate lacking; presence or absence of perideltidial areas unknown. *Permian (Cisuralian):* China.——Fig. 1271,*5a–c. *T. rostrata; a–b,* dorsal and posterior views, ×1; *c,* transverse section, ×2 (Hu, 1983).

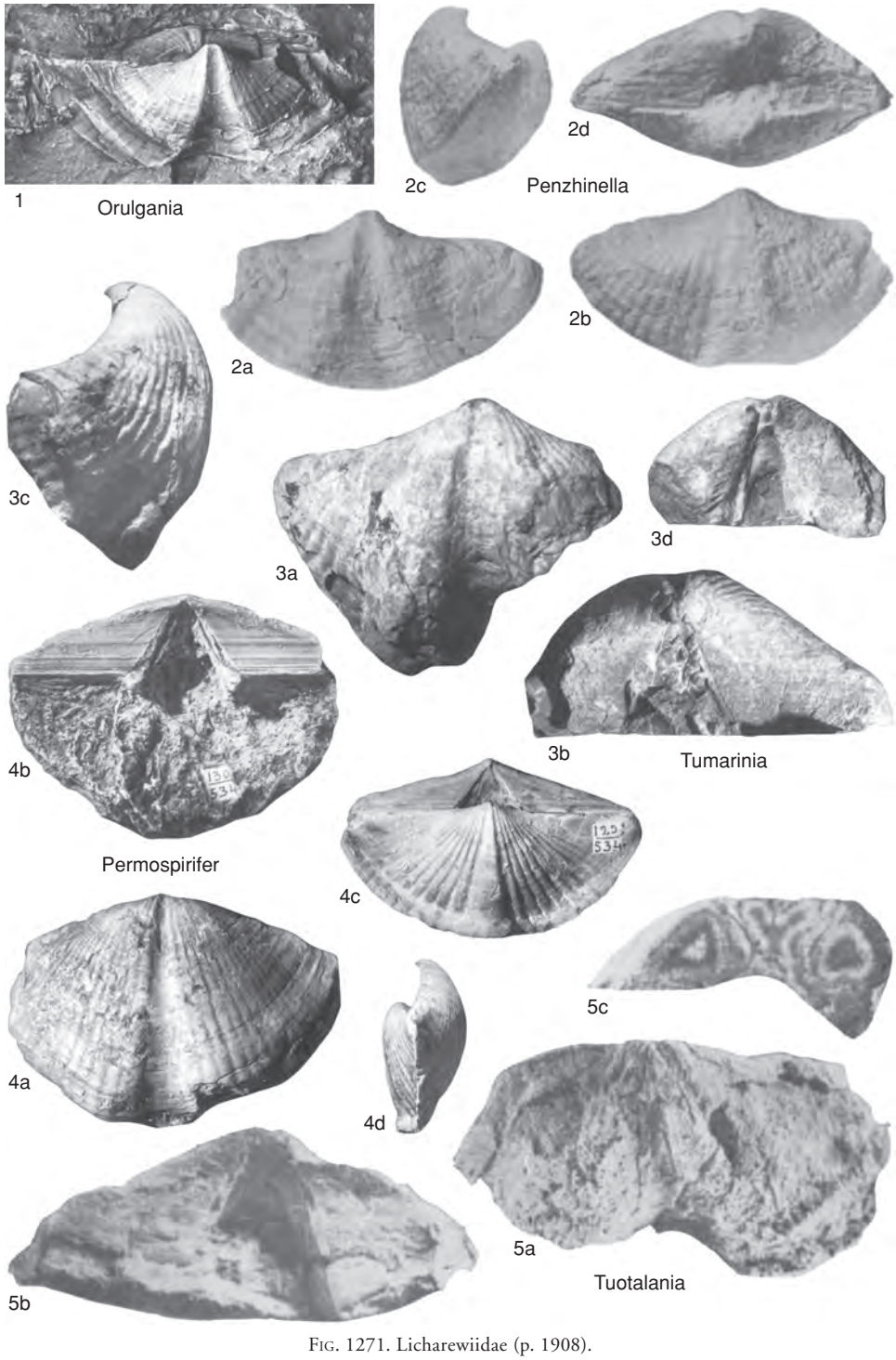

FIG. 1271. Licharewiidae (p. 1908).

PENNOSPIRIFERINOIDEA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

Superfamily PENNOSPIRIFERINOIDEA Dagys, 1972

[*nom. transl.* CARTER in CARTER & others, 1994, p. 366, *ex* Pennospiriferininae DAGYS, 1972a, p. 36]

Spiriferiform to cyrtiniform; ventral interarea usually low or only moderately high; lateral slopes ribbed; dental adminicula and median septum discrete; punctae well developed, usually densely spaced. *Upper Devonian (upper Famennian)–Lower Jurassic.*

Family PUNCTOSPIRIFERIDAE Waterhouse, 1975

[*nom correct.* CARTER in CARTER & others, 1994, p. 366, *pro* Punctospiriferinidae WATERHOUSE, 1987, p. 44, *nom. transl. ex* Punctospiriferinae WATERHOUSE, 1975, p. 17]

Usually transverse; fold and sulcus narrow, weakly to moderately developed; dental adminicula short, subparallel to slightly divergent; microornament capillate and usually regularly lamellose or subimbricate. *Upper Devonian (upper Famennian)–Middle Triassic.*

Punctospirifer NORTH, 1920, p. 212 [**P. scabricosta;* OD]. Small to medium size; outline variable, usually transverse; cardinal extremities subangular, rounded, or rarely slightly mucronate; fold and sulcus narrow to moderately wide, rounded, smooth or with single rib, often slightly flaring anteriorly; ventral interarea moderately high, weakly concave, usually apsacline; lateral slopes with moderately numerous strong, rounded plicae separated by narrow, subangular interspaces; growth varices irregularly spaced; microornament of closely spaced, imbricate growth laminae and fine, discontinuous capillae that rise and become wider with imbrications anteriorly as tiny U-shaped crenulations of lamellae in some species and sometimes terminating in minute, semierect pseudospines; dental adminicula short, slightly divergent; median septum long, high, slender; apical callus variably thick; ctenophoridium large, supported by short callus; dorsal adminicula absent or very short; adductors separated by long myophragm and bounded laterally in some species by low ridges; punctae moderately coarse; jugum probably absent. *Upper Devonian (?upper Famennian), Carboniferous (Tournaisian–Visean):* cosmopolitan.——FIG. 1272,*1a–i. *P. scabricosta,* Visean, England; *a–e,* ventral, dorsal, posterior, anterior, and lateral views, ×2; *f–i,* transverse sections, ×1.5 (Campbell, 1959b).

Alipunctifera WATERHOUSE, 1975, p. 17 [**Spiriferina kaihikuana* TRECHMANN, 1918, p. 220; OD]. Medium to large; unequally biconvex, moderately inflated; transversely semicircular in outline; cardinal extremities extended, moderately mucronate; ventral interarea moderately high, apsacline, slightly concave, transversely striated, nondenticulate; beak incurved; delthyrium open; fold and sulcus moderately narrow, well defined, smooth; lateral slopes with several low, rounded, broad plicae that become much fainter laterally; microornament possibly weakly capillate; dental adminicula and high median septum discrete; posteriorly much thickened with callus; jugum unknown. *Middle Triassic (Ladinian):* New Zealand.——FIG. 1272,*2a–c. *A. kaihikuana* (TRECHMANN); *a,* holotype, dorsal valve, ×1 (Trechmann, 1918); *b–c,* dorsal exterior and ventral interior, ×1 (Marwick, 1953).

Lamnaespina WATERHOUSE, 1976, p. 244 [**L. transennata;* OD]. Medium size, moderately inflated; transverse with rounded cardinal extremities; fold and sulcus poorly differentiated; lateral slopes with few low, rounded, undulating plicae; growth varices coarse, irregularly spaced; microornament of regularly spaced, slightly lamellose growth laminae, capillae, and very fine pustules; punctae fine, closely spaced; ventral interior with high dental adminicula and moderately long median septum. *Permian (Wordian):* New Zealand.——FIG. 1273,*2a–c. *L. transennata; a–b,* holotype, internal and external views of mold of dorsal valve, ×3; *c,* microornament, ×15 (Waterhouse, 1976).

Liriplica CAMPBELL, 1961a, p. 440 [**L. alta;* OD]. Medium size; strongly biconvex; ventral umbo strongly inflated, beak incurved; outline subovate, cardinal extremities well rounded; fold and sulcus weakly to moderately developed, sulcus with median plica, fold with median furrow; lateral slopes with few broad, rounded plicae, separated by somewhat narrower interspaces; microornament of fine, regular growth laminae and discontinuous capillae; ventral interior with thick apical callus, short dental adminicula buried in callus and long median septum; jugum unknown; punctae irregularly arranged. *Carboniferous (?Pennsylvanian):* Australia.——FIG. 1273,*1a–c. *L. alta; a–b,* ventral and dorsal valves, ×1; *c,* microornament, ×10 (Campbell, 1961a).

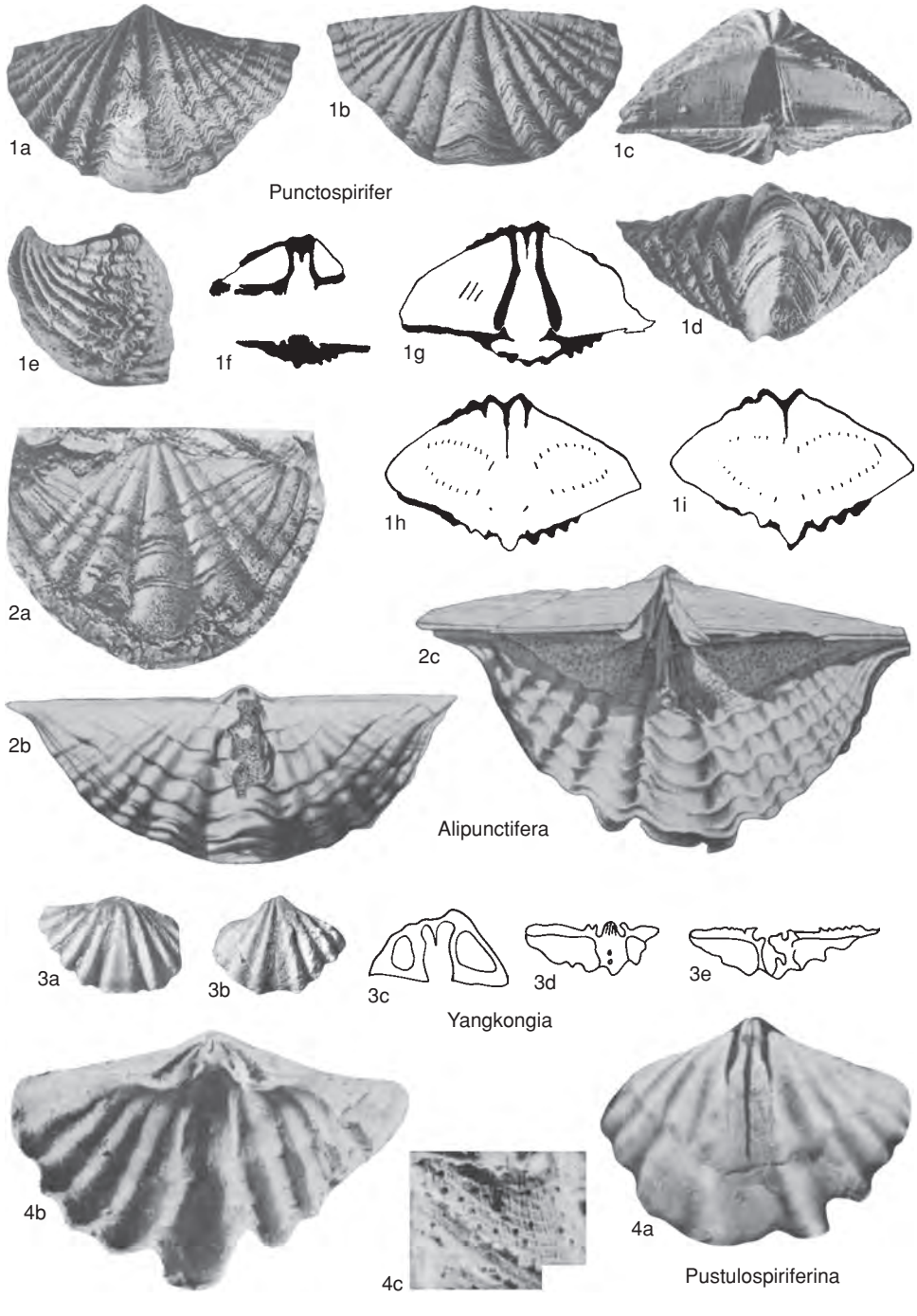

FIG. 1272. Punctospiriferidae (p. 1910–1913).

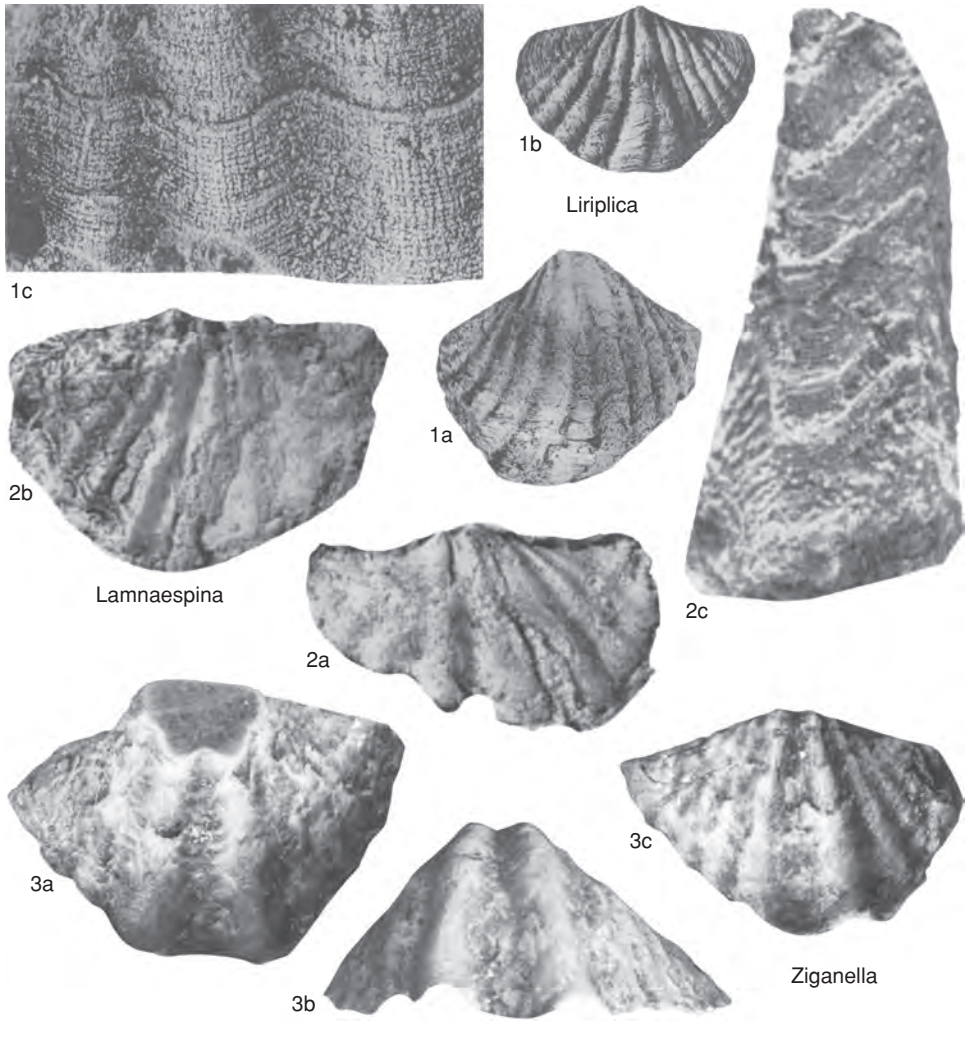

FIG. 1273. Punctospiriferidae (p. 1910–1913).

Pustulospiriferina WATERHOUSE in WATERHOUSE, CAMPBELL, & WILLIAMS, 1983, p. 303 [**Punctospirifer etheridgei* ARMSTRONG, 1970c, p. 317; OD]. Medium size; subequally biconvex; transversely subtrigonal to subquadrate in outline; cardinal extremities subangular to rounded; maximum width anterior to hinge line; fold and sulcus narrow, well developed and defined, smoothly rounded; ventral interarea high, apsacline; lateral slopes with 4 to 6 subangular plicae; microornament of capillae and fine growth lines; ventral interior with long, high median septum and shorter subparallel dental adminicula; jugum unknown. *Permian (Artinskian):* Australia.——FIG. 1272,*4a–c.* **P. etheridgei* (ARMSTRONG); *a,* holotype, mold of ventral interior; *b,* dorsal interior, ×1.8; *c,* cast of microornament, ×9 (Armstrong, 1970c).

Yangkongia XU & LIU, 1983b, p. 115 [**Y. planofolda;* OD]. Medium size; transversely subsemicircular to subtrigonal in outline; cardinal extremities subangular to slightly rounded; subequally biconvex, both valves moderately inflated; ventral beak acute, incurved; ventral interarea high, delthyrium open; hinge line less than or equal to maximum width; fold narrow, low, flattened or with weak median sinus, delineated mainly by wide interspaces; sulcus shallow, with flattened bottom, or rarely with weak rib; lateral slopes with few strong, rounded to subangular costae, separated by narrow angular interspaces; microornament faintly capillate; dorsal interior with cardinalia supported by short median callus and short dorsal adminicula; jugum unknown. *Middle Triassic:* China (Qinghai).——FIG. 1272,*3a–e.* **Y. planofolda; a,*

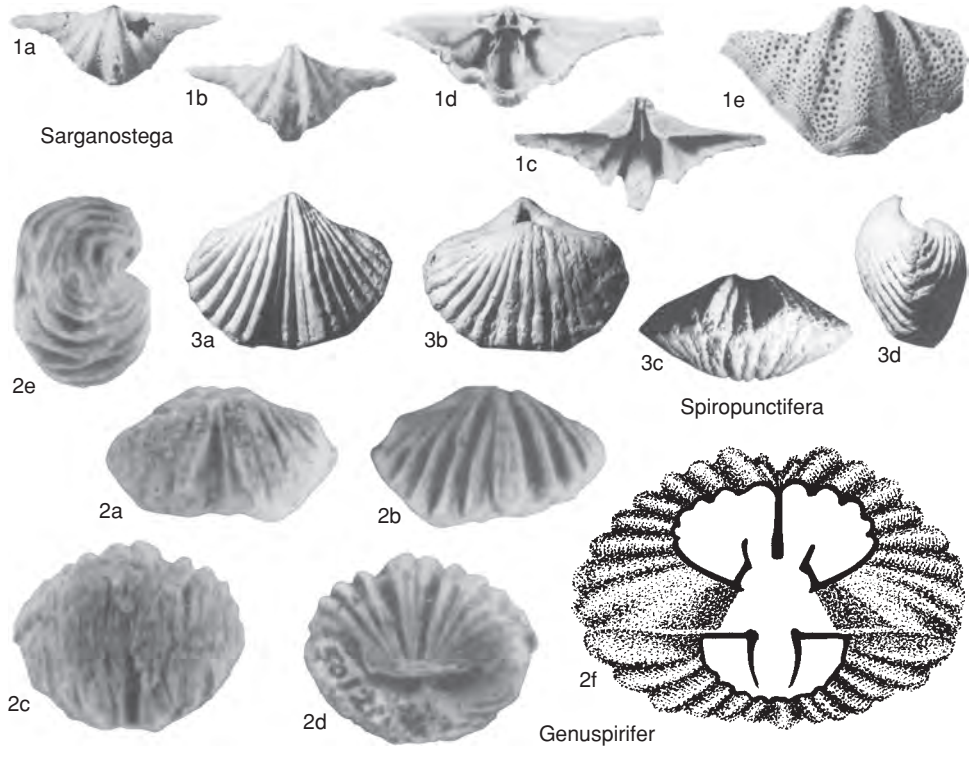

FIG. 1274. Spiropunctiferidae and Sarganostegidae (p. 1913–1921).

holotype, dorsal valve; *b,* paratype, ventral valve, ×1 (new); *c,* transverse section of ventral valve; *d–e,* transverse sections of dorsal valve, approximately ×1.5 (Xu & Liu, 1983b).

Ziganella NALIVKIN in IVANOVA, 1960, p. 280 [**Z. ziganensis;* OD]. Small; transversely subtriangular in outline; greatest width at hinge line; ventral umbonal region inflated, beak small; interarea high, weakly concave; sulcus narrow, smooth; fold low, well defined, well rounded; lateral slopes with few (5 to 6) ribs; microornament unknown; ventral interior with low median septum and very short dental adminicula buried in apical callus; dorsal interior unknown; punctae small, sparsely distributed; otherwise similar to *Punctospirifer. Upper Devonian (upper Famennian):* Russia.——FIG. 1273,*3a–c. *Z. ziganensis,* Urals; *a–b,* ventral and anterior views of large syntype, beak removed; *c,* ventral view of smaller syntype, ×2 (new).

Family SPIROPUNCTIFERIDAE Carter, 1994

[Spiropunctiferidae CARTER in CARTER & others, 1994, p. 367]

Cardinal extremities well rounded; fold and sulcus plicate; microornament absent. *Carboniferous (upper Visean)–Permian (Lopingian).*

Spiropunctifera IVANOVA, 1971, p. 120 [**S. tulensis;* OD]. Medium size; transversely subelliptical in outline; almost equally biconvex; ventral interarea moderately low, nearly orthocline; fold and sulcus moderately developed and narrow; entire surface ribbed, lateral slopes with moderately numerous strong, subangular, very rarely bifurcating plicae separated by narrower interspaces, fold with several bifurcating plicae; sulcus with strong, rarely bifurcating, median plica and 1 or 2 pairs of weaker plicae that bifurcate from sulcus-bounding plicae; dental adminicula short, nearly parallel; median septum long, thin, wedge shaped, rising anteriorly and abruptly terminating past midlength; dorsal adminicula short, merging with adductor bounding ridges; jugum large, apparently complete; punctae moderately dense, sometimes branching. *Carboniferous (upper Visean):* Russia (Moscow basin).——FIG. 1274,*3a–d. *S. tulensis;* holotype, ventral, dorsal, anterior, and lateral views, ×1 (new).

Genuspirifer LIANG, 1990, p. 388 [490] [**G. tongluensis;* OD]. Small to medium size; strongly biconvex; outline subelliptical; maximum width attained near midlength; fold and sulcus narrow,

well delineated; ventral interarea moderately low, strongly concave, apsacline; lateral slopes with few strong, slightly rounded, simple plicae and equally wide, deeply rounded interspaces; sulcus with pair of strong, simple plicae, or rarely, with additional weaker pair on walls of sulcus; fold with 3 plicae; fine growth laminae closely and regularly spaced; dental adminicula very short, divergent; median septum long, high; cardinal process low, inconspicuous; crural bases high, medially concave, nearly vertical, nearly touching valve floor; densely punctate. *Permian (Guadalupian–Lopingian):* China.——Fig. 1274,*2a–f.* **G. tongluensis; a–e,* ventral, dorsal, anterior, posterior, and lateral views, ×2; *f,* transverse section, ×3 (Liang, 1990).

Family RETICULARIINIDAE Waterhouse, 1975

[*nom. transl.* Waterhouse, 1983a, p. 138, *ex* Reticulariininae Waterhouse, 1975, p. 15]

Outline tranverse; cardinal extremities usually extended, rarely rounded; fold and sulcus narrow, usually well delimited; sulcus smooth or with weak median rib; dental adminicula divergent; microornament of coarse, hollow spines. *Carboniferous (upper Visean)–Permian (Lopingian).*

Reticulariina Frederiks, 1916, p. 16 [**Spirifer spinosus* Norwood & Pratten, 1855, p. 71; OD]. Small to medium size; moderately to strongly transverse; outline usually widely subtrigonal; cardinal extremities angular, or often alate or mucronate; ventral interarea of moderate height, concave, apsacline; delthyrium open or with apical callus; fold and sulcus narrow, well delimited; lateral slopes with few to moderately numerous, strong, simple, rounded plicae; fold and sulcus smooth or with faint median rib, rarely with additional weak ribs on sides of fold and sulcus; microornament of numerous coarse, erect, hollow spines and irregularly spaced growth laminae; dental adminicula short, divergent; median septum long, high, thin; elongate or knoblike ctenophoridium supported by convergent crural bases forming notothyrial platform; adductor field delimited by low, narrow, longitudinal ridges; shell substance coarsely punctate. *Carboniferous (upper Visean)–Permian (Lopingian):* cosmopolitan.——Fig. 1275,*2a–h.* **R. spinosa* (Norwood & Pratten), Chesterian, Illinois, USA; *a–e,* ventral, dorsal, anterior, posterior, and lateral views, ×1 (Weller, 1914); *f–h,* transverse sections, ×2 (Campbell, 1959b).

Altiplecus Stehli, 1954, p. 349 [**A. cooperi;* OD]. Small to medium size, strongly transverse; outline transversely subtrigonal to subrhombic; cardinal extremities usually mucronate or alate; fold and sulcus narrow but wider than lateral interspaces; fold high; fold and sulcus often producing characteristic subangular anterior extension; lateral slopes with very few, usually 2 or 3, rounded plicae; sulcus usually with weak median plica; microornament of few long, thick, hollow spines arranged in concentric rows along growth lines; growth varices strong, irregularly spaced, almost tegulate in some species; dental adminicula short; median septum high, thin, short; apical callosity supporting ctenophoridium; adductor field bounded laterally by low, outwardly bowed ridges; punctae regularly arranged in rhombs of four. *Permian (Cisuralian):* North America.——Fig. 1275,*4a–c.* **A. cooperi,* Wolfcampian, Texas, USA; ventral, dorsal, and lateral views, ×1.5 (Cooper & Grant, 1976b).——Fig. 1275,*4d–e. A. trapezoidalis* Cooper & Grant, Lopingian, Texas, USA; ventral and dorsal interiors, ×1.5 (Cooper & Grant, 1976b).

Gjelispinifera Ivanova, 1975, p. 86 [**G. gerasimovi;* OD]. Spines arranged in 1 or 2 rows along crests of plicae and on floor of sulcus; ventral septum low and thin; otherwise similar to *Reticulariina. Carboniferous (Pennsylvanian):* Russia (Moscow basin).——Fig. 1275,*1a–e.* **G. gerasimovi; a–d,* holotype, ventral, dorsal, anterior, and posterior views; *e,* paratype, ventral valve, ×1 (new).

Spinuliplica Campbell, 1961a, p. 442 [**S. spinulosa;* OD]. Medium size; outline transversely subovate to subpentagonal; cardinal extremities rounded; fold and sulcus moderately developed, rounded; beak ridges rounded but ventral interarea clearly defined, moderately high, apsacline; lateral slopes with few rounded, simple plicae, sulcus with weak median plica; microornament consisting of numerous irregularly arranged, fine, hollow, anteriorly directed spinules; dental adminicula strong, thick, diverging; median septum massive; ctenophoridium supported by callus and variably developed, short dorsal adminicula; punctae irregularly arranged. *Carboniferous (?Pennsylvanian):* Australia (New South Wales).——Fig. 1275,*3a–d.* **S. spinulosa; a,* holotype, mold of ventral interior; *b–c,* exterior and internal views of dorsal valve, ×1; *d,* microornament, ×10 (Campbell, 1961a).

Family PARASPIRIFERINIDAE Cooper & Grant, 1976

[Paraspiriferinidae Cooper & Grant, 1976b, p. 2,729]

Outline transversely subelliptical; cardinal extremities well rounded; fold and sulcus usually well delimited; dental adminicula short, usually divergent; microornament regularly and finely lamellose, with lamellae bearing fine, hairlike spinules in some genera. *Carboniferous (?Moscovian, Kasimovian)–Permian (Lopingian).*

Paraspiriferina Reed, 1944, p. 252 [**Spiriferina (Paraspiriferina) ghundiensis;* OD]. Small, strongly biconvex, outline transversely subelliptical, cardinal extremities well rounded; fold and sulcus well differentiated, moderately broad, rounded, smooth; sulcus subangular in some species; beak ridges lack-

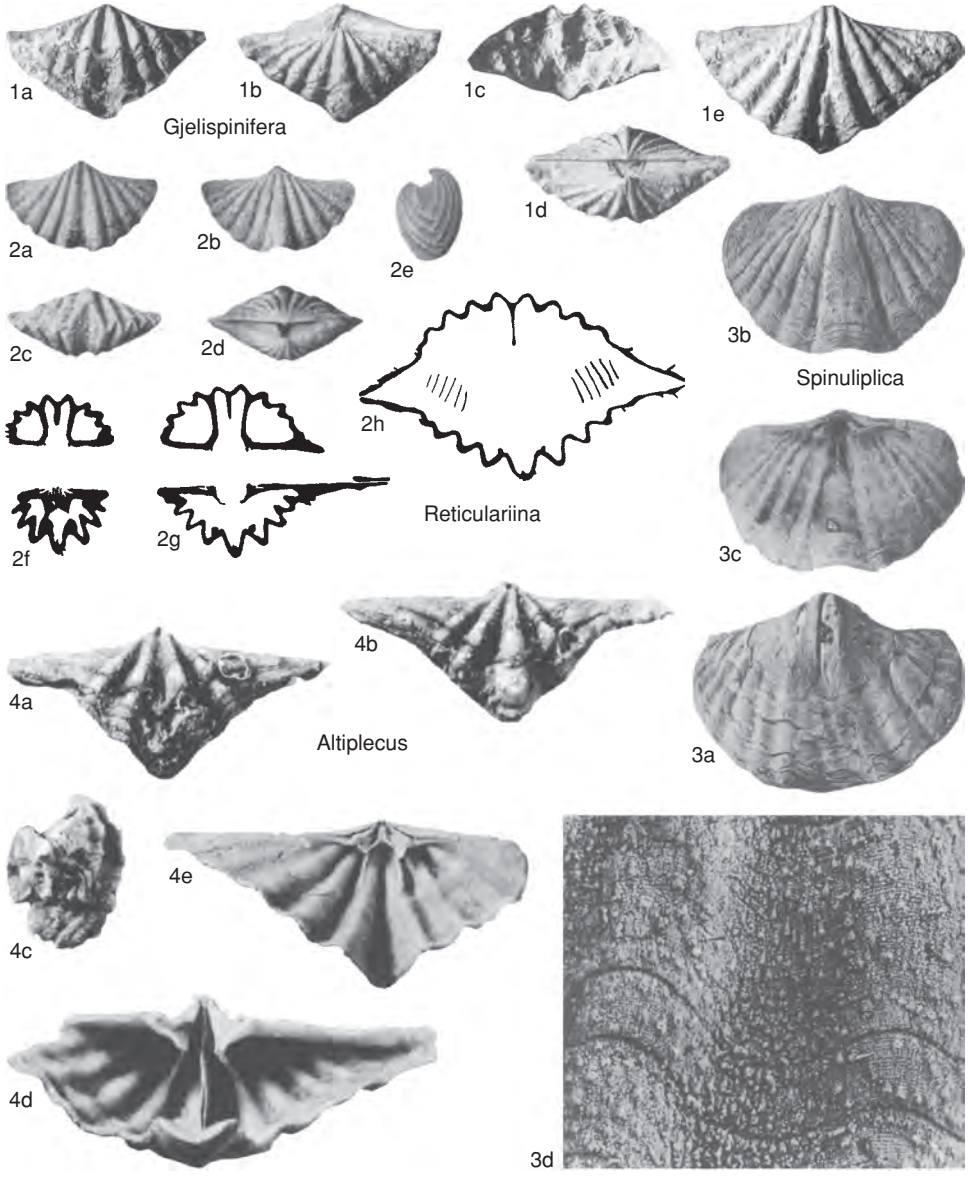

FIG. 1275. Reticulariinidae (p. 1914).

ing; ventral interarea narrow, concave; delthyrium narrow, high, with imbricating stegidial plates at edges; lateral slopes with numerous low, narrow, rounded plicae separated by narrow interspaces; microornament of lamellose, regularly and closely spaced growth laminae with numerous anteriorly directed, fine, short, hollow spinules or papillae; dental adminicula short, slightly divergent; median septum long, high, thin, commonly united with dental adminicula by small apical callosity; dorsal adminicula thin, sometimes high, enclosing dorsal adductor field; punctae fine, closely spaced. *Permian:* India, USA (western Texas).——FIG. 1276,*1a–c.* **P. ghundiensis* (REED), Guadalupian, India; dorsal, ventral, and lateral views, ×1.5 (Reed, 1944).——FIG. 1276,*1d–g. P. paginata* COOPER & GRANT, Guadalupian, western Texas, USA; *d,* exterior view of ventral valve, ×1; *e,* internal view of ventral valve, ×2; *f–g,* exterior and internal views of dorsal valve, ×1.5 (Cooper & Grant, 1976b).

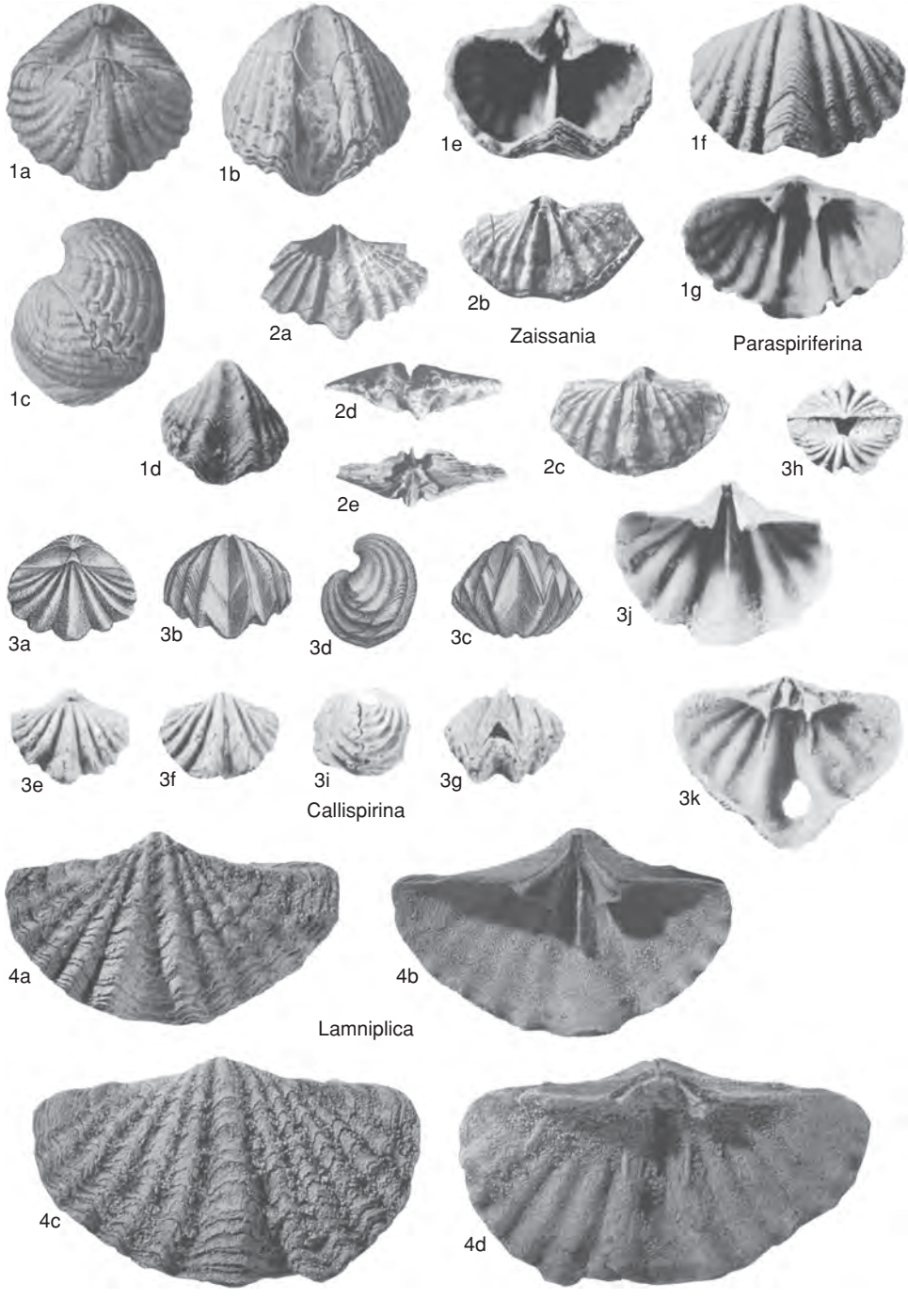

FIG. 1276. Paraspiriferinidae (p. 1914–1918).

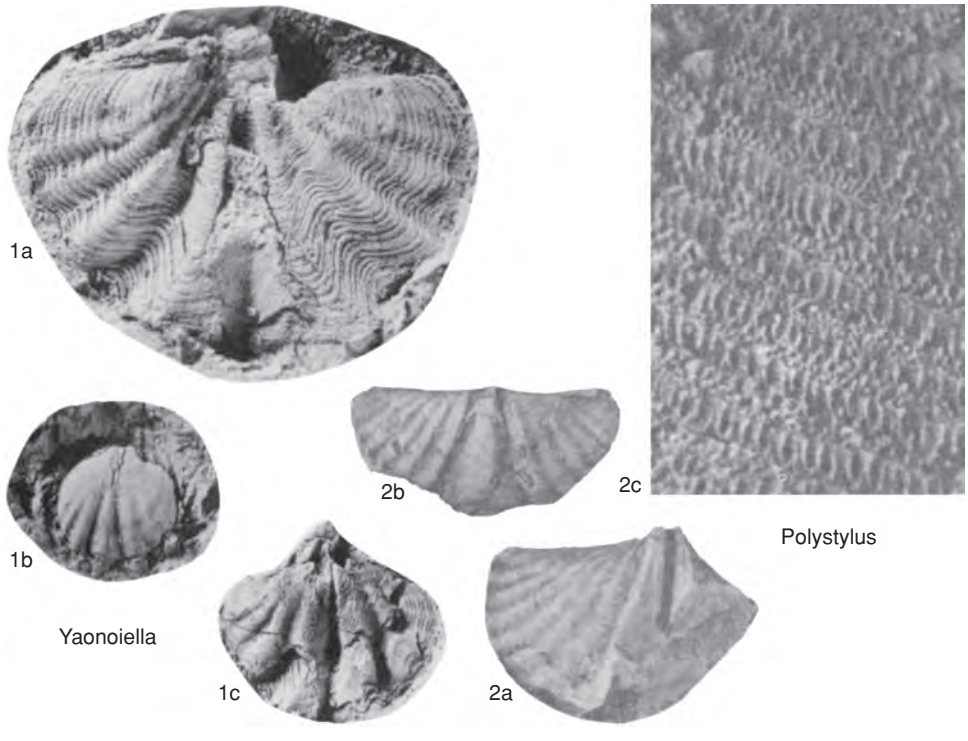

FIG. 1277. Paraspiriferinidae (p. 1917–1918).

Callispirina COOPER & MUIR-WOOD, 1951, p. 195, *nom. nov. pro Mansuyella* REED, 1944, p. 249, *non* ENDO, 1937 [**Spiriferina ornata* WAAGEN, 1883a, p. 505; OD] [=*Maia* FREDERIKS, 1924, p. 298, *non* LAMARCK, 1801, *nec* REICHENBACH, 1850, obj.; *Maya* RAKUSZ, 1932, p. 77, *non* BLATTNY, 1925, obj.]. Small to medium size, strongly biconvex; outline transversely subovate; lateral slopes with few strong, angular plicae separated by angular interspaces; fold and sulcus moderately differentiated, angular, slightly wider than lateral plicae or interspaces; microornament of regularly and closely spaced, slightly lamellose growth laminae fringed with single row of few short, solid spinules and bearing 2 rows of punctae; cardinal process raised, knoblike, supported by low dorsal adminicula that border dorsal adductor field; otherwise similar to *Paraspiriferina. Permian (Guadalupian–Lopingian):* Pakistan, USA (Texas).——FIG. 1276,*3a–d. *C. ornata* (WAAGEN), Guadalupian, Pakistan; holotype, dorsal, ventral, anterior, and lateral views, ×1 (Waagen, 1883a).——FIG. 1276,*3e–k. C. rotunda* COOPER & GRANT, Guadalupian, Texas; *e–i,* holotype, dorsal, ventral, anterior, posterior, and lateral views, ×1; *j–k,* ventral and dorsal interiors, ×2 (Cooper & Grant, 1976b).

Lamniplica WATERHOUSE & RAO, 1989, p. 32 [**L. punctata;* OD]. Medium size; fold and sulcus narrow, well delineated, smoothly rounded; lateral slopes with several (5 to 7) rounded plicae and prominent coarse growth varices; microornament of fine growth lines, rarely disrupted by punctae, but no spinules; low dorsal adminicula bounding adductor field; otherwise similar to *Paraspiriferina. Permian (Asselian):* India.——FIG. 1276,*4a–d. *L. punctata; a–b,* holotype, exterior and interior views of ventral valve, ×2; *c–d,* exterior and interior views of dorsal valve, ×2 (Waterhouse & Rao, 1989).

Polystylus KLETS, 1993, p. 123 [**P. kentshaensis;* OD]. Medium size; transversely subelliptical in outline; cardinal extremities rounded; ventral beak incurved over low, slightly concave interarea; fold and sulcus well differentiated from lateral slopes, subangular in profile, flaring anteriorly; each lateral slope with 5 to 8 coarse, rounded ribs separated by narrow interspaces; microornament of regularly imbricate growth lamellae bearing 1 row of relatively coarse, low, solid, tapered spines and up to 4 rows of much finer spines crudely arranged in quincunx; long dorsal median ridge and short crural plates present. *Carboniferous (?Moscovian):* Russia (eastern Siberia).——FIG. 1277,*2a–c. *P. kentshaensis,* Mishkinskoi Suite; *a–b,* ventral valves, ×1.5; *c,* microornament, ×13 (Klets, 1993).

Yaonoiella WATERHOUSE, 1983a, p. 142 [**Y. mantajiti;* OD]. Small; fold and sulcus narrow; lateral slopes

with few subrounded plicae; microornament of closely and regularly spaced growth laminae, each bearing 2 to 4 rows of fine spinules; otherwise similar to *Paraspiriferina. Permian (Capitanian):* Nepal.——Fig. 1277,*1a–c. *Y. mantajiti; a,* holotype, ventral valve, ×2; *b,* ventral valve, ×5; *c,* dorsal valve, ×1 (Waterhouse, Pitakpaivan, & Mantajit, 1981).

Zaissania Sokolskaya, 1968, p. 197 [**Z. zaissanica;* OD]. Medium size; outline transversely subtriangular; moderately biconvex; cardinal extremities angular to alate; fold and sulcus narrow, well developed, rounded, smooth; lateral slopes with moderately numerous, strong, rounded plicae separated by narrow, subangular interspaces; microornament of regularly spaced, subimbricate growth lamellae, each lamella fringed with minute, hairlike spinules that project anteriorly over elongate grooves or pits of adjacent growth lamellae, all arranged in quincunx; dental adminicula short, stout, slightly divergent; median septum very long, stout; very long dorsal myophragm reaching almost to anterior margin; dorsal adminicula thick, long; punctae large, widely spaced. *Carboniferous (?Moscovian* or *Kasimovian–Gzhelian), Permian (Cisuralian):* Kazakhstan.——Fig. 1276,*2a–e. *Z. zaissanica,* ?Moscovian or Kasimovian–Gzhelian; *a,* holotype, mold of ventral exterior; *b–e,* holotype, ventral, dorsal, anterior, and posterior views of steinkern, ×1 (new).

Family SPIRIFERELLINIDAE Ivanova, 1972

[Spiriferellinidae Ivanova, 1972, p. 41] [=Crenispiriferidae Cooper & Grant, 1976b, p. 2,709]

Outline usually transversely subelliptical to subtrigonal; fold and sulcus usually narrow and poorly to moderately delimited; lateral slopes with few strong, lateral plicae and subimbricate growth varices; dental adminicula very short; microornament finely pustulose. *Carboniferous (Mississippian)–Upper Triassic.*

Spiriferellina Frederiks, 1924, p. 299 [**Terebratulites cristatus* von Schlotheim, 1816, p. 28; OD] [=*Tylotoma* Grabau, 1934, p. 100, obj.]. Small; outline variable, usually moderately transverse; cardinal extremities variably rounded, angular or slightly mucronate; fold and sulcus narrow, delineated by coarse sulcus-bounding plicae and deep, wide, fold-bounding interspaces; ventral interarea moderately high, slightly concave, apsacline; lateral slopes with few high, coarse, subangular plicae separated by deep, subangular interspaces; sulcus smooth and rounded or sometimes flat bottomed, rarely with weak median rib; fold rounded; microornament of very fine, hollow pustules arranged in quincunx and covering external termination of punctae; growth laminae irregularly spaced, imbricate anteriorly; some species also with fine, hollow spinules; dental adminicula short, slightly divergent; median septum high, long; elongate ctenophoridium supported by umbonal callus; crural bases broad, converging below and in front of cardinal process in some species; dorsal adductor field bordered by low, thin ridges; jugum complete; punctae moderately coarse and regularly spaced. *Carboniferous (Mississippian)–Permian (Lopingian):* cosmopolitan.——Fig. 1278,*1a–b. *S. cristata* (von Schlotheim), Lopingian, Germany; *a,* lectotype, ventral valve, ×2; *b,* microornament, ×5 (Campbell, 1959b).——Fig. 1278,*1c–h. S. tricosa* Cooper & Grant, Guadalupian, Texas, USA; *c–e,* dorsal, ventral, and lateral views, ×3; *f–g,* ventral and dorsal interiors, ×1.5; *h,* jugum, ×3 (Cooper & Grant, 1976b).

Crenispirifer Stehli, 1954, p. 347 [**Spiriferina angulata* King, 1931, p. 122; OD]. Small to medium size; strongly biconvex; outline transversely subelliptical; profile subovate; cardinal extremities slightly to moderately rounded; fold and sulcus narrow, rounded, poorly delimited from lateral slopes; lateral slopes with few strong, very high, subangular plicae separated by deep, angular interspaces; microornament of close-set pustules or low spinules arranged in quincunx; growth varices irregularly spaced, subimbricate in some species; dental adminicula very short; jugum incomplete; punctae medium sized to coarse, arranged in quincunx. *Carboniferous (Pennsylvanian)–Permian (Lopingian):* North America.——Fig. 1278,*2a–h. *C. angulata* (King), Cisuralian, Texas, USA; *a–e,* dorsal, ventral, lateral, posterior, and anterior views, ×1; *f,* dorsal interior; *g–h,* ventral interior and oblique view, ×1.5 (Cooper & Grant, 1976b).

Lancangjiangia Jin & Fang, 1977, p. 50 [**L. spinosa;* OD]. Small to medium size; outline transversely subovate; moderately inflated; ventribiconvex; cardinal extremities rounded; fold and sulcus moderately developed, smooth, rounded, wider than bounding ventral plicae and dorsal interspaces; fold high and carinate; lateral slopes with few (3 to 4) strong, rounded or subangular plicae; growth lamellae imbricate; microornament of numerous strong spinules; dental adminicula discrete, short; median septum long, stout; ctenophoridium high, broad; jugum unknown. *Upper Triassic:* China.——Fig. 1278,*3a–b. *L. spinosa;* ventral and dorsal valves, ×2 (new).

Metriolepis Cooper & Grant, 1976b, p. 2,716 [**M. pulvinata;* OD]. Small, ventribiconvex, ventral valve subconical in some species; usually widest at hinge line; cardinal extremities often angular or alate, rarely rounded; ventral interarea flattened, moderately high to very high; delthyrium closed by imbricating stegidial plates in at least some species; fold and sulcus moderately wide, well defined by coarse ribs and deep interspaces; lateral slopes with few to very few rounded plicae that drastically decrease in

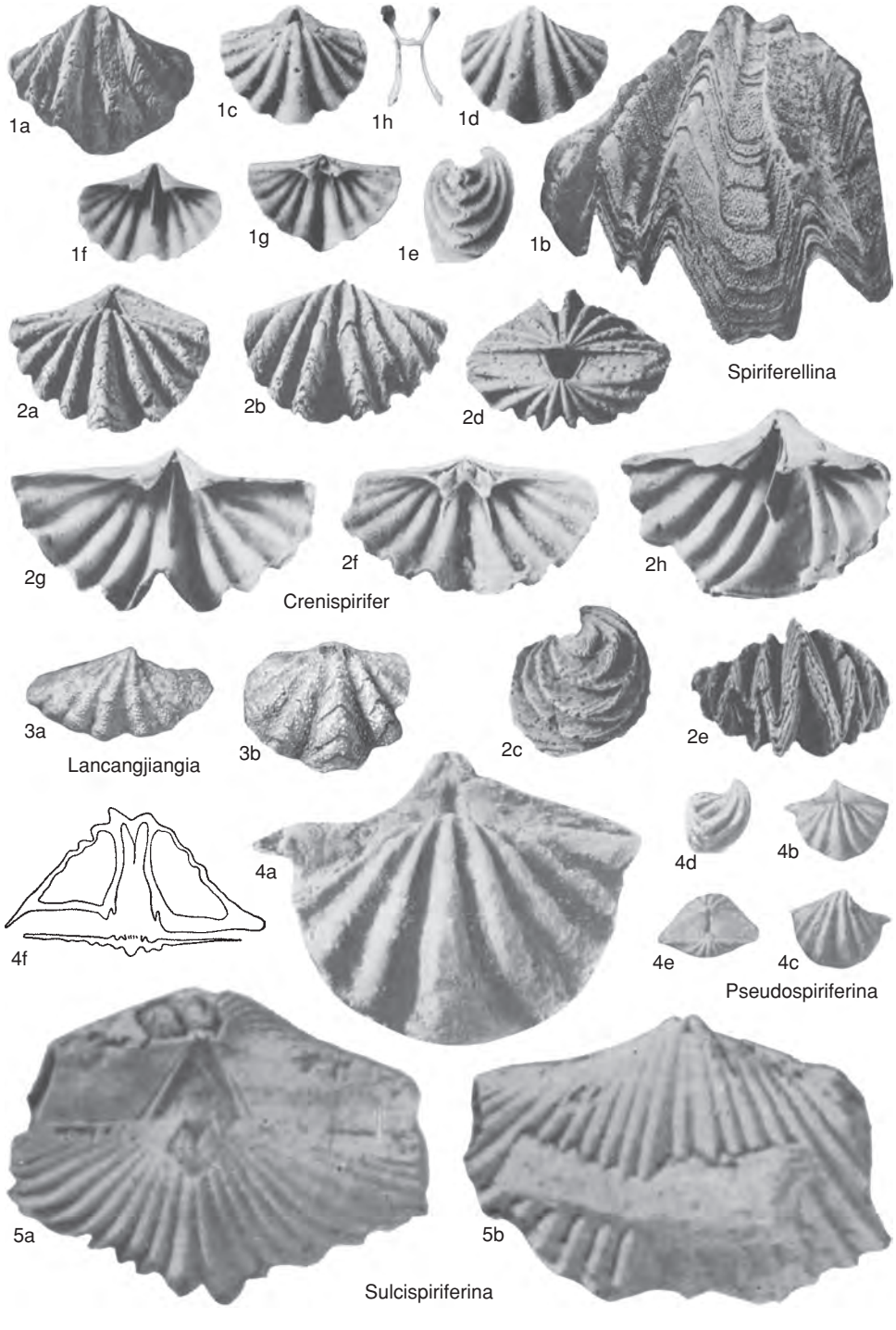

FIG. 1278. Spiriferellinidae (p. 1918–1920).

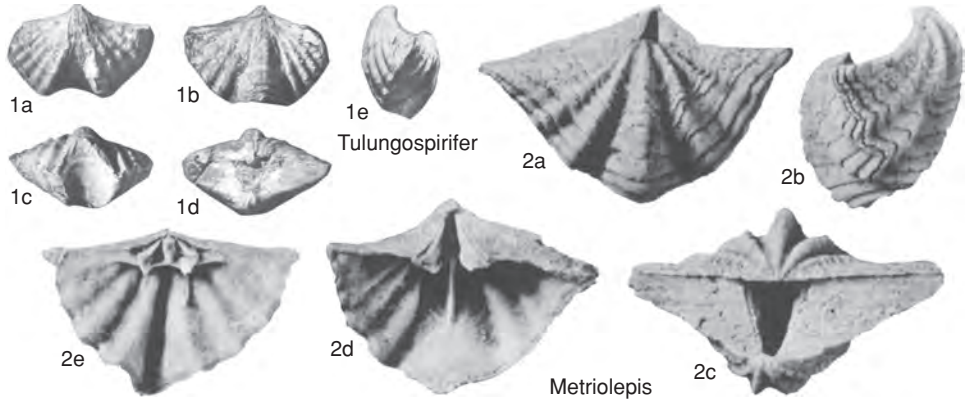

FIG. 1279. Spiriferellinidae (p. 1918–1920).

amplitude laterally; interspaces wide, rounded; sulcus rounded, flattened or with weak median rib; growth varices strong, imbricate, regularly or moderately irregularly spaced; microornament of low, rounded pustules arranged concentrically or in quincunx; dental adminicula very short; crural bases joined to base of cardinal process by short, medially convergent plates forming short, low platform; jugum complete; punctae finely to moderately dense, arranged in quincunx. *Permian:* USA (Texas).——FIG. 1279,*2a–e. *M. pulvinata,* Guadalupian; *a–c,* dorsal, lateral, and posterior views; *d–e,* ventral and dorsal interiors, ×1.5 (Cooper & Grant, 1976b).

Pseudospiriferina YANG & XU, 1966, p. 41 [**P. variabilis;* OD]. Small to medium size; transversely to longitudinally subovate; unequally biconvex; cardinal extremities often mucronate or angular, rarely rounded; maximum width usually at hinge line; ventral valve strongly inflated with acute, incurved beak and sharp, angular beak ridges; ventral interarea moderately high, concave, apsacline or nearly catacline; fold and sulcus well defined, smooth, usually rounded, wider than lateral plications; fold may be flattened or with weak median groove; lateral slopes with few (3 to 4, rarely 5 to 6) strong, rounded plicae separated by interspaces almost as wide; anterior growth varices crowded, slightly lamellose; microornament of fine, densely spaced pustules; dental adminicula and median septum discrete; punctae densely and evenly distributed. *Middle Triassic:* southwestern China.——FIG. 1278,*4a–f. *P. variabilis,* Guizhou; *a,* holotype, dorsal view, ×4; *b–e,* dorsal, ventral, lateral, and posterior views, ×1; *f,* transverse section, approximately ×3 (Yang & Xu, 1966).

Sulcispiriferina WATERHOUSE & GUPTA, 1981, p. 390 [**Spirifera vihiana* DAVIDSON, 1866, p. 41; OD]. Medium size; moderately transverse; outline subpentagonal; cardinal extremities subangular, maximum width at hinge line; ventral interarea moderately high, apsacline; fold and sulcus narrow, moderately developed; lateral slopes with moderately numerous, simple, strong, subangular plicae separated by narrow, angular interspaces; microornament of fine, low pustules only; jugum and nature of punctae unknown. *Permian (Guadalupian):* Kashmir, India.——FIG. 1278,*5a–b. *S. vihiana* (DAVIDSON), Kalabaghian, Kashmir; ventral and posterior views, ×2 (Waterhouse & Gupta, 1981).

Tulungospirifer CHING & SUN in CHING, SUN, & RONG, 1976, p. 316 [**Spiriferina stracheyi* SALTER in SALTER & BLANFORD, 1865, p. 72; OD]. Medium size; outline transversely subtrigonal; widest at hinge line, cardinal extremities alate to mucronate; fold and sulcus narrow, strongly developed, rounded, smooth; ventral interarea moderately high, concave, apsacline; lateral slopes with few to moderately numerous, low, rounded, simple plicae, separated by narrower, rounded interspaces; microornament consisting of fine, alternating radial grooves and fine spinules; dental adminicula short, divergent; median septum long, low; umbonal callus thick; dorsal umbonal callus present; jugum unknown. *Middle Triassic (Anisian):* China.——FIG. 1279,*1a–e. *T. stracheyi* (SALTER); ventral, dorsal, anterior, posterior, and lateral views, ×1 (new).

Family SARGANOSTEGIDAE Cooper & Grant, 1976

[Sarganostegidae COOPER & GRANT, 1976b, p. 2,743]

External surface with quincuntially arranged, very coarse punctae; microornament absent. *Permian (Guadalupian–Lopingian).*

Sarganostega COOPER & GRANT, 1969, p. 15 [**S. transversalis;* OD]. Small; transversely subtrigonal to

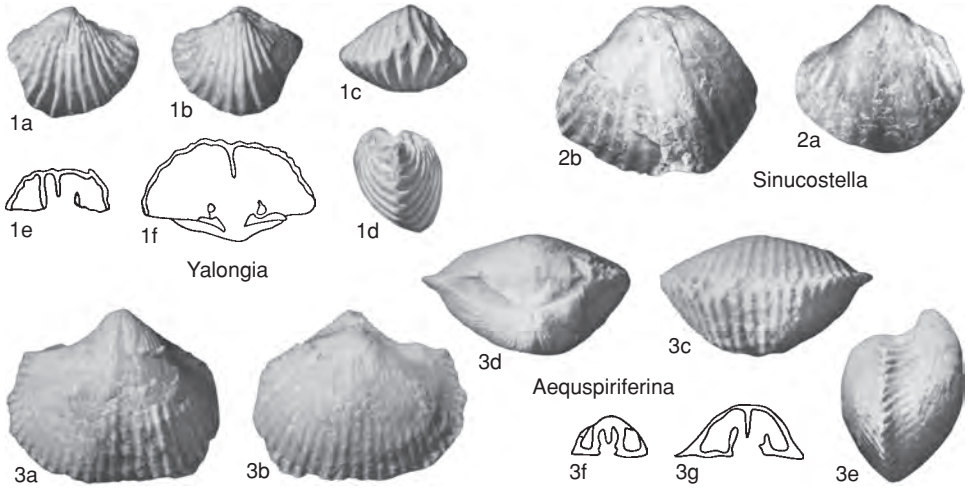

FIG. 1280. Balatonospiridae (p. 1921–1922).

subovate in outline; ventral interarea high, flattened, strongly apsacline to catacline; fold and sulcus narrow to moderately broad, moderately well defined by strong bounding plicae and interspaces; lateral slopes with few (2 to 3) strong, rounded plicae separated by wide, rounded interspaces; microornament absent; dental adminicula variably developed; ventral median septum long, high, thin; crural bases convergent, connected to anterior base of cardinal process by pair of thin transverse plates and forming pair of shallow apical recesses; jugum unknown; punctae very coarse externally, very fine internally. *Permian (Guadalupian–Lopingian):* USA (Texas).——FIG. 1274,*1a–d. *S. transversalis,* Lopingian; *a–b,* dorsal and ventral valves; *c–d,* ventral and dorsal interiors, ×1.5 (Cooper & Grant, 1976b).——FIG. 1274,*1e. S. pressa* COOPER & GRANT; microornament, ×3 (Cooper & Grant, 1976b).

Family BALATONOSPIRIDAE Dagys, 1974

[*nom. transl.* CARTER in CARTER & others, 1994, p. 368, *ex* Balatonospirinae DAGYS, 1974, p. 137] [=Nudispiriferininae Xu & LIU, 1983a, p. 82]

Outline transversely subelliptical to subquadrate or subpentagonal; fold and sulcus poorly developed; entire surface usually ribbed. *Middle Triassic, ?Upper Triassic.*

Subfamily YALONGIINAE Carter, 1994

[Yalongiinae CARTER in CARTER & others, 1994, p. 368]

Dental adminicula discrete. *Middle Triassic, ?Upper Triassic.*

Yalongia XU & LIU, 1983b, p. 112 [**Y. angulocostata;* OD]. Medium size; subequally biconvex, both valves moderately inflated; outline transversely subovate; cardinal extremities subangular or slightly rounded, greatest width slightly anterior to hinge line; ventral beak strongly incurved, interarea low; fold and sulcus poorly differentiated, weakly developed, anterior commissure almost rectimarginate; entire surface plicate; plicae strong, simple, subangular, moderately numerous, separated by moderately narrow subangular interspaces; microornament unknown; dental adminicula short, discrete; ventral median septum long, high; jugum unknown. *Middle Triassic:* Tibet.——FIG. 1280,*1a–f. *Y. angulocostata; a–d,* holotype, ventral, dorsal, anterior, and lateral views, ×1 (new); *e–f,* transverse sections, approximately ×1.5 (Xu & Liu, 1983b).

Aequspiriferina YANG & YIN in YANG & others, 1962, p. 109 [**A. multiplicata;* OD]. Small to medium size; strongly ventribiconvex; transversely subovate to subquadrate in outline; ventral beak incurved; hinge line equal to maximum width; cardinal extremities subangular to acute; ventral interarea distinct, slightly concave, catacline to slightly apsacline; fold and sulcus weakly to moderately developed; entire surfaces of both valves with numerous broadly rounded costae; microornament unknown; dental adminicula discrete; ventral median septum thickened, high distally; very short dorsal median septum; jugum unknown. *?Middle Triassic, ?Upper Triassic:* China.——FIG. 1280,*3a–g. *A. multiplicata; a–e,* ventral, dorsal, anterior, posterior, and lateral views, ×2 (new); *f–g,* transverse sections, approximately ×1.3 (Xu & Liu, 1983b).

Sinucostella XU & LIU, 1983b, p. 108 [**Aequspiriferina obscura* YANG & YIN in YANG & others,

1962, p. 110; OD]. Small to medium size; outline subovate to subpentagonal; cardinal extremities slightly rounded to subangular; subequally biconvex; ventral beak strongly incurved; interarea apsacline; hinge line nearly equal to maximum width; fold and sulcus weakly developed, poorly delineated; entire surface costate with 2 to 3 low, rounded costae on fold-sulcus and 6 to 8 on lateral slopes; microornament unknown; dental adminicula very short, discrete; ventral median septum long, high; jugum unknown. *Middle Triassic:* China (Qinghai).——Fig. 1280,*2a–b. *S. obscura* (Yang & Yin); ventral and dorsal valves, ×2 (new).

Subfamily BALATONOSPIRINAE Dagys, 1974

[Balatonospirinae Dagys, 1974, p. 137]

Dental adminicula reduced or absent; dental flanges and median septum fused by transverse plate or callus. *Middle Triassic (Anisian)–Upper Triassic.*

Balatonospira Dagys, 1974, p. 137 [**Spiriferina lipoldi* Bittner, 1890, p. 139; OD]. Small; subequally biconvex; cardinal extremities subangular; ventral umbo incurved; ventral interarea narrow, apsacline; disjunct deltidial and chilidial plates present; fold and sulcus narrow, poorly developed; lateral slopes and fold-sulcus with few strong plicae; microornament unknown; dental adminicula lacking; long, high, ventral median septum connected to dental flanges by very short transverse plate or callus; cardinal process nonstriate, bladelike, supported by apical callus; crural bases fused medially to form complete hinge plate; jugum complete, flattened. *Upper Triassic (Carnian):* Alps, Carpathian Mountains, Caucasus.——Fig. 1281,*1a–n. *B. lipoldi* (Bittner), Alps; *a–e,* syntype, dorsal, ventral, lateral, anterior, and posterior views, ×1 (Bittner, 1890); *f–i,* topotype, ventral, anterior, posterior, and lateral views, ×2 (new); *j–n,* transverse sections, approximately ×1.5 (Dagys, 1974).

Dinarispira Dagys, 1974, p. 131 [**Spiriferina pia* var. *dinarica* Bittner, 1890, p. 35; OD]. Medium size; outline transversely subquadrate; inequivalved, ventral valve moderately to strongly convex, dorsal valve weakly convex or flattened; cardinal extremities subangular; ventral umbonal region slightly compressed, overhanging hinge line, beak incurved; ventral interarea low, apsacline, concave; fold and sulcus weakly to moderately developed, moderately narrow; entire surface plicate; microornament of thick, short spinules; dental adminicula lacking; strong high, ventral median septum connected to lateral walls of umbonal region by thin plate or callus; true spondylium absent; ctenophoridium high, supported by callus; crural bases medially converging; jugum unknown. *Middle Triassic:* European Tethys.——Fig. 1281,*2a–i. *D. dinarica* (Bittner), Anisian, Alps and Caucasus; *a,* holotype, dorsal valve, ×1 (Bittner, 1890); *b–e,* dorsal, ventral, lateral, and posterior views, ×1; *f–i,* transverse sections, approximately ×1.5 (Dagys, 1974).

Koeveskallina Dagys, 1965, p. 172 [**Spiriferina koeveskalliensis* Boeckh, 1873, p. 175; OD; =*Spiriferina koeveskalyensis* Stur, 1865, p. 245]. Small to medium size, moderately ventribiconvex; reticularioid in aspect; outline transversely subovate to subrhomboidal; cardinal extremities rounded, maximum width anterior to hinge line; ventral interarea low, concave, apsacline; fold and sulcus lacking or very weakly developed; entire surfaces of both valves covered with numerous fine, mostly simple, costae; microornament of very fine, dense spinules; short, high spondylium formed by short dental adminicula and long, high median septum; dental flanges moderately high; ctenophoridium supported by thin callus; crural bases converge medially, apically fused to floor by callus; jugum incomplete. *Middle Triassic (Anisian)–Upper Triassic (Carnian):* Tethyan geosyncline.——Fig. 1281,*3a–h. *K. koeveskalyensis* (Stur), Anisian, Caucasus; *a–d,* dorsal, ventral, lateral, and anterior views, ×1; *e–h,* transverse sections, approximately ×2 (Dagys, 1974).

Nudispiriferina Yang & Xu, 1966, p. 47 [**N. minima;* OD]. Strongly inequivalved with high, strongly convex ventral and weakly convex dorsal valves; cardinal extremities angular; ventral beak incurved; fold and sulcus poorly delineated, rounded, smooth; lateral slopes with few rounded plicae; microornament absent; dental adminicula and spondylium absent; dental flanges and median septum connected by very short, transverse callus or plate; cardinal process nonstriate, knoblike, sessile; jugum unknown. *Middle Triassic:* southwestern China.——Fig. 1281,*4a–k. *N. minima,* Guizhou; *a–e,* dorsal, ventral, lateral, posterior, and anterior views; *f,* enlarged dorsal view, ×4; *g–k,* transverse sections, approximately ×2 (Yang & Xu, 1966).

Tylospiriferina Xu, 1978, p. 297 [**T. typica;* OD]. Small; outline transversely subpentagonal; subequally biconvex, ventral valve thicker than dorsal, hemipyramidal; beak slightly incurved; cardinal extremities subangular or slightly rounded; ventral interarea moderately high, slightly concave, nearly catacline, delthyrium open; fold and sulcus well delineated, narrow, rounded, smooth; lateral slopes with few strong, simple, rounded plicae with narrow interspaces; microornament densely spinulose and widely lamellose; possibly with very short dental adminicula buried in callus; long, ventral median septum anteriorly fused with and bisecting very high dental flanges to form short but deep, false spondylium; stout, high ctenophoridium and complete hinge plate supported by high, thin median septum and possibly very short dorsal adminicula; jugum unknown. *Upper Triassic:* China.——Fig. 1281,*5a–h. *T. typica; a–d,* dorsal, ventral, lateral, and anterior views, ×1; *e,* enlargement of dorsal valve, ×2; *f–h,* transverse sections, approximately ×2.4 (Xu, 1978).

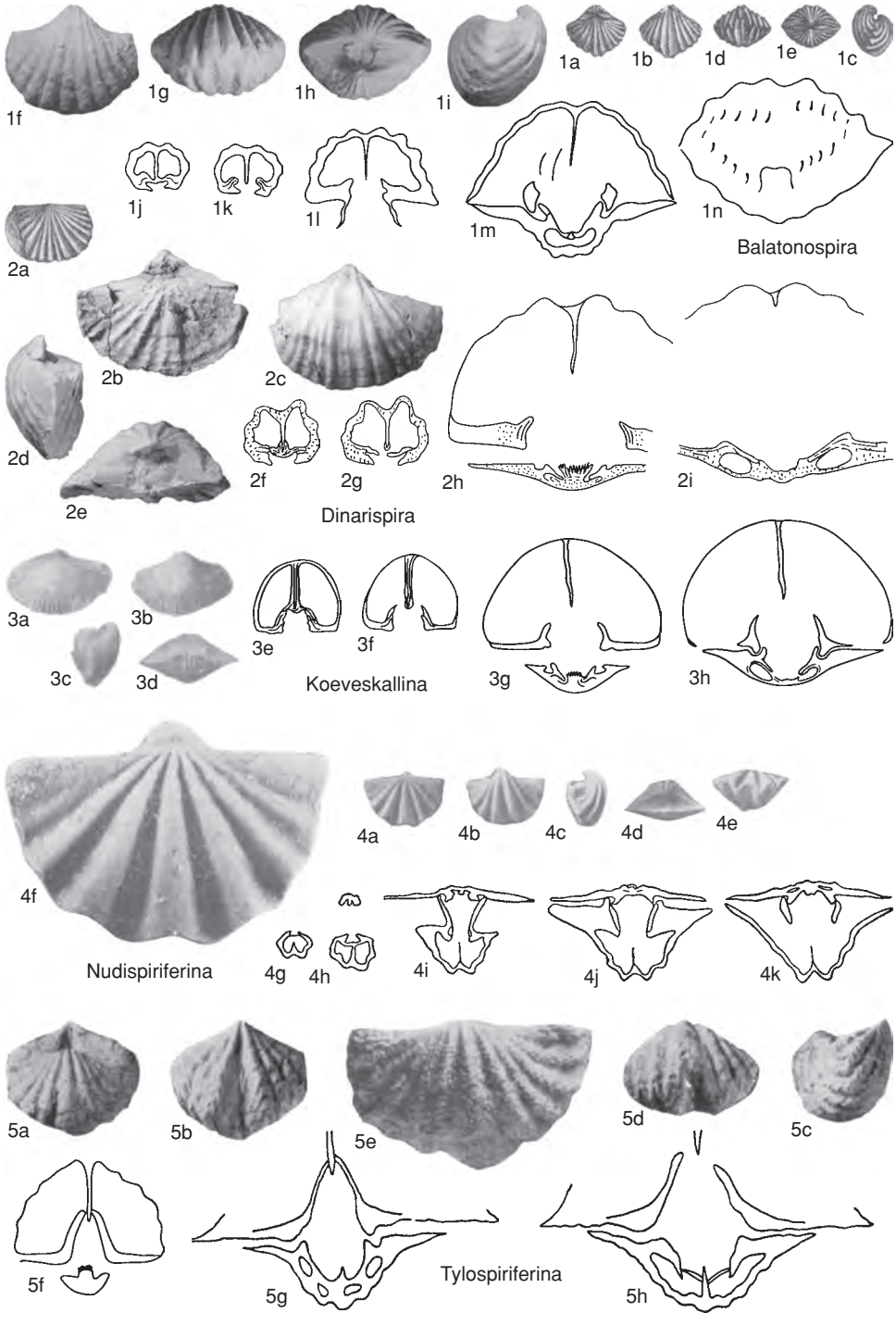

FIG. 1281. Balatonospiridae (p. 1922).

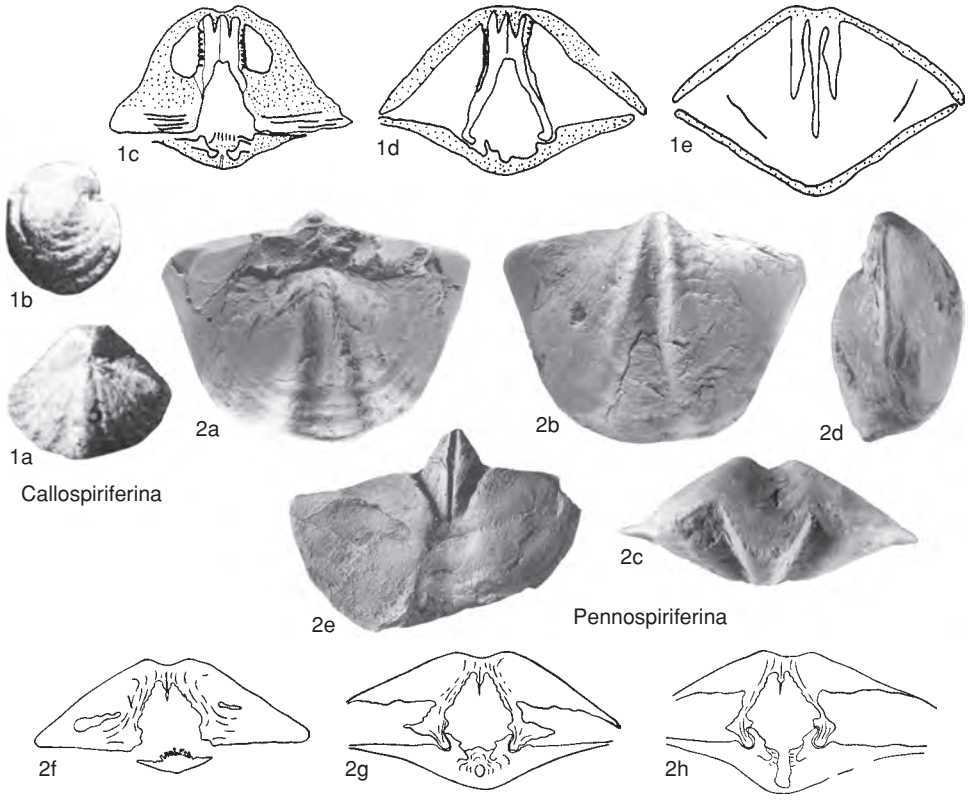

FIG. 1282. Pennospiriferinidae (p. 1924–1925).

Family PENNOSPIRIFERINIDAE Dagys, 1972

[*nom. transl.* CARTER in CARTER & others, 1994, p. 368, *ex* Pennospiriferininae DAGYS, 1972a, p. 36]

Transverse, usually with angular or extended lateral extremities; dental adminicula subparallel or converging; microornament absent. *Carboniferous (Pennsylvanian)–Lower Jurassic.*

Subfamily PENNOSPIRIFERININAE Dagys, 1972

[Pennospiriferininae DAGYS, 1972a, p. 36]

Fold and sulcus smooth; dental adminicula converging, fused with median septum by thick callus. *Middle Triassic (Ladinian)–Lower Jurassic.*

Pennospiriferina DAGYS, 1965, p. 112 [**P. popovi;* OD]. Large; strongly transverse with alate to mucronate cardinal extremities; moderately ventribiconvex, moderately inflated; fold and sulcus well defined, smooth, rounded; ventral interarea low, smooth, apsacline; lateral slopes with variably developed plicae; posterior portions of both valves much thickened with callus; jugum incomplete. *Middle Triassic (Ladinian)–Upper Triassic (Rhaetian):* northeastern Siberia.——FIG. 1282,*2a–h.* **P. popovi,* Ladinian; *a–e,* dorsal, ventral, anterior, lateral, and natural mold of ventral interior, ×1 (new); *f–h,* transverse sections, approximately ×1 (Dagys, 1965).

Callospiriferina ROUSSELLE, 1977, p. 157 [**Spirifer tumidus* BUCH, 1837, p. 52; OD; *nom. nov. pro Spirifer pinguis* VON ZIETEN, 1830 in 1830–1833, pl. 38,*5, non* SOWERBY, 1820]. Small, moderately transverse; strongly biconvex; hinge line less than maximum width; ventral interarea moderately high, concave, apsacline to catacline; fold and sulcus smooth; flanks with several simple, rounded ribs;

microornament unknown, possibly absent; dental adminicula long, close set, subparallel; ventral median septum high, fused with callus to form muscle platform; ctenophoridium large, supported by callus but no septum; jugum unknown; shell substance densely punctate. *Lower Jurassic:* Western Europe, northern Africa.——Fig. 1282,*1a–e. *C. tumidus* (Buch), Lias, Morocco; *a–b,* dorsal and lateral views, ×1; *c–e,* transverse sections, approximately ×1.6 (Rousselle, 1977).

Subfamily PUNCTOSPIRELLINAE Dagys, 1974

[Punctospirellinae Dagys, 1974, p. 135] [=Xestotrematidae Cooper & Grant, 1976b, p. 2,748]

Fold and sulcus smooth or weakly ribbed; dental adminicula discrete, usually short, not converging. *Carboniferous (Pennsylvanian)–Middle Triassic.*

Punctospirella Dagys, 1974, p. 136 [**Terebratulites fragilis* von Schlotheim, 1813, p. 104; OD]. Small; transversely subtrigonal to subovate in outline; subequally biconvex, moderately inflated; cardinal extremities angular, maximum width attained at hinge line; fold and sulcus moderately narrow, well defined, smooth, rounded; ventral interarea moderately high, apsacline; lateral slopes with few rounded, strong plicae separated by moderately narrow interspaces; dental adminicula discrete, short; ventral median septum long, high; ctenophoridium minute, knoblike, weakly striate; jugum incomplete. *Middle Triassic:* Germany, Russia, Greenland, Canada, Japan, Himalayas.——Fig. 1283,*1a–g. *P. fragilis* (von Schlotheim), Germany; *a–d,* dorsal, ventral, lateral, and anterior views, ×1; *e–g,* transverse sections, approximately ×2 (Dagys, 1974).

Arionthia Cooper & Grant, 1976b, p. 2,750 [**A. blothrhachis;* OD]. Medium size; usually strongly transverse; cardinal extremities variable, usually alate to mucronate, rarely rounded; lateral slopes with few to moderately numerous, simple or, more rarely, bifurcating plicae; fold and sulcus usually with several weaker ribs, or more rarely, smoothly rounded; dental adminicula short, often partially buried in callus; otherwise similar to *Xestotrema. Permian (Lopingian):* USA (Texas).——Fig. 1283,*2a–g. *A. blothrhachis; a–e,* holotype, dorsal, ventral, posterior, anterior, and lateral views, ×1; *f–g,* dorsal and ventral interiors, ×1.5 (Cooper & Grant, 1976b).

Laioporella Ivanova, 1975, p. 83 [**L. modesta;* OD]. Medium to large; outline transversely rhomboidal; ventral valve inflated, with high, flattened interarea and small beak; cardinal extremities angular, alate; fold and sulcus well developed and delineated; fold high, rounded; sulcus moderately deep with simple, low median rib; lateral slopes with few rounded plications; dental adminicula short, thin; ventral median septum high, thin, long; dorsal adductor scar bounded laterally by distinct ridges; brachidium unknown; punctae sparsely distributed. *Carboniferous (Pennsylvanian):* Russia (Moscow basin).——Fig. 1283,*3a–g. *L. modesta; a–e,* holotype, ventral, dorsal, lateral, anterior, and posterior views, ×1; *f–g,* ventral and dorsal interiors, ×2 (new).

Xestotrema Cooper & Grant, 1969, p. 16 [**Spirifera pulchra* Meek, 1860, p. 310; OD] [=*Mucrospiriferinella* Waterhouse, 1982b, p. 48 (type, *M. undulosa,* OD)]. Large, strongly transverse, cardinal extremities mucronate or alate in large adults; fold and sulcus narrow, rounded, smooth; ventral interarea moderately high, apsacline; lateral slopes with numerous rounded plicae separated by narrow, angular interspaces; microornament absent except for minute spinules or pustules in some juveniles; dental adminicula long; ventral median septum thin, high; punctae fine, dense. *Carboniferous (Pennsylvanian), Permian (Lopingian):* Thailand, *Pennsylvanian;* USA (Idaho, Utah, Wyoming), *Lopingian.*——Fig. 1283,*4a–e. *X. pulchrum* (Meek), Lopingian, Wyoming; ventral, dorsal, lateral, anterior, and posterior views, ×1 (Cooper & Grant, 1976b).

Family LEPISMATINIDAE Xu & Liu, 1983

[Lepismatinidae Xu & Liu, 1983a, p. 82]

Cyrtiniform or globose; lateral slopes ribbed; fold and sulcus well developed; delthyrium open; dental adminicula discrete. *Triassic–Lower Jurassic.*

Subfamily LEPISMATININAE Xu & Liu, 1983

[*nom. transl.* Carter in Carter & others, 1994, p. 369, *ex* Lepismatinidae Xu & Liu, 1983a, p. 82]

Fold and sulcus smooth; microornament of dense spinules; cardinalia sessile. *Triassic.*

Lepismatina Wang, 1955, p. 353 [**L. hsui;* OD] [=*Costispiriferina* Dagys, 1974, p. 127 (type, *Spiriferina shalshalensis* Bittner, 1899, p. 42, OD)]. Small; transversely subquadrate in outline; strongly inequivalved with high, subpyramidal ventral and low, weakly convex dorsal valves; ventral interarea high, flattened, apsacline to procline; maximum width at subangular cardinal extremities; fold and sulcus smooth, rounded; lateral slopes with few rounded plicae; microornament of regularly spaced, imbricate growth lamellae and fine, dense granules; dental adminicula moderately long, apically fused by callus to high long median septum; ctenophoridium short, broad; jugum complete with posteriorly directed process. *Middle Triassic–Upper Triassic:* China, *Middle Triassic;* western Tethys, *Upper Triassic.*——Fig. 1284,*2a–i. *L. hsui,* Middle

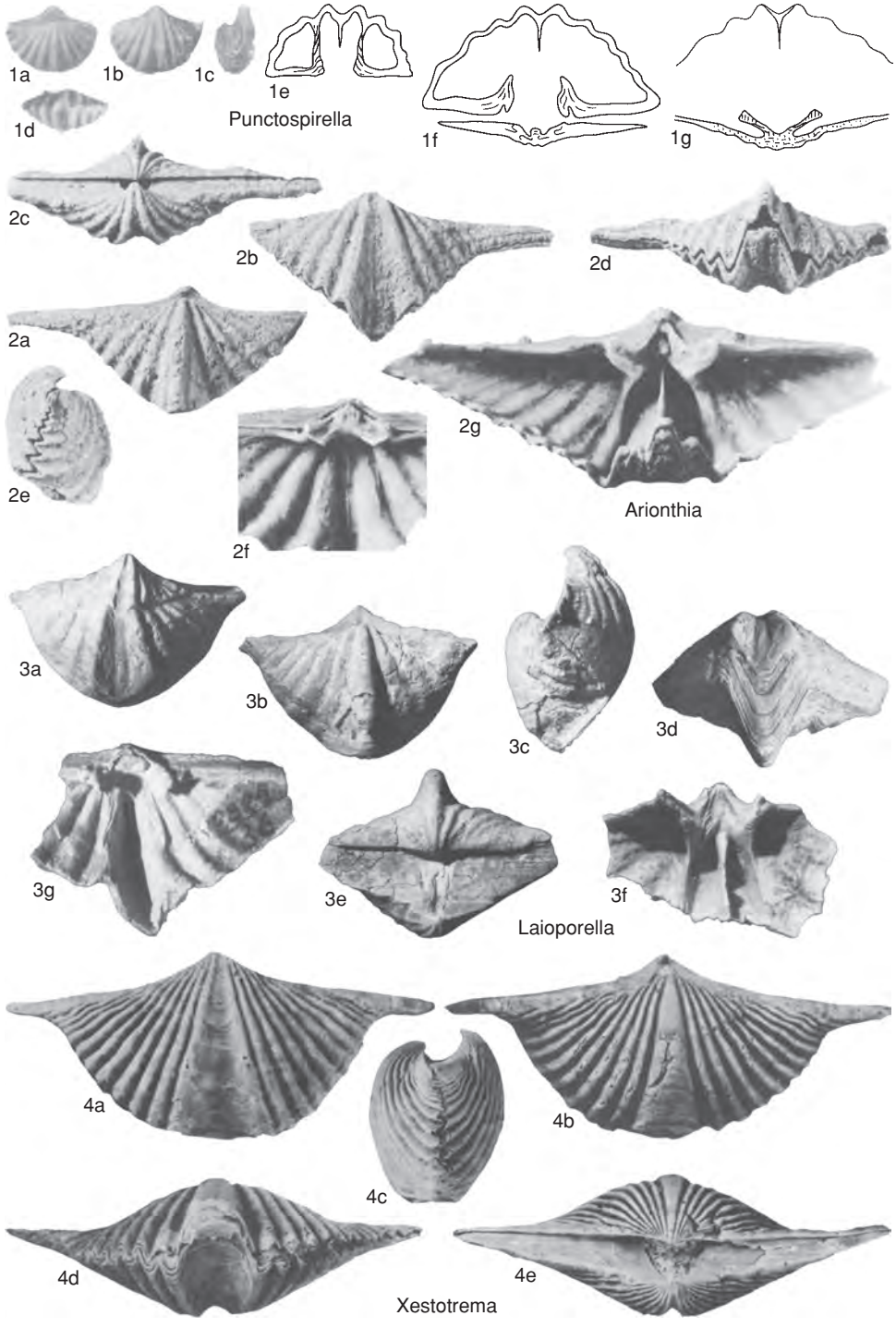

FIG. 1283. Pennospiriferinidae (p. 1925).

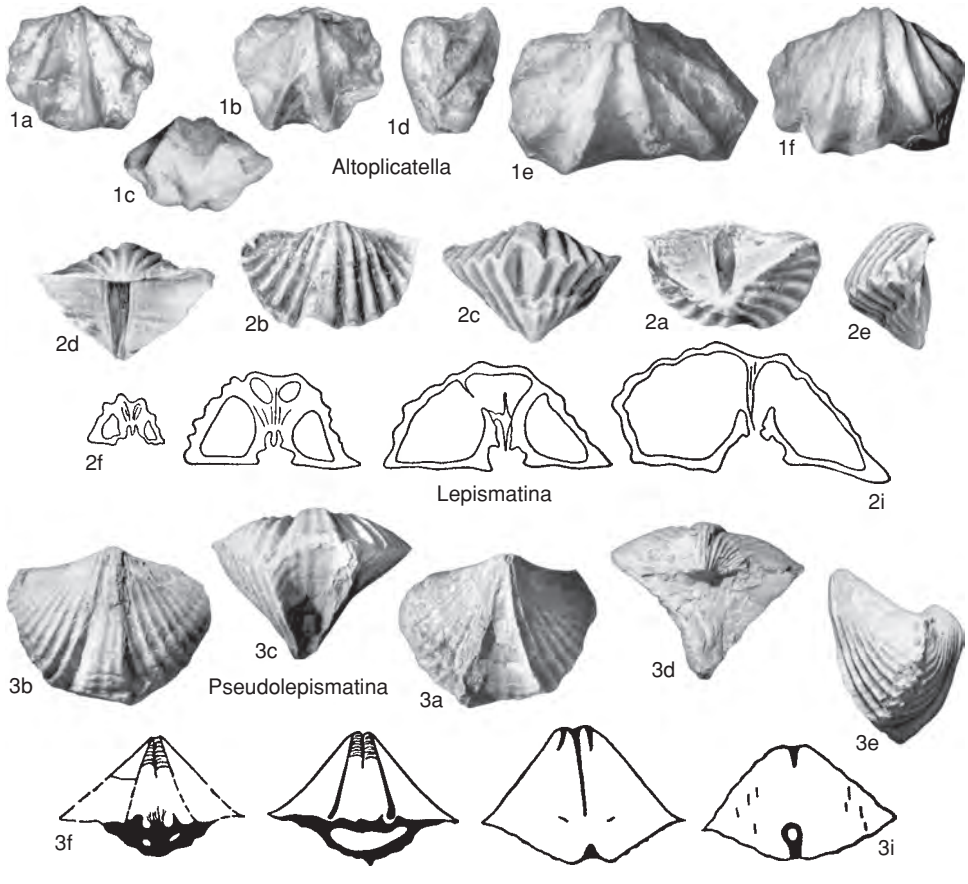

FIG. 1284. Lepismatinidae (p. 1925–1927).

Triassic, China; *a–e,* holotype, ventral, dorsal, anterior, posterior, and lateral views, ×2 (new); *f–i,* transverse sections, approximately ×3 (Yang & Xu, 1966).

Altoplicatella XU & LIU, 1983b, p. 114 [**A. altiarea;* OD]. Small to medium size; outline subpentagonal to subovate, almost equidimensional; unequally biconvex, ventral valve much more inflated, subpyramidal, dorsal valve gently convex; ventral interarea high, smooth, concave, catacline to procline; cardinal extremities well rounded, hinge line narrow; fold and sulcus moderately well defined, angular, smooth, wider than lateral plicae and interspaces; lateral slopes with 2 to 3 strong, coarse, subangular plicae; microornament unknown; high, long median septum fused to dental adminicula by callus; dorsal interior poorly known. *Middle Triassic:* China (Qinghai).——FIG. 1284,*1a–f.* **A. altiarea; a–d,* holotype, ventral, dorsal, anterior, and lateral views; *e,* large ventral valve; *f,* large dorsal valve, ×2 (new).

Pseudolepismatina CHING & SUN in CHING, SUN, & RONG, 1976, p. 321 [**P. nyalamensis;* OD]. Medium size; strongly inequivalved; ventral valve subconical, dorsal much thinner, moderately convex; cardinal extremities subangular; ventral interarea high, flattened, catacline; fold and sulcus sharply delimited, smooth; lateral slopes with moderately numerous, simple, rounded to subangular costae with narrow interspaces; microornament densely spinulose, slightly lamellose anteriorly; discrete dental adminicula and median septum fused by callus to form muscle platform; hinge plate complete with high, knoblike ctenophoridium; jugum narrowly rounded, supported by thick callus. *Triassic:* Tibet.——FIG. 1284,*3a–i.* **P. nyalamensis; a–e,* holotype, ventral, dorsal, anterior, posterior, and lateral views, ×1 (new); *f–i,* transverse sections, approximately ×1 (Ching, Sun, & Rong, 1976).

Subfamily PSEUDOCYRTININAE Carter, 1994

[Pseudocyrtininae CARTER in CARTER & others, 1994, p. 369]

Fold and sulcus smooth; cardinalia supported by short median septum; microornament absent. *Upper Triassic.*

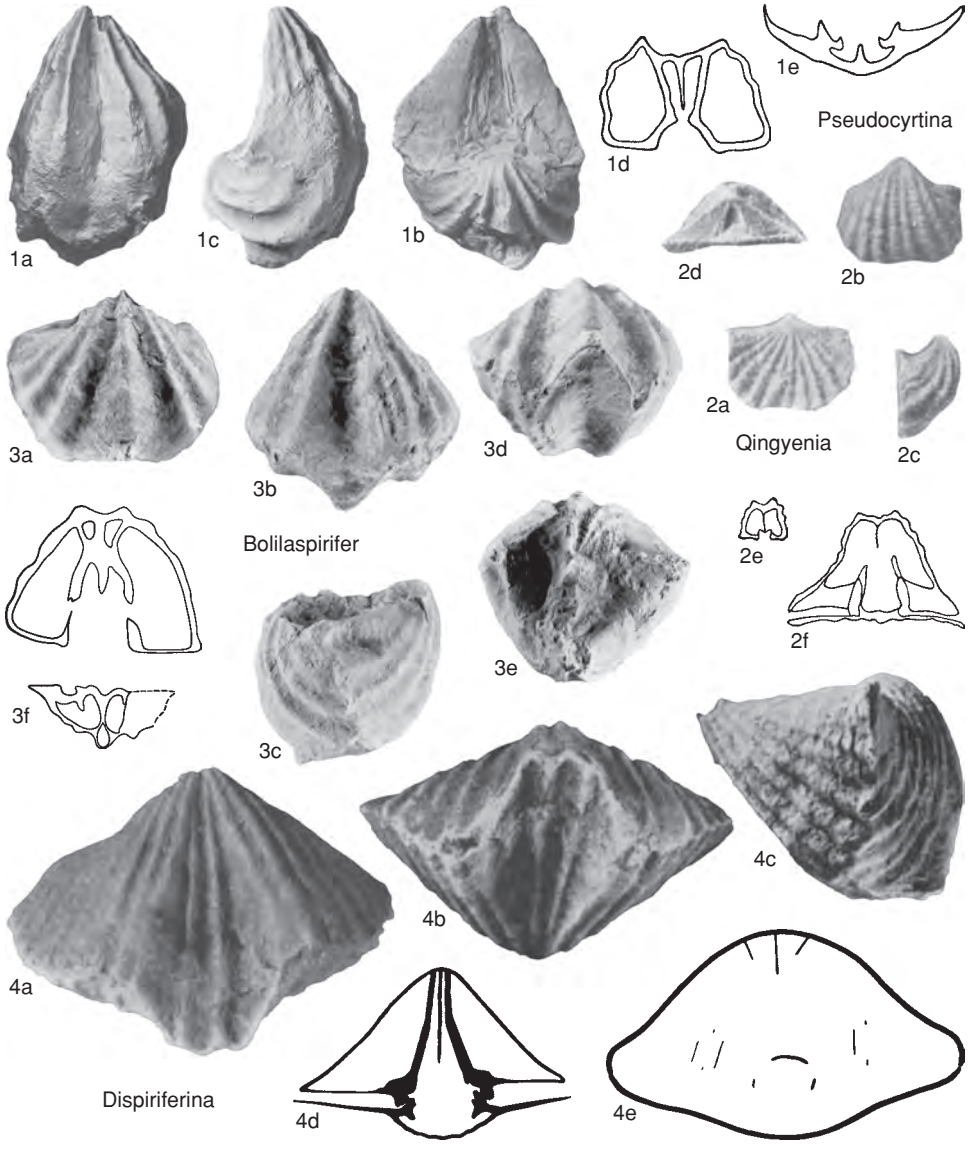

FIG. 1285. Lepismatinidae (p. 1928–1929).

Pseudocyrtina DAGYS, 1962, p. 54 [**P. norica;* OD]. Medium size; strongly and unequally biconvex; ventral valve greatly inflated, subrhomboidal; dorsal valve thinner, evenly convex; ventral interarea high, flattened, catacline or weakly apsacline; fold and sulcus well defined, rounded; lateral slopes with few, coarse, angular plicae; microornament unknown; dental adminicula short, discrete; ventral median septum long, high; ctenophoridium wide, stout; crural bases thickened; jugum unknown. *Upper Triassic (Norian):* Caucasus, Georgia.—— FIG. 1285,*1a–e. *P. norica; a–c,* holotype, ventral, posterior, and lateral views, ×1 (new); *d–e,* transverse sections, approximately ×1 (Dagys, 1963).

Bolilaspirifer SUN, 1981, p. 205 [**B. jomdaensis;* OD]. Small, unequally biconvex; outline transversely subpentagonal; lateral profile subquadrate; cardinal extremities slightly rounded, hinge line slightly less than maximum width; ventral interarea high, slightly concave, nearly catacline; beak acute, slightly incurved; delthyrium open; fold and sulcus well developed, sharply delineated; lateral slopes

with few rounded plicae; growth lines imbricate; microornament of imbricate growth lamellae only; high, stout median septum and subparallel dental adminicula united by thin, transverse delthyrial plate; hinge plate complete, concave; jugum unknown. *Upper Triassic:* China.——FIG. 1285,*3a–f.* **B. jomdaensis; a–e,* holotype, dorsal, ventral, lateral, anterior, and posterior views, ×2 (new); *f,* transverse section, approximately ×2.5 (Sun, 1981).

Subfamily DISPIRIFERININAE Carter, 1994

[Dispiriferininae CARTER in CARTER & others, 1994, p. 369]

Entirely ribbed; no dorsal septum. *Middle Triassic–Lower Jurassic.*

Dispiriferina SIBLÍK, 1965, p. 79 [**Spiriferina davidsoni* EUDES-DESLONGCHAMPS, 1855, p. 542; OD]. Medium size; transversely subovate in outline; widest at or near hinge line; cardinal extremities subangular; ventral valve high and subpyramidal; interarea high, flattened, procline; ventral beak straight or slightly incurved; dorsal valve much thinner; fold and sulcus moderately wide; plicae on lateral slopes moderately strong, rounded, well defined, rarely bifurcating, separated by subangular or moderately rounded interspaces; sulcus with pair of simple plicae; microornament apparently absent; dental adminicula very long, close set; ventral median septum long; ctenophoridium small, not bifurcated; jugum simple; punctae poorly known. *Lower Jurassic:* France, Slovakia, Morocco.——FIG. 1285,*4a–e.* **D. davidsoni* (EUDES-DESLONGCHAMPS), Slovakia; *a–c,* ventral, anterior, and lateral views, ×2; *d–e,* transverse sections, ×2 (Siblík, 1965).

Qingyenia YANG & XU, 1966, p. 50 [**Q. spinosa;* OD]. Small; outline subquadrate; ventral valve strongly convex, dorsal valve weakly concave; cardinal extremities subangular or slightly mucronate; maximum width at hinge line; ventral interarea moderately high, concave; delthyrium open; very weak ventral sulcus, fold absent; entire surface of valves covered with few coarse, rounded plicae; each plica with 1 or 2 rows of fine spinules; dental adminicula very short, discrete, subparallel; high median septum connected apically to dental flanges by thin transverse plate, forming very short, false spondylium; ctenophoridium very low; jugum unknown. *Middle Triassic:* China (Guizhou).——FIG. 1285,*2a–f.* **Q. spinosa; a–d,* holotype, dorsal, ventral, lateral, and posterior views, ×2; *e–f,* transverse sections, approximately ×2 (Yang & Xu, 1966).