

# SPIRIFEROIDEA

J. L. CARTER

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## Superfamily SPIRIFEROIDEA King, 1846

[*nom. correct.* CARTER, 1992, p. 327, *pro* Spiriferacea SCHUCHERT, 1896, p. 333, *nom. transl. ex* Spiriferidae KING, 1846, p. 28]

Ventral beak incurved, ventral interarea low, usually apsacline; hinge line denticulate; fold and sulcus usually ribbed; dorsal adminicula or crural plates rarely developed; ctenophoridium present. *Upper Devonian (Famennian)–Permian (Lopingian)*.

### Family SPIRIFERIDAE King, 1846

[Spiriferidae KING, 1846, p. 28]

Outline variable; hinge line coarsely denticulate except for narrow areas near delthyrium; delthyrial cover weakly developed or absent; lateral slopes and fold-sulcus costate to costellate; microornament capillate; short delthyrial plate variably developed; vascular impressions absent or simple. *Upper Devonian (Famennian)–Permian (Lopingian)*.

### Subfamily SPIRIFERINAE King, 1846

[*nom. transl.* WATERHOUSE, 1968, p. 9, *ex* Spiriferidae KING, 1846, p. 28]

Cardinal extremities extended in juveniles; outline variable in adults; flanks and fold-sulcus with numerous costae that commonly bifurcate; fold usually poorly delimited; dental adminicula usually developed, and when present, moderately divergent. *Carboniferous (Tournaisian)–Permian (Guadalupian)*.

*Spirifer* J. SOWERBY, 1816 in 1815–1818, p. 41 [*\*Conchylolithus (Anomia) striatus* MARTIN, 1793, pl. 23; SD ICZN Opinion 100, 1928, p. 12] [= *Spiriferus* DE BLAINVILLE, 1827 in 1825–1827, p. 291, *nom. van.*; *Spirifera* PHILLIPS, 1836, p. 216, *nom. van.*]. Medium to large; slightly to strongly transverse with angular to slightly mucronate cardinal extremities; ventral interarea of moderate height, concave, apsacline; delthyrium partially occluded by overlapping stegidial plates in type species, possibly open in others; sulcus variable in development, often weak, shallow, rounded, poorly

delimited; fold well defined posteriorly by bounding interspaces but spreading anteriorly and incorporating additional costae; ornament consisting of numerous, commonly bifurcating costae over entire surface; primary costae sometimes trifurcate, producing weak fasciculations on lateral slopes; ventral interior with thick apical callus, usually with strong, diverging dental adminicula and incised muscle field; short delthyrial plate present in at least some species. *Carboniferous (Tournaisian–Visean, ?Serpukhovian, ?lower Bashkirian)*: cosmopolitan.

**S. (Spirifer)**. Strongly transverse with alate, or more rarely, widely angular cardinal extremities in all but earliest growth stages, never well rounded in adults; ventral umbonal region broad and well developed; fold and sulcus spreading anteriorly in large adults. *Carboniferous (Tournaisian–Visean, ?Serpukhovian, ?lower Bashkirian)*: cosmopolitan.—FIG. 1165a–d. \**S. (S.) striatus* (MARTIN), Lower Carboniferous, British Isles; ventral, dorsal, anterior, and posterior views, ×1 (new).

**S. (Grandispirifer)** YANG, 1959, p. 116 [*\*G. mylkensis*; OD]. Medium to large; strongly transverse with alate cardinal extremities; ventral umbonal region moderately narrow or weakly developed, extending little posteriorly; lateral slopes and fold-sulcus covered with numerous simple and bifurcating costae; fold and sulcus narrow, weakly to moderately developed, rounded, not appreciably spreading; dental adminicula obscured by thick callus or absent. *Carboniferous (Visean)*: China.—FIG. 1166a–c. \**S. (G.) mylkensis*; ventral, dorsal, and posterior views, ×1 (Yang, 1959).

**S. (Mesochoispira)** CARTER, 1992, p. 335 [*\*Spirifer grimesi* HALL, 1858, p. 604; OD]. Medium to large; outline transverse to elongate subovate; posterior growth form with double reversal from rounded cardinal extremities in juveniles, to slightly transverse and mucronate at midsize, to rounded cardinal extremities in adults; fold and sulcus spreading anteriorly, incorporating additional costae; costae fine to medium, often flattened, with moderately narrow interspaces; ventral interior with thin, divergent dental adminicula. *Carboniferous (middle Tournaisian–middle Visean)*: North America, Belgium, Russia.—FIG. 1167a–e. \**S. (M.) grimesi* (HALL), upper Tournaisian, Oklahoma, USA; ventral, dorsal, anterior, posterior, and lateral views, ×1 (new).

**Ectochoisites** CAMPBELL, 1957, p. 71 [*\*E. watsi*; OD]. Medium size; outline subovate, slightly nasute, or subquadrate, becoming elongate in large adults, distinctly transverse in juveniles; fold and

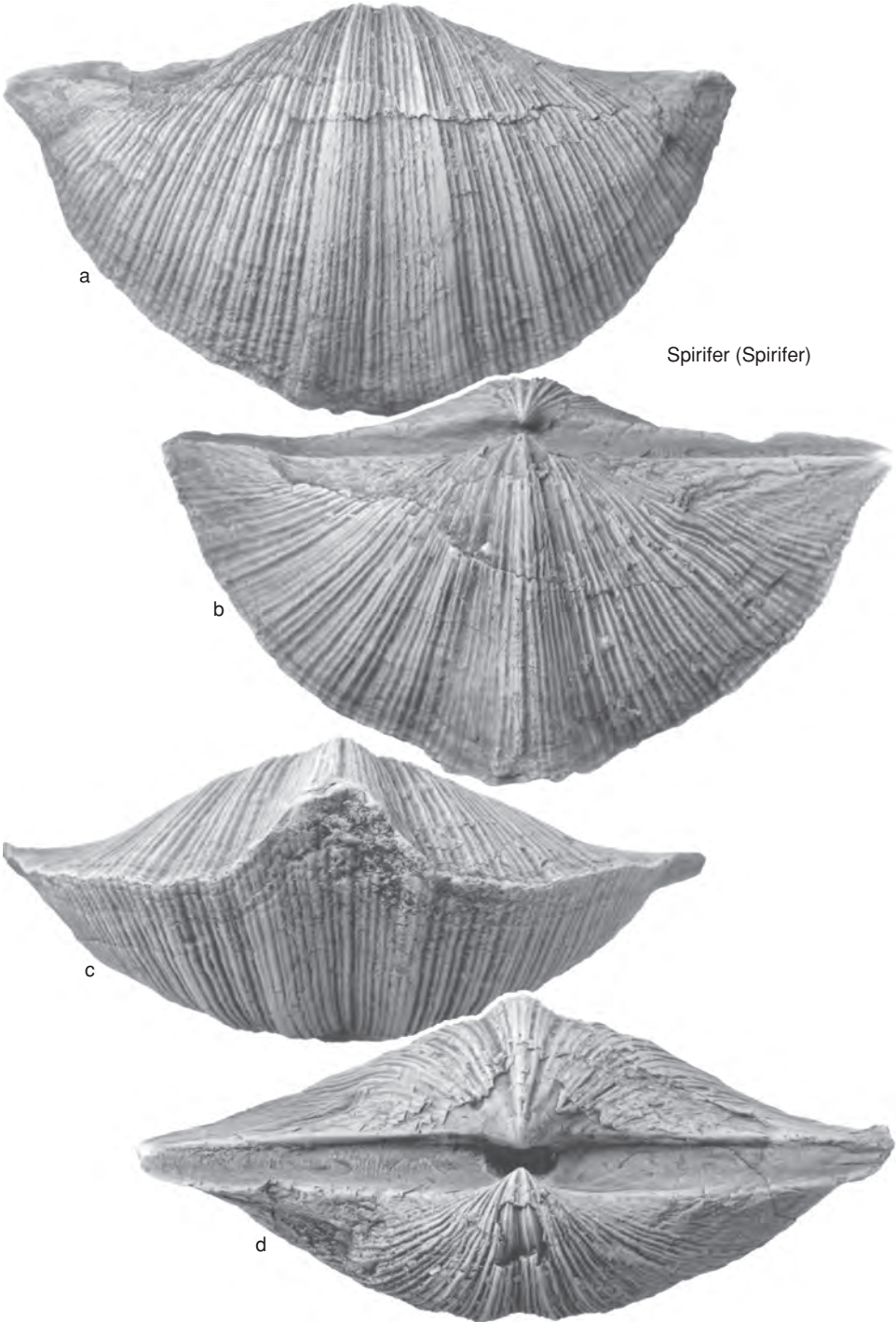


FIG. 1165. Spiriferidae (p. 1769).

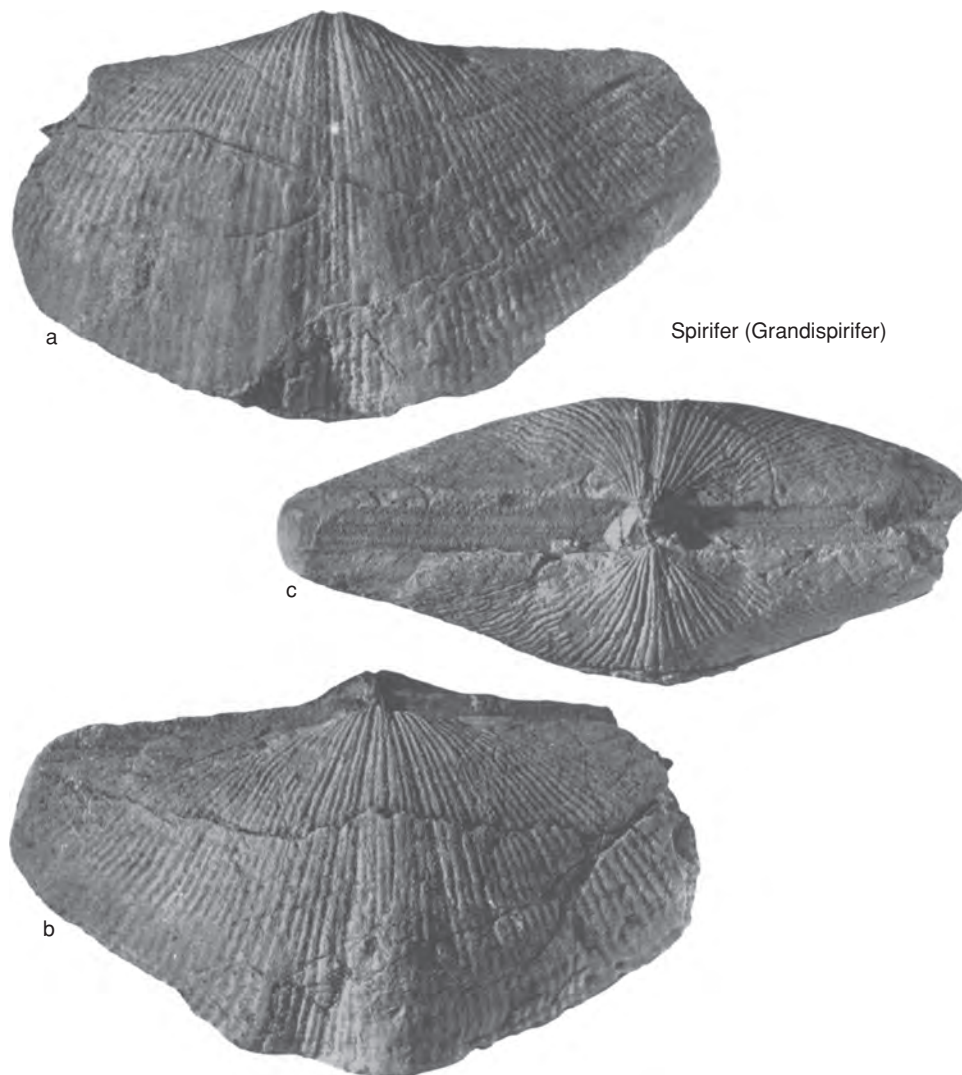


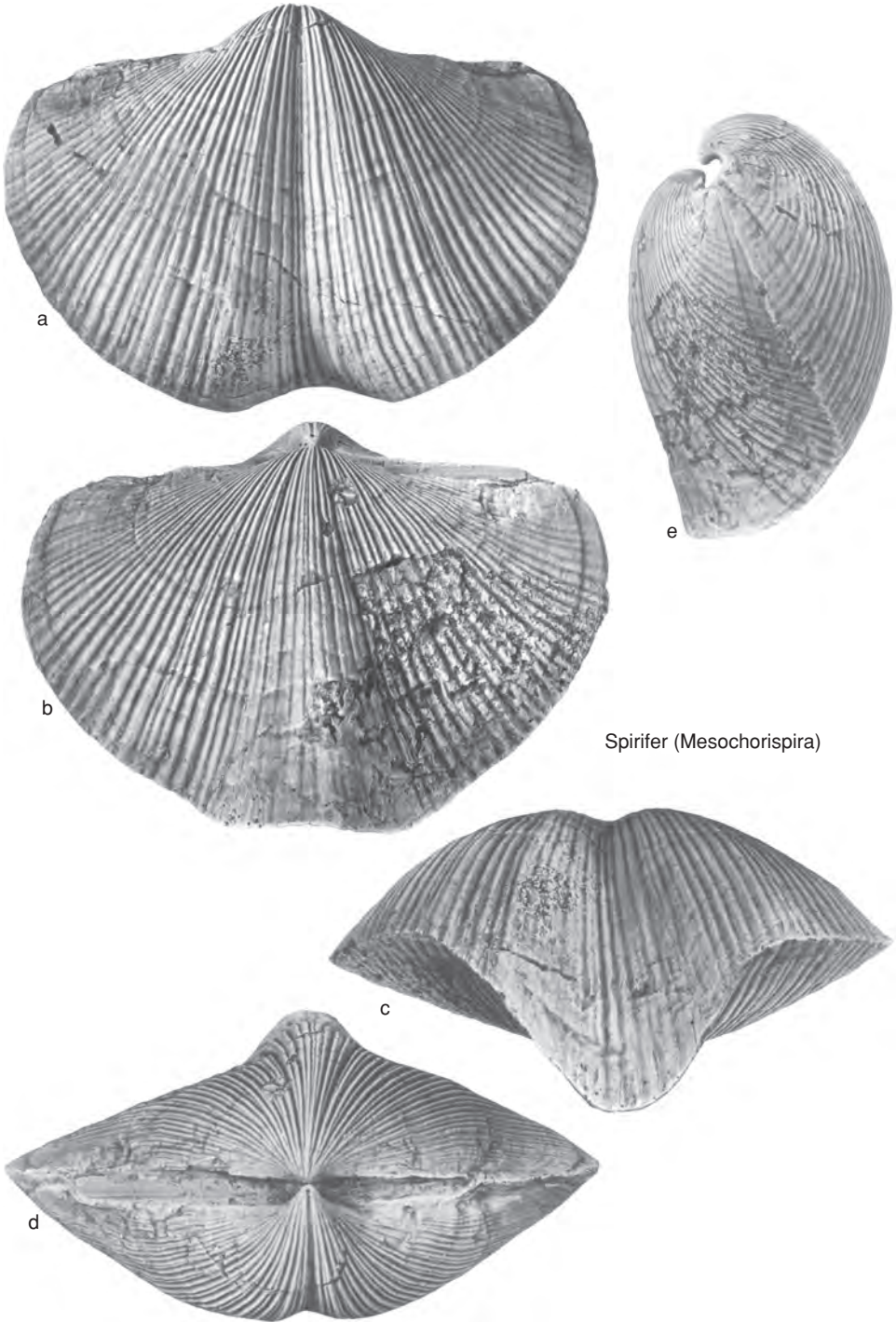
FIG. 1166. Spiriferidae (p. 1769).

sulcus moderately developed, poorly delineated; ventral umbonal region moderately inflated; ventral interarea laterally truncated, trapezoidal; entire surface multicostate; costae fine, numerous, freely bifurcating; ventral interior with moderately long, diverging dental adminicula; dorsal interior with short dorsal adminicula; vascular impressions absent. *Carboniferous (Tournaisian)*: Australia, North America.—FIG. 1168, 1a–g. \**E. watti*, Australia; a–d, ventral, dorsal, lateral, and anterior views,  $\times 1$ ; e–g, transverse sections,  $\times 1$  (Campbell, 1957).

**Larispirifer** ENOKIAN & POLETAEV in POLETAEV, 1986, p. 68 [\**Choristites jigulensis riphaeicus* EINOR in ALEKSANDROV & EINOR, 1979, p. 83; OD]. Large;

moderately transverse; fold and sulcus not appreciably spreading anteriorly; costae coarse, bifurcating or trifurcating, forming fasciculations adjacent to fold-sulcus; interspaces moderately wide; ventral interior with thick parallel dental adminicula; otherwise similar to *Spirifer (Mesochorospira)*. *Carboniferous (Kasimovian–Gzhelian)*: Russia (Bashkiria, Novaya Zemlya, polar Urals, northern Timan), Ukraine (Donets basin), western Canada.—FIG. 1169, 2a–b. \**L. riphaeicus* (EINOR); holotype, ventral and dorsal views,  $\times 1$  (Aleksandrov & Einor, 1979).

**Latispirifer** ARCHBOLD & THOMAS, 1985, p. 270 [\**L. callytharrensensis*; OD]. Large; ornament consisting of



Spirifer (Mesochorispira)

FIG. 1167. Spiriferidae (p. 1769).

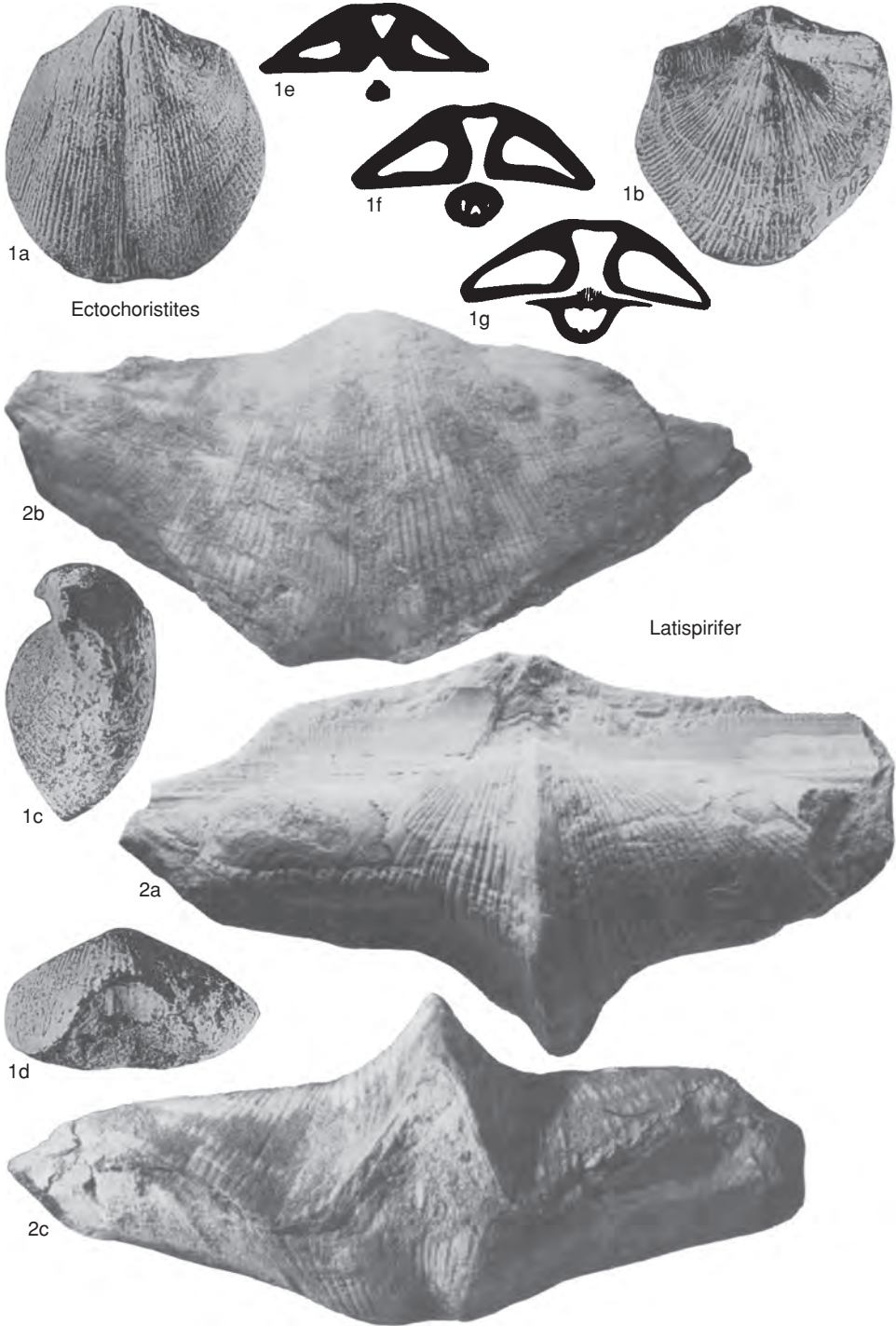


FIG. 1168. Spiriferidae (p. 1769–1774).

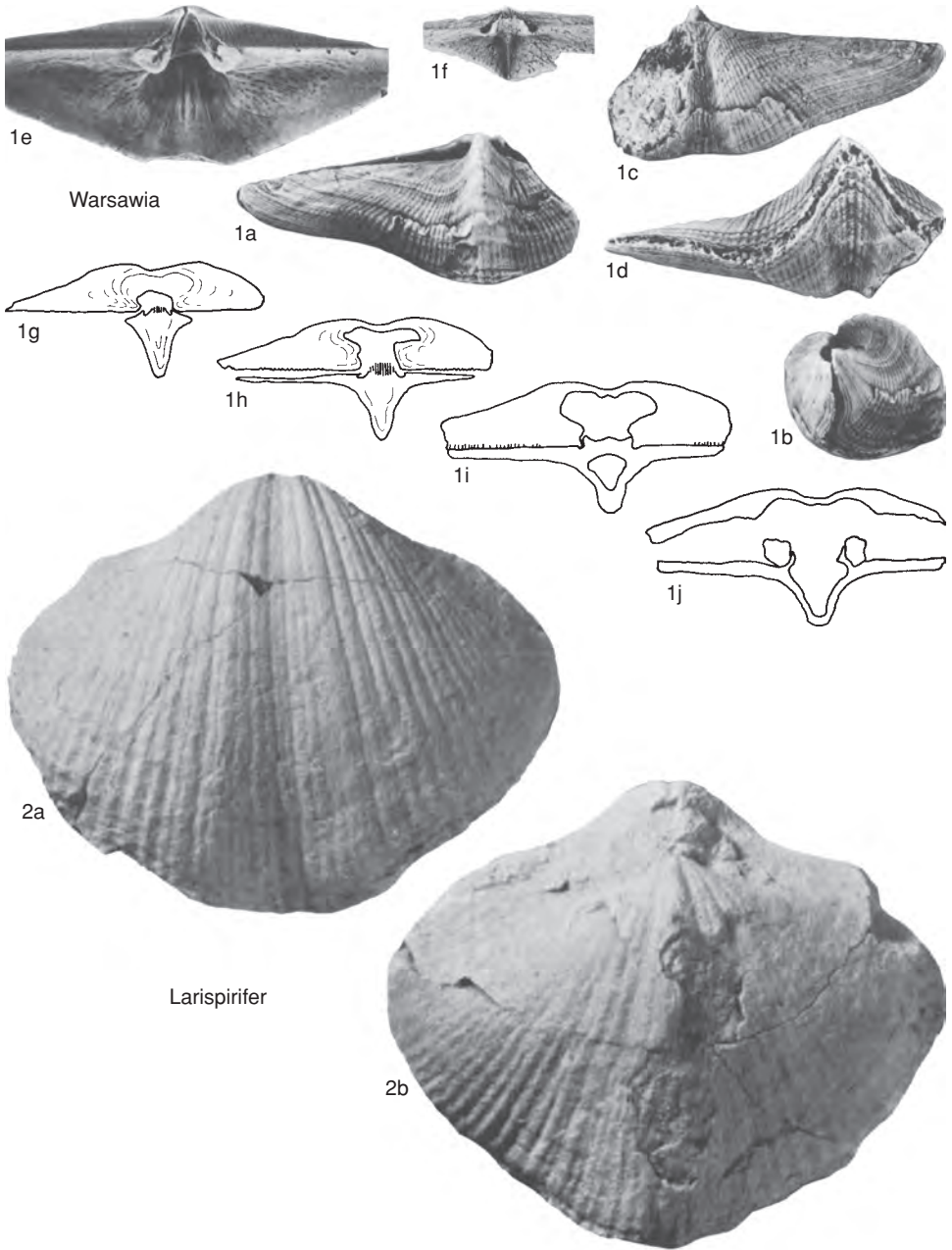


FIG. 1169. Spiriferidae (p. 1771–1775).

numerous fine, simple, bifurcating, or rarely trifurcating costae; very weak fasciculation present only in juvenile stages; ventral interior with thickened delthyrial plate; otherwise similar to *Warsawia*. *Permian (Sakmarian–Wordian)*: Western Australia.—

—FIG. 1168, 2a–c. \**L. callytharrensis*, Sterlitimikian; dorsal, ventral, and anterior views, ×1 (Archbold & Thomas, 1985). *Warsawia* CARTER, 1974, p. 684 [\**Spirifer lateralis* HALL, 1858, p. 661; OD]. Small to medium size;

strongly transverse; thick shelled; sulcus shallow and rounded, poorly delimited; fold carinate posteriorly; ventral beak broad and short; numerous fine, simple costae or coarse costellae that rarely bifurcate on lateral slopes and fold-sulcus; ventral interior lacking dental adminicula; cardinal process supported by callus; both valves with thick posterior callus. *Carboniferous (middle Visean)*: North America.—FIG. 1169, 1a–j. \**W. lateralis* (HALL); a–d, dorsal, lateral, ventral, and anterior views; e, ventral interior; f, dorsal interior,  $\times 1.5$ ; g–j, transverse sections,  $\times 1.5$  (Carter, 1974).

### Subfamily PROSPIRINAE Carter, 1974

[Prospirinae CARTER, 1974, p. 680]

Cardinal extremities extended in juveniles; growth form variable in adults; lateral slopes with relatively few, mostly simple costae; median sulcal costa usually simple or may bifurcate once; lateral sulcal costae usually simple, not numerous, derived from sulcus-bounding costae; fold clearly delimited from lateral slopes by bounding interspaces; dental adminicula usually well developed; ventral umbonal callus usually present. *Upper Devonian (upper Famennian)–Carboniferous (Visean, ?Serpukhovian)*.

**Prospira** MAXWELL, 1954, p. 35 [\**P. typa*; OD]. Small to medium size; moderately to strongly transverse in juveniles, often becoming subquadrate or subpentagonal in adults; cardinal extremities moderately to strongly mucronate; fold and sulcus narrow, well defined with variably developed costation; sulcus usually with simple median costa originating well anterior to beak, often with 1 to 3 pairs of simple lateral sulcal costae that originate by bifurcation from sulcus-bounding costae; lateral slopes with moderate number of simple costae; ventral interior with apical callus and short dental adminicula with deeply impressed muscle field. *Carboniferous (Tournaisian)*: cosmopolitan.—FIG. 1170, 1a–b. \**P. typa*, Queensland, Australia; topotype, dorsal and ventral views,  $\times 1$  (Maxwell, 1961).—FIG. 1170, 1c–d. *P. laurelensis* THOMAS, Australia; ventral and dorsal views,  $\times 1$  (Thomas, 1971).

**Andreaspira** ABRAMOV & GRIGOR'VA, 1986, p. 144 [\**A. soanensis*; OD]. Medium size; outline transverse in juveniles, transversely to longitudinally subovate in adults; cardinal extremities angular in juveniles, usually rounded in adults; moderately numerous costae usually simple or with occasional bifurcations on both lateral slopes and fold-sulcus; median sulcal costa simple; short dental adminicula present in early growth stages, often buried in thick umbonal callus in adults; otherwise similar to *Kinghiria*. *Carboniferous (?Visean)*: northeastern Siberia.—FIG. 1170, 2a–d. \**A. soanensis*; holo-

type, ventral, dorsal, anterior, and lateral views,  $\times 1$  (new).

**Austrochoristites** ROBERTS, 1971, p. 230 [\**A. levisulcatus*; OD]. Medium size; outline subtriangular in juveniles, subovate in adults; cardinal extremities extended in juveniles, rounded or subangular in adults; fold and sulcus narrow, moderately well defined posteriorly, poorly to weakly developed anteriorly; fold clearly delimited by deep bounding interspaces; ventral interarea truncated laterally, trapezoidal; lateral slopes with moderately numerous simple or posteriorly bifurcating costae, well defined posteriorly, becoming indistinct anteriorly; floor of sulcus smooth, sides with few simple costae that bifurcate from fold-bounding costae; ventral interior with moderately long, subparallel dental adminicula and much thickened umbonal region; dorsal interior with short crural plates; vascular impressions simple, narrow, linear. *Carboniferous (Tournaisian)*: Western Australia.—FIG. 1170, 4a–d. \**A. levisulcatus*; a, holotype, ventral valve; b, dorsal valve,  $\times 1$ ; c–d, transverse sections,  $\times 2$  (Roberts, 1971).

**Finospirifer** YIN, 1981, p. 240 [\**F. taotangensis*; OD]. Medium size; moderately to strongly transverse; outline subsemicircular to subquadrate; cardinal extremities moderately to strongly mucronate; fold and sulcus well developed; sulcus with disproportionately strong median plication and several pairs of narrow lateral sulcal costae; fold carinate; lateral sloping with moderately numerous simple or rarely bifurcating costae; ventral interior with delthyrial plate; otherwise similar to *Unispirifer*. *Carboniferous (Tournaisian)*: China (Hunan Province).—FIG. 1170, 5a–f. \**F. taotangensis*; a–c, dorsal, anterior, and posterior views; d–f, transverse sections,  $\times 1$  (Yin, 1981).

**Kinghiria** LITVINOVICH, 1966, p. 98 [\**K. prima*; OD]. Medium size; transverse; cardinal extremities extended, subangular to alate in juveniles and adults; fold and sulcus narrow, moderately developed; costae mostly simple, moderately numerous; ventral interior with greatly thickened umbonal region; dental adminicula buried in thick massive callus; vascular impressions weakly developed. *Carboniferous (Visean)*: Kazakhstan.—FIG. 1171, 2a–d. \**K. prima*; holotype, ventral, dorsal, anterior, and lateral views,  $\times 1$  (new).

**Parallelora** CARTER, 1974, p. 680 [\**Spirifer marionensis* SHUMARD, 1855, p. 205; OD] [= *Mariona* NALIVKIN, 1975, p. 185, obj.]. Medium size; outline variable in adults, juveniles strongly transverse; cardinal extremities strongly mucronate in juveniles, less so or nearly rounded in adults; lateral slopes with moderately numerous rounded costae, several of which may bifurcate; median sulcal costa usually simple; other sulcal costae few, rarely bifurcating; hinge line and beak ridges parallel, forming wide, low, rectangular ventral interarea; thick subdelthyrial callus present; otherwise similar to *Prospira*. *Upper Devonian (upper Famennian)–Carboniferous (Tournaisian)*: North America, Russia.

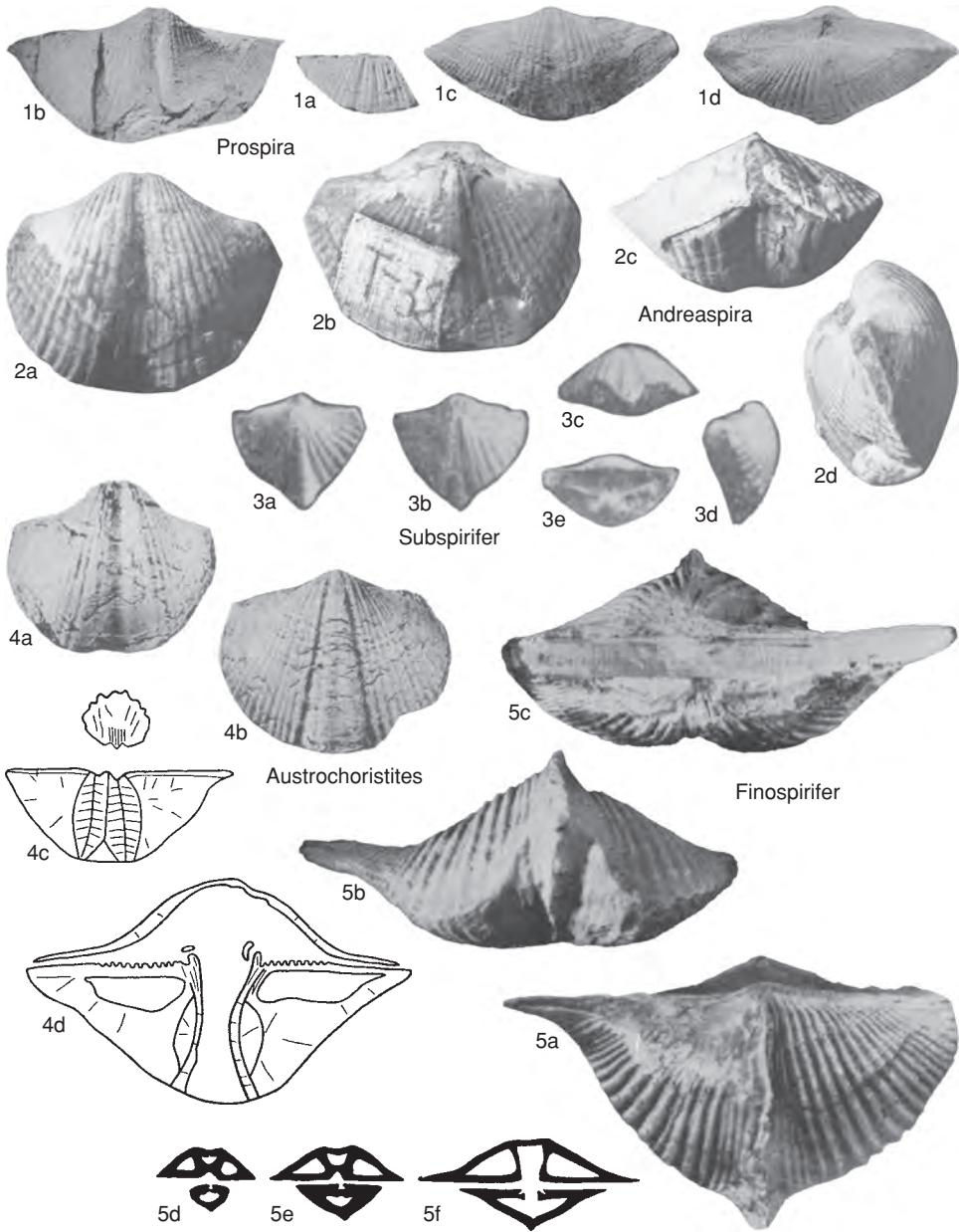


FIG. 1170. Spiriferidae (p. 1775-1777).

—FIG. 1171, 1a-g. \**P. marionensis* (SHUMARD), upper Famennian, Missouri, USA; a-e, ventral, dorsal, lateral, anterior, and posterior views,  $\times 1$ ; f-g, dorsal and ventral interiors,  $\times 1$  (Carter, 1974).  
**Subspirifer** SHAN & ZHAO, 1981, p. 48 [*S. chitzechiaoensis*; OD]. Small; outline transversely subsemicircular to subtrigonal; fold and sulcus nar-

row, well defined; ventral umbonal region weakly inflated, beak small; lateral slopes with few low, rounded costae, separated by narrow interspaces, those bordering fold-sulcus bifurcate, all others simple; sulcus with single distinct large median costa; fold seemingly smooth, carinate anteriorly; ventral interior with short, moderately strong



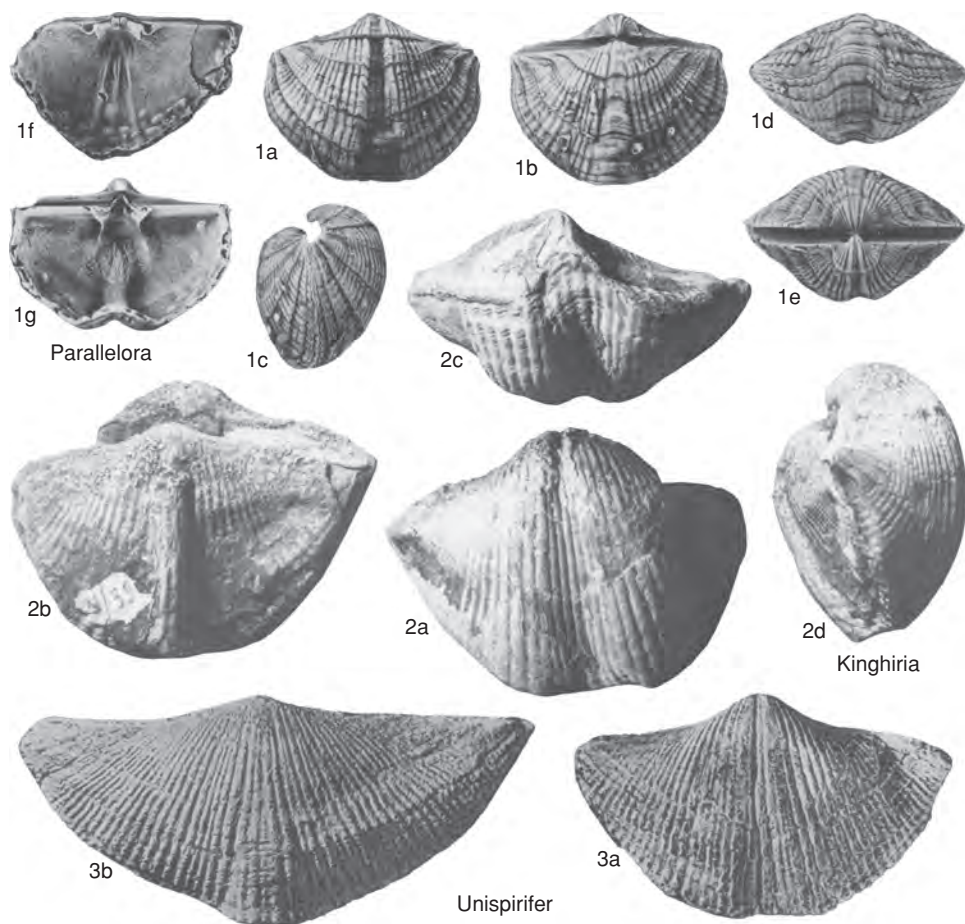


FIG. 1171. Spiriferidae (p. 1775–1777).

dental adminicula; otherwise similar to *Anthracospirifer*. [This genus may be a junior synonym of *Finospirifer* YIN, 1981.] *Carboniferous* (?upper Visean, ?Serpukhovian): China (Hunan).—FIG. 1170, 3a–e. \**S. chitzechiaoensis*, ?lower Namurian; dorsal, ventral, anterior, lateral, and posterior views,  $\times 1$  (Shan & Zhao, 1981).

**Unispirifer** CAMPBELL, 1957, p. 67 [\**Spirifer striatoconvolutus* BENSON & DUN in BENSON, DUN, & BROWNE, 1920, p. 350; OD] [= ?*Lytha* FREDERIKS, 1924, p. 298 (type, *Spiriferella tshernyschewiana* FREDERIKS, 1916, p. 30, OD)]. Medium to large; strongly transverse with alate, not mucronate, cardinal extremities in both juveniles and adults; lateral slopes with numerous simple, or rarely bifurcating, costae; sulcus with median costa that may bifurcate and several pairs of simple, or very rarely bifurcating, lateral sulcal costae; otherwise similar to *Prospira*. [*Lytha* FREDERIKS is poorly known but may prove to be the senior synonym.] *Carboniferous*

(*Tournaisian–Visean*): cosmopolitan.—FIG. 1171, 3a–b. \**U. striatoconvolutus* (BENSON & DUN), Tournaisian, New South Wales, Australia; ventral and dorsal valves,  $\times 1$  (Campbell, 1957).

### Subfamily SERGOSPIRIFERINAE Carter, 1994

[Sergospiriferinae CARTER in CARTER & others, 1994, p. 343]

Cardinal extremities rounded in juveniles; outline variable in adults; lateral slopes with few simple or bifurcating costae; lateral sulcal costae usually simple, derived from bounding costae; fold usually well delimited by bounding interspaces; dental adminicula well developed. *Upper Devonian (Famennian)–Permian*.

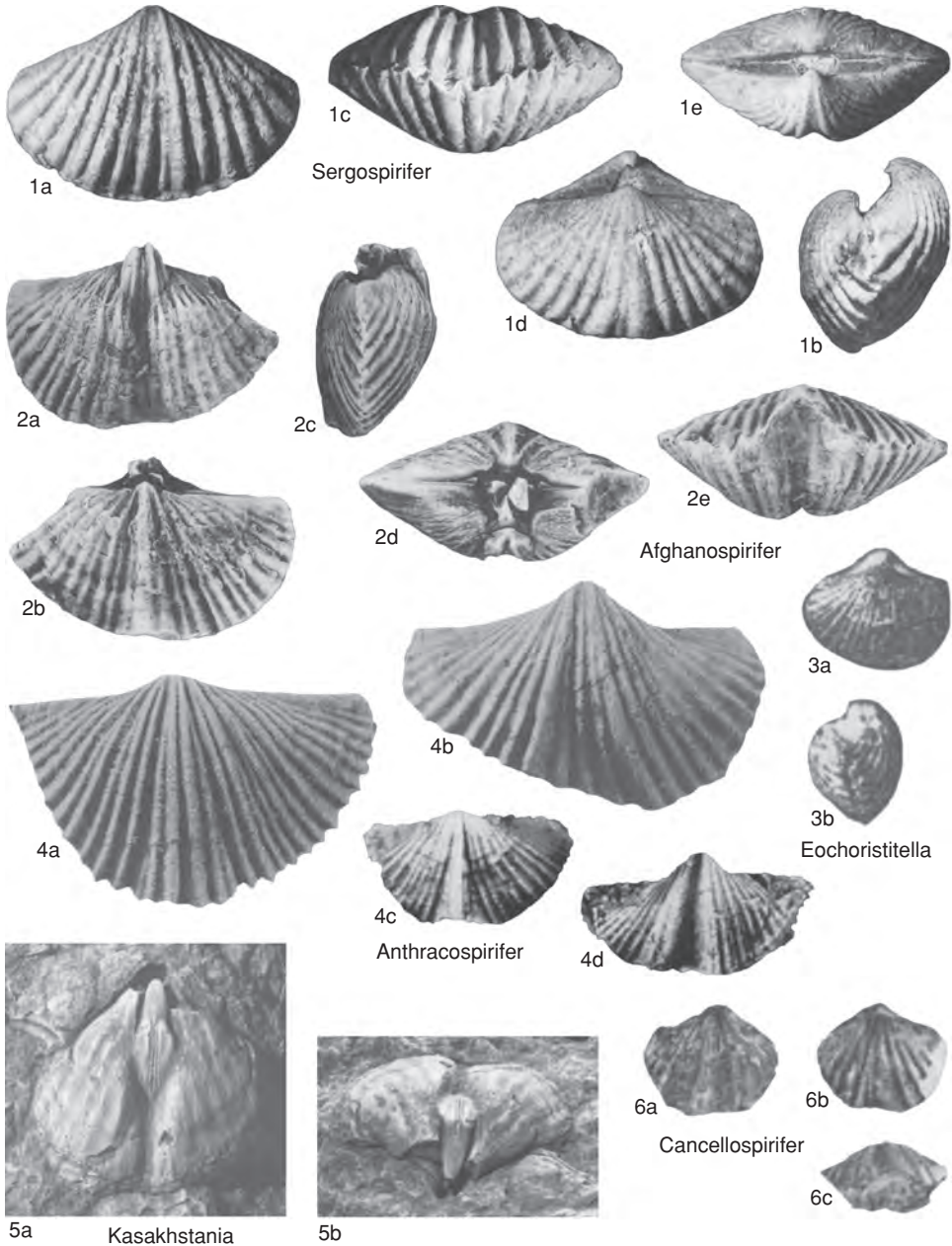


FIG. 1172. Spiriferidae (p. 1778–1779).

**Sergospirifer** IVANOVA, 1952, p. 190 [*Spirifer okensis* NIKITIN, 1890, p. 28; OD]. Small to medium size; fold and sulcus weakly to moderately developed; lateral slopes and fold-sulcus with few, coarse, simple, subangular costae; costae bounding fold and sulcus not bifurcating. *Carboniferous (Visean–Moscovian)*: Russia (Moscow basin), central USA.

—FIG. 1172, 1a–e. \**S. okensis* (NIKITIN), upper Moscovian, Moscow basin; ventral, lateral, anterior, dorsal, and posterior views of two syntypes, x2 (new).

**Afghanospirifer** PLODOWSKI, 1968, p. 255 [*A. burgutschensis*; OD]. Medium size; outline transversely subovate to subquadrate; cardinal extremi-

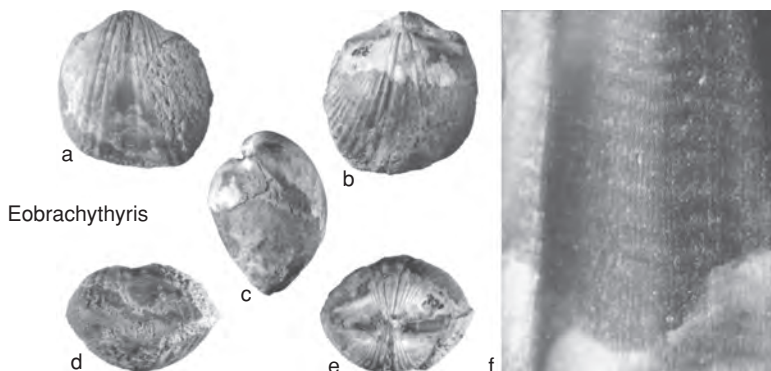


FIG. 1173. Spiriferidae (p. 1779).

ties rounded, maximum width attained slightly anterior to hinge line; fold and sulcus narrow, moderately developed; denticulation of hinge line unknown; lateral slopes with few, low, rounded, simple or bifurcating costae; ventral interior with short protuberant apical callosity and very short dental adminicula; dorsal interior with very short crural plates. *Carboniferous* (*Serpukhovian–lower Bashkirian*): Afghanistan.—FIG. 1172,2a–e. \**A. burgutschensis*; holotype, ventral, dorsal, lateral, posterior, and anterior views,  $\times 1$  (Plodowski, 1970).

**Anthracospirifer** LANE, 1963, p. 387 [\**A. birdspringensis*; OD] [=?*Plicatocyrtia* GAURI, 1965, p. 55 (type, *Spirifer zitteli* SCHELLWIEN, 1892, p. 48)]. Small to medium size; slightly to moderately transverse; outline variable from subovate to subpentagonal; cardinal extremities in adults variable from slightly rounded to slightly mucronate; costae adjacent to fold and sulcus invariably bifurcating; costae on lateral slopes few to moderately numerous, simple or more rarely bifurcating. *Carboniferous* (*Visean–Moscovian*): cosmopolitan.—FIG. 1172,4a–b. \**A. birdspringensis*, Morrowan, Nevada, USA; syntype, dorsal and ventral views,  $\times 2$  (Lane, 1963).—FIG. 1172,4c–d. *A. zitteli* (SCHELLWIEN), Moscovian–Kasimovian, Austria; holotype, dorsal and ventral views,  $\times 1$  (Gauri, 1965).

**Cancellospirifer** CAMPBELL, 1953, p. 10 [\**C. maxwelli*; OD]. Small, slightly transverse, with rounded cardinal extremities; sulcus well delimited by coarse sulcus-bounding costae; lateral slopes with few simple or rarely bifurcating costae; sulcus with 2 or 3 ribs; fold smooth or with several ribs; microornament consisting of fine, slightly imbricate growth lamellae and fine capillae; otherwise similar to *Sergospirifer*. *Permian*: Australia (Queensland).—FIG. 1172,6a–c. \**C. maxwelli*; ventral, dorsal, and anterior views,  $\times 1.1$  (Campbell, 1953).

**Eobrachythyris** BRICE, 1971, p. 182 [\**E. proovalis*; OD]. Medium size; length and width nearly equal; outline subovate to rounded subquadrate; fold and sulcus weakly developed but well differentiated; lateral slopes with few simple costae; sulcus smooth or

with median costa. *Upper Devonian* (*Famennian*): Afghanistan.—FIG. 1173a–f. \**E. proovalis*; a–e, holotype, ventral, dorsal, lateral, anterior, and posterior views,  $\times 1$ ; f, microornament,  $\times 12$  (new).

**Eochoristitella** QI, 1983, p. 405 [\**E. gansuensis*; OD]. Small, transversely subovate to subpentagonal; strongly ventribiconvex; delthyrium higher than wide, with narrow stegidial plates; sulcus shallow, V-shaped; fold indistinct, delineated only by deep, bounding interspaces; lateral slopes with few simple or rarely bifurcating or trifurcating costae with moderately wide interspaces; sulcus with weak, simple median costa and several pairs of lateral costae that may bifurcate; fold with distinct deep median interspace; ventral interior with short, thin, slightly diverging dental adminicula. *Carboniferous* (*lower Tournaisian*): China.—FIG. 1172,3a–b. \**E. gansuensis*; dorsal and lateral views,  $\times 1$  (Qi, 1983).

**Kasakhstania** BEZNOŠOVA, 1968, p. 179 [\**K. mikunovi*; OD]. Small to medium size; outline subovate, nearly equidimensional; cardinal extremities in adults rounded, maximum width near midlength; fold and sulcus moderately developed; lateral slopes with few broad, flattened, simple costae, those near fold and sulcus rarely bifurcating; umbonal region in ventral valve thickened by callus, delthyrial plate absent; otherwise similar to *Sergospirifer*. *Carboniferous* (*Pennsylvanian*): Kazakhstan.—FIG. 1172,5a–b. \**K. mikunovi*; a–b, holotype, ventral and posterior views,  $\times 2$  (new).

### Subfamily PURDONELLINAE Poletae, 1986

[Purdonellinae POLETAEV, 1986, p. 65, *nom. nov. pro* Munellinae FREDERICKS, 1924, p. 313, based on invalid junior homonym]

Outline brachythyridid in all growth stages; hinge line narrow; fold and sulcus moderately to well developed, multicostate, not delineated by discontinuity in ribbing; costae on lateral slopes often flattened,

simple or subfasciculate; ventral interior with delthyrial plate and diverging dental adminicula; vascular impressions indistinct. *Carboniferous* (*Tournaisian*)–*Permian* (*Cisuralian*).

**Purdonella** REED, 1944, p. 218, *nom. nov. pro* *Munella* FREDERIKS, 1924, p. 314, *non* BONNIER, 1896 [\**Spirifer nikitini* CHERNYSHEV, 1902, p. 542; OD]. Medium to large; outline subcircular to subovate; ventral umbonal region moderately narrow, moderately inflated; hinge line narrow, not exceeding half of maximum width; fold and sulcus weakly developed, poorly delimited from lateral slopes; entire surface multicostate with numerous, low, flattened, simple or bifurcating costae; ventral interior with short, very thin, subparallel dental adminicula and distinct delthyrial plate; shell substance relatively thin with weak development of prismatic secondary layer in umbonal region. *Carboniferous* (*Moscovian*)–*Permian* (*Cisuralian*): southern Urals, Arctic Russia.—FIG. 1174,3a–d. \**P. nikitini* (CHERNYSHEV), *Cisuralian*, southern Urals; ventral, dorsal, posterior, and lateral views, ×1 (new).

**Ala** NALIVKIN, 1979, p. 135 [\**A. tau*; OD]. Large, transverse; cardinal extremities rounded in all growth stages; fold and sulcus strongly developed, spreading anteriorly; multicostate with several primary umbonal costae trifurcating to form weak fasciculations on lateral slopes, and numerous freely bifurcating costae on fold-sulcus. *Carboniferous* (*Tournaisian*): Ural Mountains, Russia.—FIG. 1174,2a–c. \**A. tau*; holotype, ventral, dorsal, and anterior views, ×1 (new).

**Domokhotia** ABRAMOV & GRIGOR'eva, 1983, p. 130 [\**D. laticosta*; OD]. Fold and sulcus moderately developed; lateral slopes with few, broad, flattened simple, or rarely bifurcating, costae; costae in sulcus often narrower than those on lateral slopes; otherwise similar to *Purdonella*. *Carboniferous* (*Pennsylvanian*): Verkhoian'ia, Siberia.—FIG. 1175,1a–d. \**D. laticosta*, ?Bashkirian, Verkhoian'ia; ventral, dorsal, anterior, and lateral views, ×1 (new).

**Eliva** FREDERIKS, 1924, p. 319 [\**Spirifer lyra* KUTORGA, 1844, p. 92; OD]. Small for subfamily; longitudinally guttate in outline; otherwise similar to *Purdonella*. *Permian* (*Cisuralian*): Russia, USA (Texas).—FIG. 1175,2a–d. \**E. lyra* (KUTORGA), southern Urals; syntype, dorsal, anterior, lateral, and ventral views, ×1 (Chernyshev, 1902).—FIG. 1175,2e–f. *E. shumardi* COOPER & GRANT; dorsal and ventral interiors, ×2 (Cooper & Grant, 1976a).

**Mirifusella** CARTER, 1971, p. 250 [\**M. fortunata*; OD]. Medium size; adults usually longer than wide; outline longitudinally subovate; hinge line less than maximum width; cardinal extremities rounded to subangular; ventral umbonal region elongated and inflated; fold and sulcus weakly to poorly developed; ornament of few simple, rounded costae on lateral slopes; sulcus with median costa that may bifurcate; other sulcal costae, if present, bifurcate from sulcus-bounding costae; capillae forming faintly reticulate pattern with fine growth lines;

ventral interior with short delthyrial plate and moderately to widely divergent dental adminicula; umbonal region thickened in adults. *Carboniferous* (*middle Tournaisian*): central United States.—FIG. 1175,3a–g. \**M. fortunata*, Kinderhookian, Iowa, USA; a–c, ventral, lateral, and anterior views of ventral valve; d–e, lateral and dorsal views of dorsal valve, ×1.5; f–g, ventral and dorsal interiors, ×2 (Carter, 1971).

**Neomunella** OZAKI, 1931, p. 24 [\**Spirifer* (*N.*) *chaoi* OZAKI, 1931, p. 68; OD]. Medium size; with thick prismatic secondary layer; hinge line always exceeding half of maximum width; fold and sulcus moderately well developed; ventral interior with strong, divergent dental adminicula; otherwise similar to *Purdonella*. *Carboniferous* (*Pennsylvanian*)–*Permian* (*Cisuralian*): northern China, northern Urals, Yukon.—FIG. 1174,1a–c. \**N. chaoi* (OZAKI), *Pennsylvanian*, northern China; ventral, dorsal, and posterior views, ×1 (Ozaki, 1931).

**Podtsheremia** KALASHNIKOV, 1966, p. 50 [\**P. prima*; OD]. Medium size, slightly transverse; outline subovate to subrhomboidal; fold and sulcus moderately developed posteriorly, fold becoming very strong and rising sharply anteriorly in adults; cardinal extremities well rounded in early stages, becoming subangular in adults; hinge line equal to or less than maximum width in adults; entire surface multicostate; costae numerous, simple or bifurcating, rarely trifurcating; ventral interior with slightly convergent dental flanges, long slender diverging dental adminicula, and strong delthyrial plate; shell substance thin. *Carboniferous* (*Visean*): middle and northern Urals, Moscow basin, central Kazakhstan, England, French Pyrenees.—FIG. 1175,4a–g. \**P. prima*; a–b, holotype, ventral and dorsal views, ×1 (Kalashnikov, 1966); c–g, transverse sections, ×2.25 (Kalashnikov, 1974).

## Family CHORISTITIDAE Waterhouse, 1968

[*nom. transl. et correct.* IVANOVA, 1972, p. 40, *ex* Choristitidinae WATERHOUSE, 1968, p. 9]

Cardinal extremities rounded in juveniles, variable in large adults; denticulation usually well developed; numerous simple or bifurcating costae usually present on entire surface; microornament capillate; delthyrial plate absent; distinctive vascular impressions commonly present, especially in younger genera. *Carboniferous* (*Mississippian*)–*Permian*.

## Subfamily ANGIOSPIRIFERINAE Legrand-Blain, 1985

[*Angiospiriferinae* LEGRAND-BLAIN, 1985, p. 574]

Dental adminicula short and close set or absent; vascular impressions ramiform or

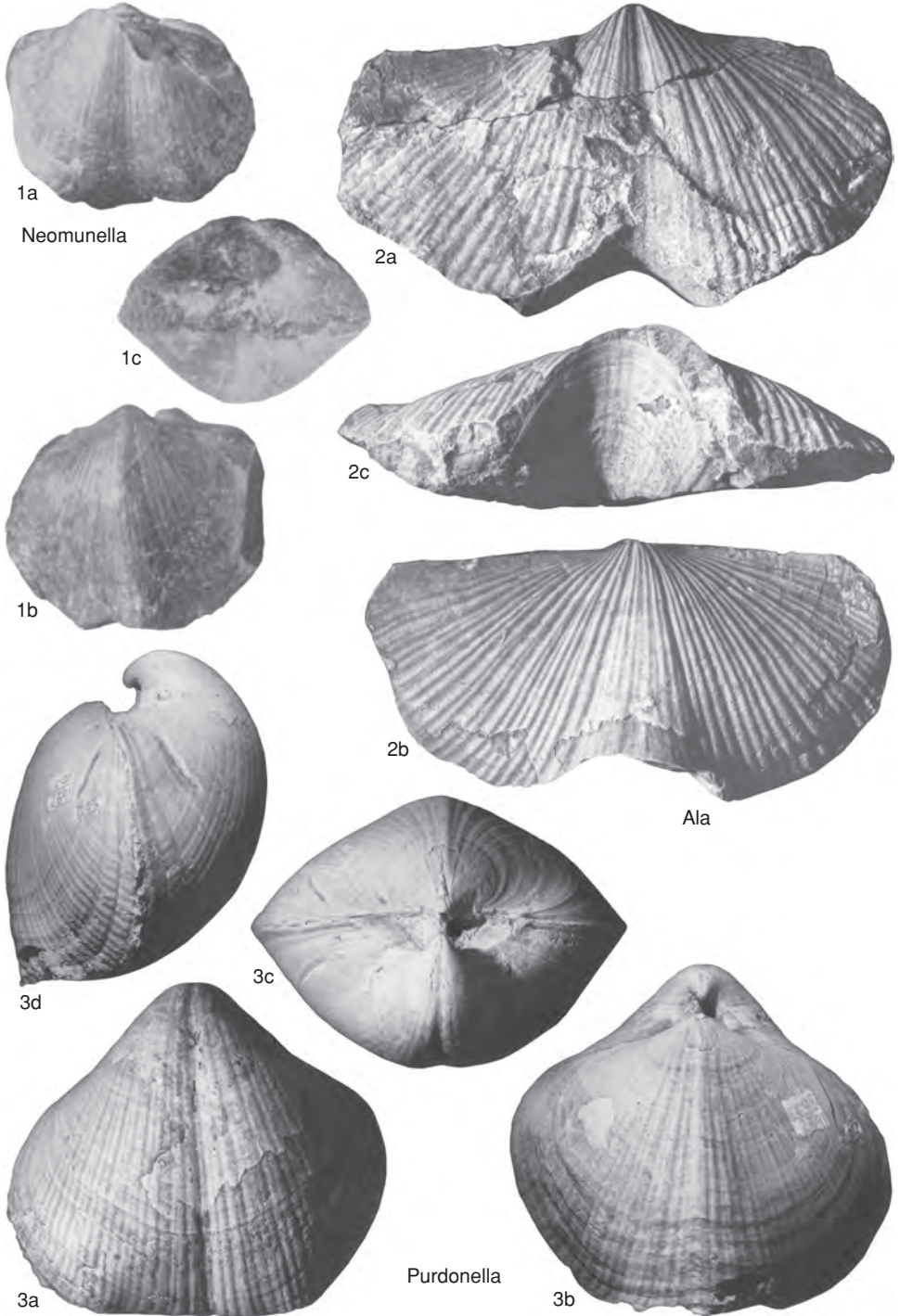


FIG. 1174. Spiriferidae (p. 1780).

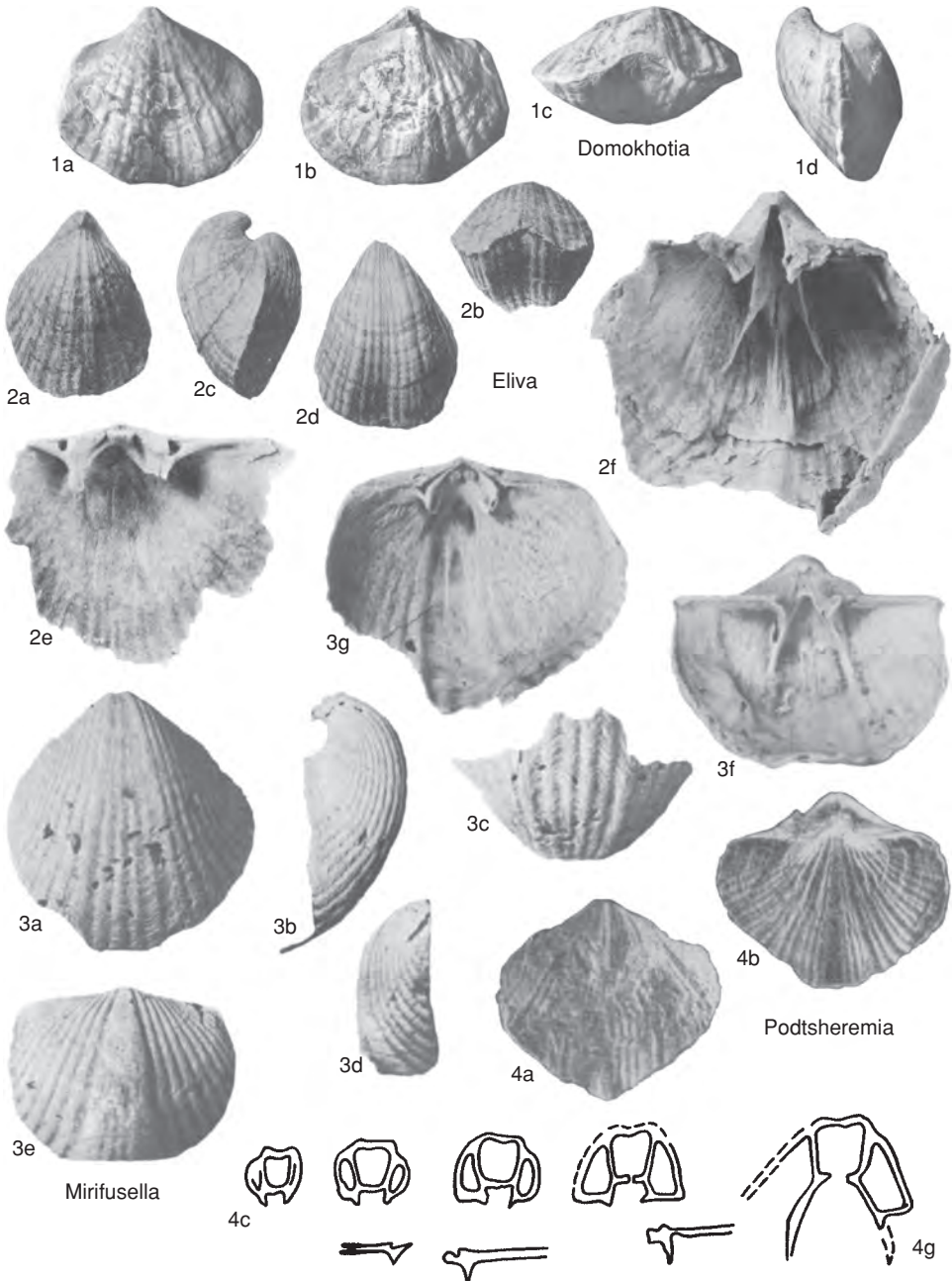


FIG. 1175. Spiriferidae (p. 1780).

weakly to moderately reticulate; micro-ornament finely cancellate, formed by weak capillae and fine, slightly lamellose growth lines. *Carboniferous (Mississippian)–Permian.*

**Angiospirifer** LEGRAND-BLAIN, 1985, p. 567 [*Spirifer trigonalis* MARTIN, 1809, pl. 36; OD]. Medium size; outline transversely subtrigonal to subquadrate; cardinal extremities well rounded in juveniles, becoming angular to alate in adults; ventral umbonal

- region broad, moderately inflated; fold and sulcus moderately developed, fold well delineated anteriorly; lateral slopes with few simple or rarely bifurcating rounded costae separated by moderately broad, rounded interspaces; sulcus with anteriorly prominent, simple median costa and 1 to 3 pairs of simple or rarely bifurcating lateral costae; ribs bifurcating immediately adjacent to fold-sulcus; microornament of very weak capillae and slightly lamellose growth lines forming faint, radially arranged, weakly granulose texture; ventral interior with short, close set, intrasulcal dental adminicula and thick, elongate internally and externally convex delthyrial callus; vascular markings crudely reticulate. *Carboniferous (Visean-lower Bashkirian)*: Europe, northern Africa, Russia.—FIG. 1176,2a–e. \**A. trigonalis* (MARTIN), upper Visean, Great Britain; a–c, neotype, dorsal, lateral, and anterior views,  $\times 1$  (Dunlop, 1962); d, vascular markings on ventral valve,  $\times 2.3$  (Legrand-Blain, 1985); e, transverse section,  $\times 15$  (Dunlop, 1962).
- Anthracothyryna** LEGRAND-BLAIN, 1984, p. 308 [\**Brachythyryna* (*A.*) *perextensa*; OD]. Vascular impressions reticulate; otherwise similar to *Brachythyryna*. *Carboniferous (upper Serpukhovian-Bashkirian)*: central Pyrenees.—FIG. 1176,3a–b. \**A. perextensa* (LEGRAND-BLAIN); a, holotype, ventral valve,  $\times 1$ ; b, ventral interior,  $\times 2.5$  (Legrand-Blain, 1984).
- Brachythyryna** FREDERIKS, 1929, p. 385, *nom. nov. pro* *Anelasma* IVANOV, 1925, p. 109, *non* DARWIN, 1851, *nec* SOERENSEN, 1873, *nec* COSSMANN, 1889 [\**Spirifer strangwaysi* DE VERNEUIL, 1845, p. 164; OD] [= *Anelasma* SEMIKHATOVA, 1939, p. 324, obj.]. Small to medium size; outline usually transverse; cardinal extremities well rounded in juveniles, becoming angular to alate or mucronate in adults; fold and sulcus moderately narrow, well delineated; lateral slopes with moderately numerous, flattened, simple costae, bifurcations rare; interspaces moderately narrow, subangular; sulcus usually with about 5 simple costae, median rib very rarely bifurcating; ribs adjacent to fold-sulcus bifurcating in umbonal region of both valves; microornament finely and regularly cancellate; dental adminicula absent; vascular impressions ramiform. *Carboniferous (Mississippian)-Permian*: Europe, Asia.—FIG. 1177,3a–c. \**B. strangwaysi* (DE VERNEUIL), Pennsylvanian, Moscow basin; ventral, dorsal, and posterior views,  $\times 1$  (Sarycheva & Sokolskaya, 1952).
- Elinoria** COOPER & MUIR-WOOD, 1951, p. 195, *nom. nov. pro* *Elinia* FREDERIKS, 1924, p. 321, *non* BLANCHARD, 1852, *nec* FERRARI, 1878 [\**Spirifer rectangulus* KUTORGA, 1844, p. 90; OD]. Medium to large; transverse; cardinal extremities rounded in juveniles, becoming subangular to mucronate in adults; ribs on lateral slopes coarse, rounded, simple, bifurcating, or more rarely, trifurcating; valves greatly thickened posteriorly by callus; otherwise similar to *Brachythyryna*. *Carboniferous (Moscovian)-Permian (Cisuralian)*: Eurasia and Canadian Arctic Islands.—FIG. 1176,1a–d. \**E. rectangula* (KUTORGA), Cisuralian, Urals; holotype, dorsal, lateral, ventral, and anterior views,  $\times 1$  (Chernyshev, 1902).
- Eobrachythyryna** LAZAREV & POLETAEV, 1982, p. 92 [\**Spirifer varians* ROTAI, 1931, p. 79; OD]. Medium to large; growth form transverse with rounded cardinal extremities in juveniles, becoming elongated in adults with truncated cardinal extremities; lateral slopes with moderately numerous coarse simple or bifurcating ribs; fold and sulcus moderately well developed and delineated; microornament of fine, regularly spaced growth lines and faint capillae; vascular impressions absent in adults, ramiform in juveniles; dental adminicula absent; ventral muscle scars deeply impressed. *Carboniferous (upper Serpukhovian)*: Ukraine (Donets basin).—FIG. 1177,1a–e. \**E. varians* (ROTAI); a–b, syntype, ventral and dorsal views; c–d, syntype, ventral and interior views; e, large ventral valve,  $\times 1$  (new).
- Prochoristitella** LEGRAND-BLAIN, 1969, p. 220 [\**P. afghanensis*; OD]. Lateral slopes with moderately numerous, simple costae with moderately narrow interspaces; sulcal costae simple, distinctly finer than those on lateral slopes; ventral interior with short, close-set dental adminicula largely buried in callus; vascular impressions weakly reticulate; dorsal valve unknown; otherwise similar to *Angiospirifer*. *Carboniferous (?upper Visean-?lower Bashkirian)*: Afghanistan.—FIG. 1177,2a–b. \**P. afghanensis*; ventral valve, ventral interior,  $\times 1$  (Legrand-Blain, 1969).
- Quizhouspirifer** XIAN Si-yuan, 1979, p. 116, *non* *Quizhouspirifer* XIAN Si-yuan, 1983b, p. 69 (type, *Q. ziyunensis*, OD) [\**Spirifer rectangulus triplicata* MANSUY, 1913, p. 67; OD]. Medium size; transverse; sulcus with 1 to 5, usually 2 or 3, very strong angular plicae, occasionally with 1 or 2 pairs of weak additional costae or costellae on sides of sulcus; microornament seemingly absent; dental flanges high; vascular impressions unknown; otherwise similar to *Brachythyryna*. *Carboniferous (Bashkirian), ?lower Permian*: Vietnam, China.—FIG. 1176,4a–g. \**Q. triplicata* (MANSUY), Vietnam, ?lower Permian; a–d, dorsal, ventral, posterior, and anterior views,  $\times 1$  (Mansuy, 1913); e–g, transverse sections,  $\times 1.25$  (Xian, 1979).

### Subfamily CHORISTITINAE Waterhouse, 1968

[*nom. correct.* CARTER, *hercin. pro* Choristitidinae WATERHOUSE, 1968, p. 9]

Dental adminicula close set, subparallel; dorsal adminicula absent; vascular impressions reticulate. *Carboniferous (?Mississippian, Pennsylvanian)-Permian (Cisuralian)*.

**Choristites** FISCHER DE WALDHEIM, 1825, p. 7 [\**C. mosquensis*; SD BUCKMAN, 1908, p. 30] [= *Yatsengina* SEMIKHATOVA, 1936, p. 216 (type, *Y. plana*); *Betachoristites* GATINAUD, 1949, p. 492 (type, *Choristites kschemyschensis* SEMIKHATOVA, 1941,

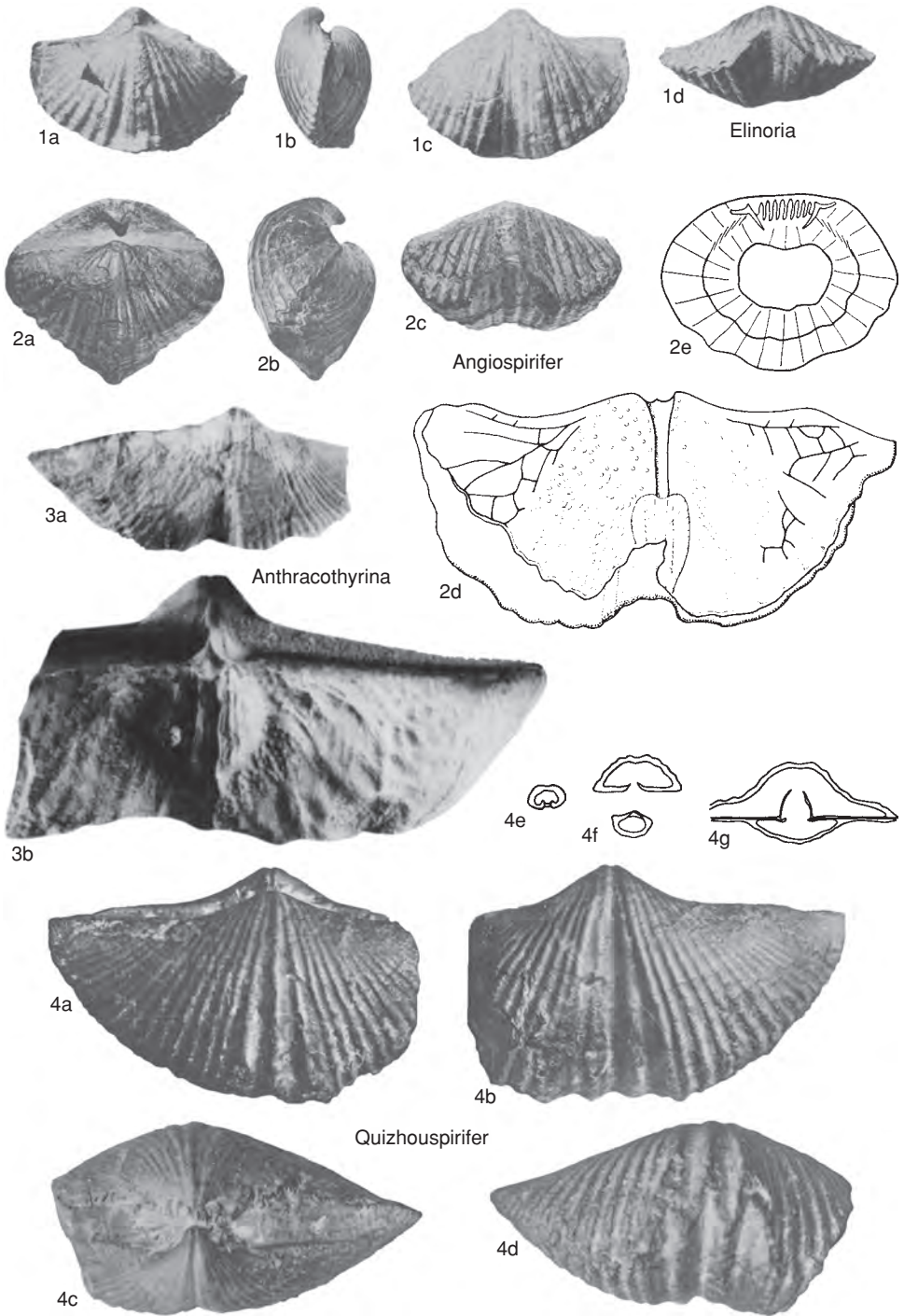


FIG. 1176. Choristitidae (p. 1782–1783).



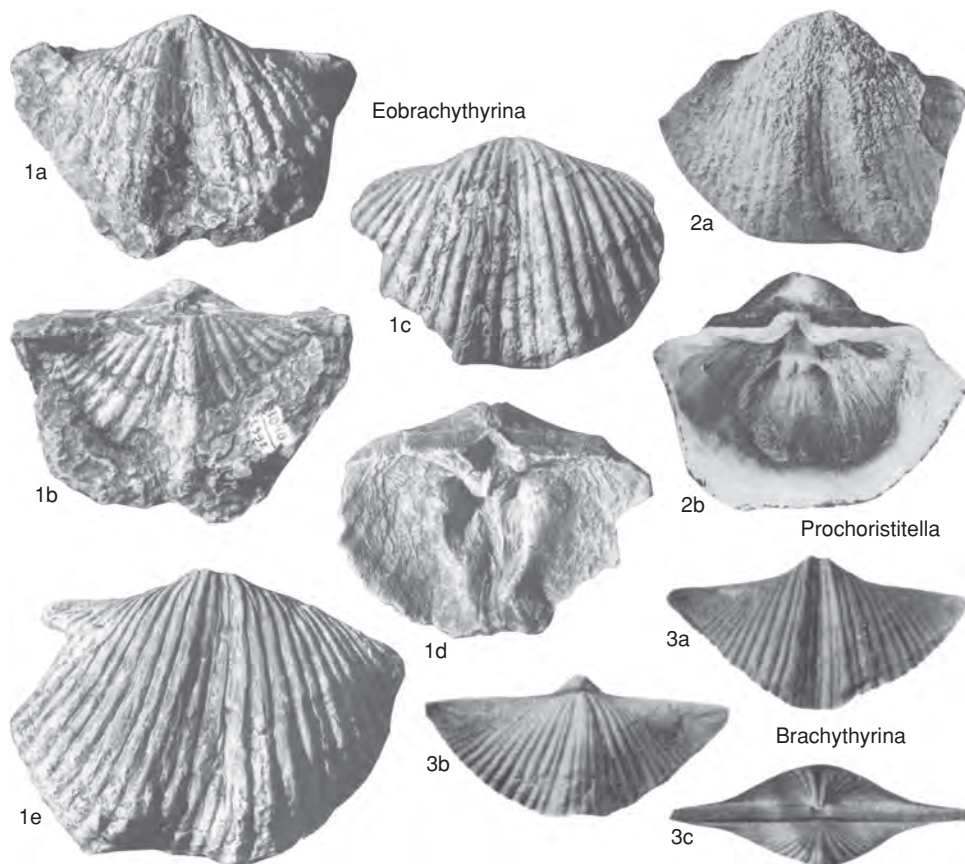


FIG. 1177. Chorititidae (p. 1783).

p. 80); *Jatsengina* IVANOVA, 1960, p. 270, *nom. null.*]. Medium to large; outline longitudinally to transversely subovate, often nearly equidimensional; ventral valve strongly inflated; umbonal region strongly incurved; cardinal extremities abruptly truncated laterally, interarea trapezoidal; hinge line usually less than maximum width; entire surface with numerous flattened, simple or bifurcating costae with narrow interspaces; microornament capillate; fold and sulcus well developed, spreading anteriorly, incorporating additional costae; ventral interior with long, slender, nearly parallel dental adminicula; adductors enclosed within adminicula; adminicula surrounded by small, rounded area of impressed pits, function unknown. *Carboniferous* (?Mississippian, Pennsylvanian), Permian (?Cisuralian): Eurasia.—FIG. 1178, 1a–c. \**C. mosquensis*, Moscovian, Moscow basin; ventral and dorsal valves, ventral interior,  $\times 1$  (Ivanov & Ivanova, 1937).

**Alphachoristites** GATINAUD, 1949, p. 492 [\**Choristites bisulcatiformis* SEMIKHATOVA, 1934b, p. 84; OD] [= *Trautscholdia* USTRITSKII, 1967, p. 37 (type,

*Spirifer trautscholdi* STUCKENBERG, 1905, p. 47, OD), *non* COX & ARKELL, 1948]. Large; fold and sulcus well developed, rounded; costae coarse, bifurcating, well rounded, with moderately broad interspaces; otherwise similar to *Choristites*. *Carboniferous* (Pennsylvanian): Russia.—FIG. 1179, 2a. \**A. bisulcatiformis* (SEMIKHATOVA), holotype; ventral valve,  $\times 1$  (Semikhatova, 1941).—FIG. 1179, 2b–d. *A. trautscholdi* (STUCKENBERG), holotype; ventral, dorsal, and lateral views,  $\times 1$  (Likharev, 1939a).

**Choristitella** IVANOV & IVANOVA, 1937, p. 163 [\**Choristites podolskensis* IVANOV & IVANOVA, 1937, p. 170; OD]. Cardinal extremities rounded, ventral interarea triangular; umbonal region narrow, slightly elongated; ventral interior with short, close-set, subparallel dental adminicula that do not reach muscle field; otherwise similar to *Choristites*. *Carboniferous* (Pennsylvanian): Russia.—FIG. 1178, 2a–f. \**C. podolskensis* (IVANOV & IVANOVA), Moscow basin; a–b, holotype, ventral and dorsal views,  $\times 1$ ; c–f, paratype, ventral, dorsal, posterior, and lateral views,  $\times 2$  (new).

**Parachoristites** BARKHATOVA, 1968, p. 164 [\**P. volongaensis*; OD]. Small to large; outline variable, often transversely subtrapezoidal or subovate; both valves moderately to strongly inflated; fold and sulcus moderately well developed, often spreading anteriorly and incorporating additional costae; cardinal extremities may be short or slightly mucronate in later growth stages; entire surface multicostate; costae on lateral slopes moderately numerous, flattened, simple or bifurcating with narrow interspaces; those on fold and sulcus similar but slightly finer and less likely to bifurcate; ventral interior with long, diverging dental adminicula that posteriorly enclose wide, impressed, ovate muscle field; dorsal interior with short crural plates; vascular impressions reticulate in at least some species. *Carboniferous (Bashkirian)–Permian (Cisuralian)*: Timan, Russia.—FIG. 1179, 1a–e. \**P. volongaensis*, Bashkirian, Timan; a–d, holotype, ventral, dorsal, anterior, and lateral views; e, ventral interior,  $\times 1$  (new).

**Settedabanina** ABRAMOV, 1970, p. 148 [\**S. stepanovi*; OD]. Medium size; strongly inflated, subequally biconvex; outline subovate to transversely subtrigonal; cardinal extremities rounded, hinge line much less than maximum width; fold and sulcus weakly to moderately developed, poorly delineated; entire surface multicostate; costae numerous, simple or bifurcating, flattened, with narrow interspaces; ventral interior with short, parallel, closely set dental adminicula; chordate ventral muscle field enclosed laterally by distinctive high ridges that converge anteriorly as thick median ridge; no indication of vascular impressions. *Carboniferous (Pennsylvanian)*: Siberia.—FIG. 1178, 3a–c. \**S. stepanovi*; a, holotype, internal mold; b–c, dorsal and ventral valves,  $\times 1$  (Abramov, 1970).

### Subfamily TANGSHANELLINEAE Carter, 1994

[Tangshanellinae CARTER in CARTER & others, 1994, p. 345]

Outline subovate with rounded cardinal extremities; dental and dorsal adminicula absent; vascular impressions poorly developed or unknown. *Carboniferous (Pennsylvanian)–Permian*.

**Tangshanella** CHAO, 1929, p. 57 [\**T. kaipingensis*; OD]. Medium size; greatest width near midlength; fold and sulcus moderately well developed; sulcus spreading anteriorly and with distinctive V-shaped profile; ventral interarea acutely triangular; entire surface multicostate; lateral slopes with few to moderately numerous bifurcations; vascular impressions unknown; externally similar to *Choristites*. *Carboniferous (Pennsylvanian)*: China.—FIG. 1180a–e. \**T. kaipingensis*; syntype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$  (new).

**Alphaneospirifer** GATINAUD, 1949, p. 491 [\**Spirifer mahaensis* HUANG, 1933, p. 41; OD] [= *Semibrachy-*

*thyrina* YANG & CHANG in YANG & others, 1962, p. 104 (type, *S. fasciculata*, OD, = *S. mahaensis* HUANG, 1933, p. 41)]. Ribs fine, numerous, with narrow interspaces, bifurcating freely, sometimes forming weak fasciculations posteriorly; fold and sulcus weakly to moderately well developed, broadly flaring anteriorly; otherwise similar to *Tangshanella*. [*Semibrachythyrina* and its type species are both junior subjective synonyms of *Alphaneospirifer* and its type species.] *Permian*: China.—FIG. 1181, 2a–d. \**A. mahaensis* (HUANG); syntype, dorsal, ventral, lateral, and posterior views,  $\times 1$  (Huang, 1933).

**Capillispirifer** ZHANG F. M. in ZHANG Chuan & others, 1983, p. 357 [\**C. xinjiangensis*; OD]. Small, transversely subovate, unequally biconvex; hinge line slightly shorter than maximum width; fold and sulcus well developed and well delineated; lateral slopes with few, mostly simple costae separated by moderately wide interspaces; sulcus with simple median costa and 1 or 2 pairs of lateral sulcal costae that bifurcate from sulcus-bounding costae; microornament densely capillate, forming cancellate pattern with fine growth lines. *Carboniferous (Pennsylvanian)*: China.—FIG. 1181, 1a–e. \**C. xinjiangensis*; holotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 2$  (new).

**Zhejiangospirifer** LIANG, 1982, p. 243 [\**Z. depressus*; OD]. Small to medium sized; fold and sulcus variably developed, moderately wide, slightly flaring anteriorly; ornament consisting of few strong, rounded costae, with numerous bifurcations, rare trifurcations; interspaces wide; otherwise similar to *Alphaneospirifer*. *Carboniferous (?Gzhelian), Permian (Cisuralian–Lopingian)*: Asia.—FIG. 1181, 3a–i. \**Z. depressus*, Cisuralian, China; a–e, holotype, ventral, lateral, dorsal, anterior, and posterior views; f–i, transverse sections,  $\times 2$  (Liang, 1990).

### Family IMBREXIIDAE Carter, 1992

[Imbrexiidae CARTER, 1992, p. 327]

Outline transversely subquadrate; maximum width at hinge line or midlength; fold and sulcus well developed, often medially subangular, flaring anteriorly in some genera; ventral interior with short to moderately long dental adminicula and short delthyrial plate; ornament of moderately numerous simple or bifurcating costae on both flanks and fold-sulcus; microornament of weak capillae and regularly imbricate growth lamellae. *Carboniferous (?middle Tournaisian, upper Tournaisian–Visean)*.

**Imbrexia** NALIVKIN, 1937, p. 105 [\**Spirifer imbrex* HALL, 1858, p. 601; OD]. Medium to large; transversely subquadrate in outline with slightly mucronate to subangular cardinal extremities in adults; juveniles mucronate; maximum width variably

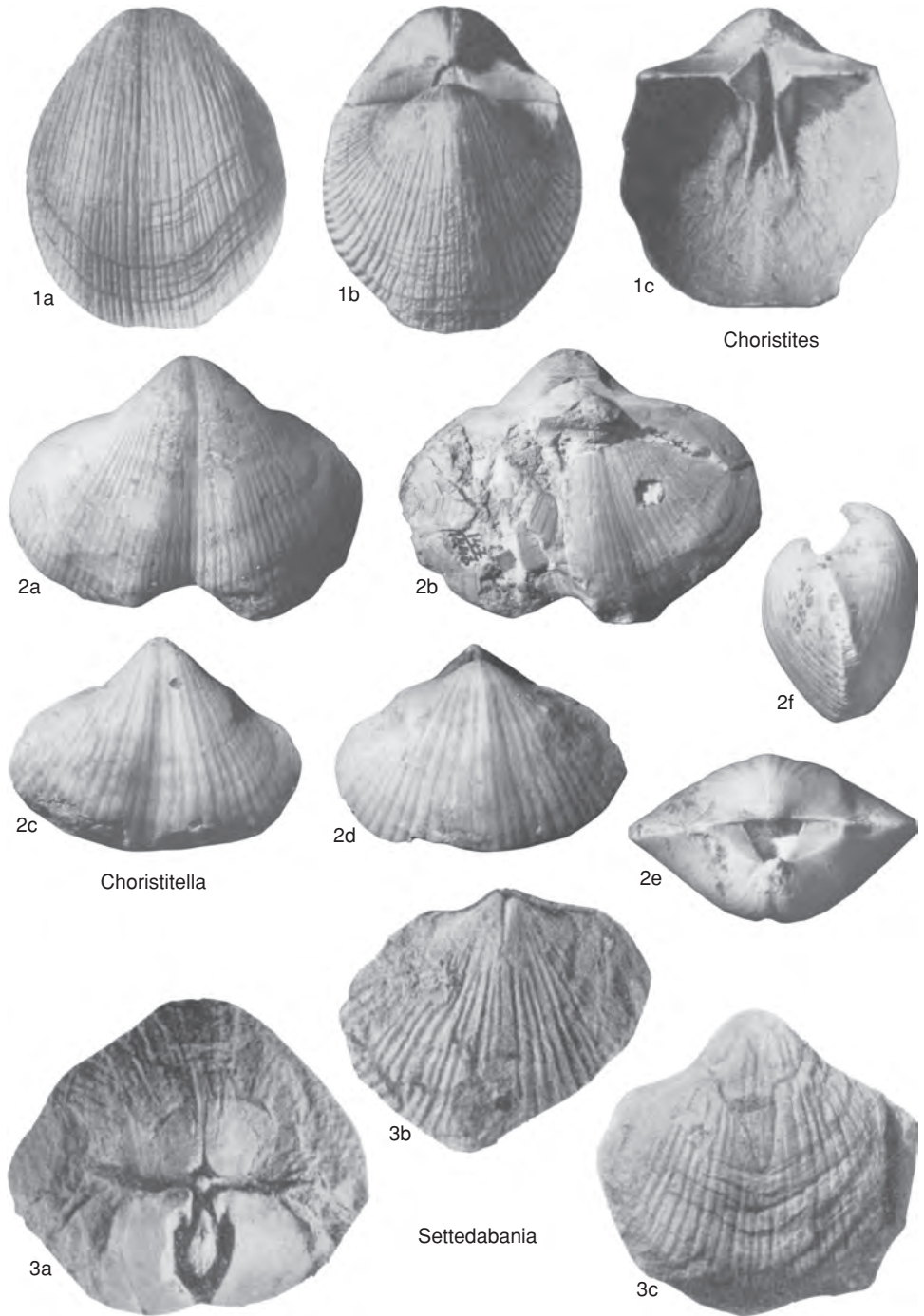


FIG. 1178. Choristitidae (p. 1783–1786).

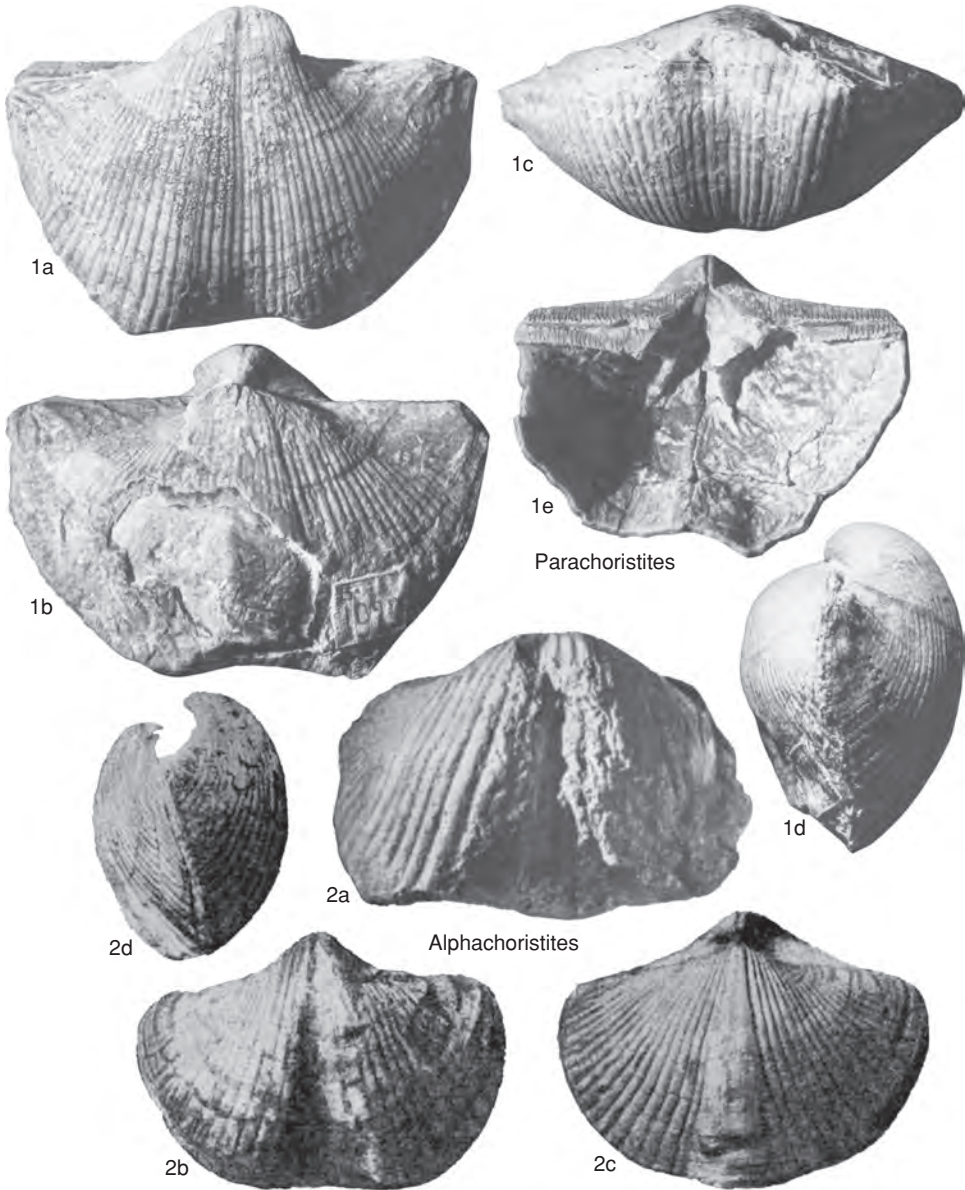


FIG. 1179. Choristitidae (p. 1785–1786).

attained, often at hinge line; fold low, subangular to weakly carinate, flaring anteriorly and incorporating additional costae from flanks; sulcus V-shaped, moderately deep, flaring anteriorly, with simple or bifurcate median costa; other sulcal costae simple or bifurcating; lateral slopes of ventral valve convex, those of dorsal valve compressed and concave near lateral extremities; lateral slopes with numerous bi-

nary lateral costae, most formed by bifurcation in umbonal region; microornament consisting of weak capillae and imbricate growth lamellae; ventral valve interior with short, divergent dental adminicula and short delthyrial plate. *Carboniferous (upper Tournaisian–Visean)*: North America, Russia.—FIG. 1182a–b. \**I. imbrex* (HALL); a–e, ventral, dorsal, lateral, anterior, and posterior views; f,

holotype, oblique posterior view of dorsal valve,  $\times 1$ ; *g-h*, transverse sections,  $\times 1.5$  (Carter, 1974).

**Fernglenia** CARTER, 1992, p. 329 [\**Spirifer vernonensis* SWALLOW, 1860, p. 644; OD]. Medium size; outline transversely subquadrate to subelliptical; cardinal extremities mucronate in juveniles, truncated or slightly mucronate in adults, rarely alate; maximum width at hinge line or near midlength; both valves well inflated, profile robust; fold and sulcus well defined, usually with 7 or more costae and simple median costa; lateral slopes with moderately numerous, mostly simple, strong costae; first lateral costa bounding fold invariably bifurcates in umbonal region; dental adminicula long for family. *Carboniferous* (?middle Tournaisian, upper Tournaisian): North America.—FIG. 1183*a-t*. \**F. vernonensis* (SWALLOW), upper Tournaisian, Missouri, USA; *a-e*, topotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$ ; *f*, microornament,  $\times 4$  (new); *g-t*, transverse sections,  $\times 1.5$  (Carter, 1992).

**Teguloocrea** CARTER, 1992, p. 331 [\**Spirifer incertus* HALL, 1858, p. 602; OD]. Slightly smaller than average for family; outline subquadrate to subsemicircular; lateral profile lenticular, only moderately inflated; cardinal extremities subangular to slightly mucronate in adults; maximum width at or near hinge line; fold and sulcus moderately developed, width variable, flaring anteriorly in large adults; sulcus with rounded shoulders; fold well defined anteriorly, occasionally subcarinate; ornament of numerous simple, bifurcating, or more rarely trifurcating costae; costae in sulcus moderately numerous, median costa simple; first lateral costae bounding fold invariably bifurcate in umbonal region; dental adminicula short or rudimentary. *Carboniferous* (upper Tournaisian): North America, Russia.—FIG. 1184*a-s*. \**T. incertus* (HALL), Oklahoma, USA; *a-e*, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$  (new); *f-s*, transverse sections,  $\times 2.5$  (Carter, 1992).

### Family TRIGONOTRETIDAE

Schuchert, 1893

[*nom. transl.* CARTER in CARTER & others, 1994, p. 345, ex Trigonotretinae SCHUCHERT, 1893, p. 156]

Usually strongly transverse in adult growth stage; fold and sulcus well developed; denticulate hinge line well developed; entire surface ribbed, often plicate; lateral slopes commonly fasciculate. *Carboniferous* (*Visean*)—*Permian* (*Lopingian*).

### Subfamily NEOSPIRIFERINAE

Waterhouse, 1968

[Neospiriferinae WATERHOUSE, 1968, p. 9]

Weakly to strongly fasciculate; costae medium to fine, nearly uniform in size anteriorly; microornament weakly capillate, often

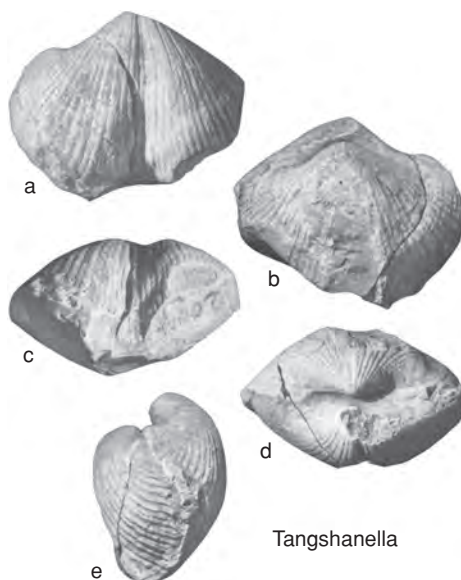


FIG. 1180. Choristitidae (p. 1786).

lamellose or imbricate; ventral interior with delthyrial plate. *Carboniferous* (*Pennsylvanian*)—*Permian* (*Lopingian*).

**Neospirifer** FREDERIKS, 1924, p. 311 (NIKITIN, 1900, p. 385, *nom. nud.*) [\**Spirifer fasciger* KEYSERLING, 1846, p. 231; OD]. Medium size; thin shelled; transverse with fasciculate and plicate lateral slopes; cardinal extremities rounded in all growth stages of type species; ventral interarea narrowly triangular in type species; subangular fold and sulcus well developed; sulcal costae numerous, not fasciculate; costae on lateral slopes not coarse, bifurcating near beaks, again in umbonal region, continuing to branch anteriorly, resulting in fascicles of 6 to 8 or more at anterior margin; costae nearly equidimensional anteriorly; ventral interior with very short delthyrial plate and short dental adminicula; microornament unknown in type species. [An accurate diagnosis of this genus cannot be made until the microornament of the type species is ascertained.] *Permian*: Russia, Pakistan.—FIG. 1185, *1a-c*. \**N. fasciger* (KEYSERLING), Cisuralian, Russia; *a*, lectotype, dorsal internal mold,  $\times 1$  (Archbold & Thomas, 1984b); *b-c*, paralectotype, ventral and posterior views of ventral valve,  $\times 1$  (new).

?**Betaneospirifer** GATINAUD, 1949, p. 491 [\**Spirifer moosakhailensis* DAVIDSON, 1862, p. 28; OD]. Medium to large; strongly transverse; cardinal extremities slightly rounded to mucronate or alate; ventral interarea widely triangular; lateral slopes moderately to strongly plicate and fasciculate; costae numerous on each plica, almost uniform in width anteriorly;

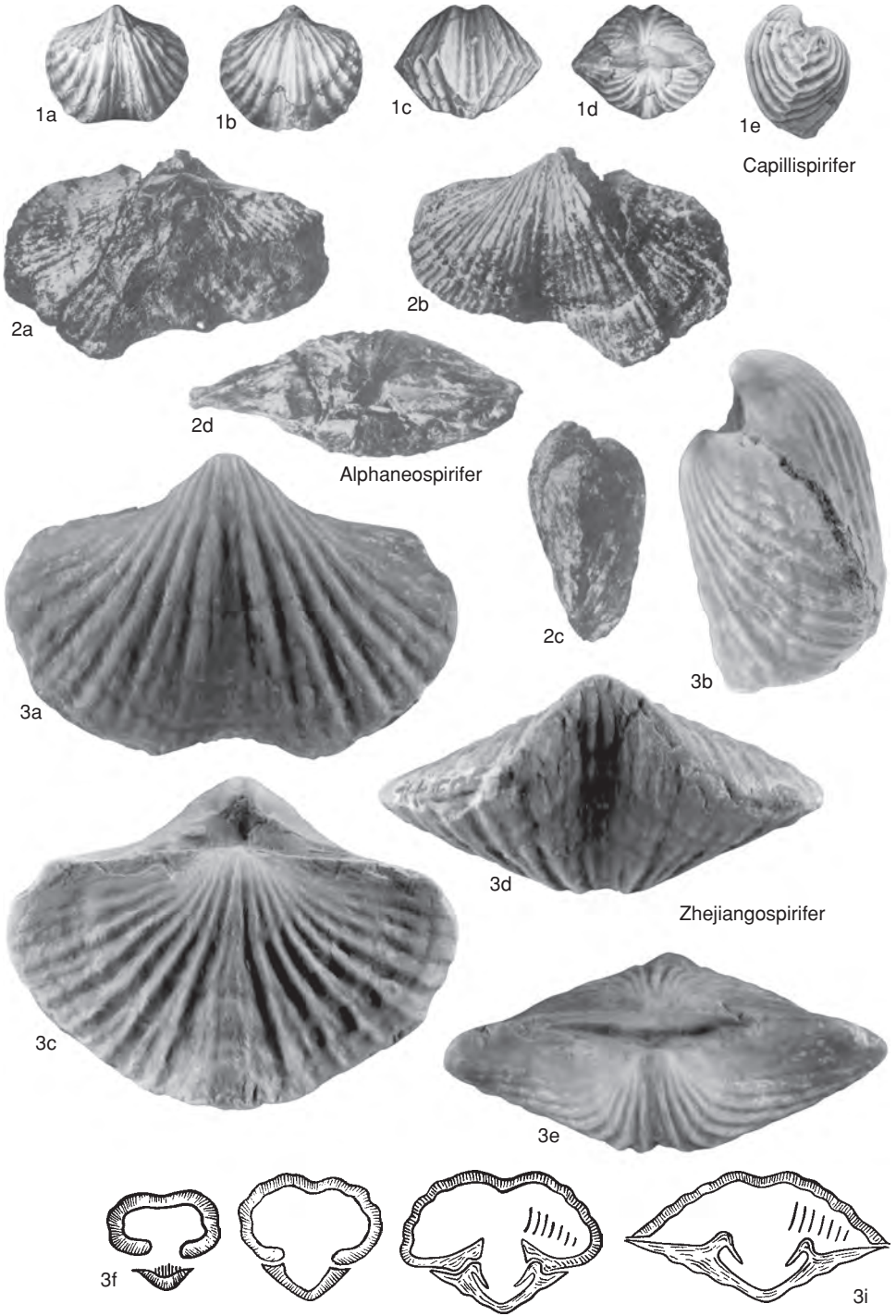


FIG. 1181. Choristitidae (p. 1786).

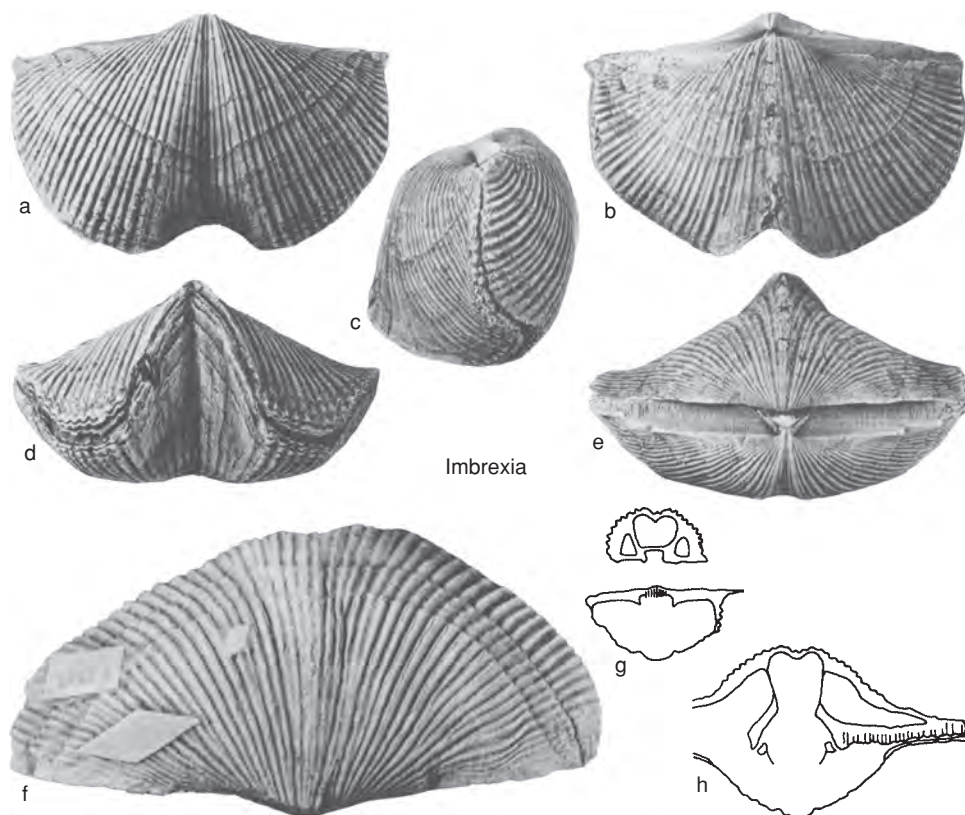


FIG. 1182. Imbrexiidae (p. 1786–1789).

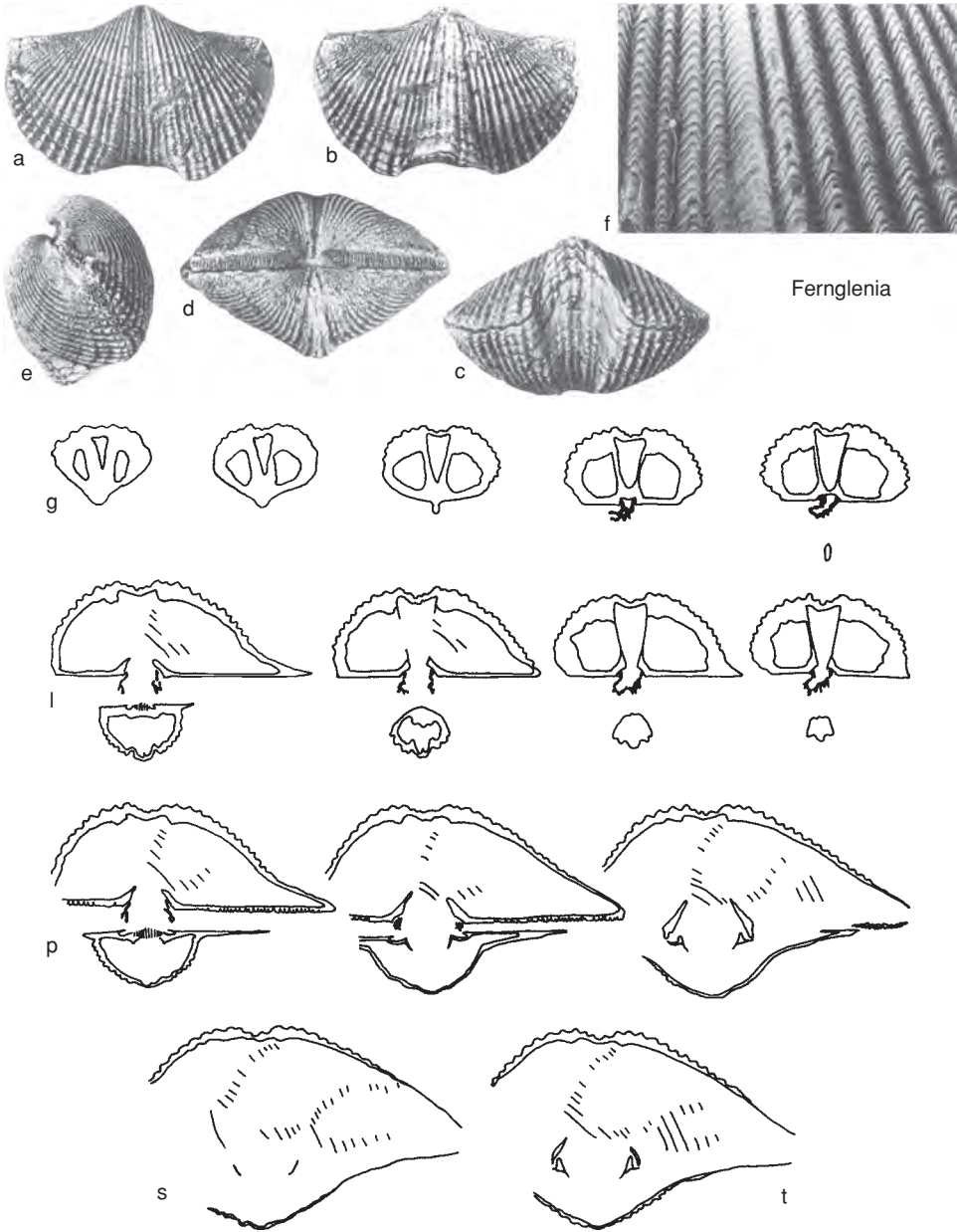
microornament regularly imbricate. [The validity of this genus is contingent on confirmation and completion of the diagnosis of *Neospirifer*.] *Carboniferous* (Pennsylvanian)–*Permian* (Lopingian): Pakistan, Russia.—FIG. 1185, 2a–e. \**B. moosakhailensis* (DAVIDSON), Cisuralian, Pakistan; lectotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$  (new).

**Blaspirifer** KULIKOV, 1950, p. 6 [\**Spirifer blasii* DE VERNEUIL, 1845, p. 168; OD]. Small; outline subovate to subrhomboidal; cardinal extremities rounded; hinge line shorter than maximum width; ventral interarea short, concave; ventral interior lacking dental adminicula; presence of delthyrial plate unknown; macroornament consisting of costae, some of which may form fasciculate plicae; microornament unknown. *Permian* (Kungurian–Roadian): European Russia.—FIG. 1186, 3a–c. \**B. blasii* (DE VERNEUIL), Kazanian; dorsal, ventral, and lateral views,  $\times 1$  (Likharev, 1939b).

**Cartorhium** COOPER & GRANT, 1976a, p. 2, 191 [\**C. retusum*; OD]. Medium to large; outline subcircular to transversely subelliptical; cardinal extremities well rounded in juveniles, rounded to subangular in adults; maximum width anterior to hinge line; fold

and sulcus well developed, fold low; ventral interior with short dental adminicula, sometimes partially buried in callus; delthyrial plate absent; ornament consisting of coarse, rounded, asymmetrically fasciculate costae, sometimes forming weak plicae; microornament of weak, irregularly spaced growth lamellae and capillae. *Permian* (Cisuralian–Guadalupian): USA (Texas).—FIG. 1186, 1a–d. \**C. retusum*, Guadalupian; a–b, holotype, ventral valve exterior and interior; c–d, dorsal valve exterior and interior,  $\times 1$  (Cooper & Grant, 1976a).

**Costatispirifer** ARCHBOLD & THOMAS, 1985, p. 278 [\**C. gracilis*; OD]. Medium sized; strongly transverse; cardinal extremities usually rounded, more rarely subangular; maximum width attained slightly anterior to hinge line; sulcus shallow, rounded; fold moderately high, subangular, almost carinate; ventral interarea high; presence of delthyrial plate not established; macroornament consisting of fine, equidimensional, simple or bifurcating costellae that may or may not form weak fasciculations on weak lateral plicae; microornament unknown; otherwise similar to *Lepidospirifer*. *Permian* (Kungurian): Western Australia.—FIG. 1186, 4a–d. \**C. gracilis*; a–b, dorsal and anterior views of dorsal



Fernglenia

FIG. 1183. Imbrexiidae (p. 1789).

valve; *c-d*, ventral valve exterior and interior,  $\times 1$  (Archbold & Thomas, 1985).

*Crassispirifer* ARCHBOLD & THOMAS, 1985, p. 282 [*\*Spirifer rosalinus* HOSKING, 1931, p. 24; OD]. Medium to large; strongly transverse in juveniles, becoming more truncated laterally in adults; outline subquadrate to subtrigonal; cardinal extremities

acutely alate in juveniles, becoming subangular to rounded in adults; ventral umbonal region and beak weakly produced; sulcus shallow, rounded, moderately broad; fold moderately high, subangular to narrowly rounded; lateral slopes with subequidimensional, rounded or slightly flattened costae forming fasciculations on low plicae; sulcus with



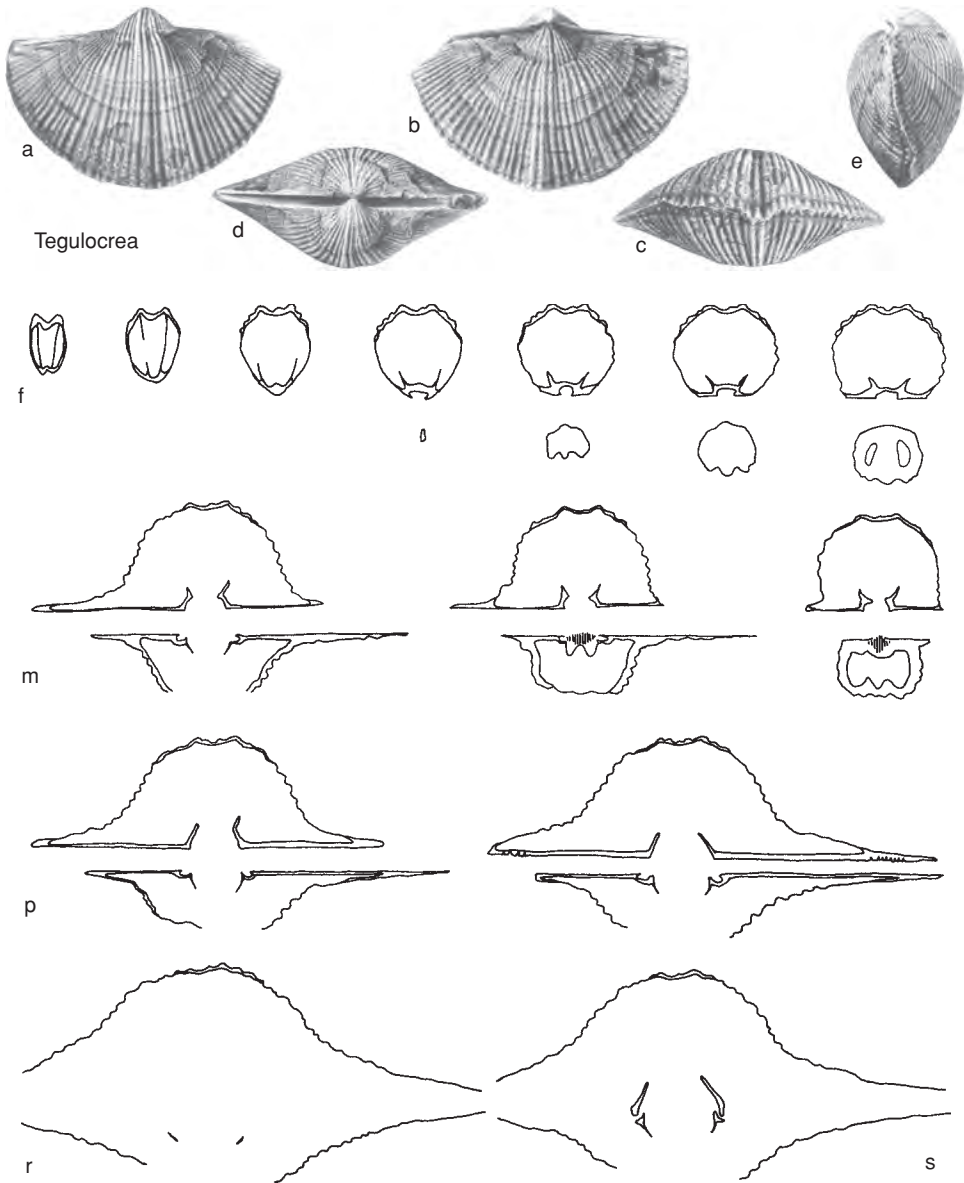


FIG. 1184. Imbrexiidae (p. 1789).

prominent median sulcal costa; microornament of fine cancellate capillae and growth laminae. *Permian (Artinskian–Roadian)*: Western Australia, Tibet, ?northeastern Siberia.—FIG. 1187*a–e*. \**C. rostralinus* (HOSKING), Artinskian, Western Australia; dorsal, lateral, ventral, posterior, and anterior views,  $\times 1$  (Archbold & Thomas, 1985). **Cratispirifer** ARCHBOLD & THOMAS, 1985, p. 280 [\**C. nuraensis*; OD]. Large; transverse; ventral interarea

high; cardinal extremities acutely alate in early growth stages, poorly known in adults; sulcus narrow, shallow; fold moderately high, narrow, subangular; posterior of valves massively thickened; flanks with low, broad plications with fascicles of 3 or 4 coarse, flattened, equidimensional costae; microornament unknown; otherwise similar to *Fusispirifer*. *Permian (Sakmarian)*: Western Australia.—FIG. 1188, *2a–d*. \**C. nuraensis*; dorsal,

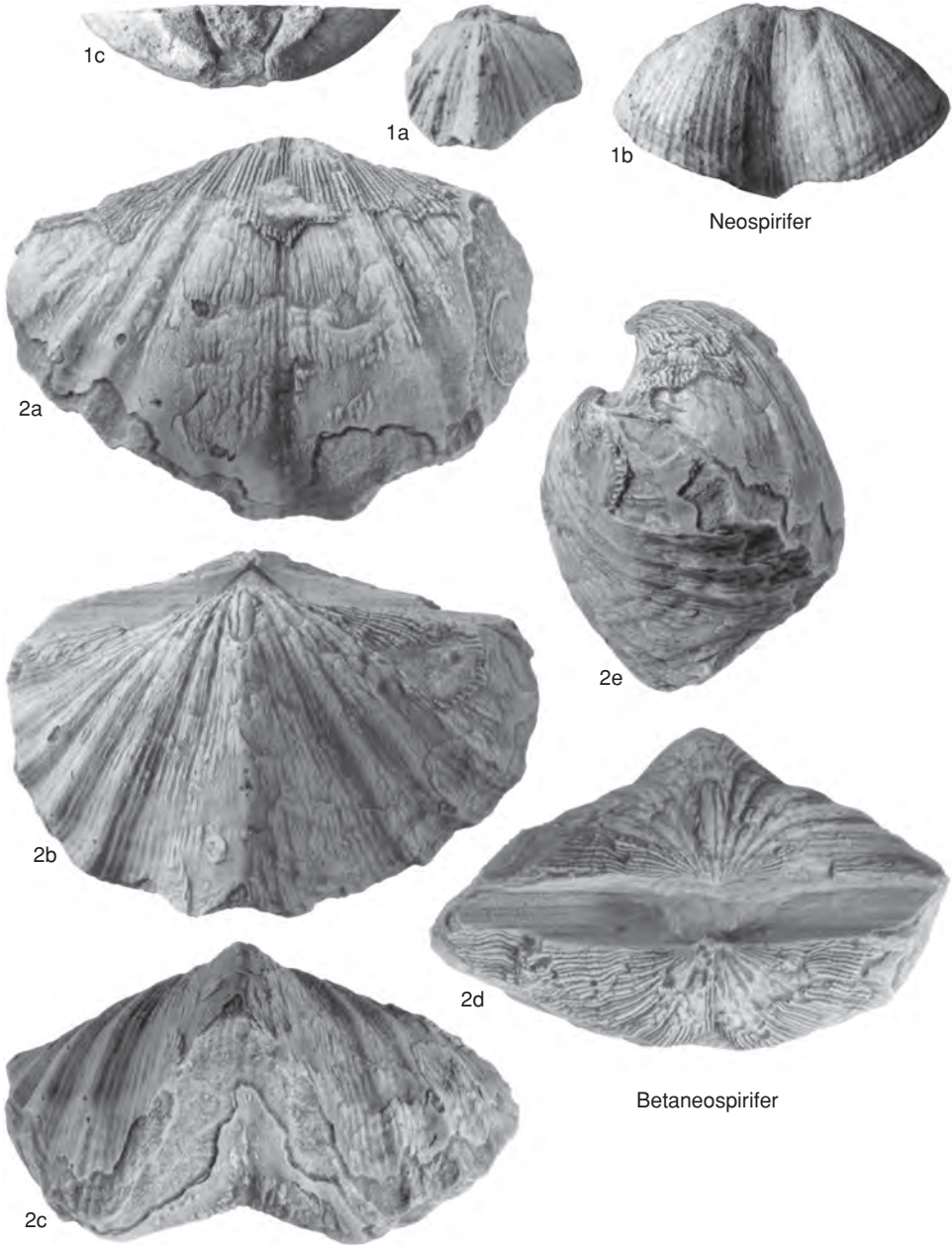


FIG. 1185. Trigonotretidae (p. 1789–1791).

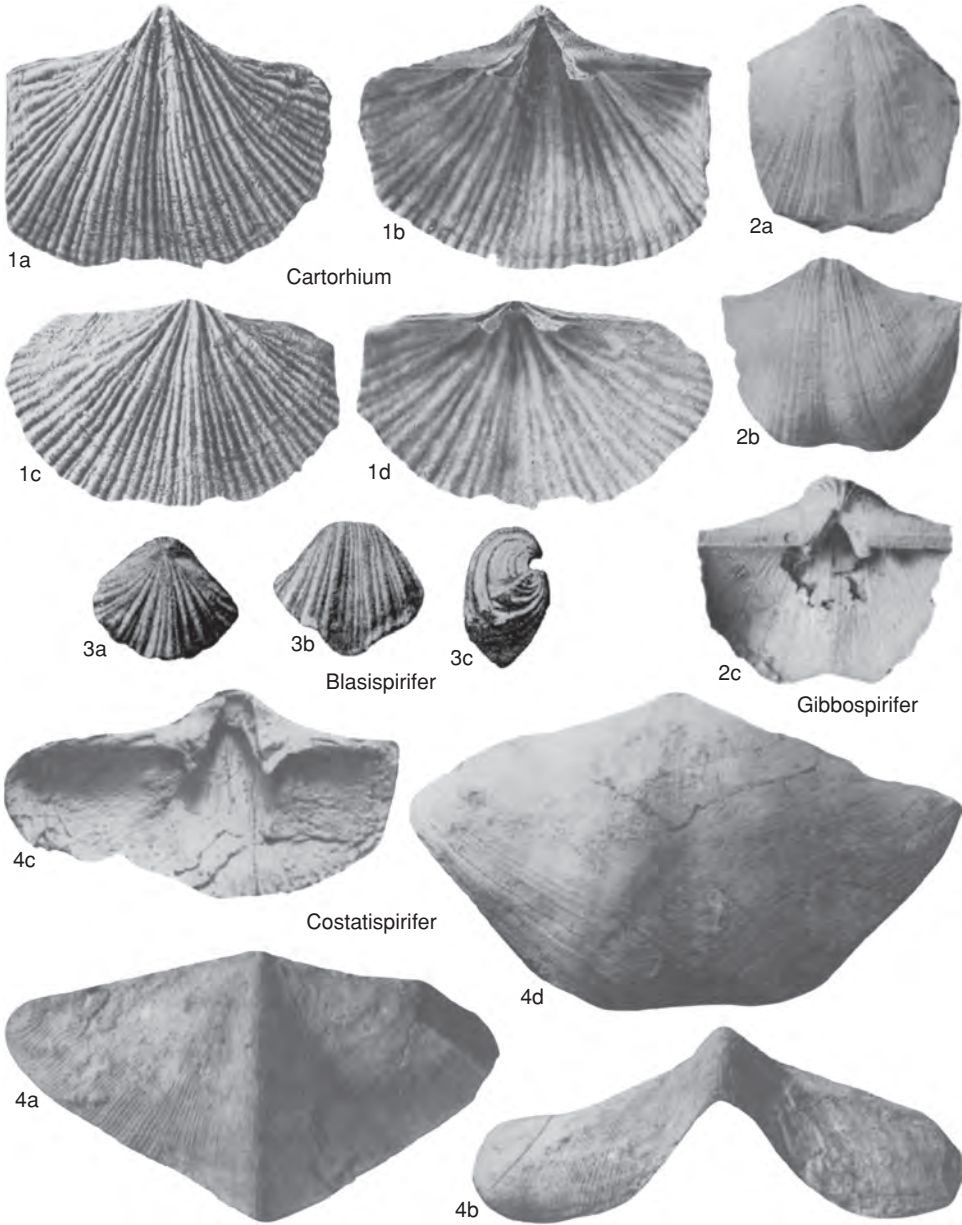


FIG. 1186. Trigonotretidae (p. 1791–1799).

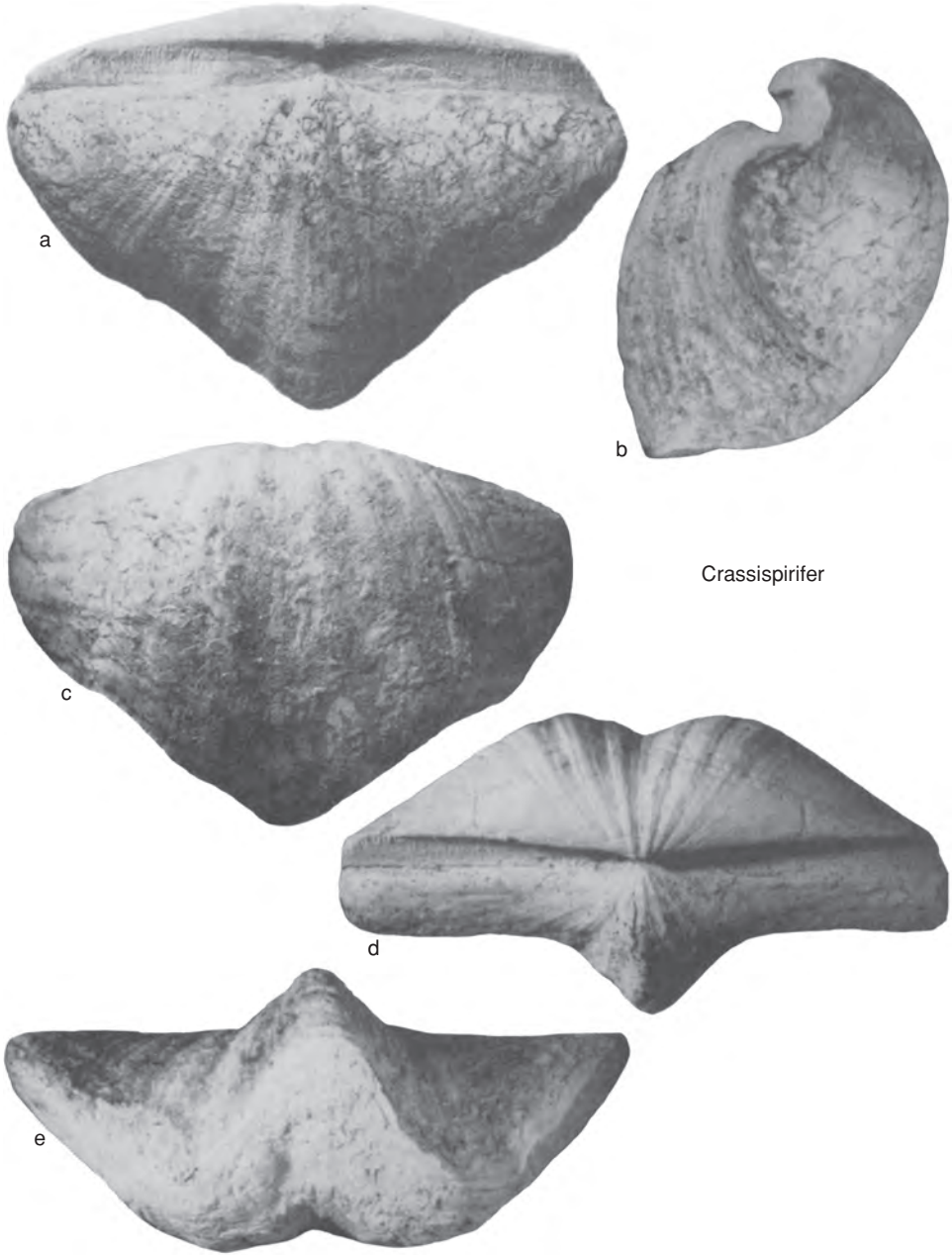


FIG. 1187. Trigonotretidae (p. 1792–1793).

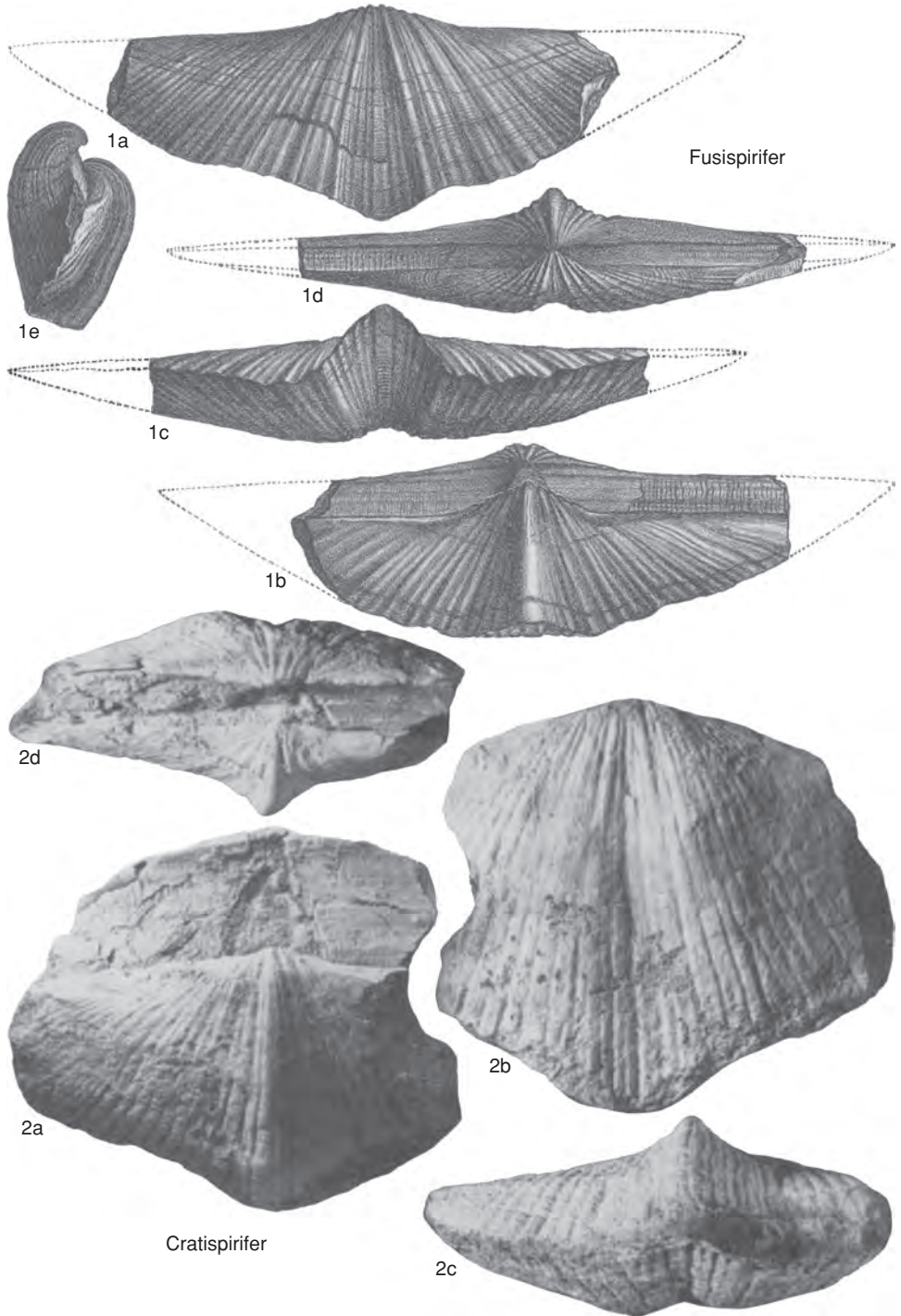


FIG. 1188. Trigonotretidae (p. 1793–1799).

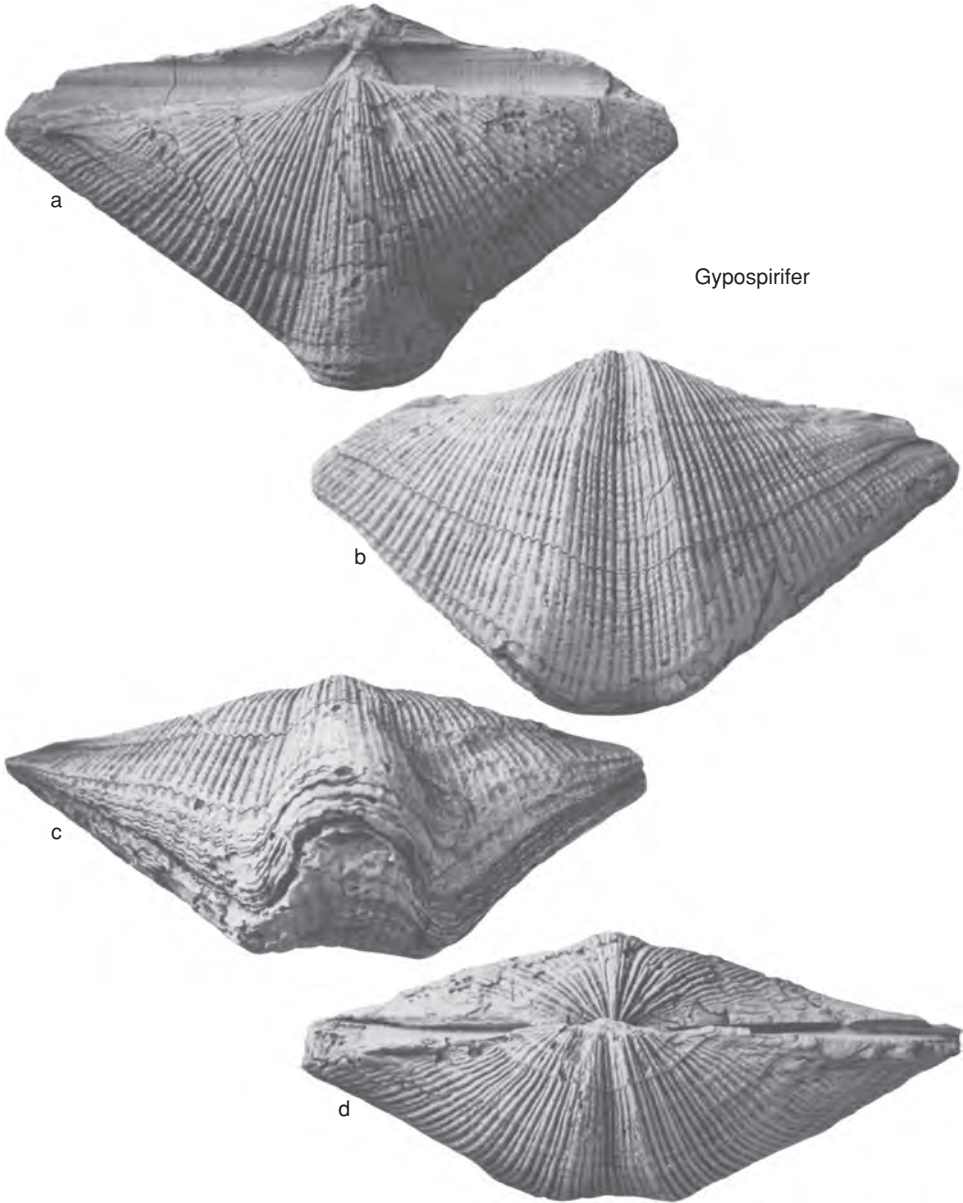


FIG. 1189. Trigonotretidae (p. 1799).

- ventral, anterior, and posterior views,  $\times 1$  (Archbold & Thomas, 1985).
- Fusispirifer** WATERHOUSE, 1966, p. 43 [*\*Spirifer nitiensis* DIENER, 1897b, p. 41; OD] [= *Transversaria* WATERHOUSE & GUPTA, 1983, p. 240 (type, *Fusispirifer marcouiformis* CHING in ZHANG & CHING, 1976, p. 209, OD)]. Strongly transverse throughout ontogeny; weakly biconvex; beak small, umbonal region poorly differentiated; cardinal extremities acutely alate in most growth stages, becoming rounded in adults of some species; sulcus narrow, with broad, commonly bifurcating median costa; fold narrow, moderately high; ventral interior much thickened by callus; delthyrial plate thickened, large; delthyrium partially occluded by stegidial plates; costae coarse to fine, nearly equidimensional, arranged in weak fascicles of 3 to 5 costae; microornament capillate, some species weakly lamellose. *Permian (Asselian–Lopingian)*: cosmopolitan.—FIG. 1188, 1a–e. *\*F. nitiensis* (DIENER), Lopingian, Nepal; syntype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$  (Diener, 1897b).
- Gibbospirifer** WATERHOUSE, 1971, p. 221 [*\*G. ettrainsensis*; OD]. Outline elongate; ventral valve arched, dorsal valve gently convex; cardinal extremities angular in adults; ventral sulcus shallow, narrow; dorsal fold low; ventral interarea moderately high; delthyrium open; ornament on lateral slopes consisting of low, indistinct plicae with bundled costae with rounded crests posteriorly, fading anteriorly; microornament reticulate, concentric lamellae dominant over capillae; dental adminicula short; ventral valve thickened with apical callus. *Carboniferous (Moscowian–Gzhelian)*: Yukon Territory, Canada.—FIG. 1186, 2a–c. *\*G. ettrainsensis*; a, holotype, ventral valve; b–c, paratype, ventral valve and interior,  $\times 1$  (Bamber & Waterhouse, 1971).
- Gypospirifer** COOPER & GRANT, 1976a, p. 2, 209 [*\*G. nelsoni*; OD]. Medium to large; transverse; cardinal extremities alate, subangular or slightly mucronate, especially in early growth stages; fold and sulcus well developed; fold well rounded; delthyrium partially or completely closed by imbricating stegidial plates; ornament consisting of numerous, fine, well rounded, almost uniform, simple or bifurcating costae that sometimes form weak fascicles posteriorly; fascicles, when present, not producing plicae; growth lamellae regularly to irregularly spaced, sometimes tegulate; ventral interior with dental adminicula usually buried in callus; delthyrial plate absent or obscured by thick callus. *Carboniferous (Bashkirian)–Permian (Cisuralian)*: USA (Texas), Bolivia, Russia.—FIG. 1189a–d. *\*G. nelsoni*, Wolfcampian, Texas; dorsal, ventral, anterior, and posterior views,  $\times 1$  (Cooper & Grant, 1976a).
- Imperiospira** ARCHBOLD & THOMAS, 1993, p. 314 [*\*I. franzjosefi*; OD]. Large; outline transversely irregularly subquadrate; lateral margins ventrally recurved and anteriorly extended to form thin, curved flanges; strong fold and sulcus producing long tongue and deeply emarginate anterior commissure; lateral slopes weakly to moderately plicate with numerous fine, even, fasciculate costae; microornament capillate and variably imbricate; dental adminicula short, buried in thick callus; true delthyrial plate very short or absent. *Permian (Sakmarian–Kungurian)*: Western Australia.—FIG. 1190a–b. *\*I. franzjosefi*; holotype, ventral and dorsal views,  $\times 1$  (Archbold & Thomas, 1993).—FIG. 1191a–b. *\*I. franzjosefi*; holotype, posterior and anterior views,  $\times 1$  (Archbold & Thomas, 1993).
- Kaninospirifer** KULIKOV & STEPANOV in STEPANOV, KULIKOV, & SULTANAEV, 1975, p. 63 [*\*Spirifer kaninensis* LIKHAREV, 1943b, p. 279; OD]. Dental adminicula absent; otherwise similar to *Betaneospirifer*; poorly known. *Permian (Roadian)*: Russia (Kanin Peninsula).—FIG. 1192a–d. *\*K. kaninensis* (LIKHAREV); ventral, dorsal, anterior, and posterior views,  $\times 1$  (new).
- Lepidospirifer** COOPER & GRANT, 1969, p. 14 [*\*L. angulatus*; OD]. Cardinal extremities well rounded in juveniles, rounded to subangular in adults; lateral slopes costellate to finely costate and weakly fasciculate, often lacking plicae; delthyrial plate very short or absent; growth lamellae finely imbricate and capillate; otherwise similar to *Neospirifer*. *Permian (Wordian)*: USA (Texas).—FIG. 1193, 1a–e. *\*L. angulatus*; holotype, dorsal, ventral, anterior, posterior, and lateral views,  $\times 1$  (Cooper & Grant, 1976a).
- Pondospirifer** WATERHOUSE, 1978, p. 93 [*\*P. magnificus*; OD]. Very large, thick, transverse, unequally biconvex; outline subquadrate; cardinal extremities subangular or slightly rounded in adults; ventral umbonal region and beak much reduced, poorly differentiated; ventral lateral extremities swollen; fold and sulcus very large, with sulcus engulfing lateral as well as anterior portion of shell; fold high, sloping gradually to each lateral margin; lateral slopes with very low, short, inconspicuous plicae and entire surface covered with fine, distinct, well-rounded costae; microornament of capillae and fine growth lines; ventral interior with dental adminicula; presence of delthyrial plate not confirmed; muscle platform as in *Neospirifer*. *Permian (Lopingian)*: Nepal.—FIG. 1194a–c. *\*P. magnificus*; ventral, dorsal, and posterior views,  $\times 1$  (Waterhouse, 1978).
- Septospirifer** WATERHOUSE, 1971, p. 222 [*\*S. tatondukensis*; OD]. Strongly transverse in all observable growth stages; cardinal extremities mucronate; lateral slopes weakly plicate and weakly fasciculate; ventral interior with distinct myophragm in anterior portion of ventral muscle field; otherwise similar to *Neospirifer*. *Permian (Asselian)*: Canada (Yukon Territory).—FIG. 1193, 2a–b. *\*S.*

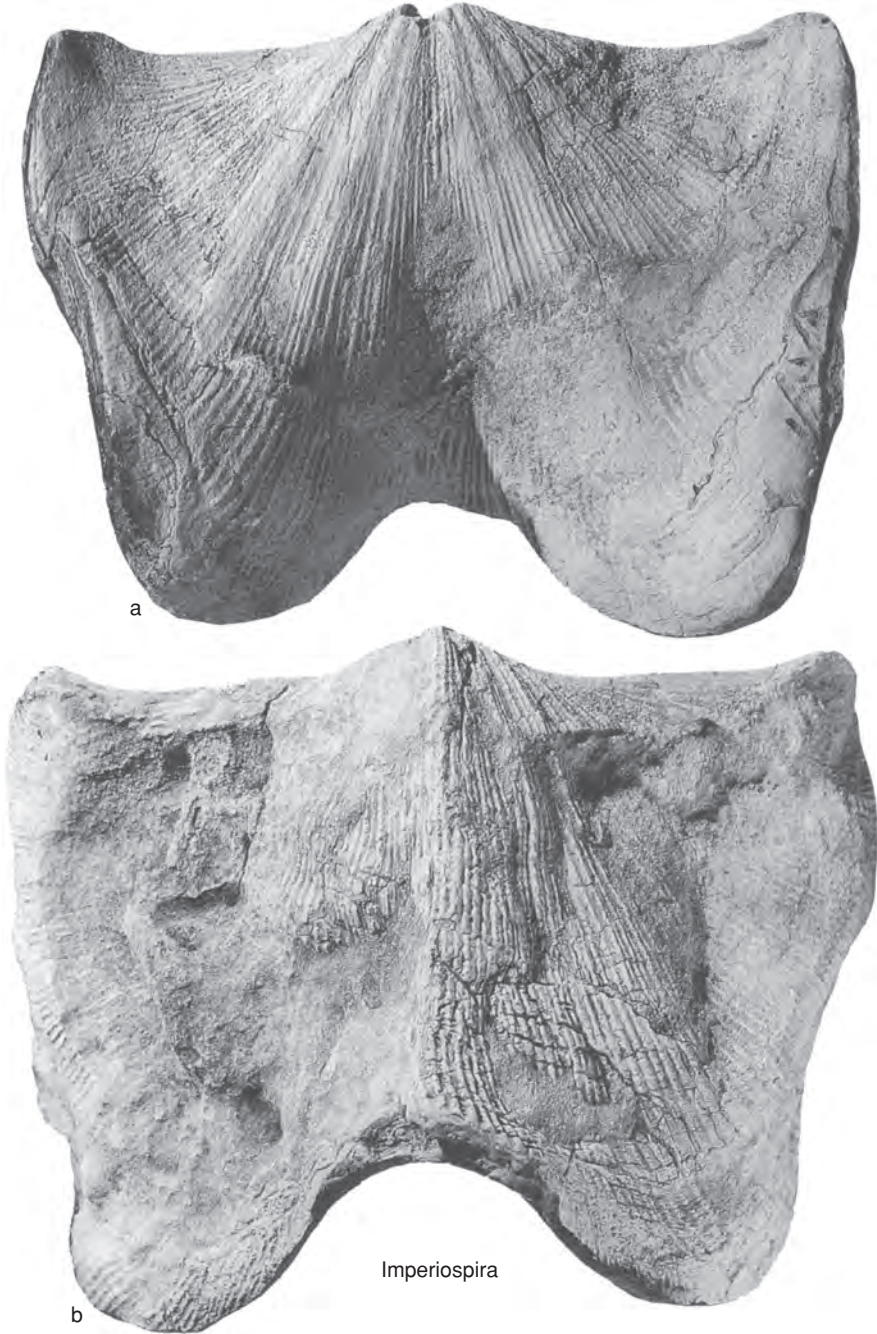
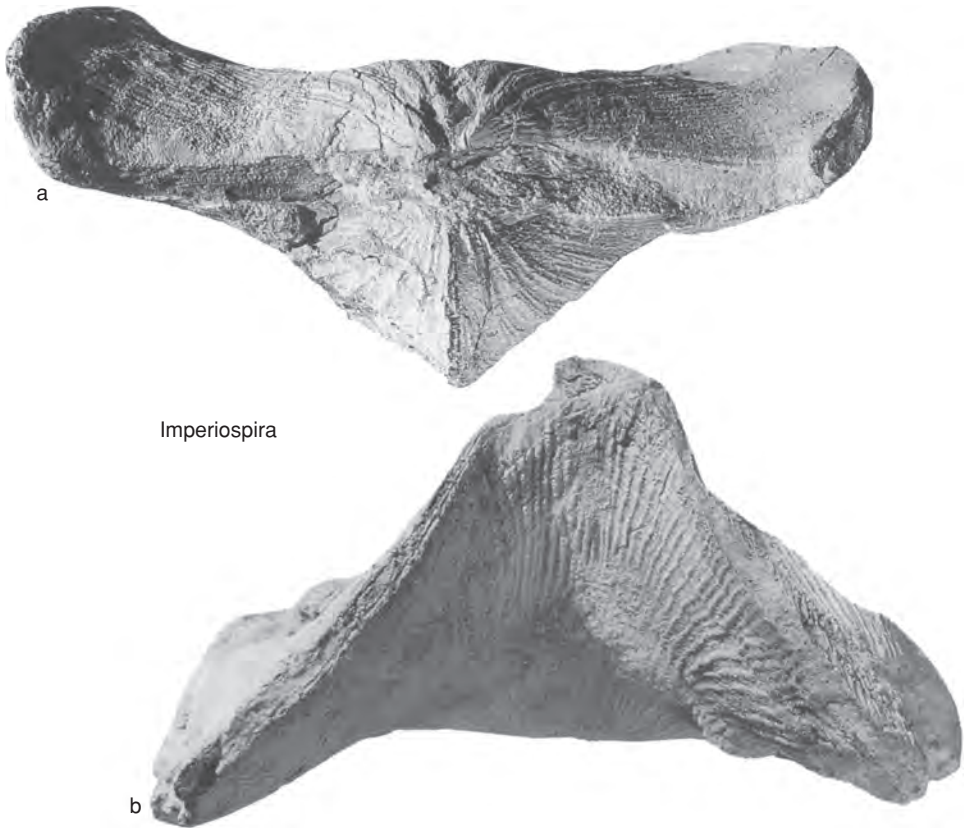


FIG. 1190. Trigonotretidae (p. 1799).





Imperiospira

FIG. 1191. Trigonotretidae (p. 1799).

*tatondukensis*; ventral and dorsal valves,  $\times 1$  (Bamber & Waterhouse, 1971).

**Tibetospirifer** LIU & WANG, 1990, p. 388 [\**T. xizangensis*; OD]. Medium size; transverse, maximum width at or near hinge line; lateral slopes with moderately numerous plicae separated by broad interspaces, each plica with 2 finer costae; sulcus with several costae, median costa bifurcating; microornament unknown; ventral interior simple, dental adminicula and delthyrial plate apparently absent. *Carboniferous (Pennsylvanian)*–*Permian*: Tibet, Siberia.—FIG. 1193, 3a–c. \**T. xizangensis*, Pennsylvanian, Tibet; dorsal, ventral, and posterior views,  $\times 1$  (Liu & Wang, 1990).

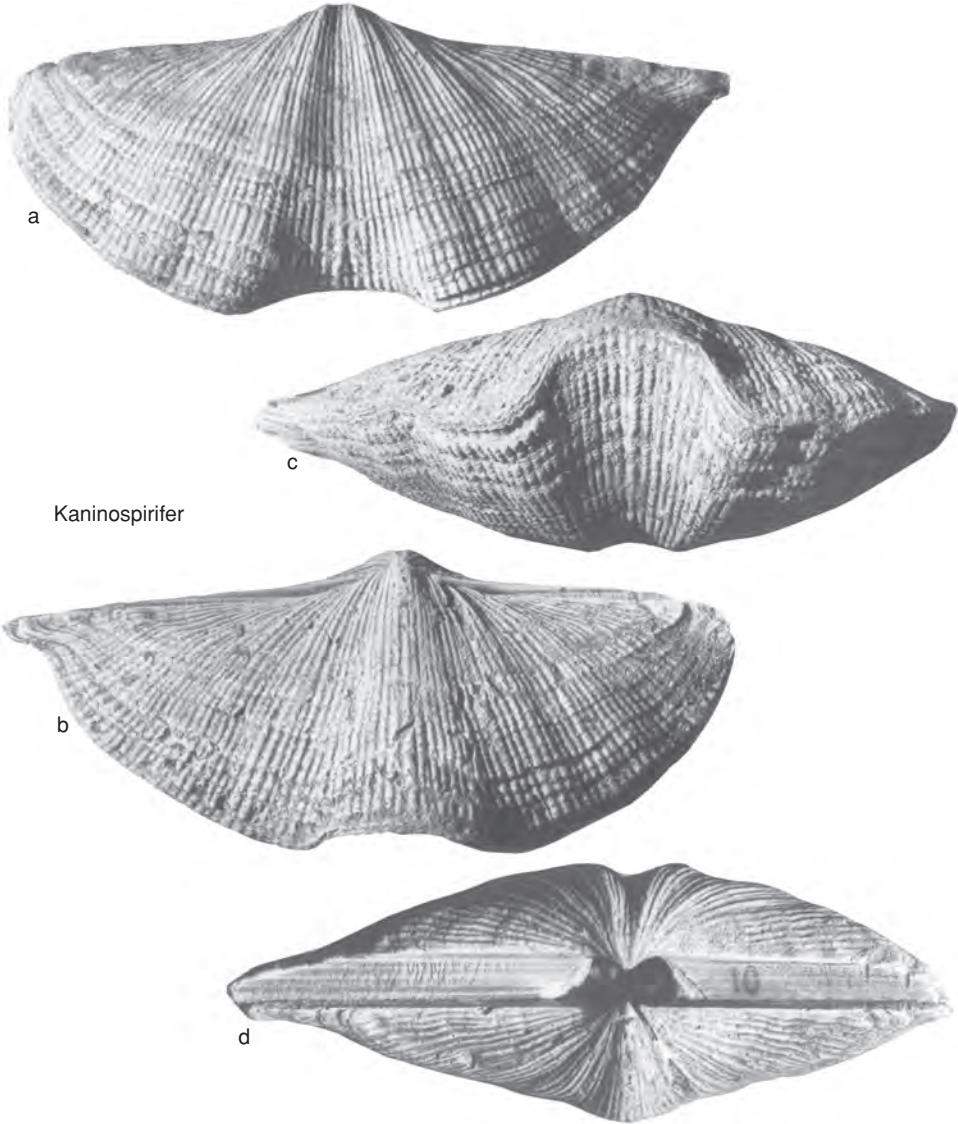
#### Subfamily TRIGONOTRETINAE Schuchert, 1893

[Trigonotretinae SCHUCHERT, 1893, p. 156]

Transverse; commonly thick shelled; fold and sulcus moderately developed; lateral

slopes weakly to strongly plicate, variably fasciculate; finer ribbing medium to coarse, often forming unequal ribs anteriorly; microornament capillate and variably cancellate; ventral interior with dental adminicula, obscured by thick, apical, commonly bulbous, delthyrial callus. *Carboniferous (Visean)*–*Permian (Kungurian)*.

**Trigonotreta** KÖNIG, 1825, p. 3 [\**T. stokesi*; SD HALL & CLARKE, 1893, p. 8] [= *Grantonia* BROWN, 1953, p. 60 (type, *G. hobartensis*, OD)]. Medium to large, thick shelled, moderately to strongly transverse; cardinal extremities highly variable; maximum width variable; fold and sulcus moderately developed; lateral slopes strongly plicate with 3 to 5 fasciculate, unequal costae per plica; variably lamellose; ventral interior much thickened by callus; delthyrium occluded by bulbous callus; dental adminicula buried in callus in adults; muscle field



Kaninospirifer

FIG. 1192. Trigonotretidae (p. 1799).

deeply incised. *Permian* (?*Asselian*–?*Kungurian*): Australia.—FIG. 1195, 2*a*–*e*. \**T. stokesi*, Tamarian, Tasmania; *a*, ventral valve; *b*–*c*, lectotype, dorsal and lateral views; *d*–*e*, ventral interior, dorsal interior,  $\times 1$  (Clarke, 1979).

**Aperispirifer** WATERHOUSE, 1968, p. 35 [\**Neospirifer wairakiensis* WATERHOUSE, 1964, p. 127; OD]. Medium to large, transverse, alate in early growth stages; cardinal extremities variable in adults; lateral slopes with weak plicae that become weaker or disappear anteriorly; entire surface covered with nu-

merous bifurcating subequal costae; some species lamellose; otherwise similar to *Trigonotreta*. *Permian* (*Artinskian*–*Kungurian*): New Zealand, Australia.—FIG. 1196*a*–*e*. \**A. wairakiensis* (WATERHOUSE), Ufimian, New Zealand; *a*, holotype, ventral valve; *b*–*d*, paratype, ventral, dorsal, and anterior views,  $\times 1$ ; *e*, ventral interior,  $\times 2$  (Waterhouse, 1964).

**Brachythyrinella** WATERHOUSE & GUPTA, 1978, p. 425 [\**Spirifer narsarhensis* REED, 1928, p. 379; OD]. Small, thin shelled for family; outline transversely subovate; cardinal extremities rounded; lateral

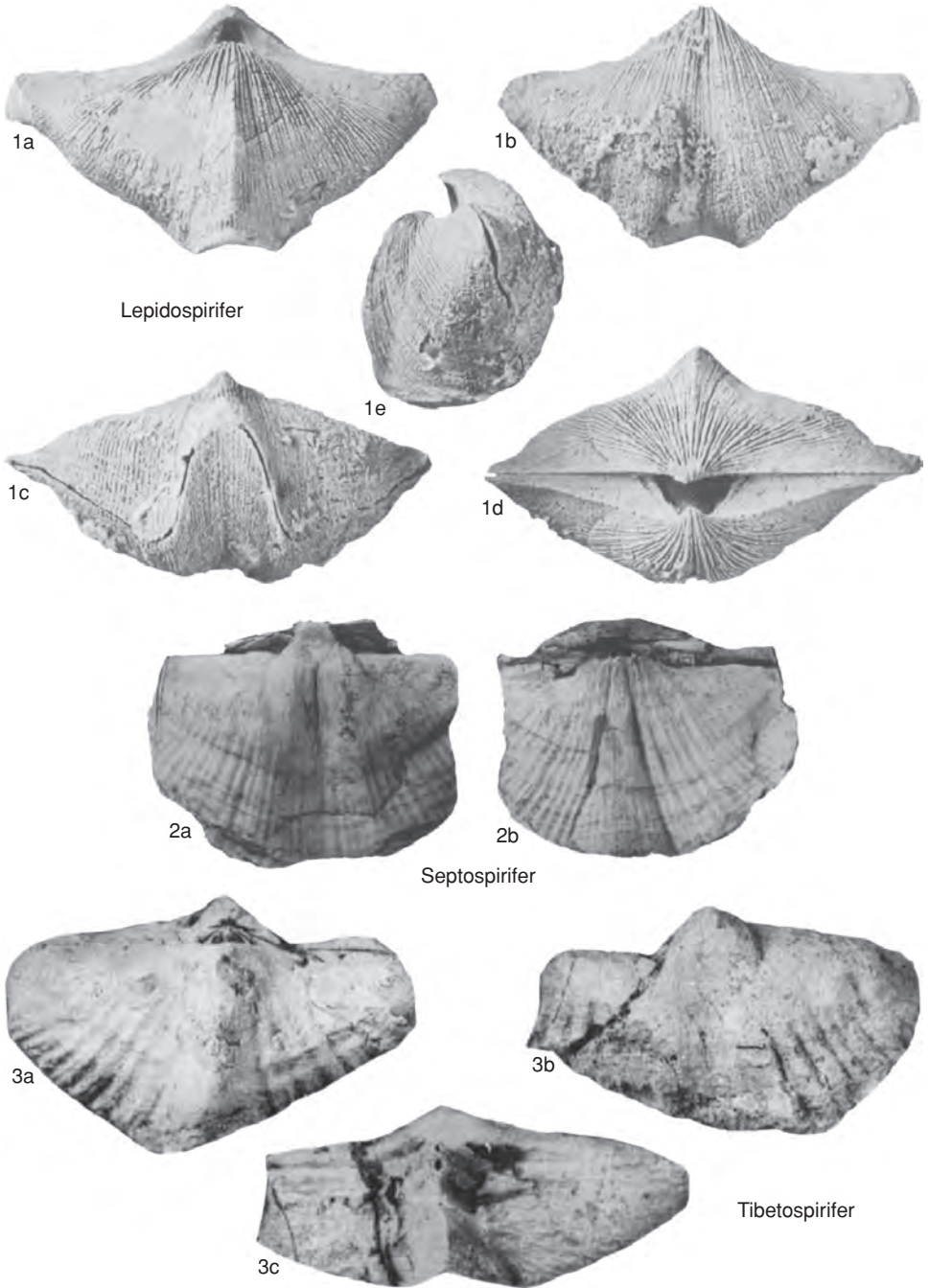


FIG. 1193. Trigonotretidae (p. 1799–1801).

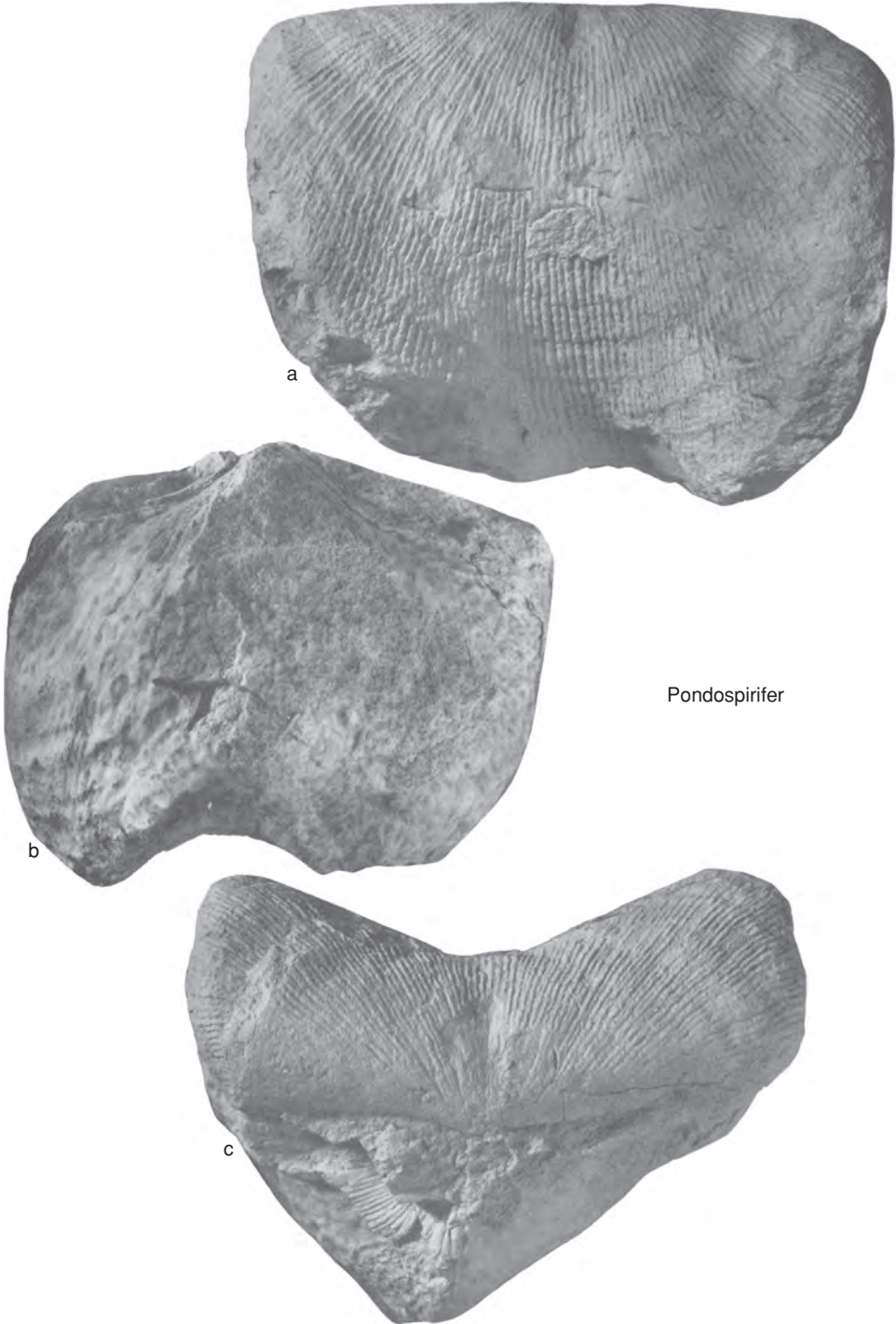


FIG. 1194. Trigonotretidae (p. 1799).

- slopes with several plicae, several of which may weakly bifurcate or trifurcate anteriorly; fold and sulcus plicate; sulcus with coarse median plica and one or more pairs of weak subplicae that split from sulcus-bounding plicae; slightly lamellose; ventral interior with short dental adminicula; lacking delthyrial plate or umbonal callus. *Permian (Cisuralian)*: India, Western Australia.—FIG. 1195, 1a–e. \**B. narsarbensis* (REED), India; a–c, syntype, dorsal, ventral, and anterior views, ×2 (Reed, 1928); d–e, topotype, ventral valve and interior, ×2 (Thomas, 1971).
- Frechella** LEGRAND-BLAIN, 1986, p. 32 [\**Neospirifer fasciostatus gwinneriformis* LEGRAND-BLAIN, 1971, p. 203; OD]. Medium to large, strongly transverse, outline subtrigonal to subsemicircular; greatest width at hinge line; cardinal extremities alate to mucronate; lateral slopes with several weak plicae and numerous costae forming fascicles of 3, rarely 2 or 4, unequal ribs per plica; ventral interior with short dental adminicula and thick umbonal callus; microornament finely reticulate. *Carboniferous (Visean–Serpukhovian)*: northern Africa.—FIG. 1197, 1. \**F. gwinneriformis* (LEGRAND-BLAIN), upper Visean, Algeria; holotype, ventral valve, ×1 (Legrand-Blain, 1971).
- Sulcifica** WATERHOUSE, 1968, p. 25 [\**S. transversa*; OD]. Large to very large; strongly transverse; cardinal extremities alate; fold and sulcus narrow, moderately well developed; lateral slopes with moderately numerous, usually simple, subangular plicae; costae absent; fold and sulcus with several coarse simple plicae; ventral interarea moderately high, flattened; ventral interior with thick apical callus obscuring internal structures; delthyrium occluded by large, bulbous apical callus; microornament subcancellate, growth lamellae subimbricate. *Permian (Kungurian)*: New Zealand, eastern Australia.—FIG. 1197, 2a–d. \**S. transversa*; a–b, ventral and dorsal valves, New South Wales, Australia, ×1 (Waterhouse, 1968); c–d, ventral and dorsal valves, Tasmania, ×1 (Clarke, 1987).

### Family SPIRIFERELLIDAE Waterhouse, 1968

[*nom. transl.* TERMIER & others, 1974, p. 136, *ex Spiriferellinae* WATERHOUSE, 1968, p. 9]

Lateral slopes plicate, coarsely costate, or fasciculate; fold usually with median furrow; delthyrium commonly partially or completely occluded by convex stegidial plates; denticulation poorly developed in narrow-hinged genera; microornament pustulose, commonly capillate; ventral interior with strong, short dental adminicula; ventral umbonal region often greatly thickened by callus with deeply impressed ventral muscle

field. *Carboniferous (Bashkirian)–Permian (Capitanian)*.

**Spiriferella** CHERNYSHEV, 1902, p. 121 [\**Spirifer saranae* DE VERNEUIL, 1845, p. 169; OD]. Medium to large, usually elongate; hinge line moderately wide, cardinal extremities rounded in juveniles, variably mucronate or rounded in adults; maximum width usually anterior to hinge line; ventral umbonal region greatly inflated; delthyrium partially or completely covered by stegidia; ribbing in sulcus highly variable; lateral slopes strongly plicate; plicae broad, rounded, simple to costate, with fasciculate costae in some species; fold normally with median groove; microornament consisting of capillae, concentrically arranged pustules, and fine, regular growth lines; ventral valve greatly thickened with secondary shell matter; ventral interior with short, diverging dental adminicula, thick umbonal callus, and deeply impressed muscle field. *Carboniferous (Bashkirian)–Permian (Capitanian)*: cosmopolitan.—FIG. 1198, 1a–d. \**S. saranae* (DE VERNEUIL), Cisuralian, Russia; a–c, ventral, lateral, and posterior views of ventral valve; d, dorsal valve, ×1 (Chernyshev, 1902).

**Alispiriferella** WATERHOUSE & WADDINGTON, 1982, p. 30 [\**Spirifer (Spiriferella) keilhavii* var. *ordinaria* EINOR, 1939, p. 140; OD]. Medium size, moderately transverse; cardinal extremities alate in early growth stages, rounded in adults; outline subrectangular to subovate; fold with wide, well-defined median groove; otherwise similar to *Spiriferella*. *Permian (Asselian–Capitanian)*: Russia (Novaya Zemlya), Yukon Territory, Canada (Arctic Islands).—FIG. 1198, 4a–c. \**A. ordinaria* (EINOR), Cisuralian, Novaya Zemlya; a, syntype, ventral valve; b–c, syntype, dorsal and anterior views, ×1 (new).

**Arcullina** WATERHOUSE, 1986b, p. 4 [\**Spiriferina polaris* WIMAN, 1914, p. 39; OD]. Fold lacking median groove or sulcus; plicae on lateral slopes possibly lacking costae; otherwise similar to *Spiriferella*. *Permian (Artinskian–Roadian)*: Urals, Western Australia, Arctic Islands.—FIG. 1198, 3a–d. \**A. polaris* (WIMAN), Kungurian, Spitzbergen; a, ventral interior; b–d, anterior, lateral, and dorsal views, ×1 (Wiman, 1914).

**Elivina** FREDERIKS, 1924, p. 315 [\**Spirifer tibetanus* DIENER, 1897a, p. 45; OD] [= *Dienerina* OZAKI, 1931, p. 25, obj.]. Small to medium size; outline longitudinally ovate to chordate; hinge line narrow; microornament of capillae and fine growth lamellae, pustules variably present; otherwise similar to *Spiriferella*. *Permian (Sakmarian–Roadian)*: India, Australia, Yukon Territory, USA (Texas).—FIG. 1199, 2a–e. \**E. tibetanus* (DIENER), Chhidruan–Kalabaghian, Himalayas; syntype, ventral, dorsal, lateral, posterior, and anterior views, ×1 (Diener, 1897a).

**Eridmatus** BRANSON, 1966, p. 75 [\**Spirifer (?Trigonotreta) texanus* MEEK, 1871, p. 179; OD]. Small,

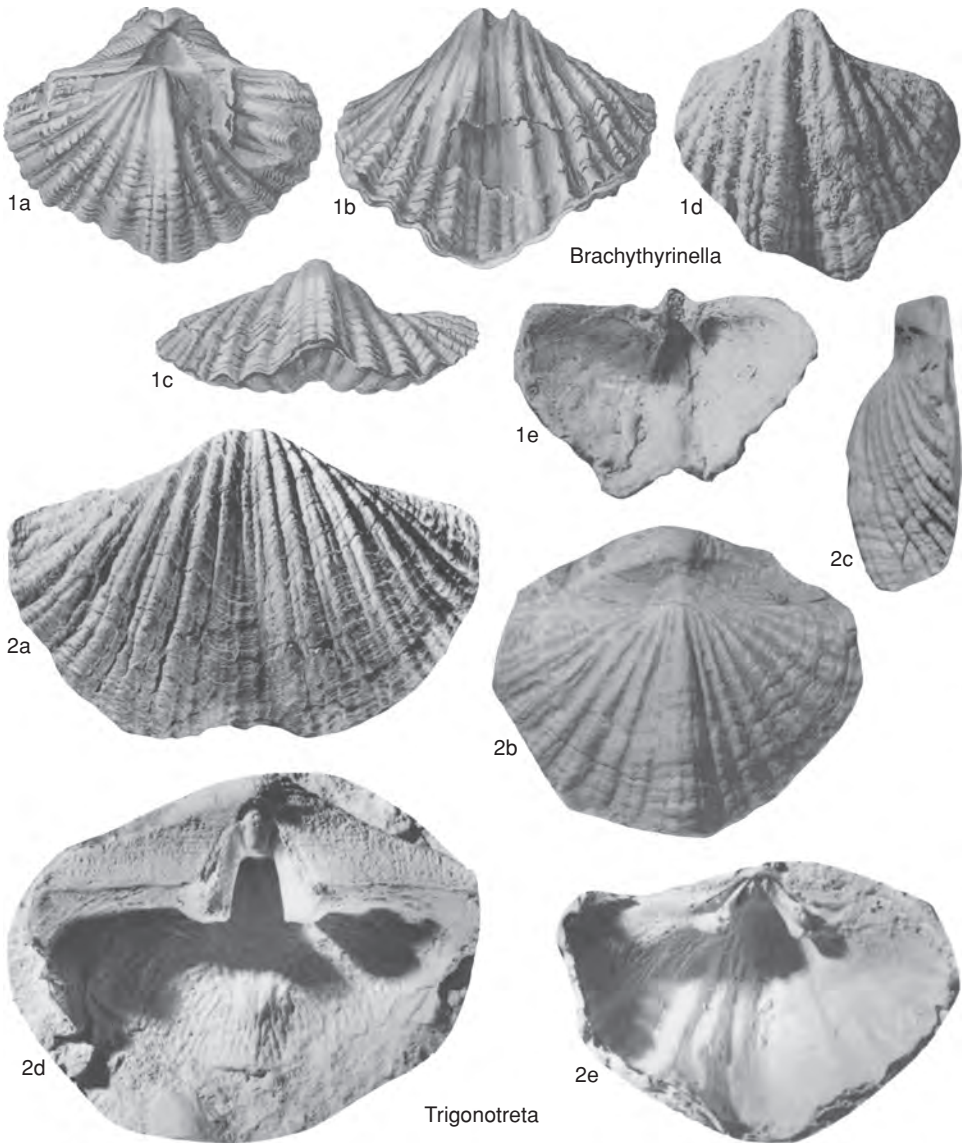
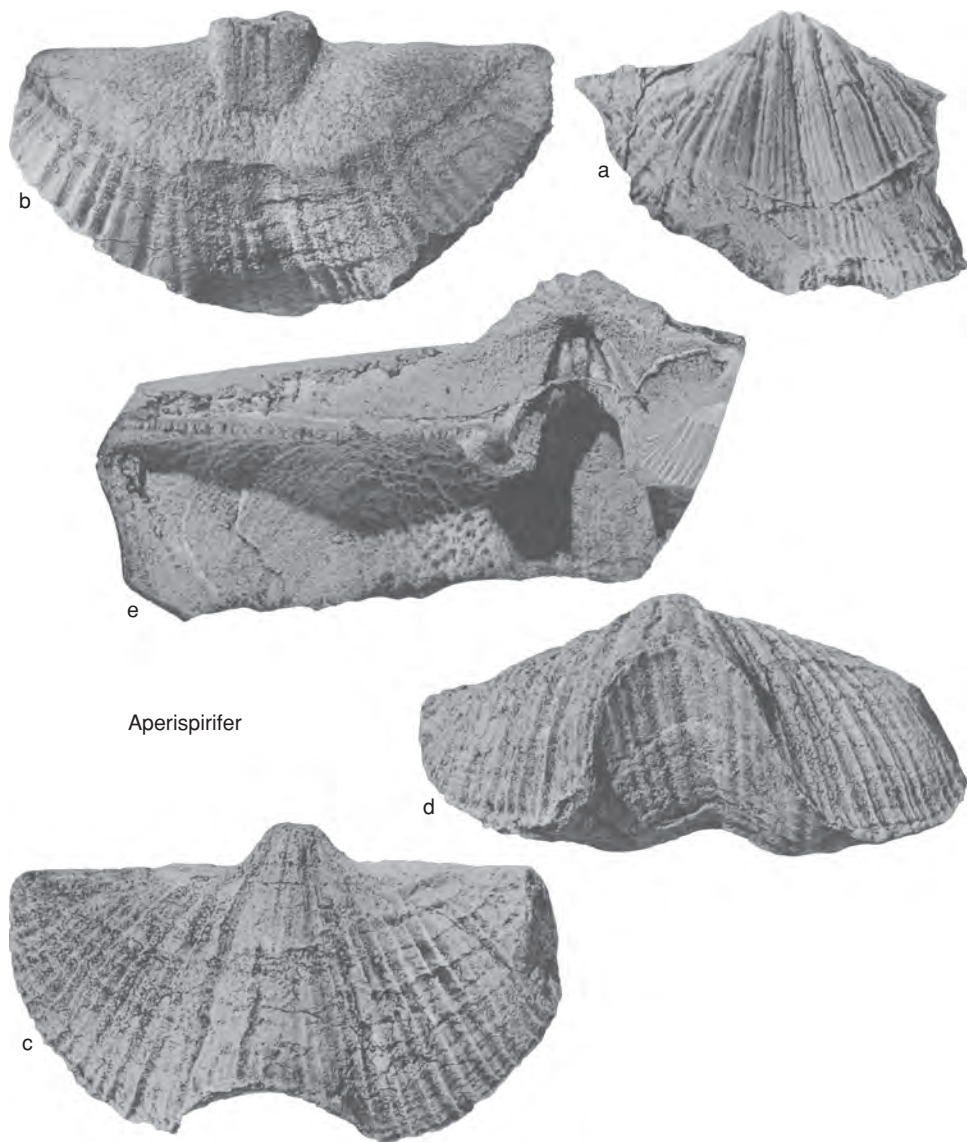


FIG. 1195. Trigonotretidae (p. 1801–1805).

elongate; hinge line extended, about equal to maximum width; cardinal extremities abruptly terminated, angular or slightly mucronate; apex of delthyrium with small, convex stegidium; fold and sulcus V-shaped, strongly developed; fold with shallow median groove posteriorly; lateral slopes with numerous strong, rounded, nearly uniform costae arranged in fascicles, forming plicae posteriorly; otherwise similar to *Spiriferella*. *Car-*

*boniferous* (Moscovian), Permian (Asselian): North America, Russia.—FIG. 1199, 1a–d. \**E. texanus* (MEEK), Desmoinesian, Kansas, USA; dorsal, ventral, lateral, and anterior views,  $\times 1$  (Spencer, 1967).

*Plicatospiriferella* WATERHOUSE & WADDINGTON, 1982, p. 34 [\**P. canadensis*; OD]. Small, with 6 or more simple plications on each lateral slope that extend to anterior margin; few costae except in sul-



Aperispirifer

FIG. 1196. Trigonotretidae (p. 1802).

cus; fold and sulcus moderately developed; otherwise similar to *Eridmatius*. *Carboniferous* (Moskopian, ?Gzhelian): Canada (Yukon Territory).—FIG. 1199, 4a–c. \**P. canadensis*, Moskopian; holotype, dorsal, lateral, and ventral views,  $\times 2$  (Waterhouse & Waddington, 1982).

**Rhombospirifer** DUAN & LI, 1985, p. 134 [\**R. zhesiensis*; OD]. Large, transversely rhomboidal in

outline, with alate cardinal extremities; delthyrium covered by stegidium; fold and sulcus well defined, smooth or with very weak costae; crest of fold slightly flattened, grooved; lateral slopes with few plicae; plicae with bifurcating or trifurcating, slightly fasciculate costae; both valves greatly thickened by secondary shell material; otherwise similar to *Timaniella*. *Permian* (Cisuralian): Inner

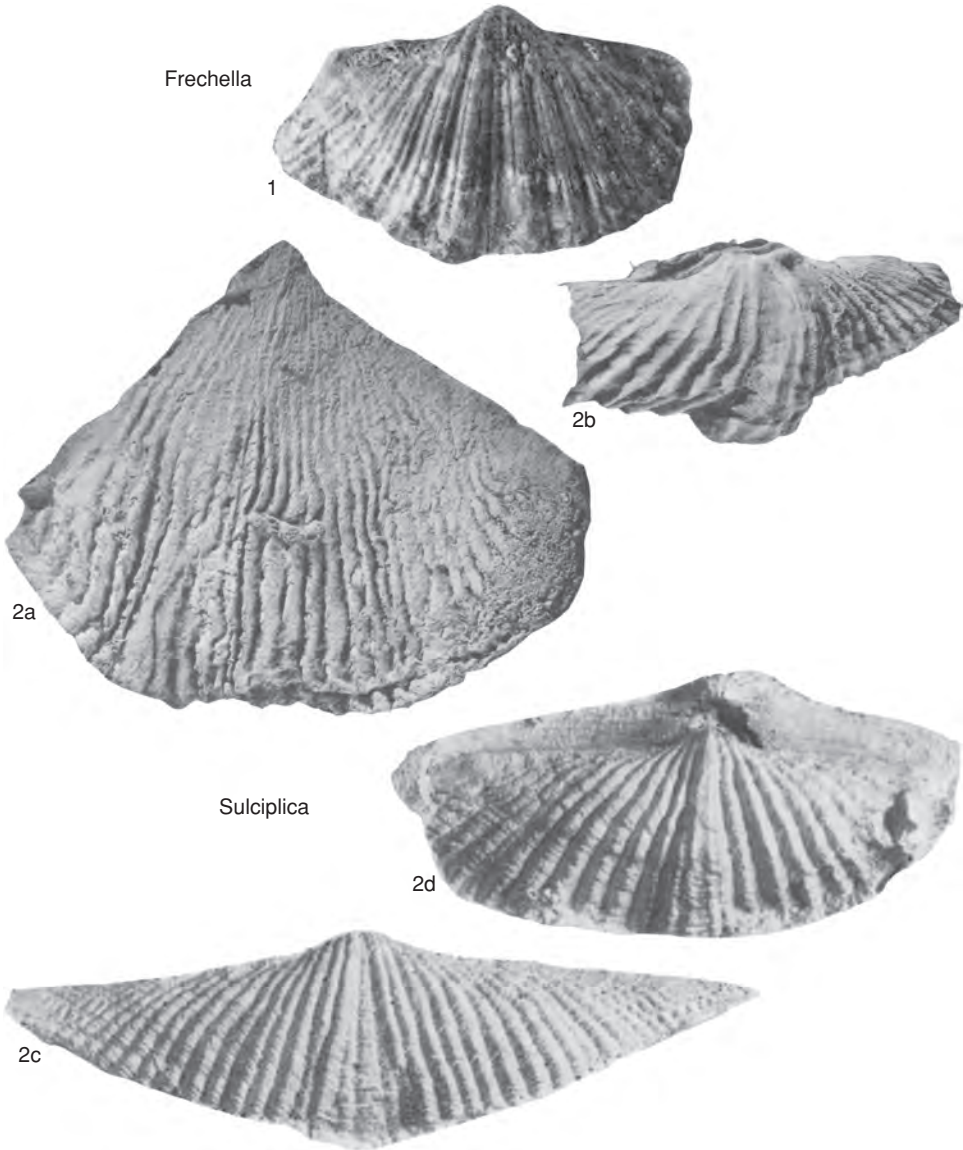


FIG. 1197. Trigonotretidae (p. 1805).

Mongolia.—FIG. 1200a–d. \**R. zhesiensis*; ventral, dorsal, lateral, and anterior views,  $\times 1$  (Duan & Li, 1985).

?*Spiriferelloides* LI, GU, & LI in LI & GU, 1985, p. 125 [\**S. xiuqienensis*; OD] [= *Spiriferellaoides* LI, GU, & LI, 1980, p. 26, *nom. nud.* (type, *S. xiujumuqinensis*, OD)]. Large; ventral interarea high; delthyrium large; fasciculate costae on lateral slopes complexly bifurcated; ventral muscle scars sagittate; otherwise similar to *Spiriferella*. [This ge-

nus is based on a single poor specimen and is virtually unrecognizable.] Permian (Cisuralian): Inner Mongolia.

*Timaniella* BARKHATOVA, 1968, p. 162 [\**T. festa*; OD]. Medium size; outline transversely subsemicircular to subtrigonal; cardinal extremities alate to slightly mucronate; delthyrium partially closed by narrow stegidial plates; lateral slopes moderately to strongly plicate; medial plicae costate, fasciculate; fold and sulcus moderately narrow, well delimited; sulcus



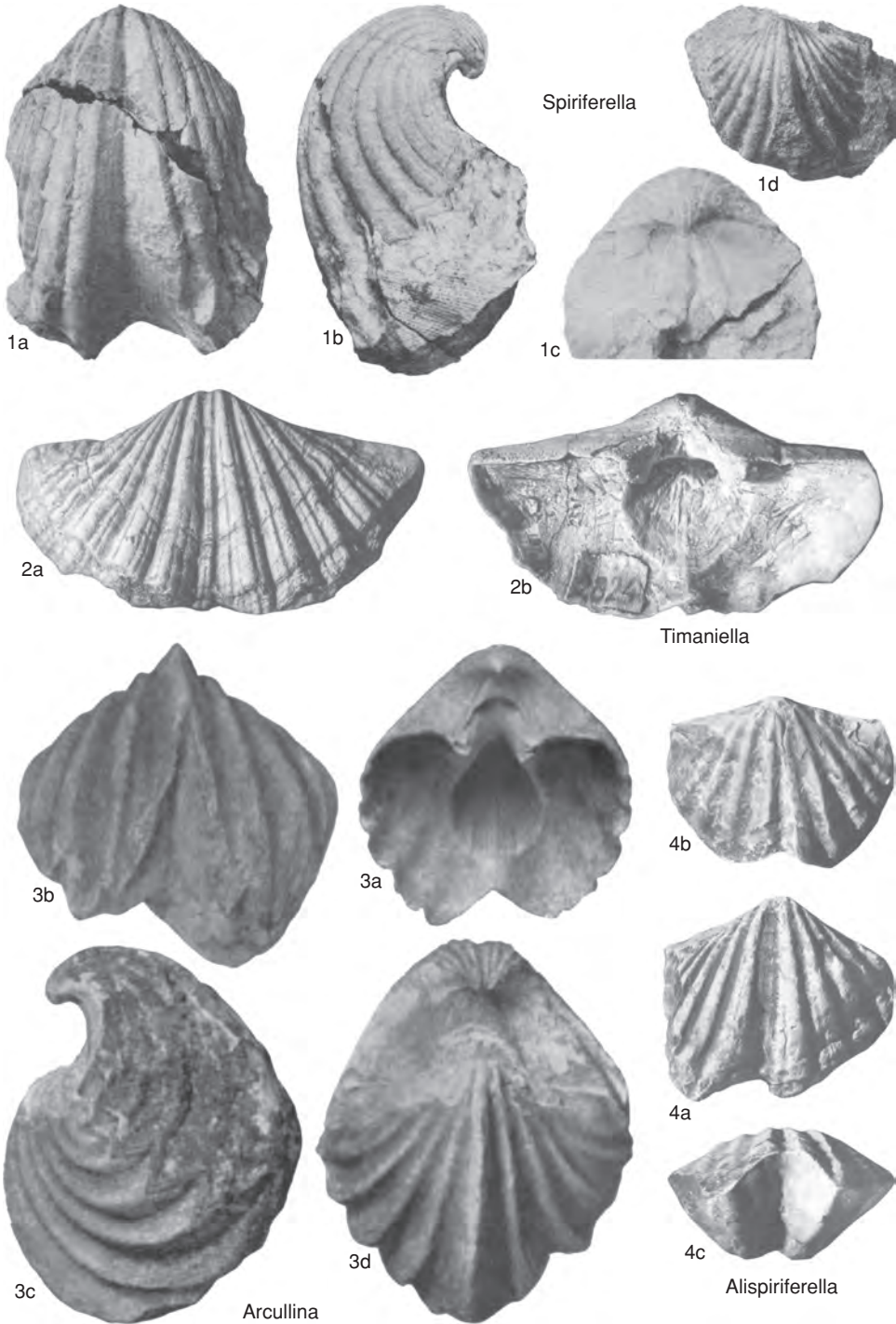


FIG. 1198. Spiriferellidae (p. 1805–1811).

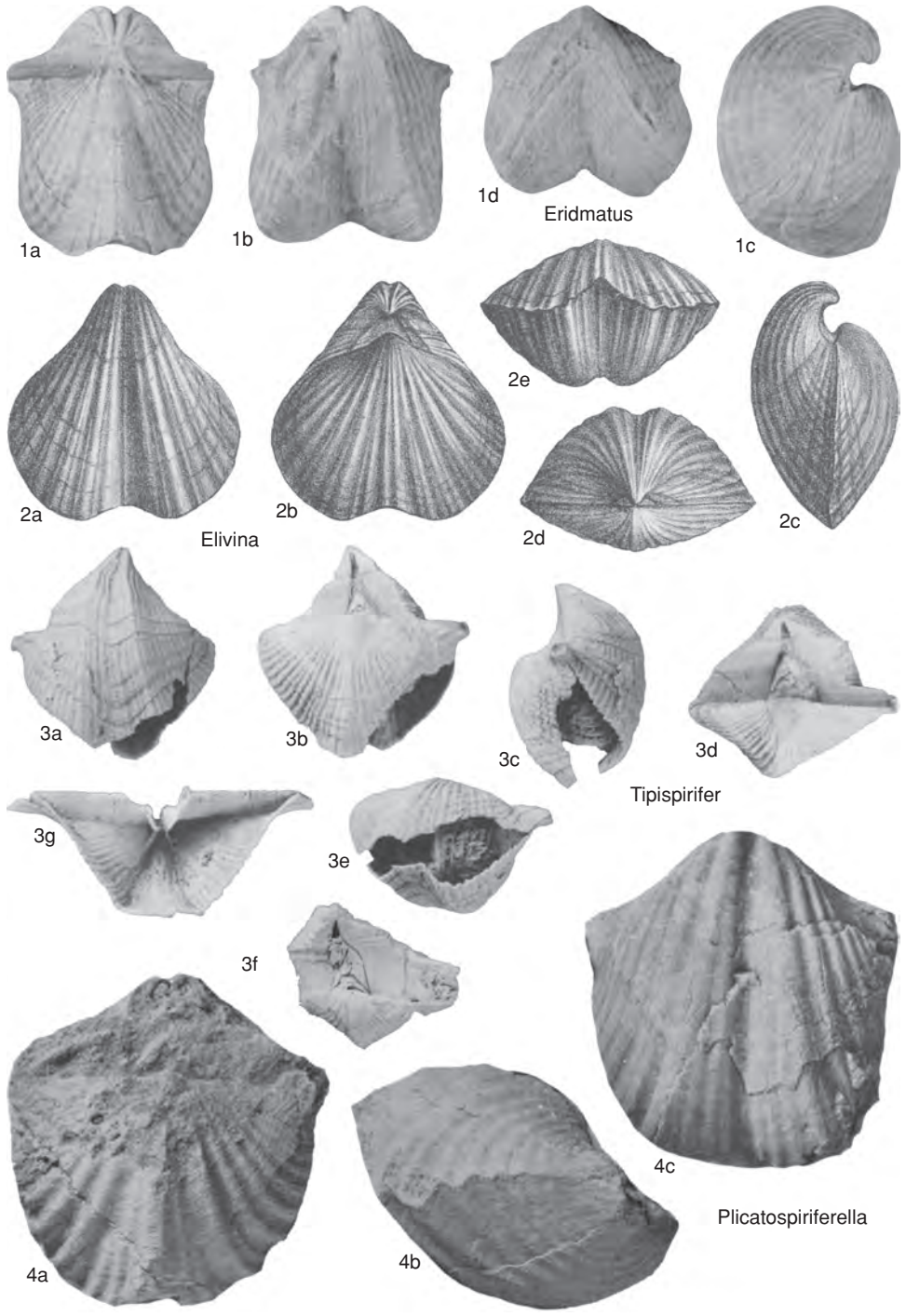
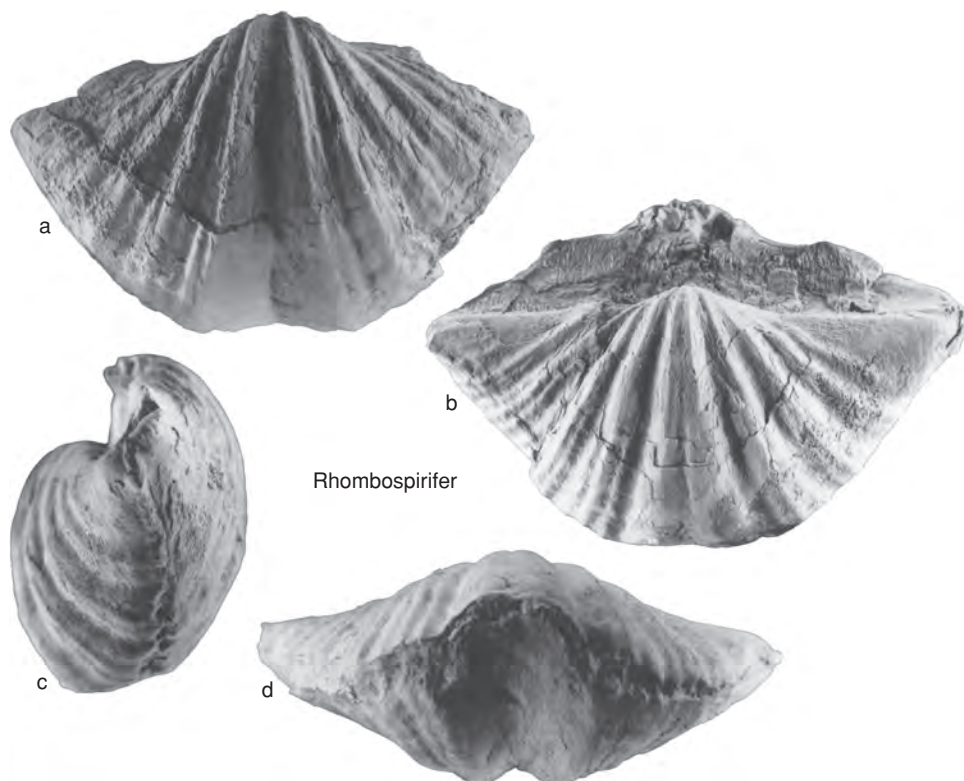


FIG. 1199. Spiriferellidae (p. 1805–1811).



Rhombospirifer

FIG. 1200. Spiriferellidae (p. 1807–1808).

with median plica and several lateral costae; fold with distinct median groove; ventral interior with thick delthyrial callus; muscle field moderately impressed, adductor scars long, narrow; diductor scars broad, longitudinally striated. *Permian (Kungurian–Roadian)*: Russia (northern Timan), Canadian Arctic Islands.—FIG. 1198, 2*a–b*. \**T. festa*, Kungurian, northern Timan; holotype, ventral exterior and interior,  $\times 1$  (new).

**Tipispirifer** GRANT, 1976, p. 213 [\**T. oppilatus*; OD]. Small for family; outline transversely subtrigonal to subrhomboidal; hinge line wide, denticulate; cardinal extremities greatly extended, mucronate; ventral beak and umbonal region narrow, slightly

incurved; ventral interarea high, slightly concave; delthyrium narrow, occluded by imbricating stegidial plates; fold and sulcus moderately developed, narrow, well delimited; entire surface costate with numerous fine, well-defined, rounded costae with narrow interspaces, increasing by both intercalation and bifurcation; microornament finely pustulose; ventral interior with false spondylium formed by converging dental flanges; dental adminicula short, divergent. *Permian (Artinskian)*: Thailand.—FIG. 1199, 3*a–g*. \**T. oppilatus*; *a–e*, holotype, ventral, dorsal, lateral, posterior, and anterior views; *f*, posterior view showing stegidial plates; *g*, ventral interior,  $\times 2$  (Grant, 1976).

# PAECKELMANELLOIDEA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

## Superfamily PAECKELMANELLOIDEA Ivanova, 1972

[*nom. correct.* CARTER in CARTER & others, 1994, p. 347, *pro* Paeckelmannelloidea IVANOVA, 1981, p. 22, *nom. transl. ex* Paeckelmannelloidea IVANOVA, 1972, p. 40]

Moderately to strongly transverse with maximum width at hinge line; ribs usually simple on flanks but geologically younger forms sometimes with bifurcations; fold and sulcus smooth or with median rib in sulcus, or more rarely, multicostate; ventral interarea usually moderately to very high, often catacline to slightly procline or weakly apsacline; hinge line denticulate; microornament usually consisting of capillae and anteriorly free growth lamellae; dental adminicula usually present; vascular markings simple, radial; crural plates and dorsal adminicula lacking; ctenophoridium present. *Upper Devonian (Famennian)–Permian (Lopingian)*.

### Family STROPHOPLEURIDAE Carter, 1974

[*nom. transl.* CARTER in CARTER & others, 1994, p. 347, *ex* Strophopleurinae CARTER, 1974, p. 677]

Ventral septum absent. *Upper Devonian (Famennian)–Permian (Lopingian)*.

### Subfamily STROPHOPLEURINAE Carter, 1974

[Strophopleurinae CARTER, 1974, p. 677]

Small, with simple lateral ribs; sulcus smooth or with median rib. *Upper Devonian (Famennian)–Carboniferous (Pennsylvanian)*.

**Strophopleura** STAINBROOK, 1947, p. 324 [\**Spirifer notabilis* KINDLE, 1909, p. 26; OD]. Small, transverse, subequally biconvex; beak ridges nearly parallel; ventral interarea apsacline; fold and sulcus narrow, rounded, smooth; flanks with numerous

strong, simple costae that become discordant and nearly perpendicular to hinge laterally; growth lamellae strong and regularly spaced; short dental adminicula buried in thick callus. *Upper Devonian (Famennian)*: USA (New Mexico, Colorado).—

FIG. 1201, 1a–e. \**S. notabilis* (KINDLE); anterior, dorsal, ventral, posterior, and lateral views, ×1 (Cooper & Dutro, 1982).

**Acuminothyris** ROBERTS, 1963, p. 15 [\**A. triangularis*; OD]. Medium size; very strongly transverse, alate, subequally biconvex; ventral interarea low, apsacline to nearly orthocline; flanks with numerous simple ribs; fold and sulcus smooth; fold-bounding ribs disproportionately strong; sulcus-bounding interspaces very deep; capillae faint; subimbricate growth lamellae regularly spaced; ventral interior with short, divergent dental adminicula. *Carboniferous (upper Tournaisian–middle Visean)*: Australia, USA (Missouri).—FIG. 1201, 4a–c. \**A. triangularis*; a–b, dorsal valve, ventral valve; c, holotype, posterior view of natural mold, ×1.5 (Roberts, 1963).

**Avisyrinx** MARTINEZ-CHACON, 1975, p. 33 [\**A. obsoleta*; OD]. Small, strongly transverse, alate, with high, concave, nearly catacline ventral interarea; lateral slopes with numerous weak, simple costae; fold and sulcus well differentiated; both fold and sulcus with very strong median plications producing bicarinate anterior profile; ventral interior with closely set dental adminicula, and short umbonal callosity that simulates delthyrial plate or syrinx; delthyrium nearly closed by stegidium. *Carboniferous (Pennsylvanian)*: Spain.—FIG. 1201, 2a–f. \**A. obsoleta*; a–d, holotype, ventral, dorsal, lateral, and anterior views, ×2; e–f, transverse sections, ×4 (Martinez-Chacon, 1975).

**Calvustrigis** CARTER, 1987, p. 68 [\**Spirifer rutherfordi* WARREN, 1932, p. 247; OD]. Medium size; strongly transverse with slightly mucronate cardinal extremities; smooth, rounded fold and sulcus moderately developed, well defined; ventral interarea nearly orthocline, strongly longitudinally grooved; ornament consisting of low, uniform, simple, straplike costae with narrow interspaces on flanks; microornament consisting of strong capillae only, imbricate growth lamellae absent; ventral interior with strong, slightly divergent dental adminicula and short delthyrial plate; posterior portions of both valves thickened with callus. *Carboniferous (middle Tournaisian)*: Canada.—FIG. 1202, 2a–e. \**C. rutherfordi* (WARREN); a–c, syntype, ventral, dorsal, and lateral views; d–e, ventral and dorsal valves, ×1 (Carter, 1987).

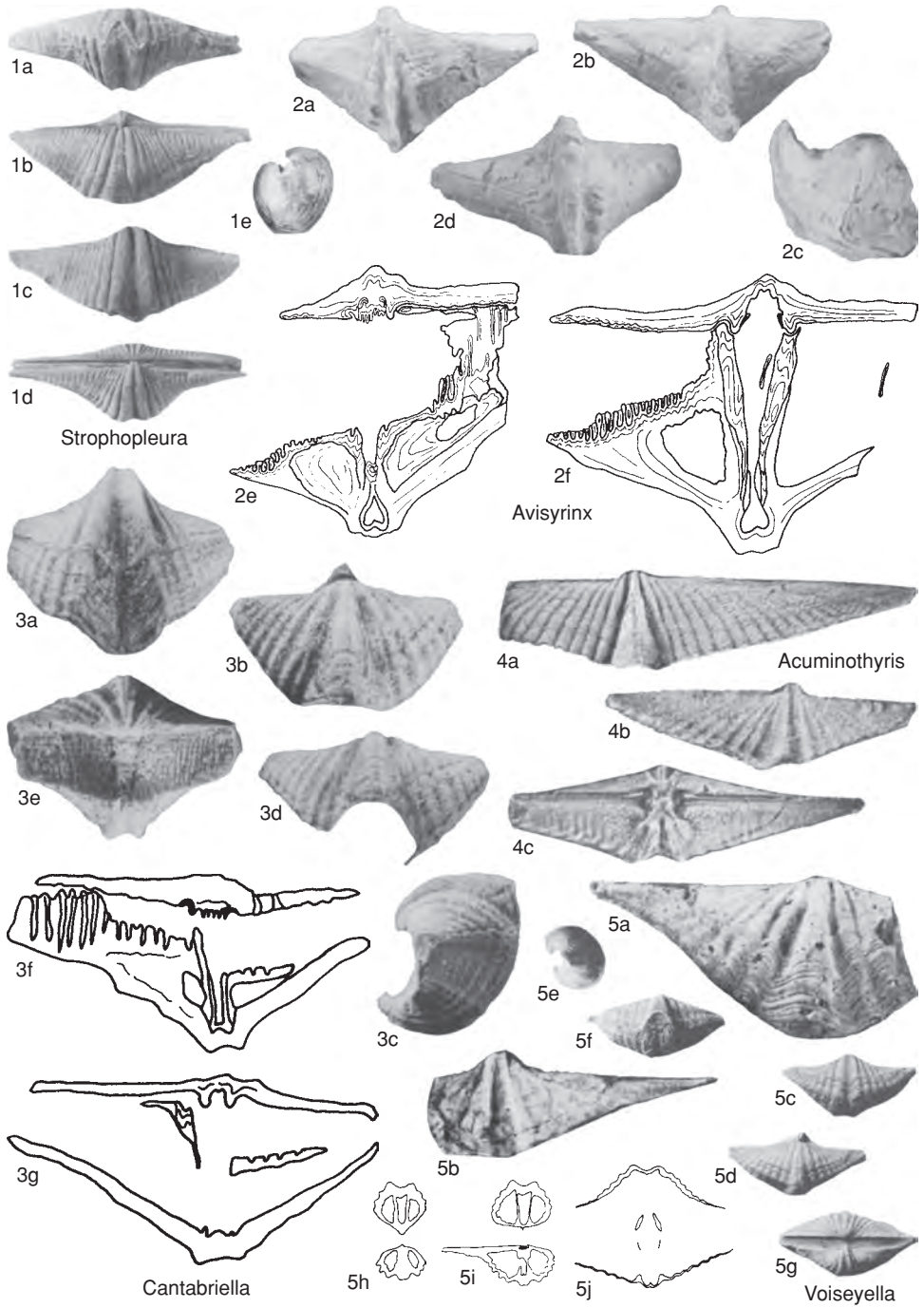


FIG. 1201. *Strophopleuridae* (p. 1812–1815).

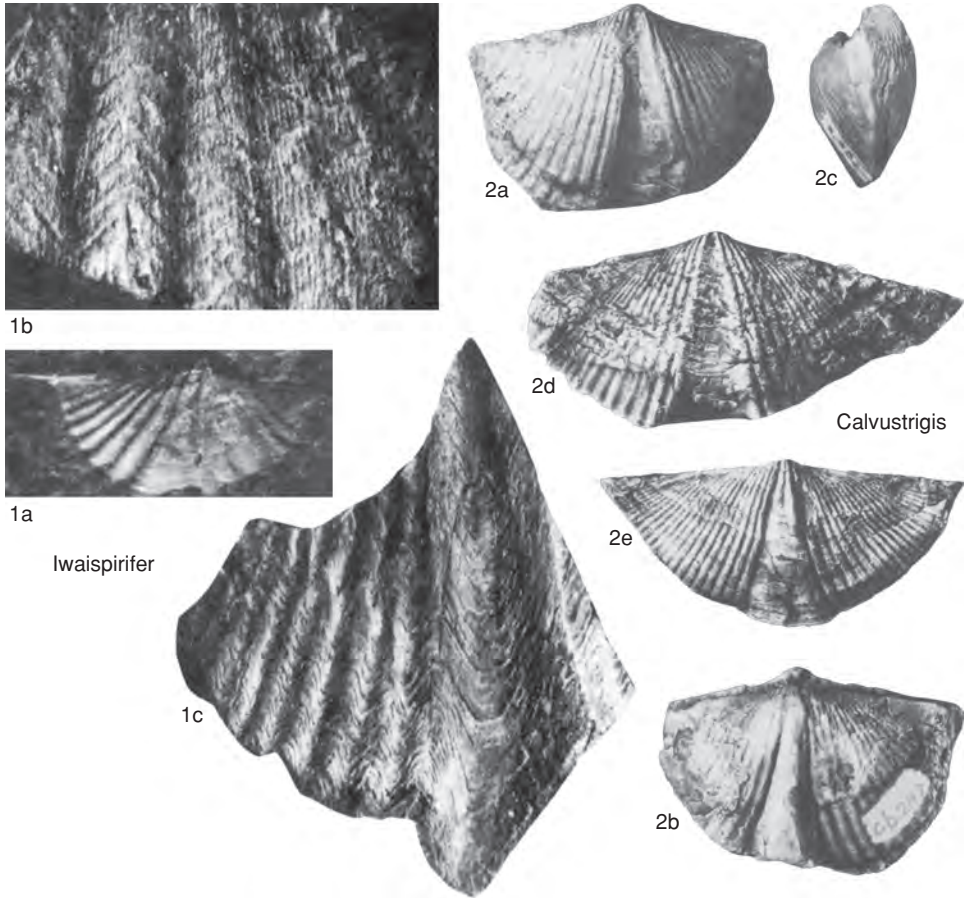


FIG. 1202. Strophopleuridae (p. 1812–1814).

**Cantabriella** MARTINEZ-CHACON & RIO-GARCIA, 1987, p. 21 [*\*Orulgania schulzi* MARTINEZ-CHACON, 1978a, p. 323; OD]. Fold and sulcus moderately broad, well developed, noncostate; ventral interarea moderately high; ventral interior with long, high, parallel dental adminicula placed within sulcus; otherwise similar to *Voiseyella*. Carboniferous (Bashkirian): northern Spain.—FIG. 1201, 3a–g. *\*C. schulzi* (MARTINEZ-CHACON); a–e, holotype, ventral, dorsal, lateral, anterior, and posterior views,  $\times 2$ ; f–g, transverse sections,  $\times 4$  (Martinez-Chacon, 1978a).

?**Iwaispirifer** TACHIBANA, 1964, p. 39 [*\*I. striatolamellosus*; OD]. Small; transversely subtrigonal; cardinal extremities mucronate; fold and sulcus moderately developed; lateral slopes with 6 to 8 simple rounded ribs; sulcus with or without median rib; growth lamellae moderately lamellose; ventral interior with short dental adminicula fused by cal-

lus. [A denticulate hinge line has not been established for this genus.] Upper Devonian (Famennian)—Carboniferous (Tournaisian): Japan.—FIG. 1202, 1a–c. *\*I. striatolamellosus*, Famennian; a, internal mold of ventral valve,  $\times 1.2$ ; b, microornament,  $\times 6$ ; c, ventral exterior enlarged,  $\times 2.5$  (Tachibana, 1981b).

**Voiseyella** ROBERTS, 1964, p. 187 [*\*Strophopleura anterosa* CAMPBELL, 1957, p. 79; OD] [= *Amesopleura* CARTER, 1967b, p. 363 (type, *Spirifera novamexicana* MILLER, 1881, p. 314, OD)]. Small, strongly biconvex; strongly transverse, with mucronate cardinal extremities; fold and sulcus narrow, noncostate and rounded; sulcus delimited by disproportionately large sulcus-bounding costae and fold by disproportionately deep and wide fold-bounding interspaces; flanks with moderately numerous simple ribs that become smaller or indistinct laterally; growth lamellae becoming crowded

and lamellose anteriorly; ventral interior with short, slender dental adminicula that follow margins of sulcus; dorsal interior with thick apical callus supporting cardinal process and long, platelike ridges that extend forward along inner crests of fold-bounding grooves. *Carboniferous (middle Tournaisian—middle Visean)*: Australia, USA (Texas, Missouri, New Mexico), Canada (Alberta).—FIG. 1201, 5a–b. \**V. anterosa* (CAMPBELL); *a*, dorsal valve exterior,  $\times 2.5$ ; *b*, ventral exterior,  $\times 2$  (Roberts, 1964).—FIG. 1201, 5c–j. *V. novamexicana* (MILLER), upper Tournaisian, New Mexico; *c–g*, ventral, dorsal, lateral, anterior, and posterior views,  $\times 1$ ; *b–j*, transverse sections,  $\times 2$  (Carter, 1967b).

### Subfamily BASHKIRIINAE

#### Nalivkin, 1979

[*nom. transl.* CARTER in CARTER & others, 1994, p. 348, ex Bashkiriidae NALIVKIN, 1979, p. 143]

Small to medium size; lateral ribs simple; fold and sulcus ribbed; ventral interarea moderately high to very high, often flattened, catacline to procline. *Carboniferous (Tournaisian–Visean)*.

**Bashkiria** NALIVKIN, 1979, p. 144 [\**B. gemma*; OD].

Costation weak or obscure; otherwise similar to *Celsifornix*. *Carboniferous (Tournaisian)*: Russia (southern Urals).—FIG. 1203, 2a–d. \**B. gemma*; holotype, ventral, dorsal, anterior, and posterior views,  $\times 2$  (new).

**Adminiculoria** WATERHOUSE & GUPTA, 1979, p. 133

[\**Spirifer middlemissi* DIENER, 1915, p. 41; OD]. Medium size; moderately transverse with moderately high, concave, apsacline ventral interarea; lateral slopes covered with strong, simple, subangular, regularly lamellose plicae; fold and sulcus with several weaker, bifurcating costae; ventral interior with apical callosity and short dental adminicula that may be buried in callus; denticulation not established. *Carboniferous (?Visean)*: Kashmir.—FIG. 1203, 3. \**A. middlemissi* (DIENER); lectotype, dorsal valve exterior,  $\times 2$  (Diener, 1915).

**Celsifornix** CARTER, 1974, p. 677 [\**C. rowleyi*; OD].

Medium size; strongly transverse, outline acutely trigonal, cardinal extremities alate; ventral interarea high, flattened, moderately apsacline to slightly procline; fold and sulcus well defined but moderately developed; entire surface covered with simple costae; sulcus with simple median costa; other sulcal costae simple, if present, derived from sulcus-bounding ribs; growth lamellae subimbricate, regularly spaced; ventral interior with long, slender, moderately divergent dental adminicula placed outside sulcus and very short delthyrial plate; ctenophoridium supported by stout callus. *Carboniferous (Tournaisian)*: USA (Missouri, Illinois).—FIG. 1203, 4a–b. \**C. rowleyi*; holotype, ventral, dorsal, posterior, anterior, and lateral views,  $\times 1$ ; *f–h*, transverse sections,  $\times 1.5$  (Carter, 1974).

**Fusella** M'COY, 1844, p. 128 [\**Spirifera fusiformis* PHILLIPS, 1836, p. 217; OD]. Small; fold and sulcus with several weak costae; growth lamellae not imbricate; ventral interior with high, subparallel dental adminicula placed well within sulcus; otherwise similar to *Voiseyella*. *Carboniferous (Visean)*: British Isles.—FIG. 1203, 1a–e. \**F. fusiformis* (PHILLIPS); holotype, ventral, lateral, dorsal, posterior, and anterior views,  $\times 1$  (Waterhouse, 1970).—FIG. 1203, 1f–g. *F. rhomboidea* (PHILLIPS); *f*, dorsal interior,  $\times 4$ ; *g*, ventral interior,  $\times 3$  (Brunton & Rissoné, 1976).

### Subfamily PTEROSPIRIFERINAE

#### Waterhouse, 1975

[Pterospiriferinae WATERHOUSE, 1975, p. 15]

Medium to large; ribs on flanks simple or bifurcating, rarely fasciculate; fold and sulcus smooth or with median rib, rarely costate; dental adminicula short and divergent. *Carboniferous (Pennsylvanian)–Permian (Lopingian)*.

**Pterospirifer** DUNBAR, 1955, p. 128 [\**Spirifer alatus*

VON SCHLOTHEIM, 1813, p. 58; OD]. Medium size, strongly transverse with alate to mucronate cardinal extremities; ventral interarea moderately high, apsacline; delthyrium closed by strongly convex stegidium in large adults; fold and sulcus smooth, or sulcus with weak median rib; lateral slopes with moderately numerous simple or rarely bifurcating costae; growth lamellae fine and regularly spaced; ventral interior with short, divergent dental adminicula and apical callus simulating delthyrial plate. *Permian (Cisuralian–Lopingian)*: Europe, Greenland, Siberia.—FIG. 1204, 2a–b. \**P. alatus* (VON SCHLOTHEIM), Germany; ventral valve, dorsal view,  $\times 1$  (Dunbar, 1955).—FIG. 1204, 2c–d. *P. terechovi* ZAVODOVSKII, Cisuralian, Siberia; ventral and dorsal views,  $\times 1$  (Zavodovskii, 1968a).

**Alispirifer** CAMPBELL, 1961a, p. 434 [\**A. laminosa*;

OD]. Plicae on flanks rather coarse, not numerous, rarely bifurcating; fold and sulcus narrow, usually smooth, rarely with faint median costa and corresponding shallow groove on fold; stegidial cover absent; otherwise similar to *Pterospirifer*. *Carboniferous (Pennsylvanian)*: Australia, South America.—FIG. 1204, 1a–f. \**A. laminosa*, New South Wales; *a–d*, ventral valve mold, dorsal valve exterior, dorsal interior, ventral valve exterior,  $\times 1$ ; *e*, microornament,  $\times 7$ ; *f*, ventral interior,  $\times 1$  (Campbell, 1961a).

**Haplospirifer** LI & GU, 1976, p. 280 [\**H. typicus*;

OD]. Large, transversely subpentagonal to subovate in outline; ventral valve more inflated than dorsal; ventral interarea high, flattened, vertically grooved; delthyrium open; ventral beak slightly incurved; fold and sulcus strongly developed; sulcus with prominent, dorsally directed tongue; dorsal valve

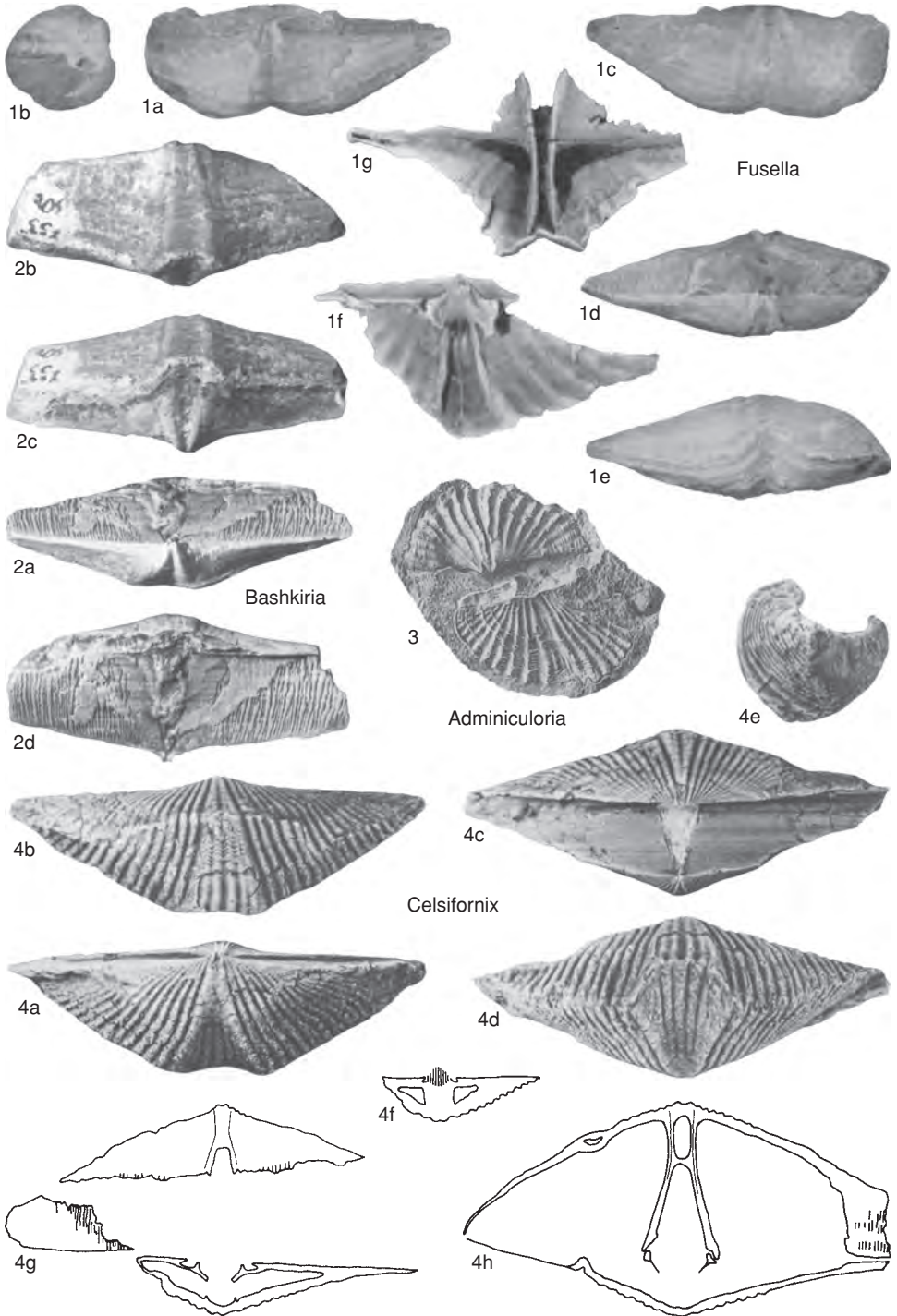


FIG. 1203. Strophopleuridae (p. 1815).



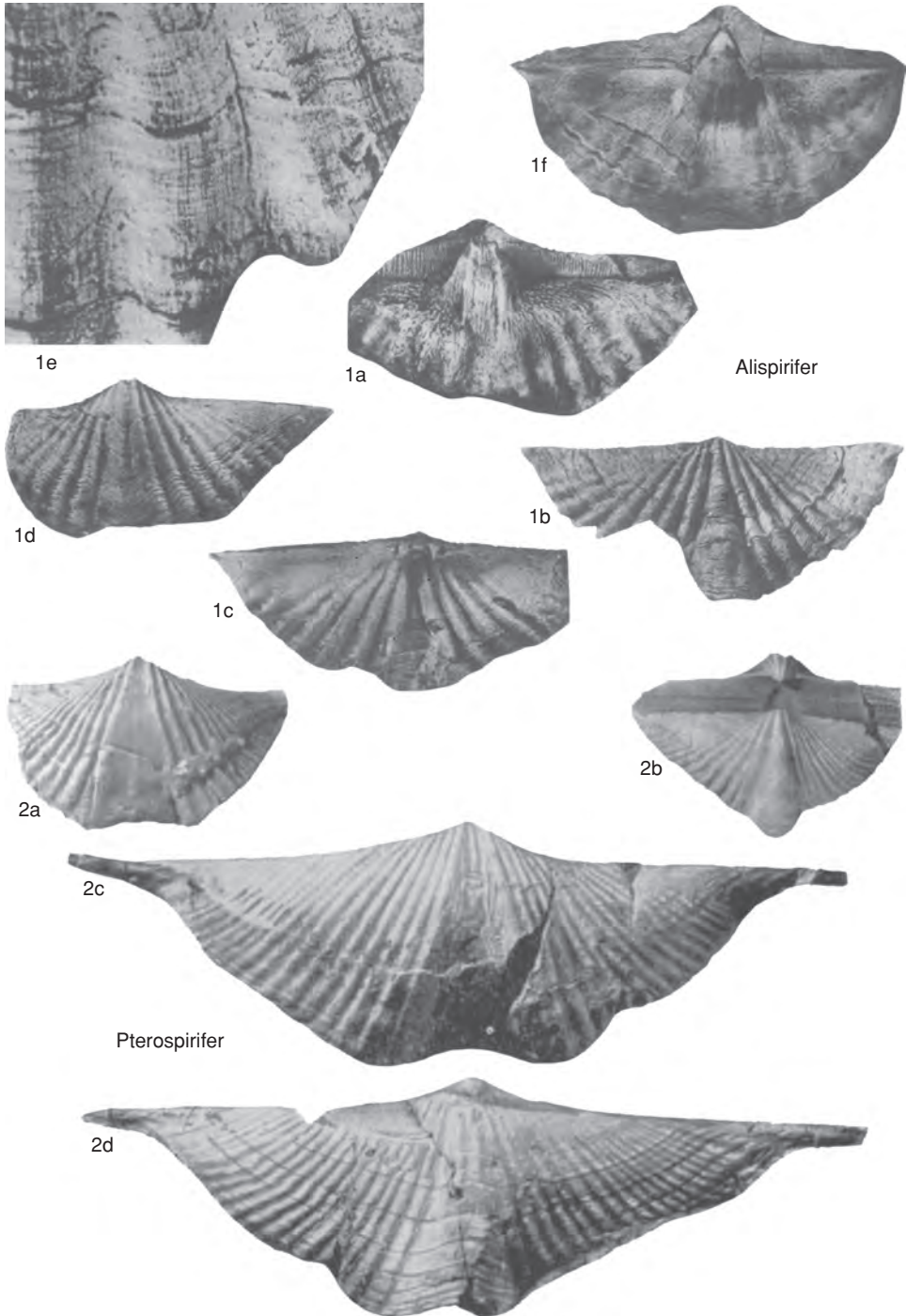


FIG. 1204. Strophopleuridae (p. 1815).

with shallow sulci adjacent to fold; lateral slopes with moderately numerous, mostly simple costae; ribs near fold-sulcus trifurcate, few others bifurcate; fold and sulcus smooth; ventral interior with short dental adminicula and large muscle scars. *Permian (Cisuralian)*: China.—FIG. 1205, 4a–d. \**H. typicus*; ventral, dorsal, anterior, and posterior views,  $\times 1$  (Li & Gu, 1976).

**Pteroplecta** WATERHOUSE, 1978, p. 56 [\**P. laminatus*; OD]. Medium to large; transverse; cardinal extremities alate; ventral interarea high; fold and sulcus well defined; flanks with few broad plicae anteriorly covered with bundled costae; fold and sulcus with several weaker costae; surface regularly lamellose and strongly capillate; ventral interior with divergent dental adminicula. *Permian (Lopingian)*: Nepal.—FIG. 1205, 2a–b. \**P. laminata*; a, holotype, dorsal valve; b, ventral valve,  $\times 2$  (Waterhouse, 1978).

**Spiriferinaella** FREDERIKS, 1926, p. 407 [\**Spirifer artiensis* STUCKENBERG, 1898, p. 266; OD]. Moderately to strongly transverse with alate cardinal extremities; fold and sulcus narrow, noncostate; sulcus well defined by disproportionately large bounding ribs; flanks with few simple, rounded plications; growth lamellae regularly spaced and imbricate; ventral interior with high, subparallel dental adminicula that follow margins of sulcus; apical region filled with thick callus. *Carboniferous (lower Moscovian)*—*Permian (Guadalupian)*: southeastern Alaska, *lower Moscovian*; Russia, *Cisuralian*; USA (Texas), *Guadalupian*.—FIG. 1205, 3a. \**S. artiensis* (STUCKENBERG), *Cisuralian*, Russia; syntype, ventral valve,  $\times 2$  (new).—FIG. 1205, 3b–e. *S. scalpata* COOPER & GRANT, *Guadalupian*, Texas; dorsal interior, dorsal, ventral, and ventral interior views,  $\times 1$  (Cooper & Grant, 1976a).

**Xizispirifer** LIANG, 1990, p. 323 [475] [\**X. zhejiangensis*; OD]. Medium size; outline subtriangular; strongly inequivalved, nearly planoconvex; ventral valve subconical, dorsal flattened; maximum width at hinge line; cardinal extremities angular; ventral interarea high, procline, slightly concave; perideltidial areas well defined; delthyrium open; fold and sulcus moderately well developed; lateral slopes with moderately numerous simple costae; fold smooth, well rounded; sulcus with broad median plica; surface lamellose; dental adminicula absent; ctenophoridium very wide. *Permian (Guadalupian)*: China (Zhejiang).—FIG. 1205, 1a–d. \**X. zhejiangensis*; holotype, ventral, posterior, lateral, and dorsal views,  $\times 2$  (Liang, 1990).

## Family PAECKELMANELLIDAE

Ivanova, 1972

[Paeckelmanellidae IVANOVA, 1972, p. 40]

With ventral median septum; lateral ribs simple. *Permian (Cisuralian–Lopingian)*.

## Subfamily PAECKELMANELLINAE

Ivanova, 1972

[*nom. transl.* WATERHOUSE, 1975, p. 15, ex Paeckelmanellidae IVANOVA, 1972, p. 40]

With short, divergent dental adminicula. *Permian (Cisuralian–Lopingian)*.

**Paeckelmanella** LIKHAREV, 1934, p. 212 [\**Spirifer dieneri* CHERNYSHEV, 1902, p. 535; OD]. Strongly transverse with mucronate to alate cardinal extremities; lateral slopes with increasingly weak, broad, simple plications; ventral interarea moderately high; fold smooth, carinate; sulcus with weak to strong median rib; ventral valve interior with short, divergent dental adminicula, delthyrial plate, and long, high median septum. *Permian (Cisuralian)*: Russia.—FIG. 1206, 1a–f. \**P. dieneri* (CHERNYSHEV); a, syntype, large dorsal valve; b–c, dorsal and posterior views of smaller syntype; d–f, ventral, dorsal, and anterior views of medium syntype,  $\times 1$  (new).

**Darvasia** LIKHAREV, 1934, p. 212 [\**D. edelsteini*; OD]. Medium size, transverse; maximum width at hinge line; ventral valve subconical, dorsal valve much thinner, weakly convex; ventral interarea very high, flattened, vertically grooved, catacline or procline, with smooth perideltidial areas; fold and sulcus narrow, moderately developed, seemingly smooth; lateral slopes with numerous narrow, weak costae; microornament unknown; ventral interior with widely divergent dental adminicula, delthyrial plate and low median septum; dorsal interior unknown. *Permian (Cisuralian)*: Tajikistan.—FIG. 1206, 2a–g. \**D. edelsteini*; a–e, holotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$ ; f–g, enlargements of views b and d,  $\times 2$  (new).

**Odontospirifer** DUNBAR, 1955, p. 154 [\**O. mirabilis*; OD]. Small, moderately transverse, with slightly alate cardinal extremities; sulcus moderately narrow, with single, simple median rib; fold narrow, high, rounded; flanks with few coarse, high, rounded, simple plicae; growth lamellae irregularly imbricate; ventral interior with very short dental adminicula and long, high median septum. *Permian (Lopingian)*: Greenland.—FIG. 1206, 4a–e. \**O. mirabilis*; a–d, holotype, dorsal, ventral, lateral, and anterior views,  $\times 2$ ; e, ventral valve posterior,  $\times 5$  (Dunbar, 1955).

## Subfamily SCENESIINAE Carter, 1994

[Scenesiinae CARTER in CARTER & others, 1994, p. 348]

With short, apical delthyrial plate; dental adminicula absent. *Permian (Cisuralian)*.

**Scenesia** COOPER & GRANT, 1976b, p. 2,756 [\**S. extensa*; OD]. Small; transversely subtriangular in outline; cardinal extremities widely extended, alate; fold and sulcus well delineated by strong, coarse plicae on ventral valve and deep, wide interspaces or sulci on dorsal valve; fold high, rounded carinate;

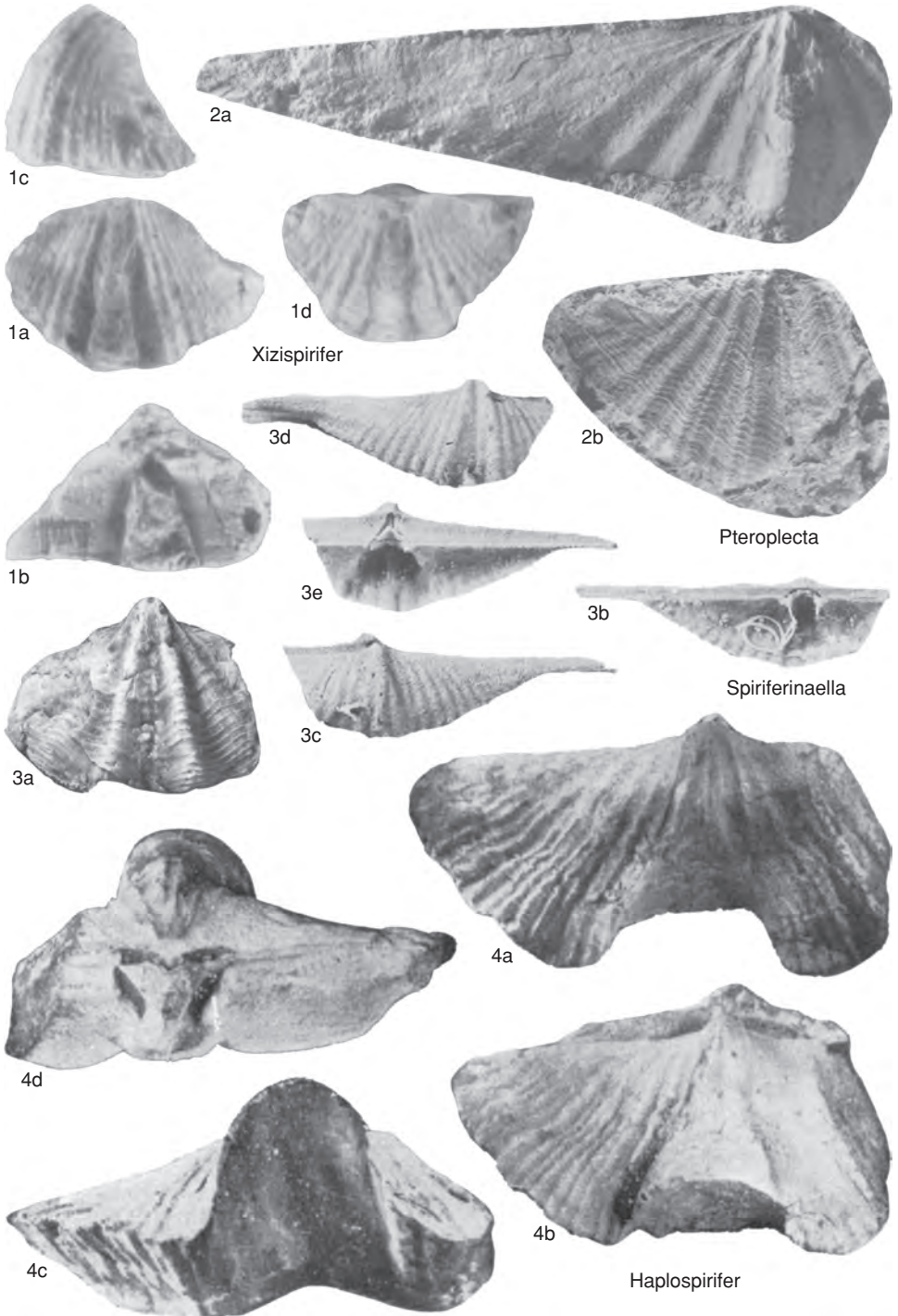


FIG. 1205. Strophopleuridae (p. 1815–1818).

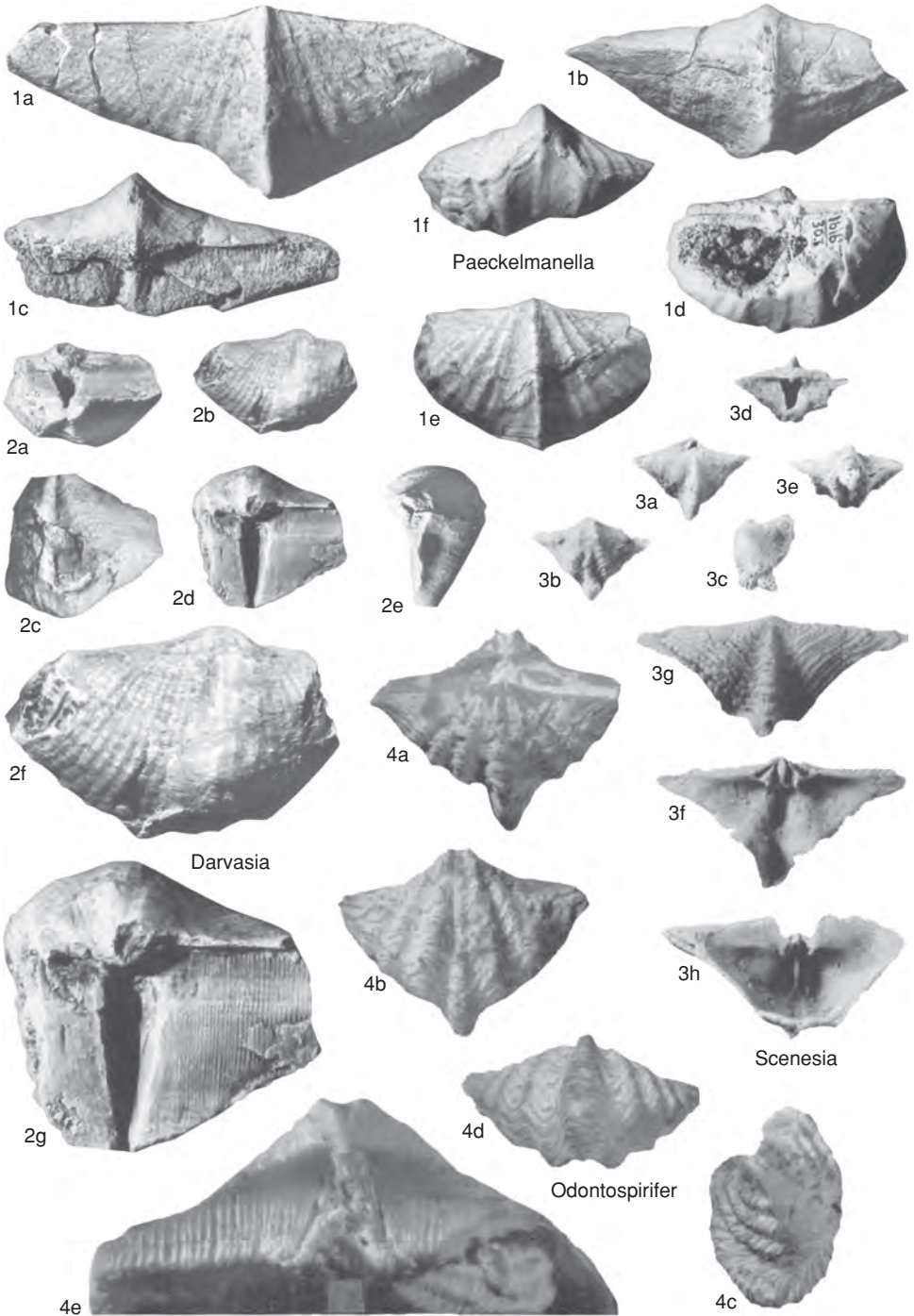


FIG. 1206. Paekelmanellidae (p. 1818–1821).

sulcus with anteriorly projecting median plica; other ribbing absent; growth lamellae regularly spaced, moderately lamellose; microornament absent. *Permian (Cisuralian)*: USA (Texas).—FIG.

1206,3a–b. \**S. extensa*; a–e, holotype, dorsal, ventral, lateral, posterior, and anterior views, ×2; f–g, dorsal interior, dorsal exterior, ×5; h, oblique view of ventral interior, ×2 (Cooper & Grant, 1976b).

## BRACHYTHYRIDOIDEA

J. L. CARTER

[retired from Carnegie Museum of Natural History]

### Superfamily BRACHYTHYRIDOIDEA Frederiks, 1924

[*nom. transl. et correct.* CARTER in CARTER & others, 1994, p. 348, ex Brachithyrinae FREDERIKS, 1924, p. 316]

Outline ovate; hinge line narrow; cardinal extremities rounded in all growth stages; lateral slopes with coarse, usually simple ribbing; fold-sulcus weakly to moderately developed; denticulation not present in younger genera; microornament absent or weakly developed; delthyrium partially covered by thin deltidium or stegidial plates; dental adminicula, subdelthyrial plate, and dorsal adminicula or crural plates absent. *Upper Devonian (Famennian)–Permian (Lopingian)*.

### Family BRACHYTHYRIDIDAE Frederiks, 1924

[*nom. transl. et correct.* PITRAT, 1965, p. 706, ex Brachithyrinae FREDERIKS, 1924, p. 316]

Primary median costa in sulcus absent. *Upper Devonian (Famennian)–Permian (Lopingian)*.

*Brachythyris* M'COY, 1844, p. 128 [\**Spirifera ovalis* PHILLIPS, 1836, p. 219; SD BUCKMAN, 1908, p. 30] [= *Ovalia* NALIVKIN, 1937, p. 107, obj.]. Small to medium size; fold and sulcus moderately narrow, well delimited; sulcus smooth or with faint costae on sides of sulcus; fold smoothly rounded; lateral slopes with broad, rounded, simple plications sepa-

rated by moderately narrow interspaces; some species faintly capillate; hinge line commonly denticulate. *Upper Devonian (Famennian)–Carboniferous (Mississippian)*: cosmopolitan.—FIG. 1207,1a–d. \**B. ovalis* (PHILLIPS), Viséan, England; lectotype, ventral, dorsal, anterior, and posterior views, ×1 (new).

*Cathayspirina* LIANG, 1990, p. 339 [478] [\**C. fenshuijiangensis*; OD]. Small, strongly and subequally biconvex; lateral slopes coarsely plicate with broad, well-rounded interspaces; fold and sulcus weakly developed, smooth, poorly delimited; shell substance thick; otherwise similar to *Brachythyris*. *Permian (Lopingian)*: China (Zhejiang).—FIG. 1207,4a–e. \**C. fenshuijiangensis*; anterior, posterior, ventral, lateral, and dorsal views, ×3 (Liang, 1990).

*Dalaia* PŁODOWSKI, 1968, p. 256 [\**D. tardiplicata*; OD]. Small to medium; outline transversely subovate; ventral umbonal region and beak poorly produced; fold and sulcus weakly developed, smooth; lateral slopes weakly plicate with narrow interspaces; ventral interior with short apical callus; microornament of faint capillae; otherwise similar to *Brachythyris*. *Permian (Cisuralian)*: central Afghanistan.—FIG. 1207,2a–f. \**D. tardiplicata*; a, holotype, ventral valve; b–f, paratype, ventral, dorsal, lateral, posterior, and anterior views, ×1 (Płodowski, 1970).

*Ella* FREDERIKS, 1918a, p. 87 [\**Martinia simensis* CHERNYSHEV, 1902, p. 569; OD]. Small, subovate to guttate in outline; ventral umbonal region elongated; fold and sulcus with several faint costae; otherwise similar to *Brachythyris*. *Permian (Cisuralian)*: Russia.—FIG. 1207,5a–d. \**E. simensis* (CHERNYSHEV), Urals; syntype, ventral, dorsal, anterior, and lateral views, ×2 (new).

*Meristorygma* CARTER, 1974, p. 689 [\**M. arctica*; OD]. Medium size; fold and sulcus moderately developed, well defined, forming subquadrate tongue; lateral ribs few, poorly defined; sulcus with median

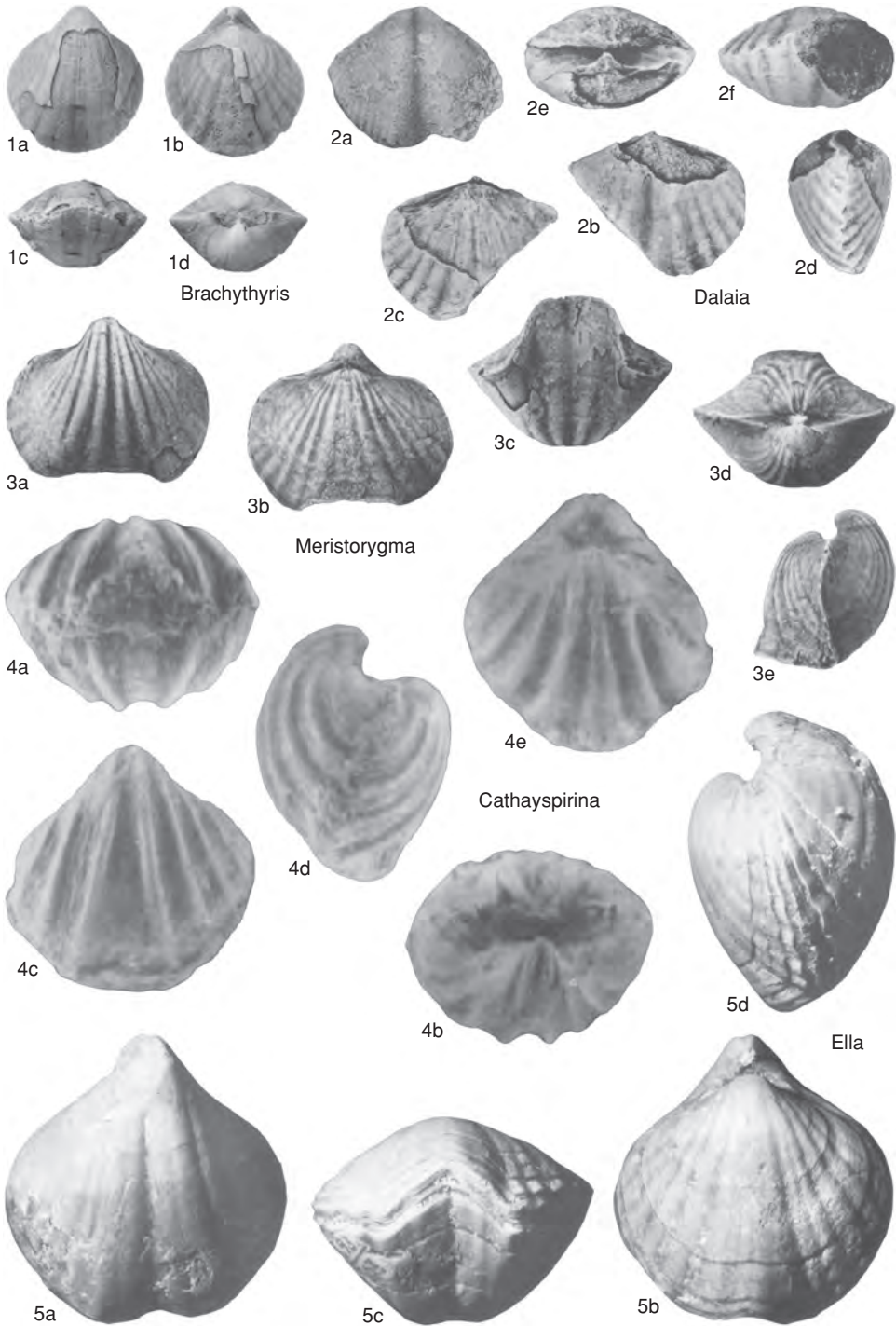
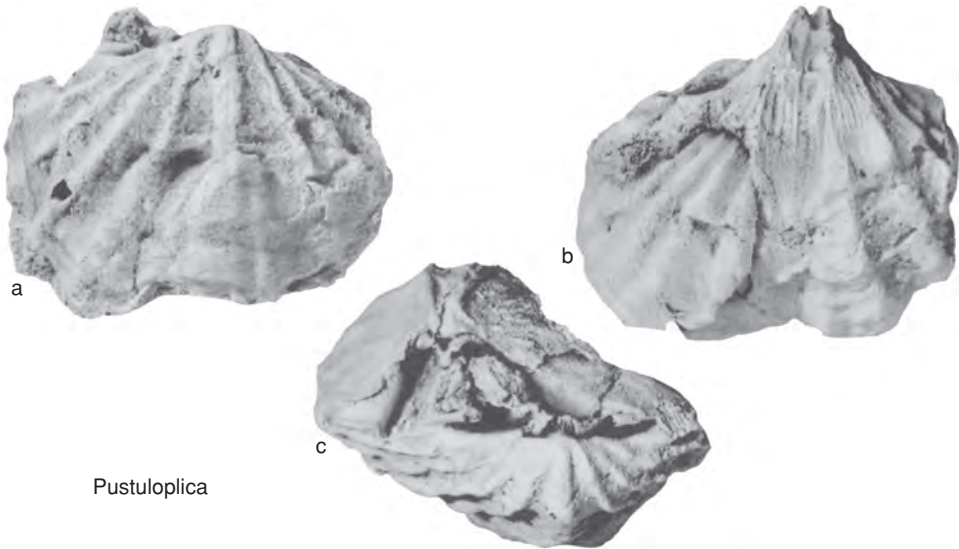


FIG. 1207. Brachythyrididae (p. 1821–1823).



Pustuloplica

FIG. 1208. Brachythyrididae (p. 1823).

furrow and 2, or rarely, 4 primary sulcal costae that bifurcate from coarse, sulcus-bounding costae; fold with 3 distinct costae, lateral 2 of which may weakly bifurcate; interspaces wide; hinge line nondenticulate; microornament absent; shell substance thick; ventral muscle field deeply impressed. *Carboniferous* (?Mississippian, Pennsylvanian)—*Permian* (*Cisuralian*): Arctic of Canada and Russia. —FIG. 1207,3a–e. \**M. arctica*, Atokan, Pennsylvanian, Ellesmere Island; holotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1$  (Carter, 1974).

**Pustuloplica** WATERHOUSE, 1968, p. 45 [\**P. baccata*; OD]. Small; strongly and subequally biconvex; fold and sulcus moderately developed; lateral slopes with several strong, coarse, simple plicae with broad interspaces; fold and sulcus with weak ribs on sides; microornament of discontinuous strong capillae or very elongated pustules, and fine growth lamellae; ventral interior with short umbonal callosity. *Permian* (*Sakmarian*): New Zealand, Australia. —FIG. 1208a–c. \**P. baccata*, New Zealand; holotype, dorsal, ventral, and posterior views,  $\times 3$  (Waterhouse, 1968).

#### Family SKELIDORYGMIDAE Carter, 1994

[Skelidorygmidae CARTER in CARTER & others, 1994, p. 349]

Sulcus with primary median costa, often with additional sulcal costae that bifurcate

from sulcus-bounding ribs. *Upper Devonian* (*Famennian*)—*Carboniferous* (*Bashkirian*).

**Skelidorygma** CARTER, 1974, p. 692 [\**Spirifer subcardiiformis* HALL, 1858, p. 660; OD]. Fold and sulcus moderately to poorly developed; surface entirely costate; lateral costae few, broad, flattened, well defined, simple; interspaces narrow; sulcus with simple median costa and 1 or 2 pairs of simple, lateral sulcal costae that bifurcate from sulcus-bounding costae in umbonal region; hinge line weakly to nondenticulate; microornament absent. *Carboniferous* (*upper Tournaisian*—*Bashkirian*): North America, Russia. —FIG. 1209,2a–e. \**S. subcardiiformis* (HALL), Visean, Illinois, USA; holotype, ventral, lateral, dorsal, posterior, and anterior views,  $\times 1$  (Carter, 1974). —FIG. 1209,2f–j. *S. bamberi* CARTER, upper Tournaisian, Alberta; f, ventral exterior,  $\times 1$ ; g, enlarged anterior view of ventral interior; h, enlarged ventral interior; i, enlarged posterior view of ventral valve,  $\times 2$ ; j, ventral valve,  $\times 1$  (Carter, 1987).

**Lithothyris** ROBERTS, 1971, p. 237 [\**L. alticostata*; OD]. Entire surface with numerous low, well-rounded, mostly simple costae with narrow interspaces; costae adjacent to or on fold-sulcus occasionally bifurcating; ventral valve with very short delthyrial plate. *Upper Devonian* (*Famennian*): Australia (Bonaparte Gulf basin). —FIG. 1209,1a–e. \**L. alticostata*; holotype, ventral, dorsal, posterior, anterior, and lateral views,  $\times 1$  (Roberts, 1971).

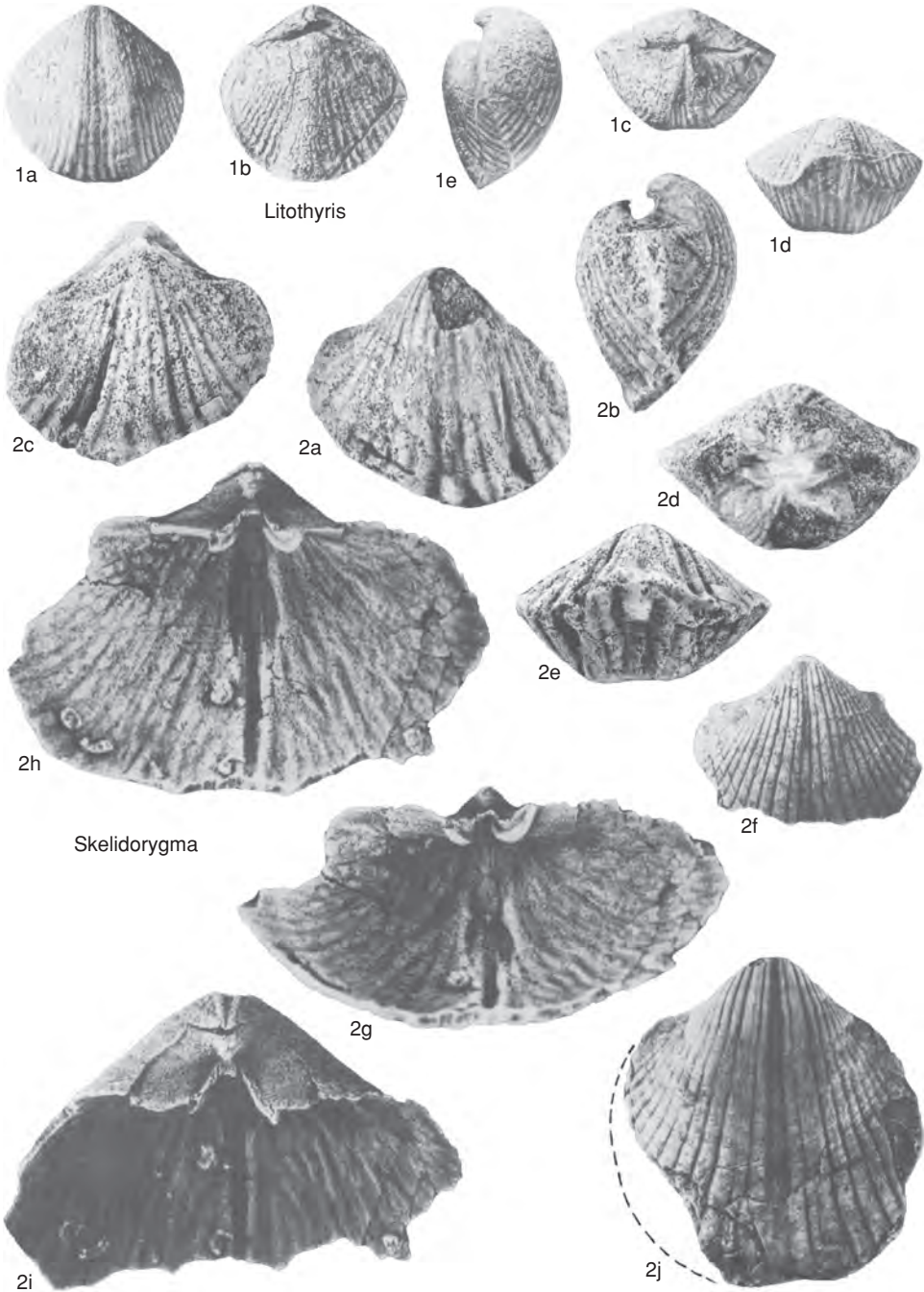


FIG. 1209. Skelidorygmidae (p. 1823).



# DELTHYRIDINA

J. G. JOHNSON,<sup>1</sup> HOU HONG-FEI,<sup>2</sup> J. L. CARTER,<sup>3</sup> and RÉMY GOURVENNEC<sup>4</sup>

[deceased, formerly of Oregon State University; <sup>2</sup>China University of Geosciences; <sup>3</sup>Carnegie Museum of Natural History; and <sup>4</sup>Université de Bretagne Occidentale]

## Suborder DELTHYRIDINA

Ivanova, 1972

[Delthyridina IVANOVA, 1972, p. 41]

Radial ornament, if present, plicate, rarely costate; concentric ornament lamellose, if present; microornament, if any, capillate,

spinulose or exopunctate; early forms with internal plates and septa, tending to become paedomorphically simple in some geologically younger forms; dorsal diductor attachment site usually striate. *Silurian* (upper Llandovery)–*Permian* (Lopingian).

# DELTHYRIDOIDEA

J. G. JOHNSON and HOU HONG-FEI

[deceased, formerly Oregon State University; and China University of Geosciences]

## Superfamily DELTHYRIDOIDEA

Phillips, 1841

[*nom. correct.* JOHNSON, 1970, p. 184, *pro* Delthyridoidea IVANOVA, 1959, p. 56, *nom. transl. ex* Delthyridae PHILLIPS, 1841, p. 54]

Biconvex, with fold and sulcus; flanks plicated; ornament of growth lamellae bearing radially arranged spines (fimbriate), or radial ornament absent; dental plates and ctenophoridium commonly present. *Silurian* (upper Llandovery)–*Carboniferous* (Visean).

## Family DELTHYRIDIDAE Phillips, 1841

[*nom. correct.* JOHNSON, 1970, p. 184, *pro* Delthyridae PHILLIPS, 1841, p. 54]

Small to medium size, pauciplicate, fimbriate; commonly with crural plates. *Silurian* (upper Llandovery)–*Middle Devonian* (Eifelian).

## Subfamily DELTHYRIDINAE Phillips, 1841

[*nom. transl. et correct.* JOHNSON, 1970, p. 184, *ex* Delthyridae PHILLIPS, 1841, p. 54]

Ventral median septum present. *Silurian* (?upper Llandovery, Wenlock)–*Middle Devonian* (Eifelian).

**Delthyris** DALMAN, 1828, p. 99 [\**D. elevata* DALMAN, 1828, p. 120; SD SCHUCHERT, 1897, p. 206]. Medium to large, ventribiconvex; equidimensional or transverse; ventral interarea apace; fold and sulcus smooth; flanks with few strong, simple plications; growth lamellae closely spaced; dental plates long, thin, subparallel to ventral median septum; crural plates present. *Silurian* (upper Llandovery, Wenlock)–*Middle Devonian* (Eifelian).

**D. (Delthyris)**. Medium size, equidimensional or transverse; ventral interarea curved. *Silurian* (?upper Llandovery, Wenlock)–*Middle Devonian* (Eifelian): cosmopolitan.—FIG. 1210, 1a–d. \**D. (D.) elevata*, Wenlock, Gotland; holotype, dorsal, ventral, lateral, and anterior views, ×2 (Bassett & Cocks, 1974).

**D. (Quadrifarius)** FUCHS, 1923, p. 854 [\**Spirifer* (*Quadrifarius*) *loculatus* FUCHS, 1923, p. 854; SD PAECKELMANN, 1931, p. 31; =*Spirifer dumontianus* DE KONINCK, 1876, p. 39]. Medium to large, transverse; ventral interarea flat to curved; fold with strong median groove, sulcus narrow, flattened medially. *Silurian* (Pridoli)–*Lower Devonian* (Lochkovian): Europe.—FIG. 1210, 2a–c. \**D. (Q.) dumontianus* (DE KONINCK), Lochkovian, Belgium; anterior, posterior, and dorsal views, ×1 (Asselberghs, 1930).

**Ivanothyris** HAVLIČEK, 1957b, p. 438 [\**Spirifer gibbosus* BARRANDE, 1879, pl. 2, 7–8; OD]. Medium size, strongly biconvex, transversely oval; ventral interarea curved, low, apace to orthocline; fold and sulcus smooth; flanks with few strong, simple plications; growth lamellae closely spaced; dental plates and ventral median septum buried in umbonal callus; crural plates obsolete. *Lower Devonian*

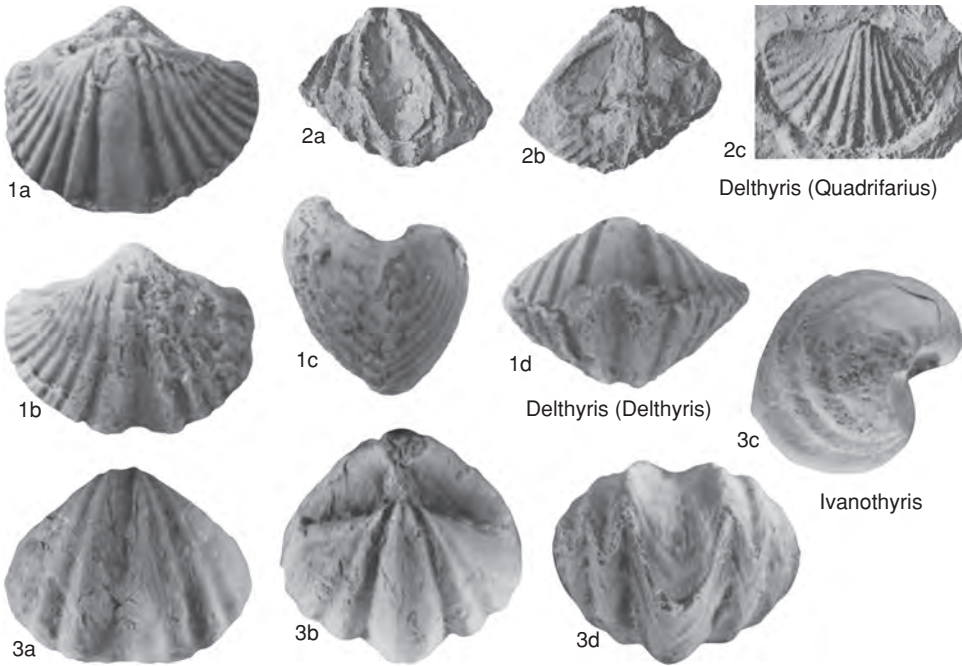


FIG. 1210. Delthyrididae (p. 1825–1826).

(Lochkovian)—Middle Devonian (Eifelian): Europe, Kazakhstan, western Siberian plain.—FIG. 1210,3a–d. \**I. gibbosa* (BARRANDE), Lochkovian, Bohemia; ventral, dorsal, side, and anterior views,  $\times 1.5$  (Havlíček, 1959).

### Subfamily HOWELLELLINAE Johnson & Hou, 1994

[Howellellinae JOHNSON & HOU in CARTER & others, 1994, p. 350]

Ventral median septum absent. *Silurian* (upper Llandovery)—Middle Devonian (Eifelian).

**Howellella** KOZŁOWSKI, 1946, p. 295, *nom. nov. pro Crispella* KOZŁOWSKI, 1929, p. 189, *non* GRAY, 1870, p. 25 [\**Terebratula crispus* VON HISINGER, 1826, pl. 7, 4; OD; *non Anomia crispus* LINNAEUS, 1758, p. 702, =*Delthyris elegans* MUIR-WOOD, 1925, p. 90]. Small to medium size, biconvex, transversely oval; ventral interarea curved, apsacline; fold and sulcus smooth; flanks with strong, simple plications; growth lamellae closely spaced; dental plates and crural plates present. *Silurian* (upper Llandovery)—Lower Devonian (Emsian): cosmopolitan.

**H. (Howellella)**. Small; flanks with few plications; dental plates thin to relatively thick, divergent. *Silurian* (upper Llandovery)—Lower Devonian (Emsian): cosmopolitan.—FIG. 1211,1a–d.

\**H. (H.) elegans* (MUIR-WOOD), upper Llandovery, Gotland; holotype, dorsal, ventral, lateral, and anterior views,  $\times 4$  (Bassett & Cocks, 1974).

**H. (Hysterohowellella)** CARLS, 1985, p. 310 [\**Howellella cortazari* CARLS, 1969, p. 343; OD]. Medium size; dental plates thin; umbonal callus lacking. Lower Devonian (Lochkovian): cosmopolitan.—FIG. 1211,3a–b. \**H. (H.) cortazari* CARLS, Spain; ventral and dorsal molds,  $\times 2$  (Carls, 1969).

**H. (Iberohowellella)** CARLS, MEYN, & VESPERMANN, 1993, p. 248 [\**H. (I.) hollmanni*; OD]. Medium to large; dental plates and minor umbonal callus present. Lower Devonian (Lochkovian—lower Pragian): cosmopolitan.—FIG. 1211,2a–b. \**H. (I.) hollmanni*, upper Lochkovian, Spain; holotype, ventral and lateral views,  $\times 2$  (Carls, Meyn, & Vespermann, 1993).

**Acanthospirifer** MENAKOVA, 1964, p. 34 [\**A. edelschsteini* MENAKOVA, 1964, p. 35; OD]. Medium size, biconvex, equidimensional; ventral interarea low, curved, apsacline; fold with median groove anteriorly; flanks with few strong, simple or, uncommonly, bifurcating plications; growth lamellae closely spaced; dental plates thin, short; crural plates present. *Silurian* (upper Wenlock)—Lower Devonian (Lochkovian): Tajikistan (Zeravshan-Gissarsk area).—FIG. 1211,4a–e. \**A. edelschsteini*, upper Wenlock, Tajikistan; a–d, holotype, dorsal, ventral, lateral, and anterior views,  $\times 1$ ; e, microornament,  $\times 4$  (Menakova, 1964).

- Aldanispirifer** ALEKSEEVA, 1967, p. 96 [\**A. belenae* ALEKSEEVA, 1967, p. 97; OD] [=*Holcospirifer* BASSETT, COCKS, & HOLLAND, 1976, p. 620 (type, *Spirifer bigugosus* M'COY, 1846, p. 36, OD)]. Medium size, biconvex, transverse, with rounded or acute cardinal angles; slightly curved, apsacline ventral interarea; fold with strong median groove; flanks with prominent plications and deep, U-shaped interspaces; dental plates thin, widely spaced; crural plates absent. *Silurian* (upper Wenlock)—*Lower Devonian* (Lochkovian): Ireland, Sette Daban area, Canadian Arctic Islands.—FIG. 1212, 1a–e. \**A. belenae*, Lochkovian, Sette Daban; holotype, ventral, dorsal, lateral, posterior, and anterior views,  $\times 1$  (Aleksseva, 1967).
- Howelloidea** SU, 1980, p. 314 [\**H. rostrata*; OD]. Medium size, ventribiconvex, transverse; fold and sulcus distinct, smooth or with plication in sulcus; flanks with low, rounded plications; ornament of spines on concentric lamellae; dental plates short, partly obscured by secondary shell material, with muscle field deeply impressed; crural plates short, divergent. *Lower Devonian* (Emsian): northeastern China (Heilongjiang province).—FIG. 1211, 7a–d. \**H. rostrata*; ventral, dorsal, anterior, posterior, and lateral views of internal mold,  $\times 1$  (Su, 1980).
- Orientospirifer** HOU & XIAN, 1975, p. 49 [\**Eospiriferina nakaolingensis* HOU, 1959b, p. 452; OD]. Small, transverse with rounded cardinal angles; ventral interarea low, apsacline; fold and sulcus smooth; lateral plications simple, subrounded; microornament of irregular spines and closely spaced concentric lamellae, prominent anteriorly; well-developed, divergent dental plates; ctenophoridium present; crural plates absent. *Lower Devonian* (Pragian–Emsian): southern China, northern Vietnam.—FIG. 1212, 5a–d. \**O. nakaolingensis* (HOU), Pragian, southern China; ventral, dorsal, anterior, and side views,  $\times 1.5$  (Hou & Xian, 1975).
- Pseudokymatothyris** CHEN, 1979, p. 22 [\**P. sinensis*; OD]. Medium to large, subquadrate, with rounded cardinal angles; ventral interarea low, curved, apsacline to orthocline; fold and sulcus prominent, smooth, rounded; flanks with few strong, rounded plications and U-shaped interspaces; concentric lamellae widely spaced; dental plates and thick umbonal callus present; short crural plates present. *Lower Devonian* (upper Pragian–lower Emsian): China (northern Sichuan).—FIG. 1211, 5a–d. \**P. sinensis*, lower Emsian; ventral, dorsal, anterior, and posterior views,  $\times 1$  (new).
- Qiansispirifer** YANG in YANG & others, 1977, p. 422 [\**Q. speciosus* YANG in YANG & others, 1977, p. 423; OD]. Small, biconvex, equidimensional; ventral interarea curved, apsacline; fold and sulcus distinct, smooth; flanks pauciplicate; growth lamellae closely spaced; slender dental plates present; ctenophoridium present; crural plates absent, platelike crural bases attached to median ridge posteriorly, free anteriorly. *Middle Devonian* (Eifelian): southern China.—FIG. 1211, 6a–d. \**Q. speciosus*; a–c, ventral, dorsal, and side views,  $\times 1$ ; d, exterior showing fine ornament,  $\times 5$  (Yang & others, 1977).
- Quiringites** STRUVE, 1992, p. 564 [\**Spirifera elegans* STEININGER, 1853, p. 72; OD]. Small, biconvex, transverse; ventral interarea curved, apsacline; fold and sulcus distinct, smooth; flanks strongly pauciplicate; growth lamellae closely spaced, with swollen spine bases; ventral myophragm and extrasinal dental plates present; ctenophoridium present; crural plates short, joining notothyrial thickening. *Lower Devonian* (Emsian)—*Middle Devonian* (Eifelian): western Europe, Canadian Arctic.—FIG. 1212, 4a–d. \**Q. elegans* (STEININGER); a–b, dorsal and posterior views (Quiring, 1915); c–d, posterior and ventral views of steinkern,  $\times 1$  (Scupin, 1900).
- Rufispirifer** HAVLÍČEK, 1987, p. 242 [\**Spirifer nucula* BARRANDE, 1879, pl. 2, 1–2; OD]. Small, strongly biconvex, slightly transverse, with obtuse cardinal angles; ventral interarea low, apsacline; fold and sulcus distinct, smooth; flanks with few, strong, rounded plications; growth lamellae closely spaced; dental plates short, thin; crural plates absent. *Silurian* (upper Wenlock–Ludlow): Czech Republic.—FIG. 1212, 2a–e. \**R. nucula* (BARRANDE), upper Wenlock, Bohemia; a–d, ventral, dorsal, side, and anterior views,  $\times 1.5$ ; e, ventral view showing fine ornament,  $\times 4.5$  (Havlíček, 1959).
- Xenospirifer** HOU & XIAN, 1975, p. 69 [\**Spirifer* (*Plectospirifer*) *fongi* GRABAU, 1931b, p. 380; OD]. Medium to large, equidimensional with subquadrate cardinal angles; ventral interarea long, curved, apsacline; fold and sulcus distinct; flanks with few strong, rounded, simple plications; concentric lamellae crossed by short radial spines or rows of granules anteriorly; long dental plates present; ctenophoridium present. *Lower Devonian* (Emsian)—*Middle Devonian* (Eifelian): Salair, western Siberian plain, southern China.—FIG. 1212, 3a–d. \**X. fongi* (GRABAU), Eifelian, southern China; ventral, dorsal, anterior, and side views,  $\times 1.5$  (new).

## Family HYSTEROLITIDAE

Termier & Termier, 1949

[*nom. transl.* JOHNSON & HOU in CARTER & others, 1994, p. 350, ex Hysterolitinae TERMIER & TERMIER, 1949a, p. 95]

Medium to large; fold and sulcus smooth or plicate; flanks commonly multiplicate; fimbriate; crural plates variably present. *Lower Devonian* (upper Lochkovian)—*Middle Devonian* (lower Givetian).

## Subfamily HYSTEROLITINAE

Termier & Termier, 1949

[Hysterolitinae TERMIER & TERMIER, 1949a, p. 95] [=Paraspiriferinae PITRAT, 1965, p. 684]

Fold and sulcus smooth; ctenophoridium present; generally lacking crural plates. *Lower Devonian* (upper Lochkovian)—*Middle Devonian* (Eifelian).

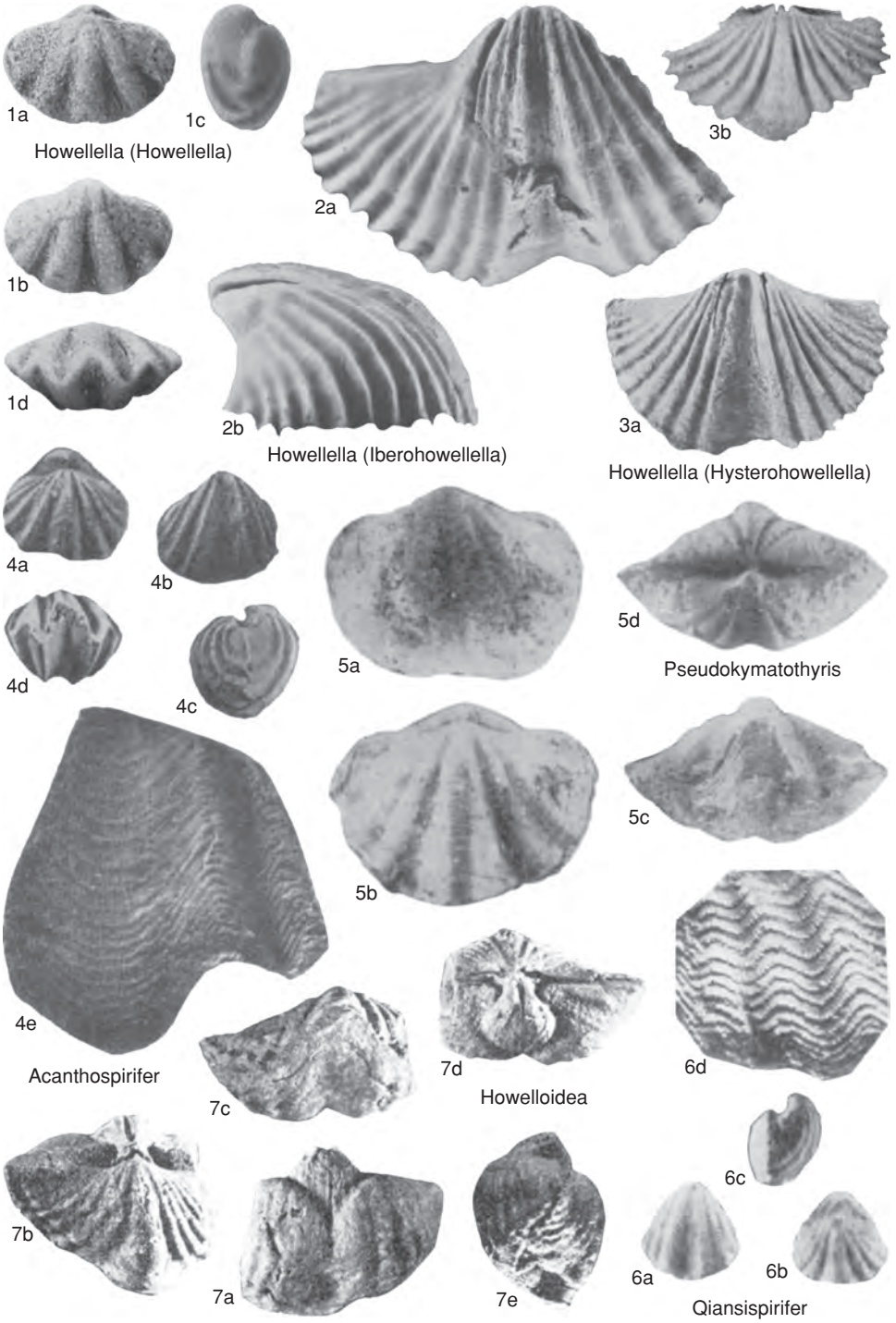


FIG. 1211. Delthyrididae (p. 1826–1827).

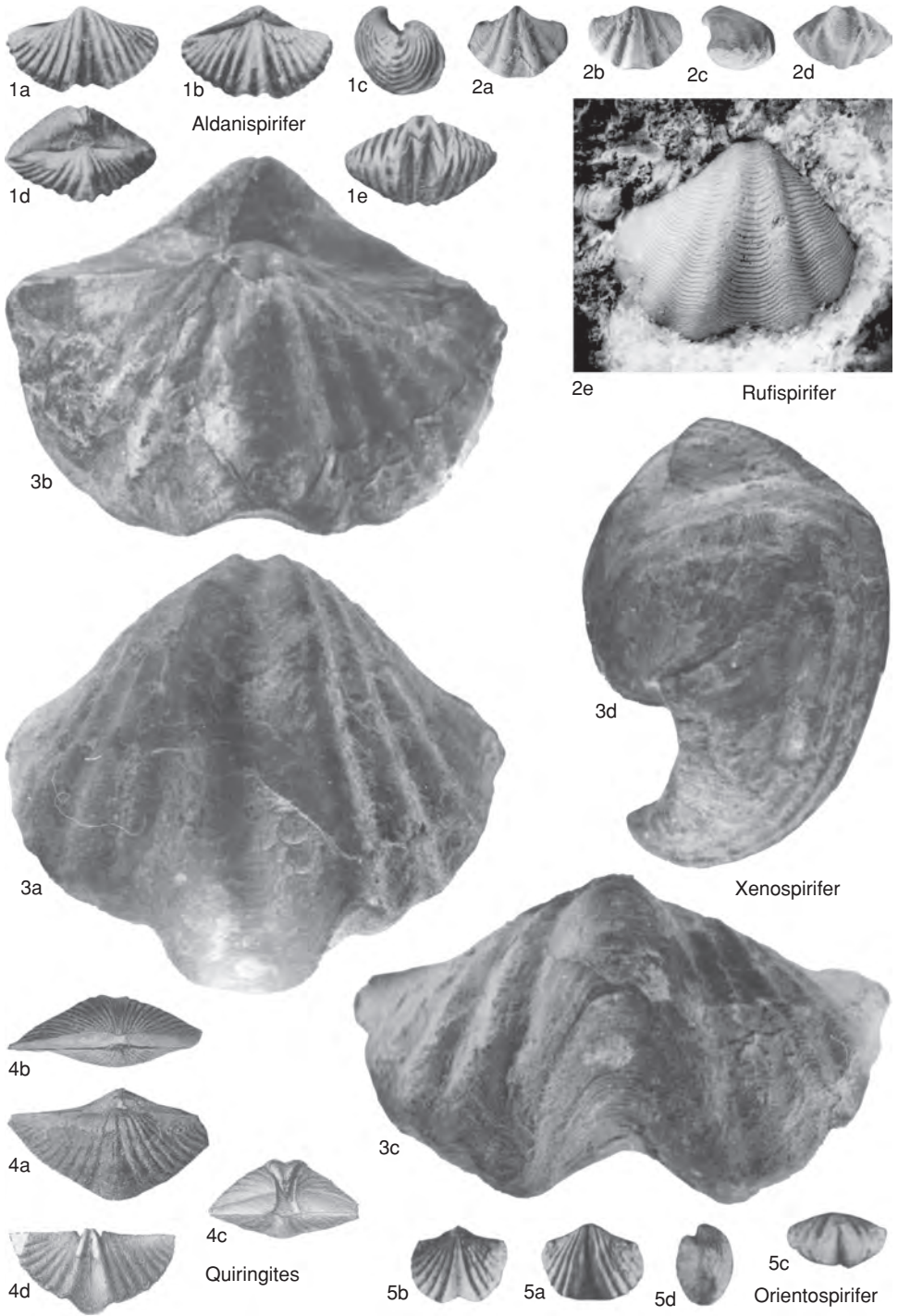


FIG. 1212. Delthyrididae (p. 1827).

- Hysterolites** VON SCHLOTHEIM, 1820, p. 247 [*\*H. hystericus* VON SCHLOTHEIM, 1820, p. 249; SD DALL, 1877a, p. 38]. Medium size, biconvex, transverse, with acute to rounded cardinal angles; ventral interarea curved, apsacline; fold and sulcus smooth; flanks with simple, rounded plications and U-shaped interspaces; growth lines numerous, strong; dental plates strong, tending to recurve medially, with little umbonal callus; ctenophoridium may be elevated; no crural plates. *Lower Devonian (Pragian–Emsian)*: Europe, western USA (Nevada).—FIG. 1213,2a–c. *\*H. hystericus hystericus*, Pragian, Germany; *a*, mold of ventral interior,  $\times 1.5$ ; *b*, mold of dorsal interior,  $\times 1$ ; *c*, ventral exterior,  $\times 1.5$  (Solle, 1963).
- Antispirifer** WILLIAMS & BREGER, 1916, p. 114 [*\*A. harroldi* WILLIAMS & BREGER, 1916, p. 116; OD]. Small, dorsibiconvex or dorsiplanar, transverse, with rounded, obtuse cardinal angles; ventral interarea low, apsacline, nearly flat; fold and sulcus low, narrow, smooth; flanks with few simple, rounded plications; growth lines numerous, strong; dental plates mostly buried in umbonal callus. *Lower Devonian (Pragian)*: eastern USA (Maine), ?Colombia.—FIG. 1214,3a–b. *\*A. harroldi*, Maine; ventral and dorsal exteriors,  $\times 1.5$  (Williams & Breger, 1916).
- Arduspirifer** MITTMAYER, 1972, p. 101 [*\*Spirifer Arduennensis* SCHNUR, 1853 in 1853–1854, p. 199; OD]. Medium size, transverse, with acute, commonly alate, cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus distinct, smooth; flanks with simple, rounded plications; dental plates mostly buried in umbonal callus. *Lower Devonian (Emsian)–Middle Devonian (Eifelian)*: Europe, North Africa.—FIG. 1214,2. *\*A. arduennensis* (SCHNUR), upper Emsian, Germany; internal mold of ventral valve,  $\times 1$  (Mittmeyer, 1972).
- Australospirifer** CASTER, 1939, p. 159 [*\*Spirifer keyserianus* CLARKE, 1913b, p. 252; OD]. Large, transverse, with acute to rounded cardinal angles; ventral interarea of medium height, apsacline, nearly flat; fold and sulcus not prominent; flanks with rounded plications, rarely bifurcating anteriorly; surface fimbriate posteriorly, capillate anteriorly; dental plates mostly buried in umbonal callus that may fill delthyrial cavity. *Lower Devonian (Emsian)*: Brazil, Argentina, Falklands, South Africa, Antarctica.—FIG. 1213,3a–c. *\*A. keyserianus* (CLARKE), Brazil; *a*, microornament,  $\times 5$ ; *b–c*, dorsal exterior, ventral exterior,  $\times 1$  (Clarke, 1913b).
- Brachyspirifer** WEDEKIND, 1926, p. 198 [*\*Spirifer carinatus* SCHNUR, 1853 in 1853–1854, p. 202; OD]. Medium to large, biconvex, transverse to equidimensional with rounded to acute cardinal extremities; ventral interarea curved, apsacline; fold and sulcus smooth; flanks with numerous simple, rounded plications; crural plates present or absent.
- B. (Brachyspirifer)**. Transverse to equidimensional with rounded cardinal angles; dental plates strong, tending to recurve medially, with little umbonal callus. *Lower Devonian (Emsian)*: Europe, western North America (Nevada).—FIG. 1213,4a–d. *\*B. (B.) carinatus* (SCHNUR), Germany; holotype, ventral, dorsal, posterior, and lateral views,  $\times 1$  (Vandercammen, 1967).
- B. (Torosospirifer)** GOURVENNEC, 1989, p. 158 [*\*Spirifer Rousseau* ROUAULT, 1846, p. 322; OD]. Transverse with acute to rounded cardinal angles; dental plates mostly buried in umbonal callus, with large, deeply impressed, ventral diductor muscle field; crural plates present, occasionally buried in umbonal callus. *Lower Devonian (Pragian–lower Emsian)*: Europe, Morocco.—FIG. 1213,5a–d. *\*B. (T.) rousseaui* (ROUAULT), Pragian, France; *a–b*, neotype, dorsal and ventral views of internal molds,  $\times 1.2$  (Gourvennec, 1989); *c*, neotype, lateral view of internal mold,  $\times 1.2$  (new); *d*, microornament,  $\times 15$  (Gourvennec, 1989).
- Costellispirifer** BOUCOT, 1973, p. 51 [*\*Spirifer perimele* CLARKE, 1907, p. 253; OD] [= *Concinnispirifer* BOUCOT, 1975, p. 367 (type, *Spirifer concinna* HALL, 1857, p. 60, OD)]. Medium size, biconvex, transverse, with acute to rounded cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus low, smooth, angular; flanks with low, rounded, simple or anteriorly grooved plications; dental plates partly buried in umbonal callus. *Lower Devonian (upper Lochkovian–lower Emsian)*: eastern North America.—FIG. 1214,4a–d. *\*C. perimele* (CLARKE), lower Emsian, Maine, USA; *a–b*, latex casts of dorsal and ventral exteriors; *c*, latex cast of dorsal interior; *d*, mold of ventral interior,  $\times 1$  (Boucot, 1973).
- Dixonella** GOURVENNEC, 1989, p. 132 [*\*Acrospirifer? rouaulti* GOURVENNEC, 1988, p. 153; OD]. Medium to large, dorsibiconvex, transverse, with acute to rounded cardinal angles; ventral interarea curved, apsacline; fold and sulcus smooth, angular; flanks with simple, subangular plications; dental plates mostly buried in umbonal callus, with large, deeply impressed, ventral diductor muscle field. *Lower Devonian (Pragian)*: Europe.—FIG. 1214,5a–c. *\*D. rouaulti* (GOURVENNEC), France; holotype, dorsal, anterior, and lateral views,  $\times 1.5$  (Gourvennec, 1989).
- Dyticospirifer** JOHNSON, 1966b, p. 1,043 [*\*D. mcolleyensis* JOHNSON, 1966b, p. 1,044; OD]. Medium to large, slightly transverse, with slightly obtuse cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus distinct, smooth; flanks with few strong, rounded plications, some of which split on dorsal valve; dental plates short, divergent, mostly buried in umbonal callus; ctenophoridium bilobed or forming enlarged mound. *Lower Devonian (Pragian)*: North America.—FIG. 1214,1a–f. *\*D. mcolleyensis*, Nevada, USA; *a–b*, ventral and side views; *c*, ventral interior; *d–e*, dorsal exterior and interior,  $\times 1.5$ ; *f*, ventral exterior of sulcus showing fimbriate ornament,  $\times 8$  (Johnson, 1966b).

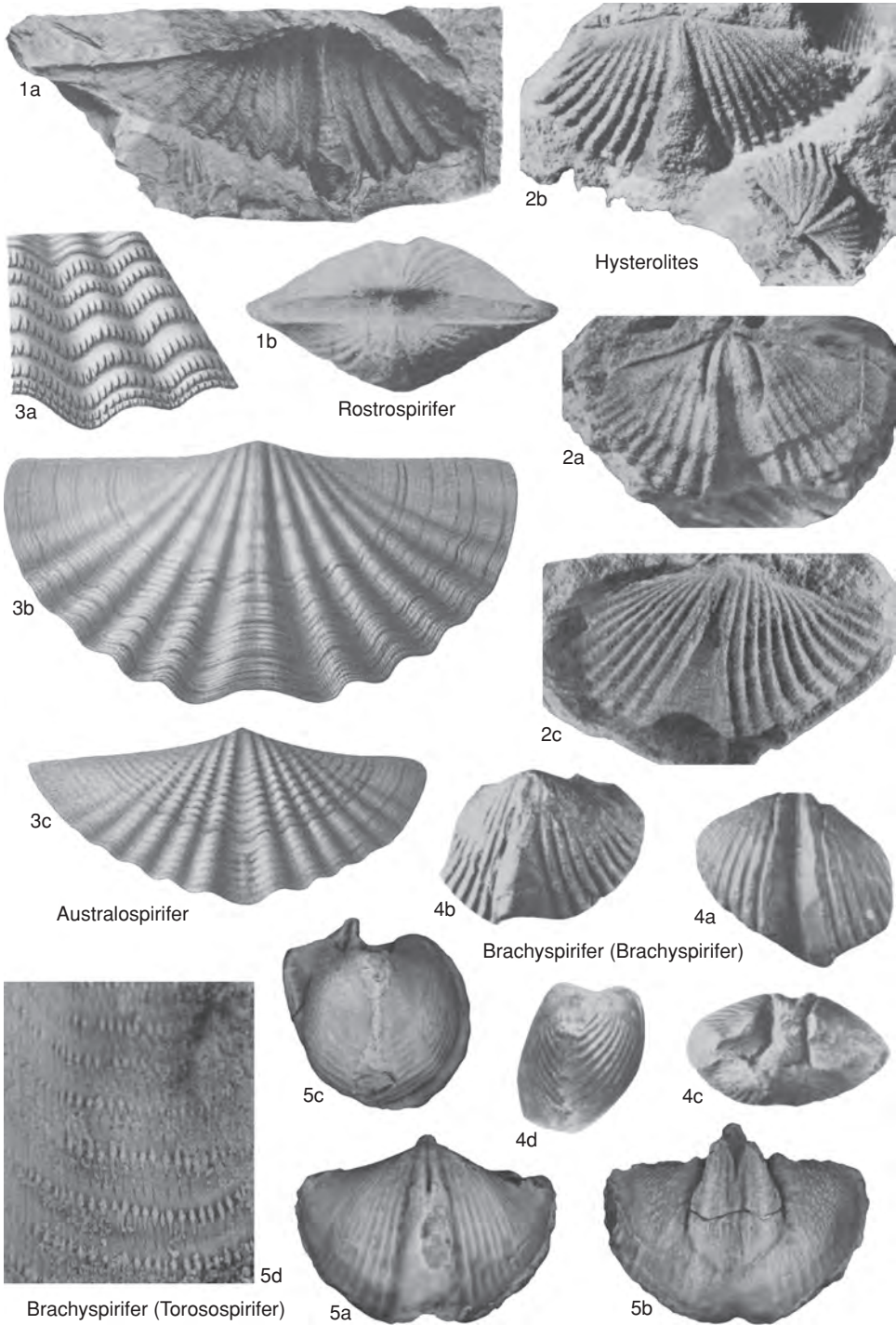


FIG. 1213. Hysterolitidae (p. 1830–1836).

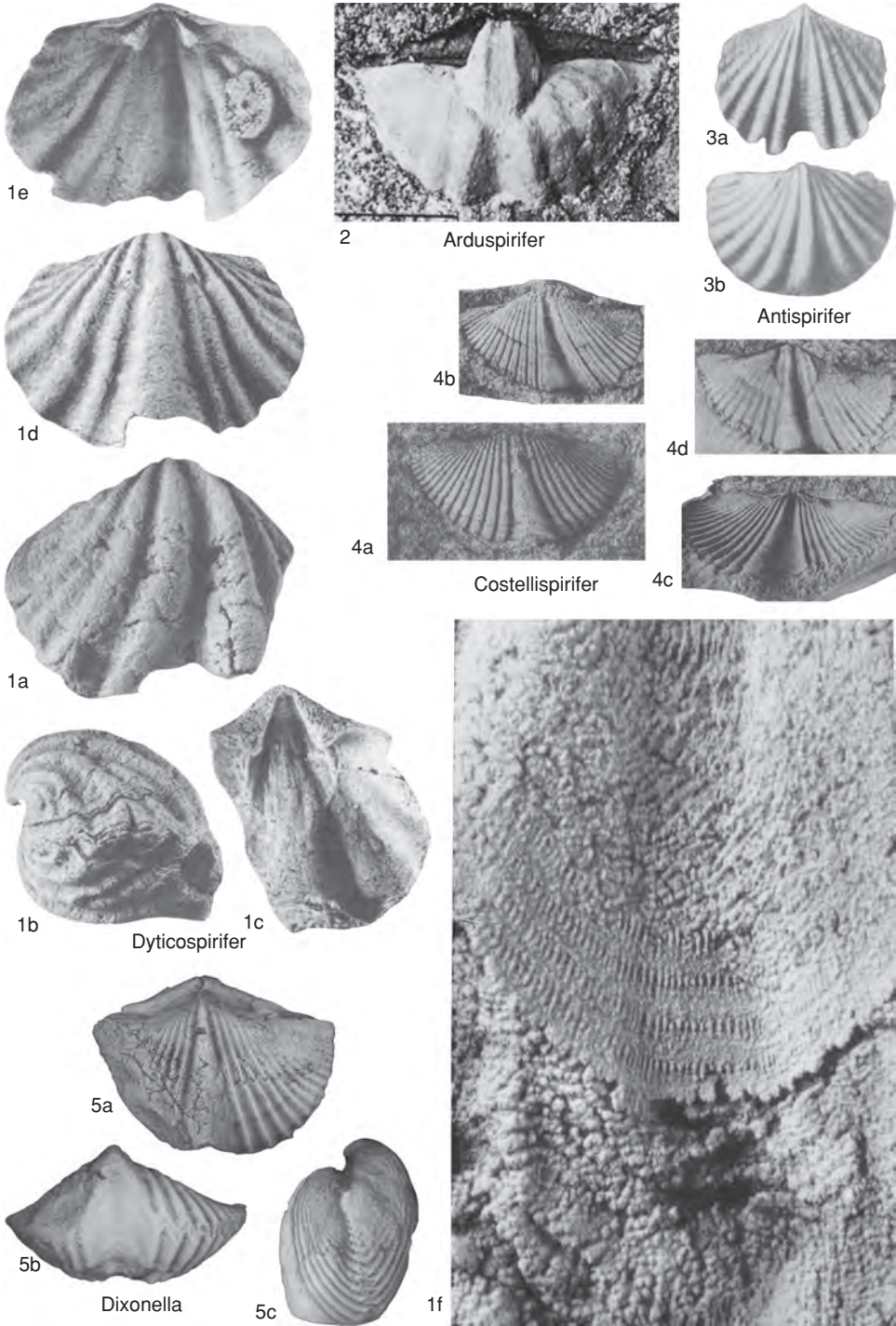


FIG. 1214. Hysterolitidae (p. 1830).



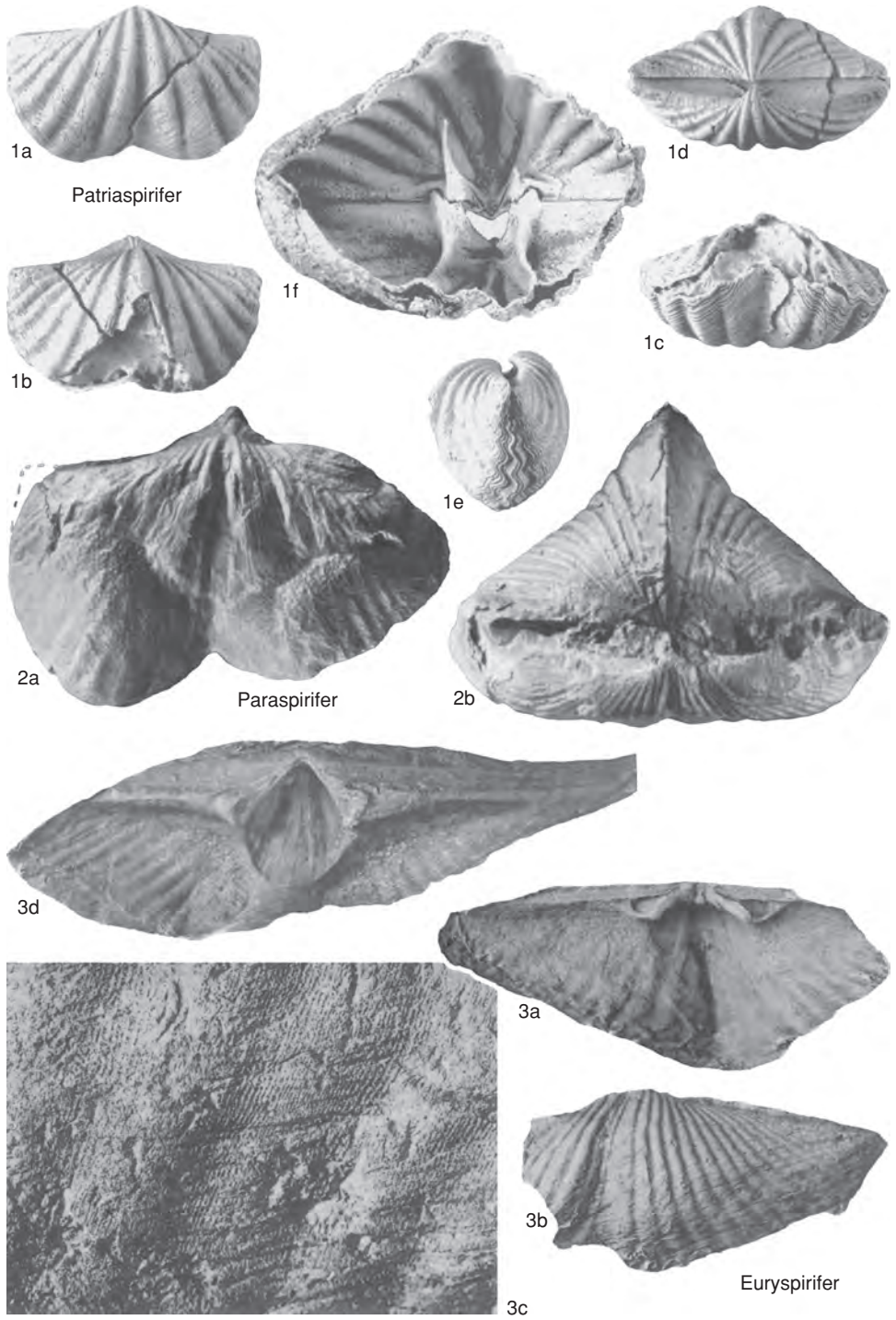


FIG. 1215. Hysterolitidae (p. 1834–1835).

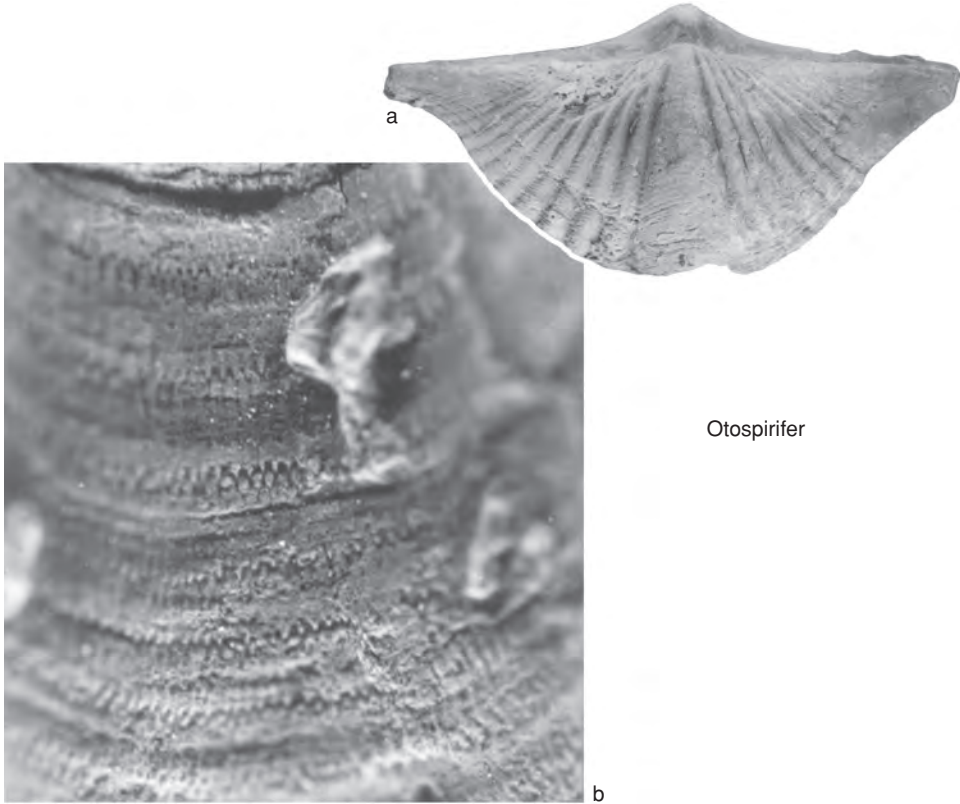


FIG. 1216. Hysterolitidae (p. 1834).

**Euryspirifer** WEDEKIND, 1926, p. 202 [\**Terebratulites paradoxus* VON SCHLOTHEIM, 1813, p. 28; OD] [= *Rhenospirifer* MITTMEYER, 1972, p. 99 (type, *Spirifer Dunensis* KAYSER, 1889, p. 33, OD)]. Large, biconvex, strongly transverse, with acute cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus smooth, or with median rib in sulcus; flanks with numerous simple plications; microornament of fine capillae and fila, becoming fimbriate; ventral diductor muscle field variably impressed in callus; crural plates lacking. *Lower Devonian (Pragian–Emsian)*: Europe, eastern USA (Maine), northern Africa.—FIG. 1215,3a–d. \**E. paradoxus* (VON SCHLOTHEIM), Emsian, Belgium; a–b, casts of dorsal interior, ventral exterior,  $\times 1$ ; c, microornament,  $\times 6.5$ ; d, cast of ventral interior,  $\times 1$  (Vandercammen, 1963).

**Otospirifer** HOU & XIAN, 1975, p. 65 [\**O. shipaiensis*; OD]. Medium to large, transverse, with acute cardinal angles; ventral interarea low, apsacline; fold and sulcus smooth; lateral plications numerous, simple; concentric lamellae with double rows of granules; long, divergent dental plates present, with some umbonal callus; ctenophoridium broad; crural plates lacking. *Lower Devonian (Emsian)*: south-

ern China.—FIG. 1216a–b. \**O. shipaiensis*, upper Emsian; a, dorsal view,  $\times 1.5$ ; b, exterior showing fine ornament,  $\times 5$  (new).

**Paraspirifer** WEDEKIND, 1926, p. 198 [\**Spirifer cultrijugatus* ROEMER, 1844, p. 70; OD]. Medium to large, dorsibiconvex, transverse, with acute to rounded cardinal angles; ventral interarea curved, apsacline; fold and sulcus smooth, angular, becoming carinate; flanks with numerous, simple or anteriorly bifurcating plications; dental plates mostly buried in umbonal callus, with large, deeply impressed, ventral diductor muscle field. *Lower Devonian (Emsian)–Middle Devonian (Eifelian)*: cosmopolitan.—FIG. 1215,2a–b. \**P. cultrijugatus* (ROEMER), Eifelian, Germany; holotype, ventral and posterior views,  $\times 1$  (Solle, 1971).

**Patriaspirifer** JOHNSON, 1995a, p. 198 [\**Spirifer kobehana* MERRIAM, 1940, p. 86; OD]. Medium to large, transverse, with cardinal angles rounded or at right angle, rarely acute; ventral interarea low, curved, apsacline; fold and sulcus smooth; flanks with few broad, low, simple plications and U-shaped interspaces; microornament of concentric growth lamellae with rows of simple spines (fimbriate); dental plates partly buried in umbonal



FIG. 1217. Hysterolitidae (p. 1836).

callus; crural plates lacking. *Lower Devonian (Pragian–lower Emsian)*: eastern and western conterminous United States, eastern Canada.—FIG. 1215, 1a–f. \**P. kobehana* (MERRIAM), lower Emsian, Nevada, USA; a–e, ventral, dorsal, anterior, poste-

rior, and lateral views,  $\times 1$ ; f, interior view of both valves,  $\times 1.5$  (Johnson, 1970).

**Rostrospirifer** GRABAU, 1931a, p. 407 [*\*Spirifer tonkinensis* MANSUY, 1908, p. 41; OD] [= *Neodelthyris* HOU, 1963, p. 413 (type, *N. sinensis*

- HOU, 1963, p. 414, OD]. Medium to large, transverse, with acute cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus smooth; flanks with strong, simple plications; dental plates well developed, divergent, partly buried in umbonal callus; crural plates short or lacking. *Lower Devonian (Emsian)*: southern China, northern Vietnam, New Zealand.—FIG. 1213, 1a–b. \**R. tonkinensis* (MANSUY), lower Emsian, northern Vietnam; cast of ventral valve exterior and cast of posterior view exterior,  $\times 1$  (Mansuy, 1908).
- Trigonospirifer** WANG, RONG, & CHEN, 1987, p. 132 [\**Subcuspidella trigonata* HOU & XIAN, 1975, p. 68; OD]. Large, biconvex, transverse, with acute cardinal angles; ventral interarea moderately high, steeply apsacline, with apical deltidium; fold and sulcus prominent, smooth, rounded; flanks with few strong, rounded plications and U-shaped interspaces; concentric lamellae widely to closely spaced; dental plates thick, with umbonal callus; crural plates lacking. *Lower Devonian (upper Emsian)*: China (central Guangxi).—FIG. 1217, 1a–d. \**T. trigonata* (HOU & XIAN); ventral, dorsal, anterior, and side views,  $\times 1$  (new).
- Xinjiangospirifer** HOU & ZHANG, 1983, p. 362 [\**X. moriensis*; OD; =*Acrospirifer primaevus kazakhstanica* KAPLUN, 1961, p. 101]. Medium to large, equidimensional to moderately transverse with quadrate cardinal angles; ventral interarea long, orthocline, with deltidium; fold distinct, smooth; sulcus smooth or with single median plication; lateral plications numerous, simple, forming flat cross section with narrow interspaces; concentric lamellae widely spaced; dental plates short, commonly with thick umbonal callus; ctenophoridium in notothyrial chamber. *Lower Devonian (Emsian)*: Kazakhstan, northeastern China (Xinjiang).—FIG. 1217, 2a–c. \**X. primaevus kazakhstanica* (KAPLUN), China; ventral, dorsal, and side views,  $\times 1$  (new).
- Subfamily FIMBRISPIRIFERINAE**  
Pitrat, 1965
- [*nom. transl.* WANG in WANG & ZHU, 1979, p. 77, ex Fimbrispiriferidae PITRAT, 1965, p. 687]
- Fold, sulcus, and flanks plicate; crural plates variably present. *Lower Devonian (Pragian)–Middle Devonian (lower Givetian)*.
- Fimbrispirifer** COOPER, 1942, p. 231 [\**Spirifer venustus* HALL, 1860, p. 82; OD]. Medium to large, biconvex, equidimensional; ventral interarea curved, apsacline; fold, sulcus, and flanks with numerous bifurcating plications of U-shaped cross section and U-shaped interspaces; microornament of closely spaced, zigzag concentric lamellae with small spines along edges; strong dental plates present; crural plates present. *Lower Devonian (Emsian)–Middle Devonian (lower Givetian)*: eastern North America.—FIG. 1218, 1a–f. \**F. venustus* (HALL), lower Givetian, eastern USA; a–e, ventral, dorsal, anterior, posterior, and side views; f, ventral external mold showing concentric ornament,  $\times 1$  (Jones & Boucot, 1983).
- Struveina** BOUCOT, 1975, p. 364 [\**Spirifer daleidensis* STEININGER, 1853, p. 71; OD]. Medium size, biconvex, transverse; ventral interarea curved, apsacline; fold, sulcus, and flanks with numerous bifurcating plications that may be bundled, or sulcus may be smooth at venter; concentric lamellae closely spaced; dental plates without umbonal callus. *Lower Devonian (Emsian)*: Europe.—FIG. 1218, 2a–d. \**S. daleidensis* (STEININGER), Belgium; a, microornament,  $\times 5.5$ ; b–d, dorsal, ventral, and posterior views of internal mold,  $\times 1$  (Vandercammen, 1963).
- Vandercammenina** BOUCOT, 1975, p. 363 [\**Spirifer trigeri* DE VERNEUIL, 1850b, p. 781; OD]. Medium to large, biconvex, transversely quadrate; ventral interarea curved, apsacline; fold, sulcus, and flanks with numerous simple plications; concentric lamellae closely spaced; dental plates long, with little umbonal callus. *Lower Devonian (Pragian–Emsian)*: Europe, Turkey, eastern Canada (Nova Scotia).—FIG. 1219a–e. \**V. trigeri* (DE VERNEUIL); a–d, lectotype, dorsal, ventral, posterior, and lateral views, Nêhou Formation, France,  $\times 1$  (Gourvenec, 1989); e, mold of ventral interior, middle Siegenian, Belgium,  $\times 1$  (Vandercammen, 1963).
- Family ACROSPIRIFERIDAE**  
Termier & Termier, 1949
- [*nom. transl.* JOHNSON & HOU in CARTER & others, 1994, p. 351, ex Acrospiriferinae TERMIER & TERMIER, 1949a, p. 96]
- Medium to large, transverse; capillate with fila; crural plates variably present. *Lower Devonian (upper Lochkovian)–Middle Devonian (Eifelian)*.
- Subfamily ACROSPIRIFERINAE**  
Termier & Termier, 1949
- [Acrospiriferinae TERMIER & TERMIER, 1949a, p. 96]
- Flanks strongly plicate; delthyrium lacking apical deltidium; dental plates strong or partly buried in umbonal callus; ctenophoridium on floor of notothyrial chamber attached to myophragm, or elevated. *Lower Devonian (upper Lochkovian–Emsian)*.
- Acrospirifer** HELMBRECHT & WEDEKIND, 1923, p. 952 [\**Spirifera primaeva* STEININGER, 1853, p. 72; SD WEDEKIND, 1926, p. 202]. Large, biconvex, with obtuse cardinal angles; ventral interarea curved, apsacline; fold and sulcus smooth; flanks with few strong, simple plications; dental plates divergent; ventral diductor muscle field impressed in thick callus; broad ctenophoridium may be slightly elevated. *Lower Devonian (Pragian–Emsian)*: Europe, northern Africa.—FIG. 1220, 1a–d. \**A. primaevus*

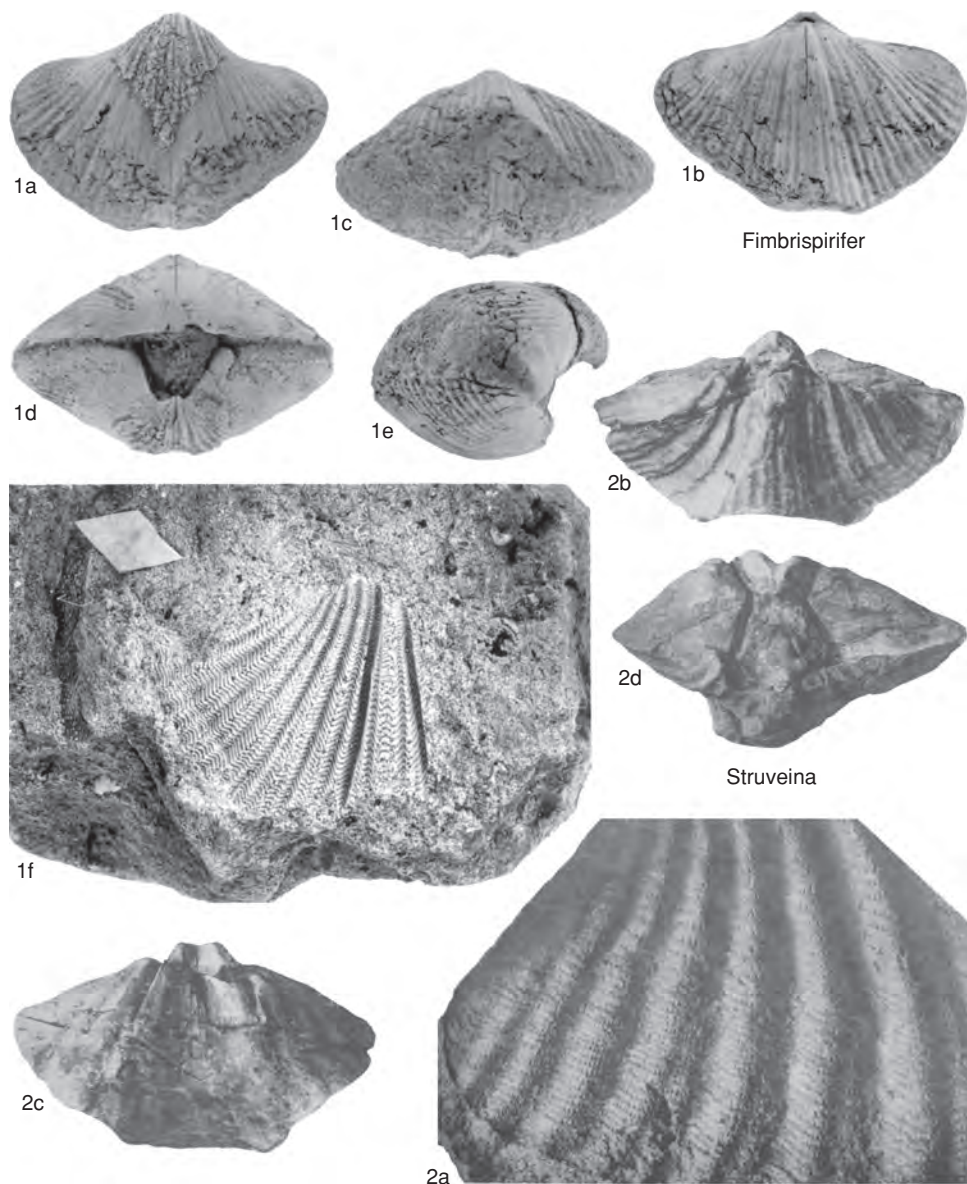


FIG. 1218. Hysterolitidae (p. 1836).

(STEININGER), Pragian, Germany; *a-b*, ventral and dorsal exteriors; *c-d*, molds of ventral and dorsal interiors,  $\times 1$  (Maillieux, 1931).

**Mauispirifer** ALLAN, 1947, p. 445 [*\*M. hectori*; OD]. Small to medium, biconvex, with slightly acute cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus distinct; flanks with strong, rounded, simple plications; capillae interrupted anteriorly by concentric lamellae; dental plates short, thin, free of umbonal callus; cteno-

phoridium elevated. *Lower Devonian (upper Lochkovian–Emsian)*: Europe, Australia, New Zealand. —FIG. 1221*a-b*. *\*M. hectori*, New Zealand; *a*, dorsal valve,  $\times 1$ ; *b*, ventral valve,  $\times 3$  (Allan, 1947).

**Xerospirifer** HAVLIČEK, 1978, p. 103 [*\*X. excelsus* HAVLIČEK, 1978, p. 104; OD]. Medium size, biconvex, with obtuse cardinal angles; ventral interarea curved, apsacline; fold and sulcus smooth, angular; flanks with numerous, strong, rounded, simple

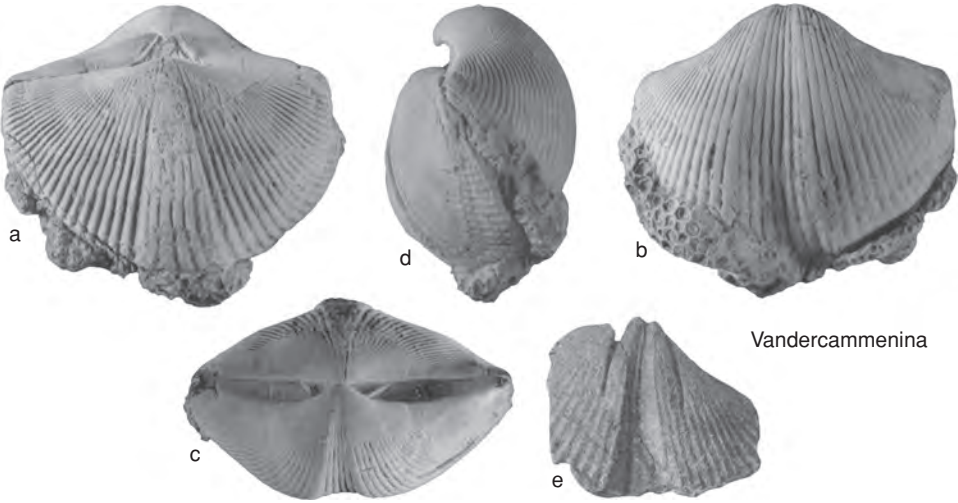


FIG. 1219. Hysterolitidae (p. 1836).

plications; strong dental plates present, recurving medially, free of umbonal callus. *Lower Devonian (Pragian)*: Czech Republic.—FIG. 1220, 2a–g. \**X. excelsus*, Bohemia; a–e, ventral, dorsal, posterior, anterior, and side views,  $\times 1.8$ ; f, ventral internal mold,  $\times 1.8$ ; g, dorsal exterior showing fine ornament,  $\times 10$  (Havlíček, 1978).

#### Subfamily COSTISPIRIFERINAE Termier & Termier, 1949

[Costispiriferinae TERMIER & TERMIER, 1949a, p. 98]

Multiplicate, with narrow interspaces; ventral interarea low, trapezoidal; delthyrium broad with apical deltidium; dental plates short, widely spaced, partly buried in umbonal callus; sockets strong, simple, curved; ctenophoridium not built up. *Lower Devonian (Pragian)*.

**Costispirifer** COOPER, 1942, p. 232 [\**Spirifer arenosus planicostatus* SWARTZ, 1929, p. 56; OD]. Fold and sulcus inconspicuous, plicate; simple plications on flanks. *Lower Devonian (Pragian)*: eastern North America, USA (Nevada).—FIG. 1222, 2a–e. *C. arenosus* (CONRAD), Maryland; a–c, exterior, interior, and interior oblique views of ventral valve; d–e, exterior and interior views of dorsal valve,  $\times 1$  (new).

**Cumberlandina** BOUCOT, 1975, p. 371 [\**Spirifer cumberlandiae* HALL, 1857, p. 63; OD]. Fold and sulcus low, smooth; simple plications on flanks. *Lower Devonian (Pragian)*: eastern North America.—FIG. 1222, 1a–d. \**C. cumberlandiae* (HALL), Maryland, USA; a–b, dorsal and ventral

views; c–d, dorsal and ventral interiors,  $\times 1$  (Hall, 1859).

#### Subfamily ELYMOSPIRIFERINAE Johnson & Hou, 1994

[Elymospiriferinae JOHNSON & HOU in CARTER & others, 1994, p. 352]

Fold and sulcus plicate; flanks with bifurcating plications. *Lower Devonian (Pragian)–Middle Devonian (Eifelian)*.

**Elymospirifer** WANG in WANG, YU, & WU, 1974, p. 40 [\**Indospirifer kwangsiensis* HOU, 1959b, p. 458; OD]. Medium to large, biconvex, transversely quadrate; ventral interarea curved, apsacline; fold, sulcus, and flanks with numerous bifurcating plications of U-shaped cross section and U-shaped interspaces; microornament of variably developed radial lirae interrupted by fine growth lines; dental plates long, extrasinal, without umbonal callus; ctenophoridium bilobed; short crural plates present. *Lower Devonian (lower Emsian)*: Taimyr, southern China.—FIG. 1223, 3a–e. \**E. kwangsiensis* (HOU), southern China; a–d, ventral, dorsal, anterior, and side views,  $\times 1.5$ ; e, exterior showing fine ornament,  $\times 5$  (Wang & Rong, 1986).

**Borealispirifer** HOU & SU in SU & HOU, 1993, p. 140 [\**Eospirifer (Multispirifer) bifurcatus* KAPLUN, 1961, p. 91; OD]. Medium to large, biconvex, flattened ventrally, with slightly acute cardinal angles; ventral interarea low; fold and sulcus broad, not sharply bounded, plicate; flanks with bifurcating plications; dental plates intrasinal, with some umbonal callus; ctenophoridium and vestigial crural plates present. *Lower Devonian (Pragian–lower Emsian)*: Kazakhstan.—FIG. 1224a–d. \**B. bifurcatus*

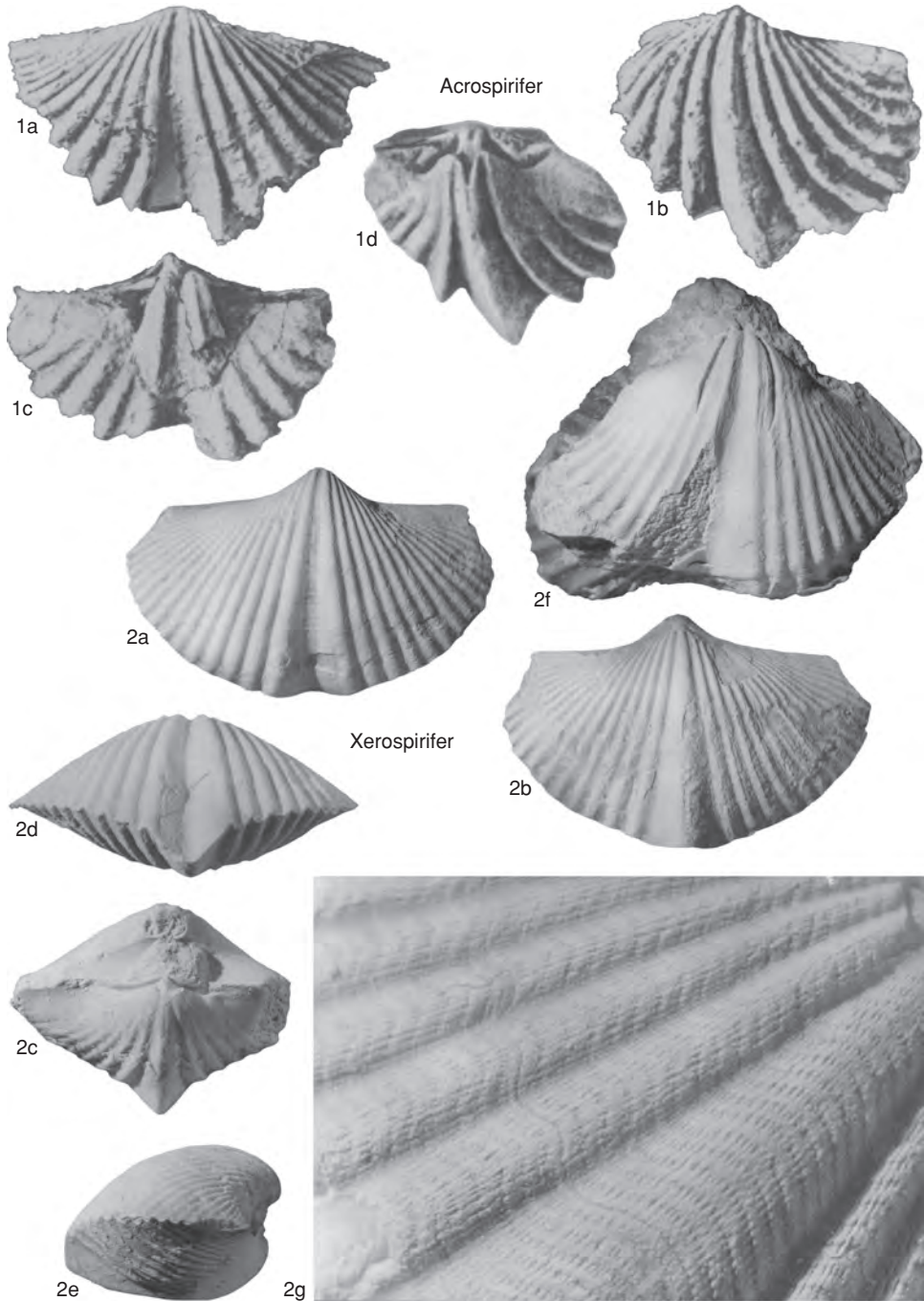


FIG. 1220. Acrospiriferidae (p. 1836–1838).



a

Mauispirifer



b

FIG. 1221. Acrospiriferidae (p. 1837).

(KAPLUN); *a*, holotype, ventral valve internal mold; *b–c*, dorsal valve internal mold, ventral valve exterior,  $\times 1$ ; *d*, microornament,  $\times 8$  (Kaplun, 1961).

**Multispirifer** KAPLUN, 1961, p. 88 [*\*Spirifer solitarius* KRANTZ, 1857, p. 152; OD]. Medium to large, biconvex, with slightly acute cardinal angles; ventral interarea curved, low, apsacline; fold and sulcus plicate; flanks with subangular plications that may bifurcate; strong dental plates, free of umbonal callus; ctenophoridium elevated. *Lower Devonian (Pragian–lower Emsian)*: Europe.—FIG. 1223, *1a–b*. *\*M. solitarius* (KRANTZ), Germany; ventral valve internal mold and dorsal valve exterior, magnification unknown, probably  $\times 1$  (Krantz, 1857).

**Perryspirifer** JONES & BOUCOT, 1983, p. 339 [*\*Spirifer scheii* MEYER, 1913, p. 25; OD]. Medium size, biconvex, with rounded cardinal angles; fold and sulcus prominent; bifurcating plications on fold, sulcus, and flanks; capillae fine; dental plates and ventral callus present; ctenophoridium and vestigial crural plates present. *Lower Devonian (Emsian)–Middle Devonian (Eifelian)*: Canadian Arctic Islands.—FIG. 1223, *2a–e*. *\*P. scheii* (MEYER), Emsian; ventral, dorsal, side, and anterior views, ventral interior,  $\times 1$  (Jones & Boucot, 1983).

### Family CYRTINOPSIDAE

Wedekind, 1926

[*nom. transl.* BOUCOT, 1957a, p. 38, ex Cyrtinopsinae WEDEKIND, 1926, p. 198]

Growth lamellae frilly, capillae interrupted; ctenophoridium lacking or, in younger genera, rudimentary. *Silurian (Wenlock)–Middle Devonian (Givetian)*.

### Subfamily CYRTINOPSINAE

Wedekind, 1926

[Cyrtinopsinae WEDEKIND, 1926, p. 198] [=Kozlowskiellinae BOUCOT, 1958, p. 1,031, *nom. correct. pro* Kozlowskiellinae BOUCOT, 1957b, p. 317]

With ventral median septum; crural plates lacking. *Silurian (Wenlock)–Middle Devonian (Givetian)*.

**Cyrtinopsis** SCUPIN, 1896, p. 247 [*\*Spirifer undosus* SCHNUR, 1853, p. 204; OD]. Medium to large, transverse, cardinal angles acute; ventral interarea moderately high, flat to curved, catacline or apsacline, with open delthyrium; fold and sulcus smooth; flanks with strong plications; capillae take form of crenulations crossed by fila; dental plates and median septum forming spondylium; bilobed cardinal process, becoming striate ctenophoridium in some. *Lower Devonian (Lochkovian)–Middle Devonian (Eifelian)*: Europe, Salair, Russia (Gorno-Altay), western USA (Nevada), Australia, New Zealand.—FIG. 1225, *1a–f*. *\*C. undosa* (SCHNUR), Eifelian, Germany; *a–d*, dorsal, anterior, posterior, and lateral views,  $\times 1$ ; *e*, microornament,  $\times 3$ ; *f*, transverse section of ventral valve,  $\times 5$  (Boucot, 1957a).

**Kozlowskiellina** BOUCOT, 1958, p. 1,031, *nom. nov. pro* Kozlowskiella BOUCOT, 1957b, p. 318, *non* PRIBYL, 1953 [*\*Kozlowskiella strawi* BOUCOT, 1957b, p. 320; OD]. Small, transverse, cardinal angles acute; ventral interarea moderately high, flat to curved, catacline or apsacline; deltidial plates apically perforate, medially conjunct; fold and sulcus smooth; flanks with strong plications; capillae crossed by fila; dental plates and discrete median septum present; bilobed cardinal process, can become ctenophoridium. *Silurian (Wenlock–Ludlow)*: Britain, Gotland, eastern North America.—FIG. 1225, *3a–e*. *\*K. strawi* (BOUCOT), Wenlock, British Isles; holotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 1.5$  (Boucot, 1957b).

**Megakozlowskiella** BOUCOT, 1957b, p. 322 [*\*Spirifer perlamellosus* HALL, 1857, p. 57; OD]. Medium to large, transverse to equidimensional; ventral interarea moderately high, flat to curved, apsacline; deltidial plates apically perforate, medially conjunct; fold and sulcus smooth; flanks with strong plications; capillae crossed by fila; dental plates and discrete median septum present. *Lower Devonian (Lochkovian)–Middle Devonian (Givetian)*: eastern North America, USA (New York, Nevada).—FIG. 1225, *2a*. *\*M. perlamellosus* (HALL), Albany, New York, Lower Devonian; dorsal view,  $\times 1$  (Hall, 1857).—FIG. 1225, *2b–h*. *M. magnapleura* JOHNSON, Pragian, Nevada; *b*, ventral interior,  $\times 2$ ; *c*, dorsal interior,  $\times 3$ ; *d–h*, ventral, dorsal, side, posterior, and anterior views,  $\times 1.5$  (Johnson, 1970).

**Plicocyrtina** HAVLIČEK, 1956, p. 608 [*\*Cyrtina (Plicocyrtina) sinuplicata* HAVLIČEK, 1956, p. 608; OD]. Medium size, transverse, with acute cardinal angles; ventral interarea moderately high, flat to



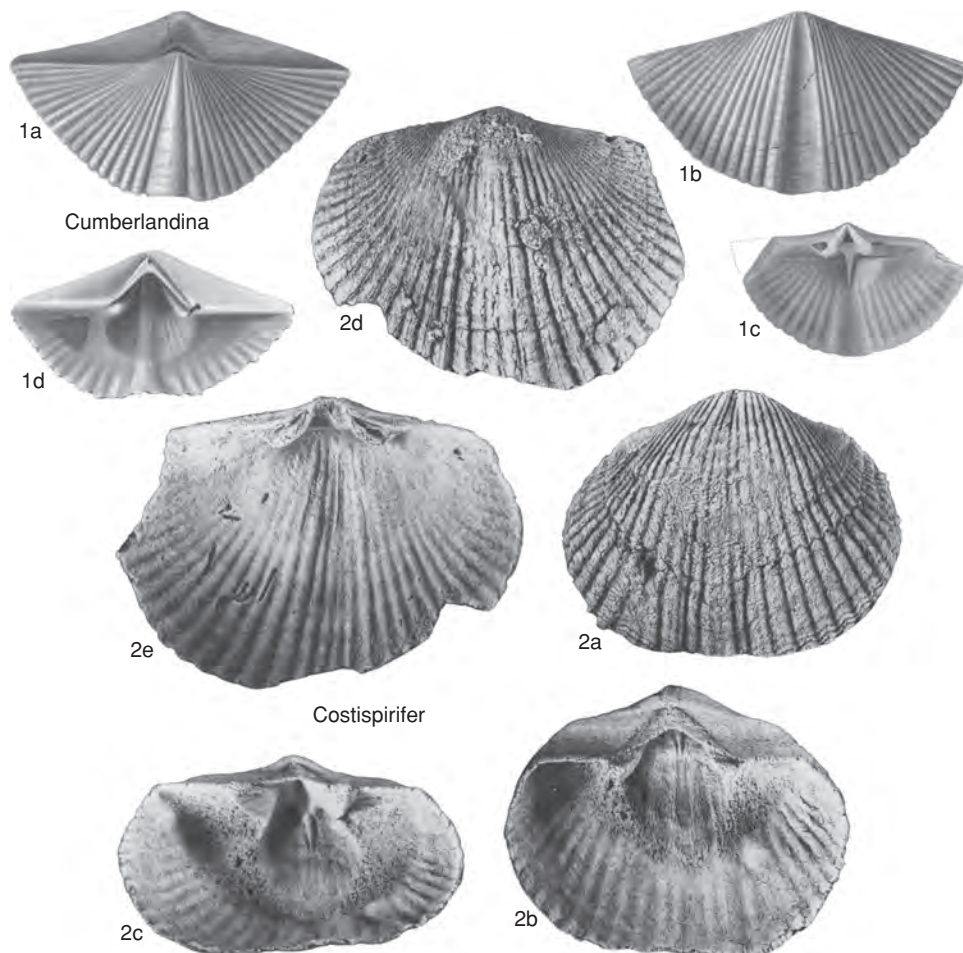


FIG. 1222. Acrospiriferidae (p. 1838).

curved, apsacline, with open delthyrium; fold and sulcus prominent, with median plication in sulcus; flanks with strong plications; short dental plates and median septum form spondylium; bilobed cardinal process, can become ctenophoridium. *Lower Devonian (Pragian–Emsian)*: Czech Republic, northern Africa, eastern North America (Yukon). —FIG. 1225, 4a–c. \**P. sinuplicata* (HAVLÍČEK), Emsian, Czech Republic; a–b, ventral and dorsal valves,  $\times 1.5$ ; c, posterior view of dorsal valve, enlarged (Havlíček, 1956).

#### Subfamily ARASPIRIFERINAE Johnson, 1994

[Araspiriferinae JOHNSON in CARTER & others, 1994, p. 352]

Without ventral median septum; crural plates present. *Silurian (Wenlock–Ludlow)*.

**Araspirifer** HAVLÍČEK, 1987, p. 242 [\**A. araneus*; OD]. Small, transverse, with square cardinal angles; ventral interarea curved, apsacline, with open delthyrium; fold and sulcus smooth; flanks with strong plications, capillae faintly developed or lacking; strong teeth tracks, dental plates without median septum; crural plates closely spaced; ctenophoridium lacking. *Silurian (Wenlock–Ludlow)*: Bohemia. —FIG. 1226, 2a–d. \**A. araneus*, upper Wenlock; a–c, ventral, dorsal, and anterior views,  $\times 3$ ; d, dorsal view,  $\times 1.5$  (Havlíček, 1959).

**Boucotinskia** BRUNTON & COCKS in BRUNTON, COCKS, & DANCE, 1967, p. 179 [\**Delthyris sulcata* VON HISINGER, 1831, p. 140; OD; =*Delthyris sulcata* VON HISINGER, 1828, p. 228, *nom. nud.*]. Small, transverse, cardinal angles acute; ventral interarea curved, apsacline; deltidial plates discrete; fold and sulcus smooth; flanks with strong plications; dental

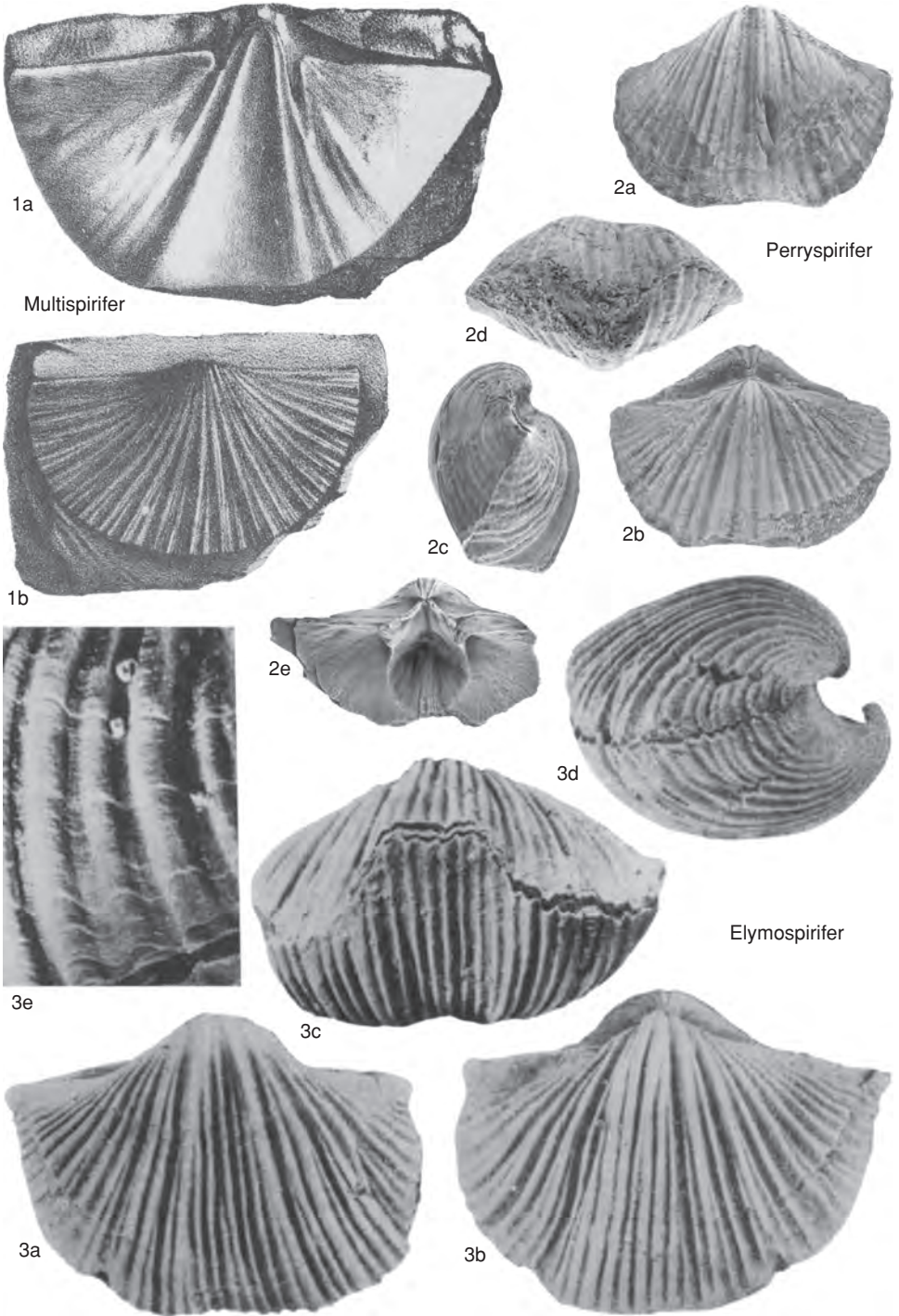


FIG. 1223. Acrospiriferidae (p. 1838–1840).

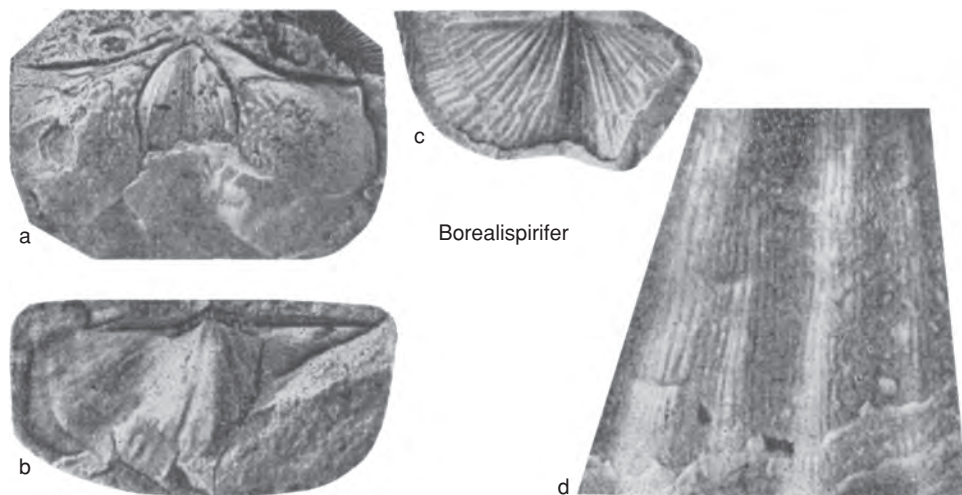


FIG. 1224. Acrospiriferidae (p. 1838–1840).

plates without median septum; crural plates short; ctenophoridium present. *Silurian* (*Wenlock–Ludlow*): Britain, Gotland, eastern North America.—FIG. 1226, 1a–e. \**B. sulcata* (VON HISINGER), Ludlow, Gotland; lectotype, posterior, anterior, lateral, dorsal, and ventral views,  $\times 3$  (Boucot, 1957b).

#### Family MUCROSPIRIFERIDAE Boucot, 1959

[*nom. transl.* JOHNSON & CARTER in CARTER & others, 1994, p. 352, ex Mucrospiriferinae BOUCOT, 1959b, p. 745]

Growth lines lamellose; ctenophoridium present; crural plates absent. *Middle Devonian* (*Eifelian*)–*Carboniferous* (*Visean*).

#### Subfamily MUCROSPIRIFERINAE Boucot, 1959

[Mucrospiriferinae BOUCOT, 1959b, p. 745]

Transverse, multiplicate; without median septum. *Middle Devonian* (*Eifelian*)–*Upper Devonian* (*Famennian*).

*Mucrospirifer* GRABAU, 1931a, p. 408 [\**Delthyris mucronatus* CONRAD, 1841, p. 54; OD] [= *Lamellispirifer* NALIVKIN, 1937, p. 87, obj.; *Khinganospirifer* SU, 1976, p. 221 (type, *Mucrospirifer paradoxiformis* HOU, 1959a, p. 154, OD)]. Medium to large, biconvex, transverse, mucronate; ventral interarea low, curved, apsacline to orthocline; stegidial plates present; fold and sulcus well defined, smooth or with a median groove in fold; flanks with numerous, simple plications, crossed by numerous growth

lamellae, some with fila crossed by fine capillae; wedge-shaped umbonal thickening; dental plates short. *Middle Devonian* (*Eifelian–Givetian*): Germany, Poland, northeastern China (Heilongjiang Province), eastern North America.—FIG. 1227, 4a–b. \**M. mucronatus* (CONRAD), Givetian, New York; ventral and dorsal valves,  $\times 1$  (Cooper, 1944).

*Apousiella* CARTER, 1972, p. 732 [\**Spirifer bouchardi* MURCHISON, 1840, p. 253; OD] [= *Bouchardopsis* MAILLIEUX, 1933, p. 80, *nom. nud.*]. Medium size, planoconvex to ventribiconvex, transverse, mucronate; ventral interarea low, curved, orthocline; fold and sulcus well defined, with median groove in fold; ventral flanks concave to flattened in profile; flanks with numerous, simple plications, crossed by numerous imbricate growth lamellae and fila; dental plates absent. *Upper Devonian* (*Frasnian*): western Europe.—FIG. 1227, 2a–c. \**A. bouchardi* (MURCHISON), middle Frasnian, Belgium; dorsal, ventral, and lateral views,  $\times 1$  (Vandercammen, 1963).—FIG. 1227, 2d–b. *A. belliloci* (RIGAUX), middle Frasnian, France; ventral, dorsal, anterior, posterior, and lateral views,  $\times 1.5$  (Carter, 1972).

*Eleutherokomma* CRICKMAY, 1950, p. 219 [\**E. hamiltoni* CRICKMAY, 1950, p. 220; OD] [= *Dmitrispirifer* LIASHENKO, 1973, p. 126 (type, *D. nalivkini* LIASHENKO, 1973, p. 127, OD); *Sculptospirifer* SU, 1980, p. 318 (type, *Eleutherokomma acutiplicatus* SU, 1976, p. 214, OD)]. Small to medium, biconvex, transverse, mucronate; ventral interarea low, curved, apsacline to orthocline; fold and sulcus well defined, smooth; flanks with simple plications, crossed by numerous growth lamellae, with fila crossed by capillae; wedge-shaped umbonal thickening present; dental plates long, divergent. *Middle Devonian* (*Givetian*)–*Upper Devonian* (*Frasnian*):

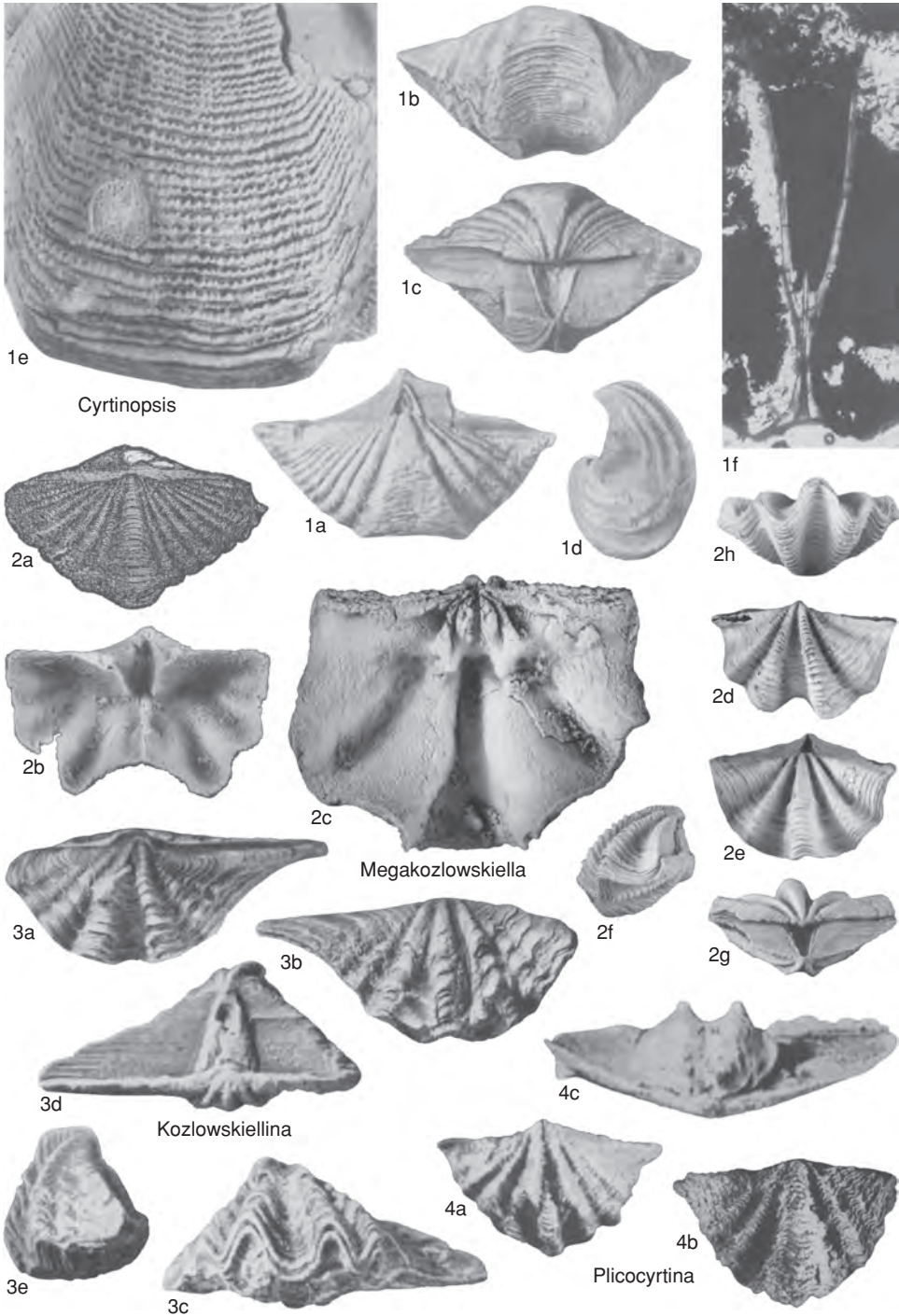


FIG. 1225. Cyrtinopsidae (p. 1840–1841).

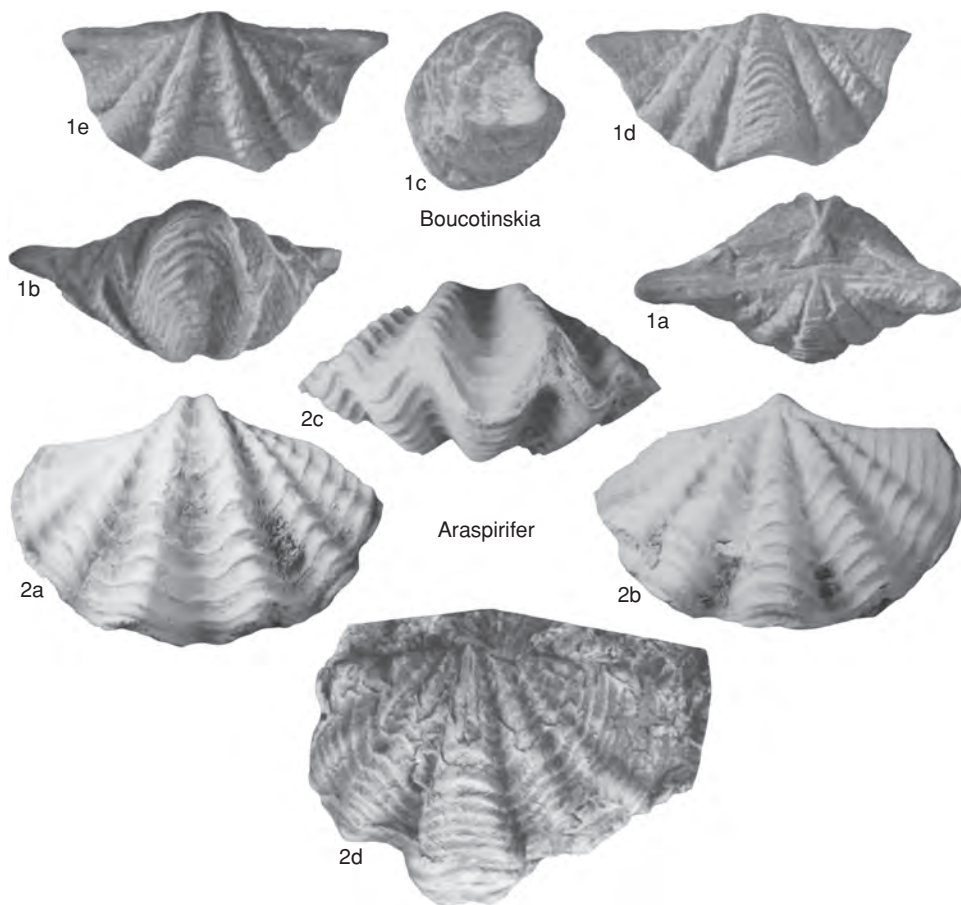


FIG. 1226. Cyrtinopsidae (p. 1841–1843).

western North America, eastern Europe, northern Africa, Afghanistan, northeastern China.—FIG. 1227, 1a–c. \**E. hamiltoni*, Givetian, Alberta; a, holotype, ventral valve,  $\times 1.8$ ; b, dorsal valve,  $\times 2$ ; c, microornament,  $\times 5$  (Crickmay, 1950).

**Sulcatospirifer** MAXWELL, 1954, p. 11 [\**S. primus*; OD]. Medium size, biconvex, transverse, with acute cardinal angles; ventral interarea curved, moderately high apsacline; fold and sulcus prominent, rounded, with wide furrow on fold, otherwise smooth or with faint parietal plications; flanks with numerous simple plications crossed by lamellose growth lines; microornament of interrupted capillae and scattered tubercles; dental plates thin, divergent. *Upper Devonian (Famennian)*: eastern Australia.—FIG. 1227, 3a–c. \**S. primus*; a–b, holotype,

internal and external molds of dorsal valve,  $\times 2$ ; c, microornament of ventral valve,  $\times 5$  (new).

#### Subfamily TYLOTHYRIDINAE Carter, 1972

[Tylothyridinae CARTER, 1972, p. 730]

Outline variable, with moderately numerous lateral costae; radial microornament lacking; with dental plates and ventral median septum. *Middle Devonian (upper Givetian)–Carboniferous (Visean)*.

**Tylothyris** NORTH, 1920, p. 195 [\**Cyrtia laminosa* M'COY, 1844, p. 137; OD] [= *Welleria* MAILLIEUX,

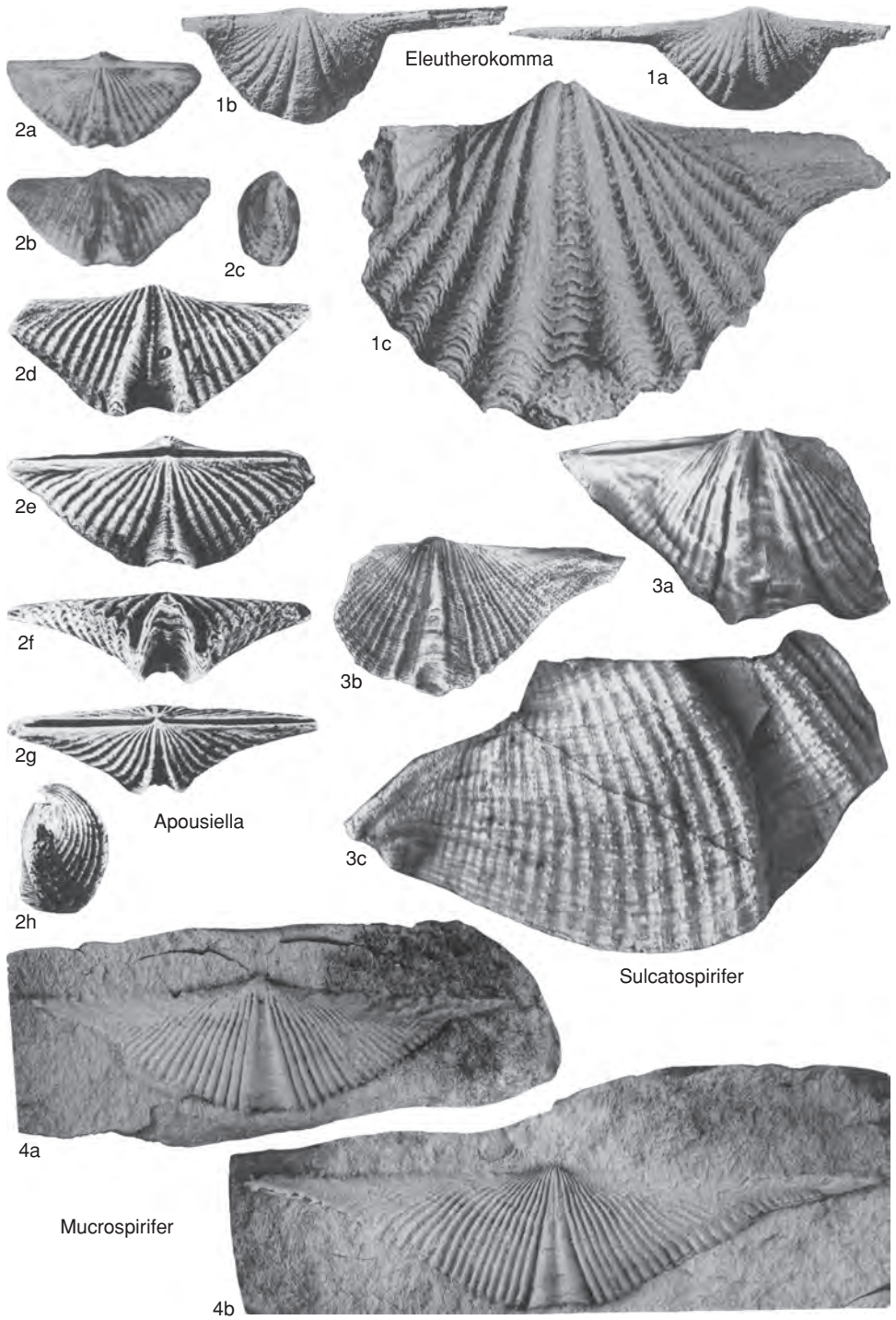


FIG. 1227. Mucrospiriferidae (p. 1843–1845).

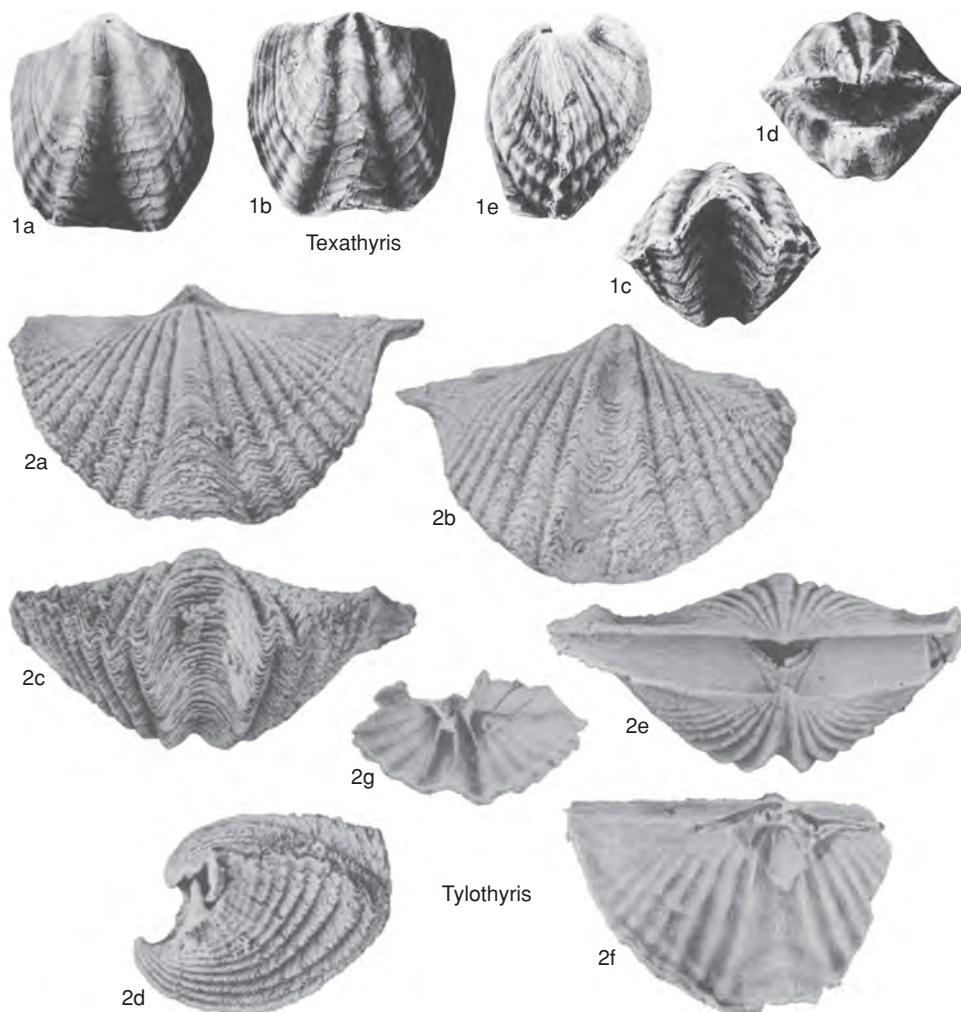


FIG. 1228. Mucrospiriferidae (p. 1845–1847).

1931, p. 35, *nom. nud.*]. Small to medium, biconvex, transverse, with angular to rounded cardinal extremities; ventral interarea low to high, apsacline to catacline; fold and sulcus smooth; flanks with simple, rounded plications and numerous imbricate growth lamellae; dental plates and median septum partly buried in callus. *Middle Devonian (upper Givetian)–Carboniferous (Visean)*: cosmopolitan. —FIG. 1228, 2a–g. \**T. laminosa* (M'COY), Visean, Ireland; a–f, dorsal, ventral, anterior, lateral, and posterior views, dorsal interior; g, oblique anterior view of ventral interior,  $\times 1.5$  (Brunton, 1984).

**Texathyris** CARTER, 1972, p. 730 [\**T. elegantula*; OD].

Small, biconvex, elongate; cardinal angles rounded, obtuse; ventral interarea short, curved, apsacline; fold and sulcus smooth, well defined by strong bounding plications; flanks with a few nearly obsolescent plications and prominent growth lamellae; dental plates and median septum present; ctenophoridium lacking crural plates. *Carboniferous (lower Tournaisian–middle Tournaisian)*: southern USA (Texas). —FIG. 1228, 1a–e. \**T. elegantula*; holotype, ventral, dorsal, anterior, posterior, and lateral views,  $\times 3$  (Carter, 1972).