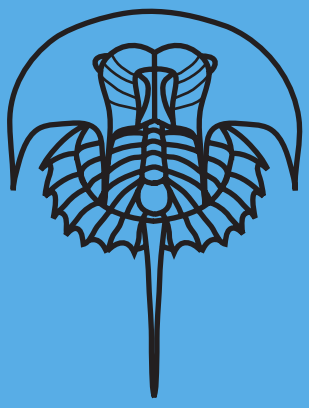

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PART L, REVISED, VOLUME 3B, CHAPTER 7: SYSTEMATIC DESCRIPTIONS OF THE PERISPHINCTOIDEA

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Superfamily PERISPHINCTOIDEA Steinmann, 1890

[*nom. transl.* Wedekind, 1918, p. 103, *ex* Perisphinctinae Steinmann in Steinmann & Döderlein, 1890, p. 441]

Perisphinctoids have a worldwide distribution from the Middle Jurassic to the Lower Cretaceous where they are the most characteristic and widespread group of ammonites, and their origin in the Stephanoceratidae is well established (Galácz, 2012).

They are a large group with a great variety of morphologies, evolute planulates with sharp, branched ribbing being typical for the whole group and frequently recurring throughout their long range. Besides these, other morphologies occur—from cadicone and sphaerocone to oxycone coilings, and coronate-tuberculate to coarse wedge-shaped ornament—resulting in closely homeomorphic forms, within or even outside the superfamily (e.g., Late Jurassic *Euaspidoceras* and *Gravesia* vs. Late Cretaceous *Pseudaspidoceras* and *Fagesia,* respectively).

Callomon's statement (in Donovan, Callomon, & Howarth, 1981, p. 123) that "the proverbial difficulties of classifying this group have been also greatly reduced by the discoveries of the last 20 years" has been confirmed and amplified, by subsequent work. These new discoveries have allowed many of the previously disconnected, sometimes homeomorphic forms, as Callomon wrote, to be joined stratigraphically and geographically, but the classification adopted here is surely still provisional. It is shown diagrammatically in Figure 1, down to subfamily level. The result is a family tree with numerous branches of different lengths and contents in number of genera. Groups of genera known to have evolved independently over a considerable time span are ascribable to family group status.

Dimorphism is widely developed in the group: macroconchs have simple apertures, and some attain large sizes (giant-forms of the English Portland Beds); microconchs are sometimes quite different from their associated macroconchs, and can be dwarf planulates or coiled eccentrically (tulitids, aspidoceratids), normally with lappets in the adult aperture, but sometimes with simple apertures (e.g., Paraboliceratinae).

Perisphinctoid sutures are without the lobe U_n in their early development (except in the problematical subfamily Parkinsoniinae), unlike stephanoceratid sutures in which U_n is consistently developed (for further explanation and figure, see Howarth, 2017, p. 1–2, fig. 1).

Aptychi are double valved, are only occasionally found in situ, and differ from family to family. Some are with a granular surface (*Granulaptychus*), others are concentrically ribbed (*Praestriaptychus*) as in some stephanoceratids (*Garantiana*) or have an unribbed punctate outer surface (*Laevaptychus*) in *Aspidoceras* and *Hybonoticeras.*

Énay, Raymond, & Michael K. Howarth. 2019. Part L, Volume 3B, Chapter 7: Systematic Descriptions of the Perisphinctoidea. Treatise Online 120:1–184, 107 fig.

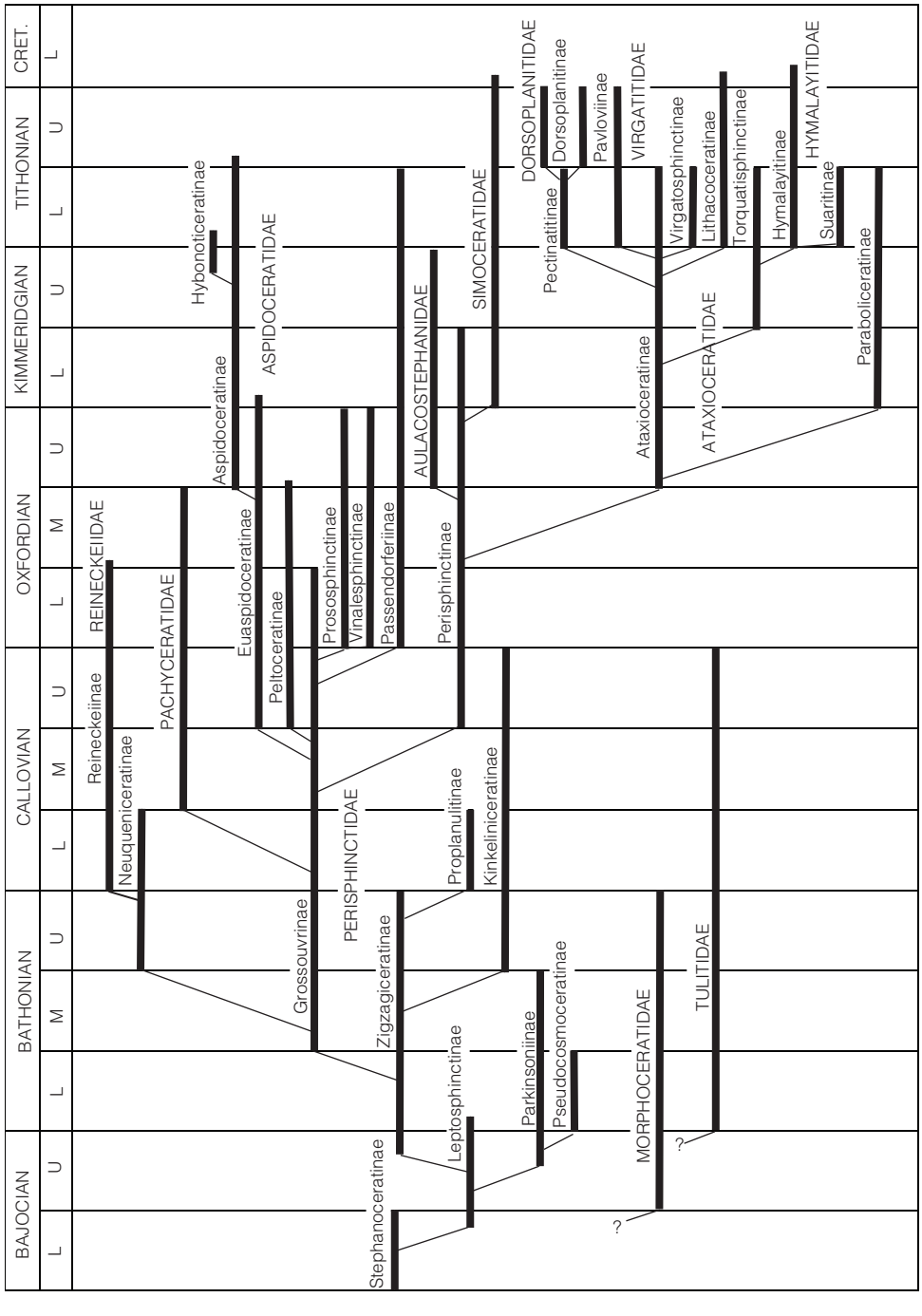

FIG. 1. Phylogeny of the superfamily Perisphinctoidea (Énay, new).

Provincialism, a well-known feature of Perisphinctoidea, reached its climax in the Upper Jurassic (and Lower Cretaceous). It began as a latitudinal distribution reflecting climatic belts, with some provinces changing in the course of time. Some families and genera are bipolar (*Perisphinctes*), while others are restricted to one hemisphere only (Aulacostephanidae, Subboreal), and others are restricted to an area or province (*Virgatites,* Russian Platform; *Vinalesphinctes,* Caribbean). *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone)–Lower Cretaceous (upper Hauterivian, ?lower Barremian)*: worldwide.

Family PERISPHINCTIDAE Steinmann, 1890

[*nom. transl.* Hyatt, 1900, p. 580, *ex* Perisphinctinae Steinmann in Steinmann & Döderlein, 1890, p. 441]

Embracing a wide range of morphologies from evolute and serpenticone, with rounded, quadrate, or depressed whorls in some to moderately involute, with compressed oval whorls. Ribbing simple, biplicate or triplicate, varying from fine and dense to coarse and widely spaced, with large folds on the side of the adult whorl in some forms. There is a tendency towards smooth outer whorls or at least venters in some macroconchs. Constrictions, parabolae, parabolic ribs, tubercles, spines, and bullae are characteristic of some forms. Sutures are complex. Dimorphism is widespread, with lappets terminating most adult microconchs, which can reach sizes larger than 200 mm in diameter; macroconchs larger, with some giants up to almost 1 m in diameter. Sutures differ from those of Stephanoceratoidea in lacking the lobe element U_n (Howarth, 2017, p. 2, fig. 1), except in the case of the subfamily Parkinsoniinae, whose members are considered to be perisphinctids for reasons given below (p. 15). *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone)–Upper Jurassic (lower Kimmeridgian):* worldwide.

Subfamily LEPTOSPHINCTINAE Arkell, 1950

[Leptosphinctinae Arkell, 1950, p. 363] [=Bigotitinae Westermann, 1956, p. 271]

The first perisphinctids, derived from Stephanoceratinae; early forms are small, becoming larger later, with round whorls, compressed to slightly depressed, moderately dense ribs, and prorsiradiate constrictions that may become inconspicuous or absent in more coarsely ribbed forms; ribs tend to fade on the venter that has a midventral smooth band or groove; ribs divide at fine ventrolateral tubercles, making inner whorls coronate. Dimorphic: ribs tend to fade on the adult body chamber of macroconchs; a shallow constriction at the mouth border is followed by a simple peristome with a ventral projection. Microconchs have elaborate, spatulate lappets that sometimes constrict the aperture severely. *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone–lower Bathonian,* Zigzag *Zone):* Europe, Caucasus, Turkmenistan, Pamirs, northern Africa, Russia, Indonesia (Papua), Papua New Guinea, USA, Canada, Mexico, Chile, Argentina.

Stephanosphinctes Sandoval & Westermann, 1986, p. 1266 [**S. buitroni;* OD]. Small evolute serpenticones, whorl section coronate on inner whorls, subcircular later; very short primary ribs divide at small to moderate tubercles at the umbilical margin into bundles of prorsiradiate secondary ribs that pass radially across the venter; ribs tend to fade on the adult body chamber; several deep, oblique constrictions per whorl. Probably dimorphic; macroconchs have constricted sinuous mouth border; adult mouth border of microconchs unknown. *Stephanosphinctes* is transitional between Stephanoceratinae and Leptosphinctinae, retaining the umbilical tubercles of the former and developing the deep, oblique constrictions of the latter subfamily. Galácz, 2012. *Middle Jurassic (Bajocian, top* Humphriesianum*–bottom* Subfurcatum *Zone):* Mexico, Hungary.——Fig. 2,*1a–c.* **S. buitroni,* Los Rebajes, 3.5 km southeast of San Juan Mixtepec, Oaxaca, Mexico; *a,* holotype, macroconch with an incomplete body chamber; *b–c,* paratype, body chamber, fragment of ?microconch; ×1 (Sandoval & Westermann, 1986, fig. 39-1,*4–5*).

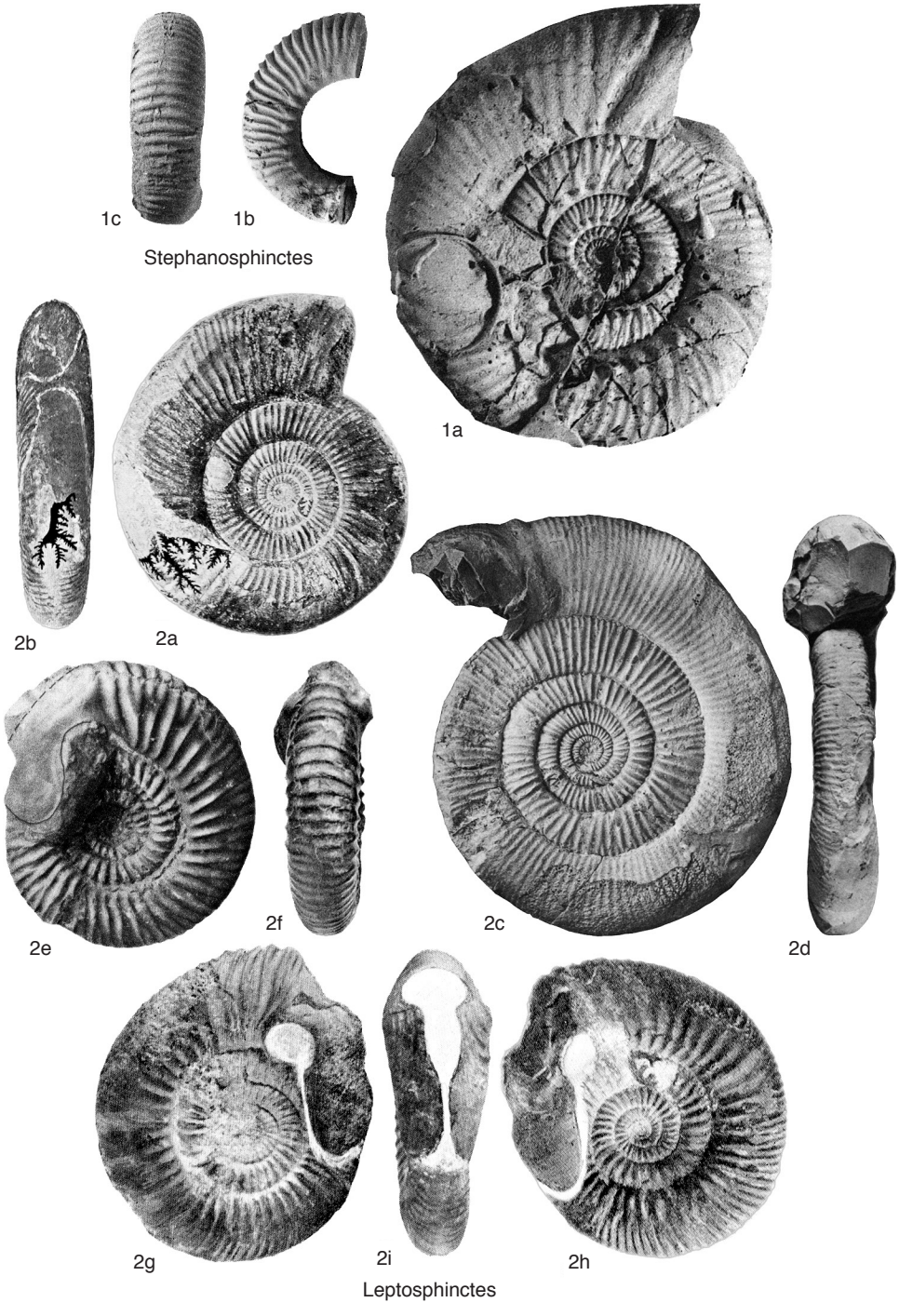

FIG. 2. Perisphinctidae, Leptosphinctinae (p. 3–5).

Leptosphinctes Buckman, 1920, pl. 160 [**L. leptus;* OD] [=*Kubanoceras* Kakhadzé & Zesashvili, 1955, p. 707; also Kakhadzé & Zesashvili, 1956, p. 31 (type, *Perisphinctes (Grossouvria) asinus* Zatwornitzky, 1914, p. 553, OD); =*Cleistosphinctes* Arkell, 1957, p. 314, *non* Arkell & Lucas, 1953, p. 2258, *nec* Arkell, 1956a, p. 32, 77, 176, 264, 363, both *nom. nud.* and invalid under ICZN Code, 1999, Article 13.1 (type, *Leptosphinctes cleistus* Buckman, 1920, pl. 161, OD); =*Oxysphinctes* Beznosov in Beznosov & Mikhaylova, 1981, p. 54 (type, *O. kubanensis,* OD); =*Bajocisphinctes (Obsoletosphinctes)* Beznosov in Beznosov & Mikhaylova, 1981, p. 54 (type, *Leptosphinctes (Cleistosphinctes) obsoletus* Pavia, 1973, p. 134, OD); =*Otiosphinctes* Beznosov, 1982, p. 130 (*Otiosphinctes* Beznosov in Beznosov & Mikhaylova, 1979, p. 6–7, *nom. nud.*), *nom. nov. pro Praebigotites (Otosphinctes)* Beznosov in Beznosov & Mikhaylova, 1981, p. 51, *non Otosphinctes* Buckman, 1926, pl. 649 (type, *Pseudobigotella otiophora* Buckman, 1920, pl. 191, OD)]. Small, evolute, rounded to slightly compressed whorl section; fine to moderate radial ribs bifurcate, or secondaries are intercalated, high on the whorl side and pass across the rounded venter; 2–4 deep, prorsiradiate constrictions per whorl; suture complex, with highly retracted and incised umbilical lobe and long, florid lateral lobes. Macroconchs (*Leptosphinctes*) have adult body chamber almost one whorl long, on which ribs are lost in some species, ending in a broad, shallow, oblique constriction, then a simple, flared final peristome with a ventral projection. Microconchs (*Kubanoceras, Cleistosphinctes*) are much smaller, weakly coronate on inner whorls, with stronger ribs remaining to the end of the adult mouth border, which has a peristome with very large, asymmetric lappets that embrace the preceding whorl and largely obstruct the aperture. The morphology of the macroconch is similar to that found repeatedly in many descendants, giving rise to much homeomorphy: e.g., with Callovian *Choffatia,* Oxfordian *Arisphinctes,* many Volgian *Dorsoplanites,* and Tithonian *Virgatosphinctes. Middle Jurassic (Bajocian, upper Subzone of* Humphriesianum–*lower* Parkinsoni *Zones):* Europe, Caucasus, Russia (Crimea), Pamirs, northern Africa, Egypt (Sinai), Indonesia (Papua), Papua New Guinea, Canada (British Columbia, Alberta), USA (Alaska, Oregon, Montana), Mexico, Chile, Argentina.——Fig. 2,*2a–b.* **L. leptus* (Buckman), holotype, macroconch, *Subfurcatum* Zone, *Polygyralis* Subzone, Frogden Quarry, Oborne, Dorset, England, ×0.5 (Buckman, 1920, pl. 160,1–2).——Fig. 2,*2c–d. L. chaudonensis* Pavia, holotype, complete macroconch, early form retaining a *Stephanoceras*-like peristome, *Humphriesianum* Zone, *Blagdeni* Subzone, Chaudon, Digne, Alpes-Haute-Provence, France, ×0.5 (Pavia, 1973, pl. 22,7).——Fig. 2,*2e–f. L. asinus* (Zatwornitzky), lectotype (designated by Rostovtsiev, 1985, p. 164), complete microconch with large, drooping lappet, Upper Bajocian, Kuban, Krasnodar Krai, Russia, ×1 (Zatwornitzky, 1914, pl. 17,*20–21*).——Fig. 2,*2g–i. L. cleistus* Buckman, holotype, microconch, *Subfurcatum* Zone, *Polygyralis* Subzone, Frogden Quarry, Oborne, Dorset, England, ×1 (Buckman, 1920, pl. 161).

Vermisphinctes Buckman, 1920, pl. 162 [**V. vermiformis;* OD] [=*Prorsisphinctes* Buckman, 1921, pl. 200 (type, *Perisphinctes pseudomartinsi* Siemiradzki, 1899 in 1898–1899; p. 328, OD); =?*Phanerosphinctes* Buckman, 1921, pl. 211 (type, *P. phanerus,* OD); =*Stomphosphinctes* Buckman, 1921, pl. 247 (type, *S. stomphus,* OD); =*Glyphosphinctes* Buckman, 1925a, pl. 544 (type, *G. glyphus,* OD); =*Spathia* Schindewolf, 1925, p. 319 (type, *Ammonites martinsi* d'Orbigny, 1846 in 1842–1851, p. 381, pl. 125, *recte Ammonites martiusi,* see Fischer & others, 1994, p. 111), OD); =*Cobbanites* Imlay, 1962, p. 26 (type, *C. talkeetnanus,* OD); =*Choffatisphinctes* Beznosov, 1982, p. 57 (type, *Perisphinctes* (*Choffatia*) *faunus* Siemiradzki, 1899 in 1898–1899, p. 333, OD)]. Macroconchs (*Prorsisphinctes*) larger and more variable than *Leptosphinctes,* from compressed, densely ribbed forms to more inflated and depressed, coarsely ribbed forms, and the densely ribbed forms become smooth on the adult body chamber, which has a simple peristome; primary ribs bifurcate on inner whorls, but may divide into 3 or 4 secondaries on outer whorls. Microconchs (*Vermisphinctes*) also larger than those of *Leptosphinctes,* and ribs persist on the adult body chamber, which has a terminal constriction and less pronounced lappets. *Middle Jurassic (upper Bajocian, upper* Parkinsoni *Zone):* Europe, Caucasus, USA (Alaska).——Fig. 3*a–b.* **V. vermiformis,* holotype, ?microconch, *Parkinsoni* Zone, *Truellei* Subzone, Half-way House, Sherborne, Dorset, England, ×0.7 (Buckman, 1920, pl. 162).——Fig. 3*c–d. V. pseudomartinsi* (Siemiradzki), holotype, macroconch, *Garantiana* Zone, Bayeux, France, ×0.7 (Siemiradzki, 1899 in 1898–1899, pl. 22,*26;* p. 328, fig. 84).——Fig. 3*e. P. stomphus* (Buckman), holotype, macroconch, *Parkinsonia* Zone, Vetney Cross, Bridport, Dorset, England, ×0.45 (Buckman, 1921, pl. 247).——Fig. 3*f–h. P. talkeetnanus* (Imlay), holotype, macroconch with adult mouth border, Little Nelchina River, 62°07.25′N, 147°42′W, Talkeetna Mountains, Cook Inlet, Alaska, USA; *f–g,* ×0.3; *h,* suture, ×0.5 (Imlay, 1962, pl. 7,*8–9,* pl. 8,*1*).

Caumontisphinctes Buckman, 1920, pl. 163 [**C. polygyralis;* OD] [=*Praebigotites* Wetzel, 1936, p. 533 (type, *P. westfalicus,* OD); =*Infraparkinsonia* Westermann, 1956, p. 268 (type, *Parkinsonia inferior* Bentz, 1924, p. 174, OD); =*Infragarantiana* Westermann, 1956, p. 268 (type, *Garantiana primitiva* Wetzel, 1936, p. 540, OD); =*Patrulia* Sturani, 1971, p. 176 (type, *P. aenigmatica,* OD)]. Similar to *Leptosphinctes,* but more evolute, ribs sharper and coarser, and inner whorls coronate, with ventrolateral tubercles from which secondary ribs bifurcate and continue up to a midventral smooth band or groove; constrictions are inconspicuous

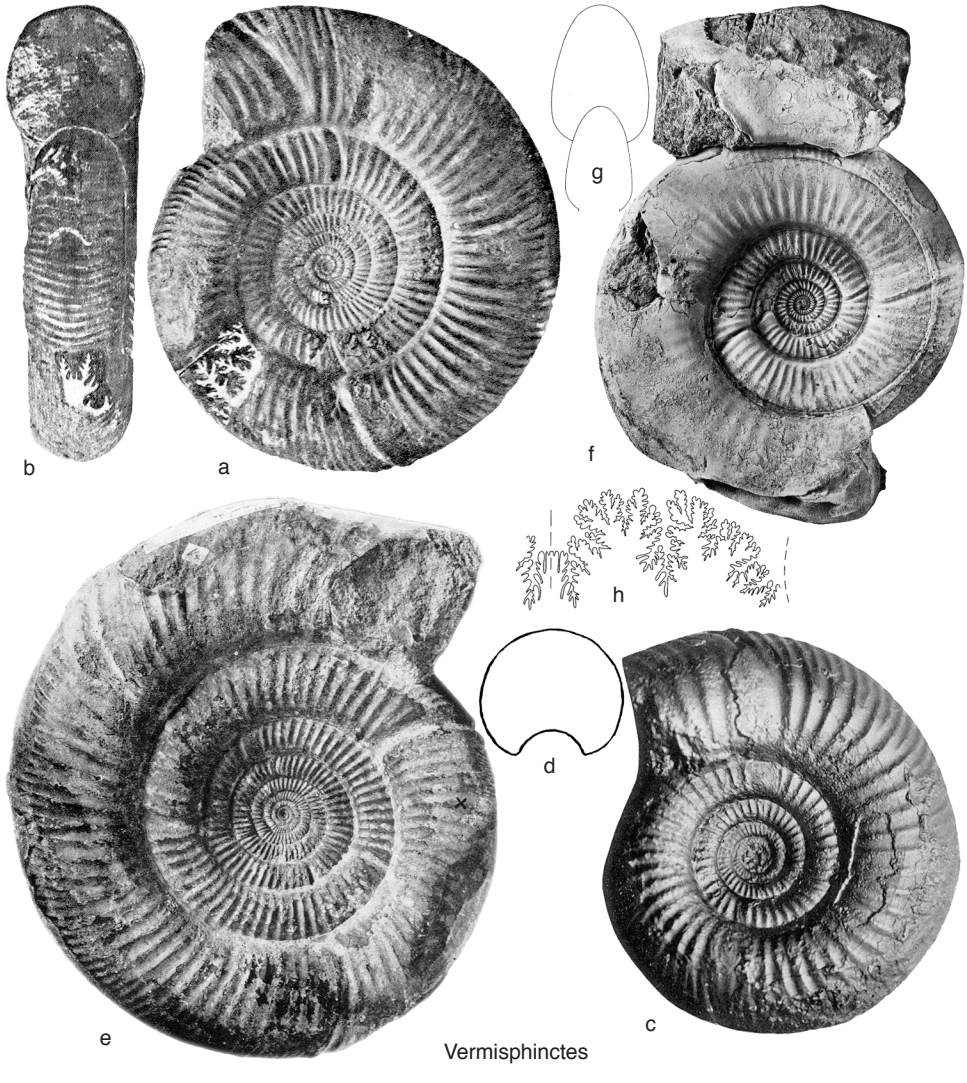

FIG. 3. Perisphinctidae, Leptosphinctinae (p. 5).

or absent. Macroconchs: ribs persist on the adult whorl in some species, though others become smooth; the final mouth border is simple and preceded by a constriction. Microconchs (*Infraparkinsonia*) are similar to those of *Leptosphinctes,* but more evolute, coronate, with coarser, simple and bifurcate ribs that may alternate at the ventral groove and smaller, spatulate lappets. Probably a short-ranging offshoot from *Leptosphinctes* and a probable ancestor of the Parkinsoniinae. SCHWEIGERT, DIETZE, & DIETL, 2002. *Middle Jurassic (upper Bajocian,* Subfurcatum *Zone):* Europe, Caucasus.——FIG. 4,*1a.* **C. polygyralis,* holotype, complete macroconch, *Subfurcatum* Zone, *Polygyralis* Subzone, lower Clatcombe, Sherborne, Dorset, England, ×1 (Buckman, 1920, pl. 163).——FIG. 4,*1b–c. C. bifurcus* BUCKMAN, holotype, immature ?macroconch, Frogden Quarry, Oborne, Dorset; *a,* side view; *b,* whorl cross section; ×1 (Buckman, 1920, pl. 192,*1–2*).——FIG. 4,*1d–e. C. inferior* (BENTZ), lectotype, microconch, Bethel, Bielefeld, Germany, ×1 (Bentz, 1924, pl. 8,*4a–b*).——FIG. 4,*1f. C. phaulus* (BUCKMAN), holotype, complete microconch with lappet, *Subfurcatum* Zone, *Polygyralis* Subzone, Lower Clatcombe, Sherborne, Dorset, England, ×1 (Buckman, 1920, pl. 169).

Bajocisphinctes BUCKMAN, 1927, pl. 713 [**Perisphinctes bajociensis* SIEMIRADZKI, 1899 in 1898–1899, p. 334; M] [=*Microbajocisphinctes* FERNANDEZ-LOPEZ, 1985, p. 491 (type, *M. densi-*

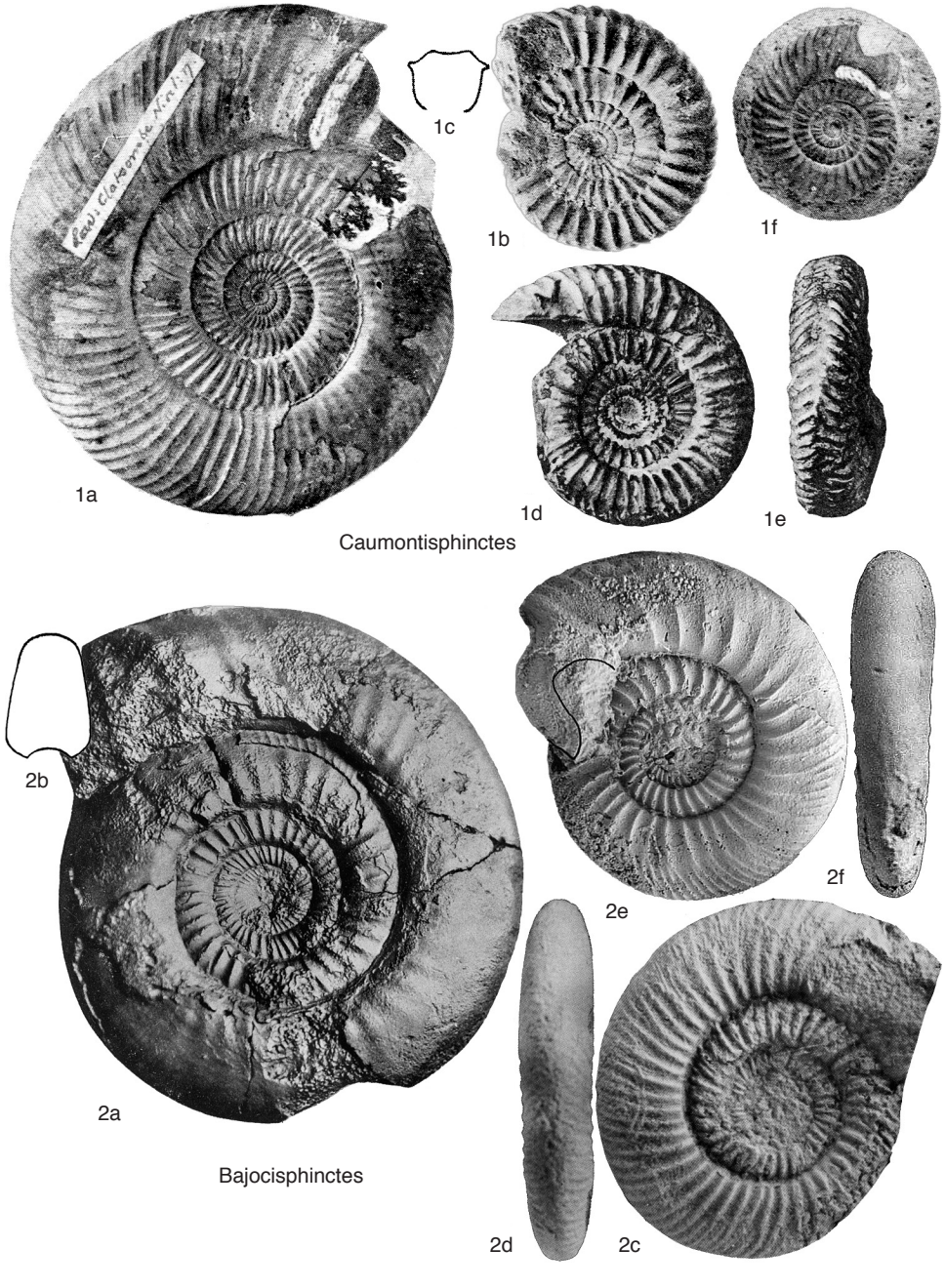

FIG. 4. Perisphinctidae, Leptosphinctinae (p. 5–8).

costatus, OD)]. Relatively small, evolute inner whorls rounded, larger whorls in macroconchs becoming more compressed with an arched, sub-oval whorl section; ribs less dense and more strongly curved forwards than in *Leptosphinctes,* and constrictions less prominent and suture less complex. Macroconchs with simple mouth border; microconchs (*Microbajocisphinctes*) with spatulate lappets, but less extreme than in *Leptosphinctes.* Probably derived from *Leptosphinctes,* and ancestor

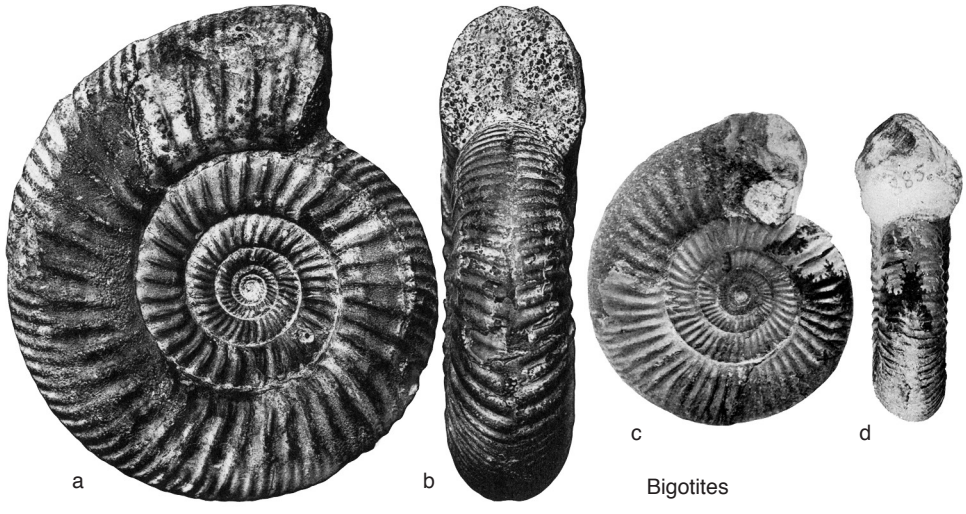

FIG. 5. Perisphinctidae, Leptosphinctinae (p. 8).

of *Bigotites.* PAVIA, 1973; DIETL, 1974; GALÁCZ, 1980; FERNANDEZ-LOPEZ, 1985; GAUTHIER, RIOULT, & TRÉVISAN, 1996. *Middle Jurassic (upper Bajocian,* Subfurcatum–Garantiana *Zones):* western Europe (mainly in the Submediterranean Province of the western Tethys).——FIG. 4,*2a–b.* **B. bajociensis* (SIEMIRADZKI), lectotype, macroconch, Bayeux, Normandy, France, ×0.67 (Siemiradzki, 1899 in 1898–1899, pl. 24,*40;* p. 334, fig. 85).——FIG. 4,*2c–d. B. densicostatus,* holotype, microconch, *Garantiana* Zone, *Dichotoma* Subzone, Embalse San Blas, Caudé, Teruel, Spain, ×1 (Fernandez-Lopez, 1985, pl. 50,*5a–b*).——FIG. 4,*2e–f. B. robustus* FERNANDEZ-LOPEZ, 1985, holotype, microconch with lappet, *Garantiana* Zone, *Tetragona* Subzone, Embalse San Blas, Caudé, Teruel, Spain, ×0.8 (Fernandez-Lopez, 1985, pl. 51,*4a–b*).

Bigotites NICOLESCO, 1918, p. 36, *nom. nov. pro Bigotella* NICOLESCO, 1917, p. 167, *non* COSSMANN, 1914, p. 174 (gastropod) [**Bigotella petri* NICOLESCO, 1917, p. 153; SD NICOLESCO, 1931, p. 9, 23, ICZN Opinion 324, 1955, p. 236; *non Bigotella thevenini* NICOLESCO, 1917, SD BUCKMAN, 1920, p. 29] [=*Pseudobigotella* LEMOINE, 1918, p. 34 (type, *Bigotella haugi* NICOLESCO, 1917, p. 158, OD); =*Haselburgites* BUCKMAN, 1920, p. 30; 1921, p. 55; 1921, pl. 203 (type, *H. admirandus,* OD); =*Planisphinctes* BUCKMAN, 1922, pl. 327, (type, *P. planilobus,* OD); =*Lobosphinctes* BUCKMAN, 1923b, pl. 447 (type, *L. intersertus,* OD); =*Parabigotites* IMLAY, 1961, p. 472, (type, *P. crassicostatus;* OD)]. Evolute inner whorls, round whorl section; coarse primary ribs bifurcate high on the whorl side; secondary ribs end at a midventral smooth band or groove; some specimens have several constrictions per whorl, from which the whorl enlarges segmentally; suture broader, with shorter lobes than in *Leptosphinctes.* Macroconchs become more involute, compressed, and smooth on large outer whorls, and have plain mouth border; microconchs remain evolute and have lateral lappets. FERNANDEZ-LOPEZ & others, 2007. *Middle Jurassic (upper Bajocian, upper* Garantiana–Parkinsoni *Zones–lower Bathonian,* Zigzag *Zone):* England, Germany, France, Portugal, Spain, Slovakia, Hungary, Caucasus, western Turkmenistan, northern Africa, USA (Alaska).——FIG. 5*a–b.* **B. petri* (NICOLESCO), holotype, ?macroconch, Upper Bajocian, *Garantiana* Zone, Sully, Bayeux, France, ×0.65 (Nicolesco, 1931, pl. 8,*4a–b*).——FIG. 5*c–d. B. planilobus* (BUCKMAN), holotype, microconch with lappet, Burton Bradstock, Dorset, England, ×0.65 (Buckman, 1922, pl. 327).

Subfamily ZIGZAGICERATINAE Buckman, 1920

[*nom. transl.* ARKELL, 1950, p. 363, *ex* Zigzagiceratidae BUCKMAN, 1920, p. 30] [=Pseudoperisphinctinae SCHINDEWOLF, 1925; *nom. correct.* ARKELL, 1950, p. 363, footnote 24, *ex* Pseudoperisphinctidae SCHINDEWOLF, 1925, p. 319].

Derived from *Bigotites* (Leptosphinctinae), in which parabolic nodes develop at the ventrolateral furcation points on the ribs, especially on the coronate, innermost whorls where the primary ribs are widely spaced, rectiradiate, and cruciform, with the secondaries sweeping forwards almost tangentially from the parabolae in zigzag fashion. This zigzag stage is confined to the nucleus in most genera, but in *Zigzagiceras* it may extend over the whole phragmocone of the microconch and onto the middle whorls of the macroconch. Macroconchs

are large, becoming more involute, inflated, and smooth on later whorls, with extremely elaborate sutures having thin, long, spidery elements and highly retracted umbilical lobe; microconchs have lappets ranging from short to highly spatulate. *Middle Jurassic (top upper Bajocian–upper Bathonian):* Europe, Iran, Saudi Arabia, Russia, Uzbekistan, ?Mexico, Canada, Argentina, Chile.

Procerites Siemiradzki, 1898 in 1898–1899, p. 78, 303 [**Procerites schloenbachi* Grossouvre, 1906, p. 8; SD ICZN Opinion 301, 1954a, p. 251] [=*Siemiradzkia* Hyatt, 1900, p. 582 (type, *Ammonites aurigerus* Oppel, 1857 in 1856–1858, p. 476, OD, ICZN Opinion 301, 1954a, p. 251); =*Zigzagites* Buckman, 1922, pl. 301 (type, *Z. imitator,* OD); =*Parkinsonites* Buckman, 1922, pl. 302 (type, *P. fullonicus,* OD); =*Phaulozigzag* Buckman, 1926, pl. 643 (type, *P. phaulomorphus,* OD); =*Euprocerites* Wetzel, 1950, p. 76; obj., ICZN Opinion 301, 1954a, p. 251]. Variocostate planulates; inner whorls evolute, with coronate stage confined to the nucleus; primary ribs sharp and dense, bifurcating irregularly and indistinctly, with some simple ribs and intercalatories; constrictions on inner whorls in some forms. Dimorphic: macroconchs large, becoming more involute on outer whorls; ribs fade first on the whorl side, then becoming entirely smooth; final aperture simple. Microconchs have fine, sharp, somewhat irregular ribs on the phragmocone with frequent simple ribs and intercalatories; ribs become stronger, thicker, and the secondaries are distorted by numerous parabolae on the adult body chamber of some species; no constrictions; large, spatulate lappets in the adult mouth border. The earliest genus, derived from *Bigotites.* The lectotype (d'Orbigny, 1846 in 1842–1851, pl. 49,*1*) and the neotype (Grossouvre, 1919, pl. 15,*6*) of the type species of *Siemiradzkia,* both designated by Arkell (1959, p. 212), are lost. Figures are given here of that lost neotype, and a more recently collected specimen, that closely resembles d'Orbigny's figure of the lost lectotype. Stephanov, 1972; Fischer & others, 1994. *Middle Jurassic (upper Bajocian, upper* Parkinsoni *Zone–middle Bathonian):* Europe, northern Africa, Caucasus, Russia (Trans-Caspia), Uzbekistan, Iran, Pamirs, Madagascar, Canada (British Columbia, Alberta), USA (Montana, Atlanta), ?Mexico.——Fig. 6*a–d*. **P. schloenbachi* (Grossouvre)*; a–b,* lectotype (lost), macroconch, lower Bathonian, Eimen, Brunswick, Germany, ×0.5 (Arkell, 1958, p. 172, fig. 2A–B); *c–d,* a phragmocone, eastern France, ×0.5 (Arkell, 1958, p. 182, fig. 66).——Fig. 6*e–f. P. aurigerus* (Oppel), lower Bathonian, Saint-Benin d'Azy, Nièvre, France; *e,* neotype (lost; designated by Arkell, 1959, p. 212; see also Fischer & others, 1994, p. 138), microconch with a large, but highly distorted lappet, ×0.9 (Grossouvre, 1919, pl. 15,*6*); *f–g,* a microconch closely resembling the lectotype (designated by Arkell, 1959, p. 212), ×0.9 (Fischer & others, 1994, pl. 51,*5a,c*).

Protozigzagiceras Fernandez-Lopez & others, 2007, p. 396 [**Zigzagiceras torrensi* Sturani, 1966, p. 47; OD]. Moderately evolute, rounded whorl section; inner whorls with zigzag ribbing; widely spaced primary ribs, ventrolateral tubercles, and secondary ribs curving slightly forwards across venter; on middle and outer whorls ribs more closely spaced and bifurcate at ventrolateral tubercles. Dimorphic: macroconchs large, up to 300 mm in diameter, become more involute, and tend to lose the ribs on the final whorls; microconchs reach 70 mm in diameter, and retain ribs on adult whorl; adult mouth borders unknown. Derived from *Procerites. Middle Jurassic (lower Bathonian,* Zigzag *Zone):* France, Spain, Portugal, England, Hungary, Slovakia, Iran.——Fig. 7,*1a–d. *P. torrensi* (Sturani), Bas Auran, Alpes-de-Haut-Provence, France; *a–b,* holotype, phragmocone of microconch, ×1 (Fernandez-Lopez & others, 2007, fig. 12); *c–d,* complete phragmocone and beginning of body chamber of macroconch, ×0.6 (Fernandez-Lopez & Pavia, 2013, fig. 11).

Franchia Sturani, 1966, p. 52 [**Zigzagiceras (Franchia) arkelli;* M]. Large, evolute, coarse-ribbed early forms, the zigzag stage confined to the innermost whorls and only partially developed as irregular thickening of some primary ribs into bullae combined with constrictions; secondary ribs interrupted on the venter. Dimorphic: macroconchs up to 260 mm in diameter, microconchs up to about 60 mm; final mouth borders unknown in both dimorphs. *Middle Jurassic (lower Bathonian,* Zigzag *Zone):* France.——Fig. 7,*2a–d. *F. arkelli,* Bas Auran, Alpes-de-Haut-Provence, France; *a–b,* holotype, macroconch, ×0.3; *c–d,* paratype, ?microconch, ×1.5 (Fernandez-Lopez & Pavia, 2013, fig. 4A–B, 6B–C).

Zigzagiceras Buckman, 1902, p. 7 [**Ammonites zigzag* d'Orbigny, 1846 in 1842–1851 , p. 390; OD] [=*Procerozigzag* Arkell, 1953, p. 37 (type, *Stephanoceras crassizigzag* Buckman, 1892, p. 449, OD]. Inner whorls evolute with characteristic zigzag ribbing, with large, distant primary ribs ending at ventrolateral nodes, and fine secondary ribs strongly projected on the tabulate venter. Microconchs (*Zigzagiceras*): the zigzag stage extends over the whole phragmocone, reverting to perisphinctid-style bifurcating ribs on the adult body chamber, which has lappets. Macroconchs (*Procerozigzag*): zigzag stage extends to the middle whorls; later whorls stout, depressed, with normal ribs before becoming smooth on the body chamber; sutures complex and spidery as in *Procerites,* with deeply retracted umbilical lobes. *Middle Jurassic (lower Bathonian,* Zigzag *Zone):* Europe, Uzbekistan, ?Mexico.——Fig. 8*a–d. *Z. zigzag* (d'Orbigny), holotype, ?microconch, Niort, Deux-Sèvres, France; *a–b,* ×1 (d'Orbigny, 1846

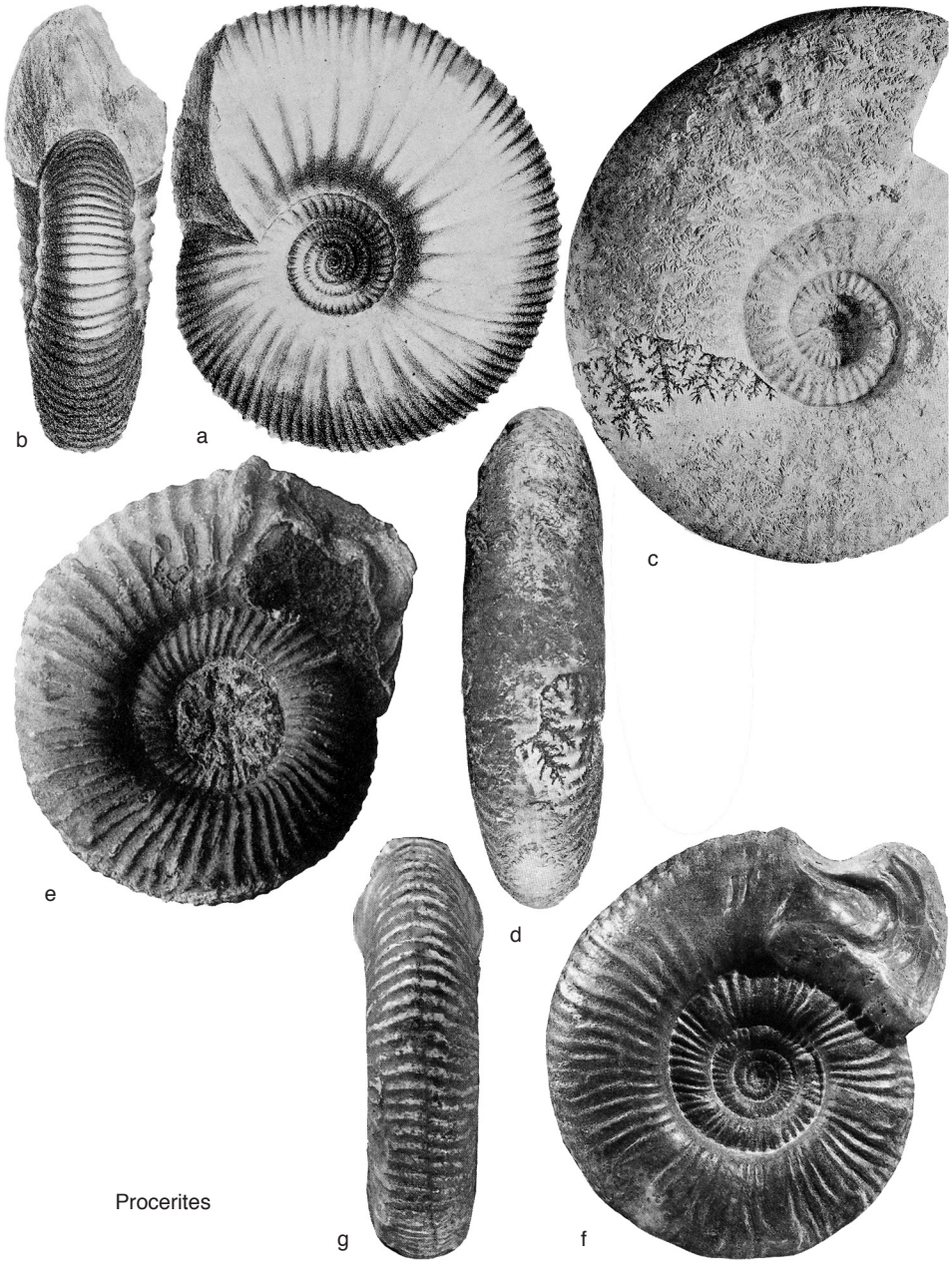

FIG. 6. Perisphinctidae, Zigzagiceratinae (p. 9).

in 1842–1851, pl. 129,*9–10*); *c–d,* ×1 (Fischer & others, 1994, pl. 51,*1a,c*).——FIG. 8*e–g. Z. euryodos* (SCHMIDT, 1846), complete microconch with lappet, Crewkerne, Somerset, England, ×1 (Arkell, 1958, pl. 21,*1a–c*).——FIG. 8*h–i. Z. crassizigzag* (BUCKMAN), lectotype (designated by ARKELL, 1953, p. 37), macroconch, Broad Windsor, Dorset, England, ×0.5 (Buckman, 1892, pl. 14,*2–3*).——FIG. 8*j. Z. postpollubrium garnieri* STURANI, 1966, suture, Bas Auran, Barrême, Basses-Alpes, France, ×0.35 (Sturani, 1966, pl. 17,*7*).——FIG. 8*k–l. Z. clausiprocerum* BUCKMAN, 1925b, macroconch, Broad

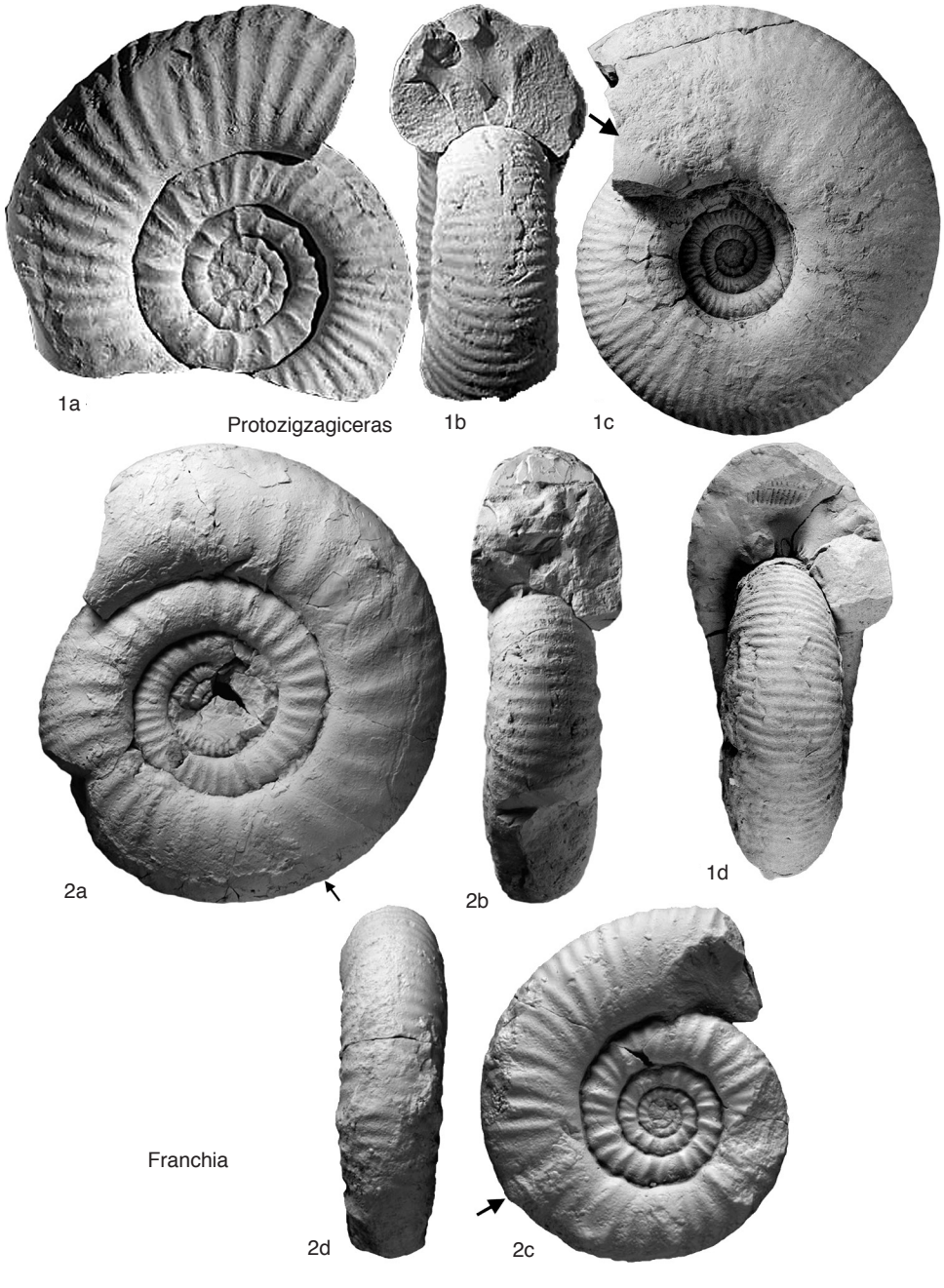

FIG. 7. Perisphinctidae, Zigzagiceratinae (p. 9).

Windsor, Dorset, England, ×0.45 (Buckman, 1925b, pl. 595A–595B).

Wagnericeras BUCKMAN, 1921, p. 33 [**Ammonites wagneri* OPPEL, 1857 in 1856–1858, p. 477, *nom. nov. pro Ammonites planula* D'ORBIGNY, 1846 in 1842–1851, p. 416, *non* HEHL in ZIETEN, 1830 in 1830–1833, p. 9; OD] [=*Suspensites* BUCKMAN, 1922, pl. 346 (type, *S. suspensum*, OD); =*Pseudoperisphinctes* SCHINDEWOLF, 1923, p. 346 (type, *Perisphinctes rotundatus* ROEMER, 1911, p. 44, M, ICZN Opinion 324, 1955, p. 237)].

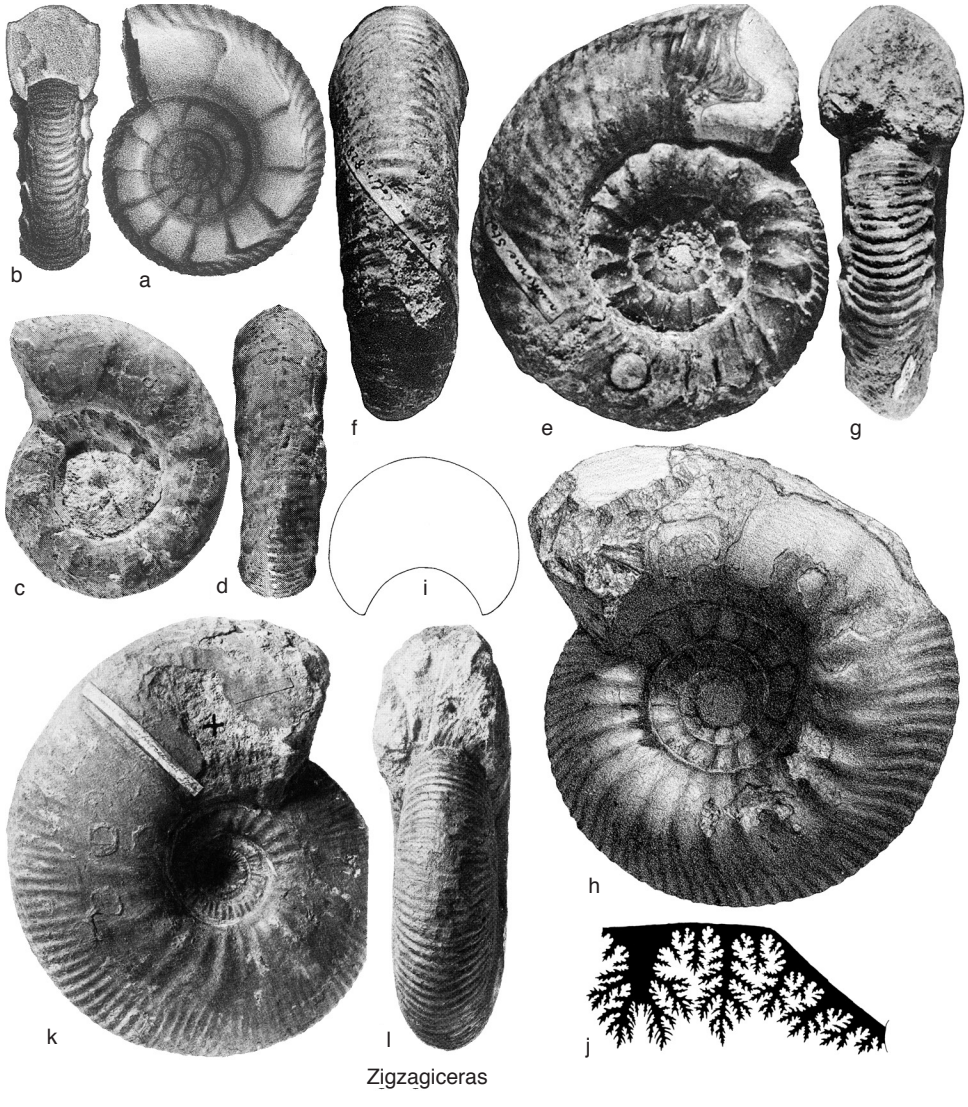

FIG. 8. Perisphinctidae, Zigzagiceratinae (p. 9–11).

Moderately involute; stout, depressed, cadiconic inner whorls; middle and outer whorls less depressed with rounded venter; fine primary ribs on inner whorls become coarse and bullate near the umbilical edge on later whorls, and bifurcate or trifurcate low on whorl side, with some intercalatories; secondary ribs pass uninterrupted over the venter; zigzag rib stage confined to the innermost whorls. Dimorphic: macroconchs large, and outer whorls tend to become smooth; microconchs poorly known. Sutures more open, the umbilical lobe less retracted than in *Procerites*. *Middle Jurassic (lower–upper Bathonian):* Europe, Ukraine (Crimea).——FIG. 9*a–b*. **W. wagneri* (OPPEL), lectotype (designated by ARKELL, 1958, p. 176), macroconch, Ranville, Calvados, France, ×0.75 (Fischer & others, 1994, pl. 53,*3a–b*).——FIG. 9*c–d*. *W. suspensum* (BUCKMAN, 1922), holotype, macroconch, *Progracilis* Zone, middle Bathonian, Minchinhampton, Gloucestershire, England, ×1 (Arkell, 1958, pl. 29,*8a–b*).——FIG. 9*e–h*. *W. rotundata* (SCHINDEWOLF), type species of *Pseudoperisphinctes*, *Aspidoides* Zone, Lechstedt, Hildesheim, Lower Saxony, Germany; *e–f,* lectotype (designated by ARKELL, 1950, p. 363, footnote 24), macroconch, ×0.5 (Roemer, 1911, pl. 8,*2,* pl. 5,*6*);

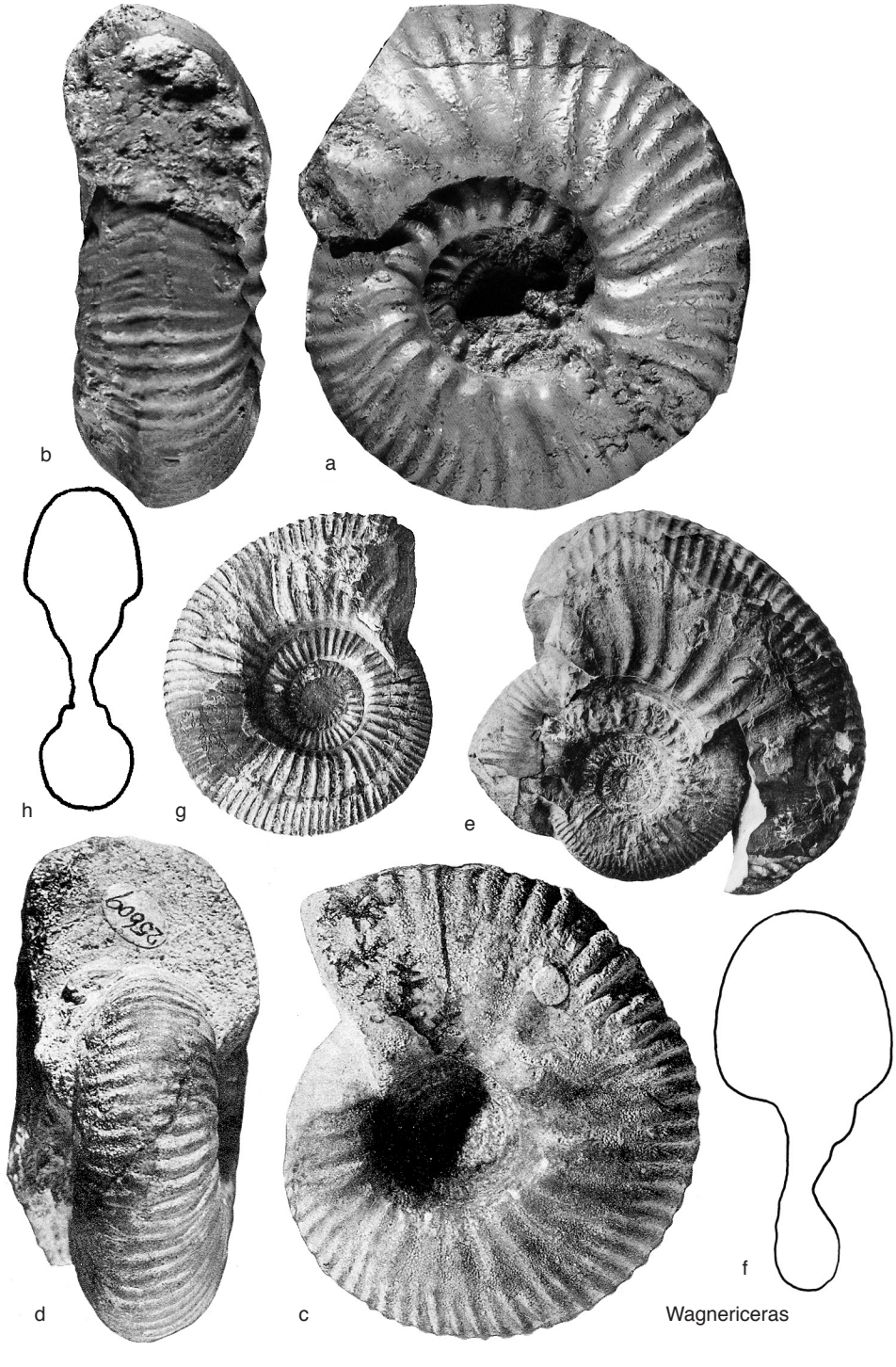

FIG. 9. Perisphinctidae, Zigzagiceratinae (p. 11–14).

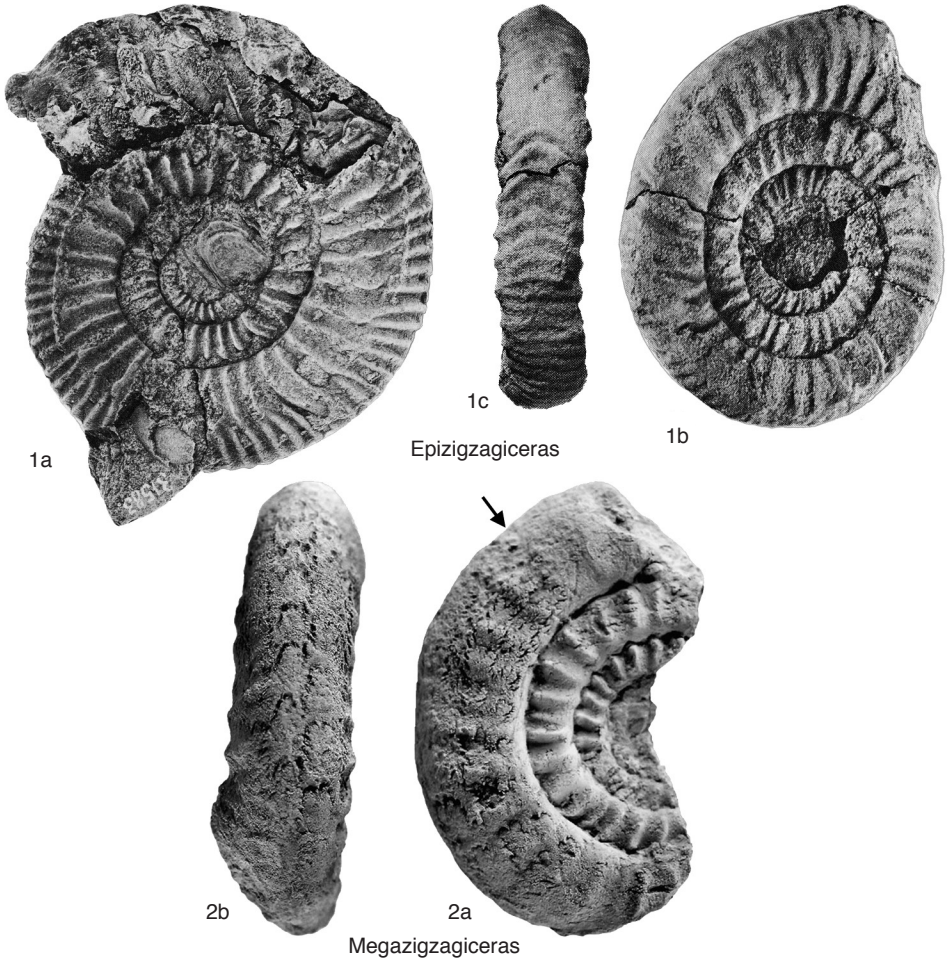

FIG. 10. Perisphinctidae, Zigzagiceratinae (p. 14).

g–h, a possible microconch, ×1 (Roemer, 1911, pl. 9,*3*, pl. 5,*9*).

Epizigzagiceras FREBOLD in FREBOLD & TIPPER, 1973, p. 1119 [**E. evolutum;* OD]. Evolute, whorls slightly compressed, with flat sides and flat or arched venter; inner whorls with irregular ribs, dividing ventrolaterally into two or three secondaries that are continuous across the venter; parabolic nodes develop on the larger ribs; deep constrictions; outer whorls are perisphinctid with more regular ribs; specimens are known up to 130 mm in diameter, but evidence of dimorphism has not been found. More evolute and compressed than other zigzagiceratinids, except *Megazigzagiceras* which has a rounded whorl section. *Middle Jurassic (late upper Bajocian–lower Bathonian):* Canada (British Columbia).——FIG. 10,*1a–c.* **E. evolutum*, Texas Creek, 54°32.1′N, 127°14.5′W, 27 km southwest of Smithers, British Columbia, Canada; *a,* holotype, ×0.6; *b–c,* paratype, ×1 (Frebold in Frebold & Tipper, 1973, pl. 1,*1,2a–b*).

Megazigzagiceras FERNANDEZ-LOPEZ & PAVIA, 2013, p. 21; 2014, p. 734 [**M. subarabicum;* OD]. Evolute, rounded whorls; primary ribs straight, blunt, curving forwards on venter; ventrolateral tubercles on middle whorls. Known only from a single, eroded specimen. *Middle Jurassic (lower Bathonian):* Saudi Arabia.——FIG. 10,*2a–b.* **M. subarabicum,* holotype, phragmocone and part of body chamber of ?microconch, Wadi al Hisyan, 24°57′N, 45°56′E (latitude and longitude from Énay & others 1987, fig. 1), 85 km northwest of Riyadh, Saudi Arabia, ×0.6 (Fernandez-Lopez & Pavia, 2013, fig. 19).

Subfamily PARKINSONIINAE Buckman, 1920

[*nom. transl.* Arkell, 1957, p. 308, *ex* Parkinsonidae Buckman, 1920, p. 28] [=Parkinsonidés Nicolesco, 1917, p. 157, vernacular name]

Compressed planulates with coronate innermost whorls; sharp, strong, and radial primary ribs divide high on the whorl side, sometimes at small tubercle; secondary ribs sweep forwards on the venter terminating at a prominent siphonal smooth band or groove; inconspicuous constrictions in early forms are infrequent or absent later. Dimorphic: adult body chambers nearly one whorl in length. Macroconchs attain large sizes up to 500 mm in diameter and have wide variation in rib density, becoming smooth on outer whorls. Microconchs smaller, with less variable rib density, with lappets in early species that later become vestigial, leaving simple, sinuous, and ventrally projected adult mouth borders. Septal sutures have the umbilical lobe U_n, as in Stephanoceratidae. Associations with *Praestriaptychus* are known, as in some stephanoceratids.

The classification of this group has given much trouble due to the resemblance of various species to members of other groups, particularly in their ventrally interrupted ribbing (Callomon in Donovan, Callomon, & Howarth, 1981, p. 150, note 1). Thus the group has been traditionally derived from *Garantiana*, while the relation to other perisphinctids remained unclear, and the early sutural ontogeny was considered by Schindewolf (1965, p. 206–208 [476–478]) to indicate descent from Stephanoceratidae, though the evidence he put forwards was hardly conclusive. However, their evolution from *Caumontisphinctes* can now be followed from their appearance in the *Garantiana* Zone, upper Bajocian, to their disappearance in the middle Bathonian. The earliest forms are the smallest and most evolute and strongly resemble *Caumontisphinctes* of the *Subfurcatum* Zone, which were themselves derived from *Leptosphinctes*. Subsequent development of the subfamily is towards larger and more involute forms, which also indicates genetic liaison with perisphinctids and hence their inclusion in Perisphinctidae. Schweigert, Dietze, & Dietl, 2002; Dietze & Dietl, 2006. *Middle Jurassic (upper Bajocian, middle* Garantiana *to* Parkinsoni *Zones–middle Bathonian):* Europe, North Africa, Ukraine (Donetsk), Russia (Russian Platform), Georgia, Iran, Pakistan (Pamirs).

Parkinsonia Bayle, 1878, pl. lxvii [**Ammonites parkinsoni* J. Sowerby, 1821b, p. 1; SD H. Douvillé, 1879, p. 91] [?=*Subparkinsonia* Mascke, 1907, p. 24, 35 (type, *S. divisa,* OD, *nom. nud.,* type species not identifiable); =*Durotrigensia* Buckman, 1928, pl. 767A (type, *Ammonites dorsetensis* Wright, 1856, p. 309, 321, OD); =*Gonolkites* Buckman, 1925a, pl. 546 (type, *G. convergens*, OD); ?=*Okribites* Kakhadzé, 1937, p. 145 (type, *O. okribensis,* by virtual tautonomy, ICZN Code, 1999, Art. 69A.2); ?=*Atlantosphinctes* Wetzel, 1967, p. 571 (type, *A. normannicus;* OD); =*Djanaliparkinsonia* Kutuzova, 1975, p. 89 (type, *Parkinsonia lutshnikovi*, OD); =*Rarecostites* Besnesov & Kutuzova, 1982, p. 42 (type, *Cosmoceras parkinsoni* var. *rarecostatum* Buckman, 1881, p. 599, OD)]. Compressed, evolute inner whorls with a flat venter and midventral groove become more involute with rounded venter on large outer whorls and generally more depressed whorls in some species; sharp, straight or slightly curved ribs bifurcate at small or inconspicuous lateral to ventrolateral tubercles; secondary ribs curve forwards across the venter, ending at, and sometimes alternating across, the prominent midventral groove. Rib density variable from moderately fine to coarse and widely spaced. Dimorphic: microconchs are adult at the more evolute, compressed stage and ribbed to the final, sinuous mouth border; some early species have small lappets and a short ventral projection. Macroconchs attain sizes up to 500 mm in diameter, become more involute, more depressed, with a rounded venter, the ribs fading first on the upper side of the whorl, then becoming completely smooth on the final whorl. Sutures simple in microconchs, becoming variably complex in macroconchs. *Middle Jurassic (upper Bajocian–middle Bathonian):* Europe, northern Africa, Ukraine (Donetsk), Russia (Russian Platform), Uzbekistan (Gissar Mountain Range), Georgia, Iran, Pakistan (Pamirs).——Fig. 11*a–b. *P. parkinsoni*, lectotype, wholly septate microconch, *Parkinsoni* Zone, *Densicosta* Subzone, Yeovil, Somerset, England, ×0.5 (new; The Natural History Museum, London, NHMUK 43925).——Fig. 11*c–d. P. rarecostata* (Buckman, 1881), lectotype (designated by Howarth, herein), complete adult microconch with small lappet in the mouth border, type species of *Rarecostites,* Moutiers-en-Cinglais, Calvados, France, ×0.5 (Fischer & others, 1994, pl. 48,*a–b*).——Fig.

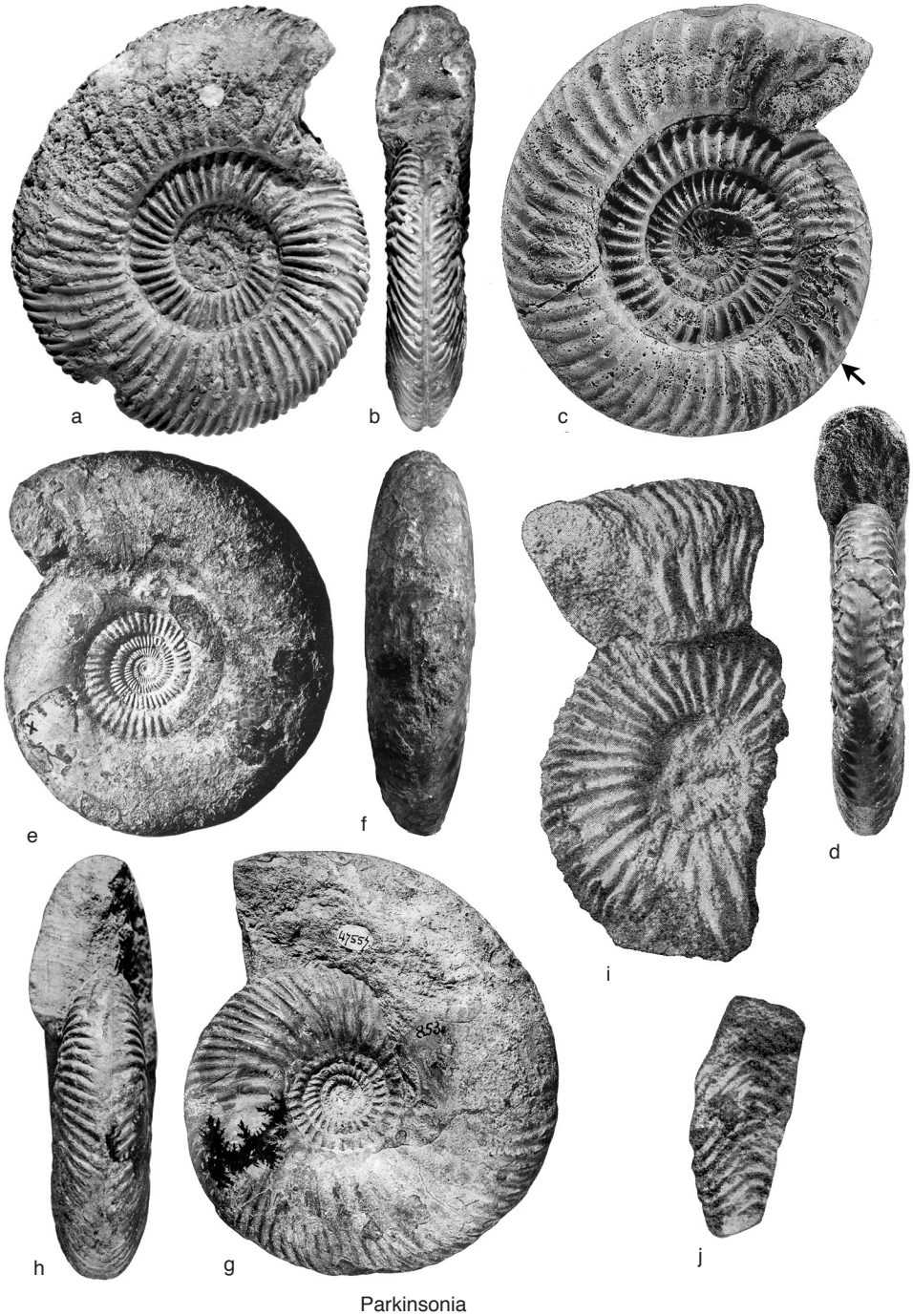

FIG. 11. Perisphinctidae, Parkinsoniinae (p. 15–17).

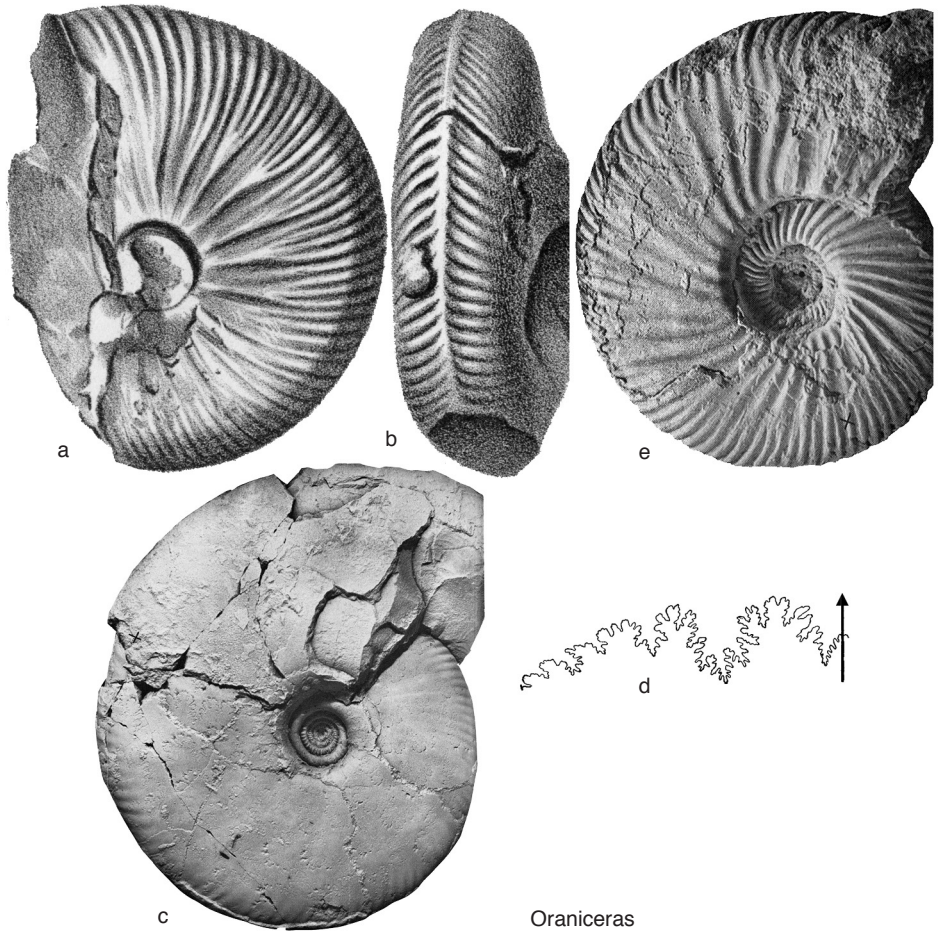

FIG. 12. Perisphinctidae, Parkinsoniinae (p. 17–18).

11*e–f. P. dorsetensis* (WRIGHT), lectotype, type species of *Durotrigensia,* macroconch, *Parkinsoni* Zone, Halfway House, Sherborne, Dorset, England; *a,* ×0.12 (Buckman, 1928, pl. 767A); *b,* ×0.12 (new; NHMUK C.3392).——FIG. 11*g–h. P. convergens* (BUCKMAN), holotype, type species of *Gonolkites,* macroconch, *Zigzag* Zone, *Convergens* Subzone, Grange Quarry, Broad Windsor, Dorset, England, ×0.5 (Arkell, 1956b, pl. 19,*1a,* pl. 18,*8*).——FIG. 11*i–j. P. okribensis* KAKHADZÉ, holotype, type species of *Okribites,* microconch, Jonéthi, Okriba, Georgia, ×1 (Krymholts, 1958, pl. 34,*4a–b;* also figured by Kakhadzé, 1937, pl. 6,*3*).

Oraniceras FLAMAND, 1911, p. 917 [**O. hamyanense;* M]. Compressed, involute; inner and middle whorls with dense, furcating ribs and numerous intercalatories; in some specimens a keel-like, raised fillet may replace the ventral smooth band on either test or cast; sutures simplified. Macroconchs become large, discoidal, the primary ribbing soon fading, but vestigial secondaries persist and then finally disappear. Microconchs have sinuous peristomes. Somewhat provincial distribution. *Middle Jurassic (lower Bathonian,* Zigzag *Zone,* Macrescens *Subzone):* Morocco, Algeria, Tunisia, Sicily, Switzerland, France, Germany, Poland, Russia (southern Russia, central Asia).——FIG. 12*a–b. *O. hamyanense*, holotype, ?macroconch, El-Harchaia, Méchéria, Algeria, ×1 (Flamand, 1911, pl. 7,*12a–b*).——FIG. 12*c–d. O. gyrumbilica* (QUENSTEDT); *c,* macroconch, Messtetter Talbach, Lautlingen, Württemberg, Germany, ×0.35 (Hahn, 1970, pl. 2,*1*); *d,* suture, Bouxwiller, Bas-Rhin, Alsace, France ×0.7 (Nicolesco, 1928, p. 60, fig. 35).——FIG. 12*e. O.*

wuerttembergica (Oppel), microconch, Röttingen, Aalen, Germany, ×0.9 (Hahn, 1970, pl. 4,*7*).

Subfamily PSEUDOCOSMOCERATINAE Sazonov, 1960

[Pseudocosmoceratinae Sazonov, 1960, p. 147]

A subfamily derived from Parkinsoniinae in which ribs and tubercles are gradually lost, eventually becoming entirely smooth, with a rounded venter. Confined to eastern Ukraine and southern Russian. Mitta, 2004. *Middle Jurassic (lower Bathonian):* Russia, Ukraine.

Pseudocosmoceras Mourachkine, 1930, p. 148 [**Cosmoceras michalskii* Borissjak, 1908, p. 36; OD]. Small; inner whorls involute, rounded; middle whorls more evolute, compressed, with tabulate venter bordered by small tubercles at ends of slightly prorsiradiate, vestigial secondary ribs; outer whorls become wholly smooth, oval, with rounded venter. Dimorphic: macroconchs smooth with rounded venter; microconchs retain flat venter and vestigial secondary ribs. Possibly derived from *Oraniceras*. *Middle Jurassic (lower Bathonian):* Russia (Saratov, Volgograd, Dagestan, Chechnya), Ukraine (Kharkiv, Donetsk).——Fig. 13,*1a–g.* **P. michalskii* (Borissjak); *a–c,* syntype, microconch, Chutor Kowaljewka, Donetsk, Ukraine; *a–b,* ×1; *c,* ×2 (Borissjak, 1908, pl. 3,*18a–b*, pl. 9,*5b*); *d,* another syntype, suture, Chutor Kowaljewka, Donetsk, Ukraine, ×1 (Borissjak, 1908, pl. 3,*19*); *e–f,* ?macroconch, Lower Povolzhye, Medveditsa-Ilovlja interfluve, Volgograd, Russia, ×0.7 (Nikolaeva, 1967, p. 55, fig. 1a–b); *g,* macroconch, adult suture, Donetsk, Ukraine, ×0.5 (Borissjak, 1908, pl. 9,*5c*).

Medvediceras Nikolaeva, 1967, p. 58 [**Pseudocosmoceras masarowici* Mourachkine, 1930, p. 153; OD]. Similar to *Pseudocosmoceras,* but smooth and round-whorled throughout and lacking the tabulate middle stage. Dimorphic. Mitta, 2004. *Middle Jurassic (lower Bathonian):* Russia.——Fig. 13,*2a–b.* **M. masarovici* (Mourachkine); *a–b,* lectotype, Medveditza River, Saratov, Russia, ×0.4 (Mitta, 2004, pl. 4,*1*).——Fig. 13,*2c–d. M. inclarum* (Mourachkine, 1930), ?microconch, Medveditza River, Saratov, Russia, ×1 (Mitta, 2004, pl. 3,*8*).

Sokurella Mitta, 2004, p. 33 [**S. galaczi;* OD]. Involute, compressed, rounded whorls; inner whorls with bifurcating ribs, which quickly weaken from midwhorl side, leaving faint traces on outer whorls. Dimorphic in size only. Probably derived from *Pseudocosmoceras*. *Middle Jurassic (lower Bathonian):* Russia (lower Volga River area).——Fig. 13,*3a–c.* **S. galaczi,* lower Volga River, Saratov, Russia; *a–b,* holotype, complete macroconch with mouth border, ×0.8 (Mitta, 2004, pl. 3,*1a–b); c,* paratype, body chamber of a ?microconch, ×1 (Mitta, 2004, pl. 3,*2,* lower specimen).

Subfamily GROSSOUVRINAE Spath, 1930

[Grossouvrinae Spath, 1930, p. 36; retained under Article 40.1, ICZN Code, 1999] [=Siemiradzkiinae Westermann, 1958, p. 75; =Gracilisphinctinae Beznosov, 1982, p. 54]

Descendants of Zigzagiceratinae in the Middle Bathonian, of varying morphologies, mainly evolute to moderately involute, always with rounded to compressed whorl sections, and some forms with variocostate ribbing in the macroconchs. Dimorphic throughout, the microconchs with lappets, very long or drooping and seriously constricting the aperture in some forms. Although previously described as homeomorphic ancestors of Perisphinctinae, Grossouvrinae differ in the generally smaller sizes of both dimorphs and a tendency to be more involute, with more rounded whorl sections. The subfamily was previously named Pseudoperisphinctinae, but the poorly characterized genus *Pseudoperisphinctes* is now considered to be a synonym of *Procerites* (Zigzagiceratinae), and Grossouvrinae (type genus is *Grossouvria,* the microconch associate of *Choffatia*) is the next available subfamily name. *Middle Jurassic (middle Bathonian)–Upper Jurassic (lower Oxfordian):* worldwide.

Gracilisphinctes Buckman, 1920, pl. 193 [**Ammonites gracilis* J. Buckman, 1844, p. 71, 104, *non* Zieten, 1830, p. 9, =*Procerites progracilis* Cox & Arkell, 1950 in 1948–1950, p. 94; OD]. Similar to *Procerites,* but differs in having more evolute, quadrate, and deeply constricted inner whorls and more compressed outer whorls. *Middle Jurassic (middle–?upper Bathonian):* Europe, Madagascar, ?Caucasus.——Fig. 14,*1a–b. G. progracilis* (Cox & Arkell), holotype, Middle Bathonian, *Progracilis* Zone, Sevenhampton Common, Gloucestershire, England, ×0.5 (Arkell, 1958, p. 174, fig. 63).

Prevalia Stephanov, 1972, p. 62 [**P. thressa;* OD]. Similar to *Procerites,* but with constrictions, and biplicate, triplicate, or fasciculate ribbing modifying little on the adult body chambers of both dimorphs, and lappets in the microconch less elaborate. *Middle Jurassic (upper Bathonian):* Europe, Caucasus.——Fig. 14,*2a–d.* **P. thressa; a–b,* holotype, microconch with lappet, upper Bathonian, *Retrocostatum* Zone, Prevala, Mihailovgrad, Bulgaria, ×0.8 (Stephanov, 1972, pl. 14,*1a,d*); *c–d,* macroconch, Hurigny, Mâcon, France, ×0.4 (Lissajous, 1923, pl. 14,*1*).

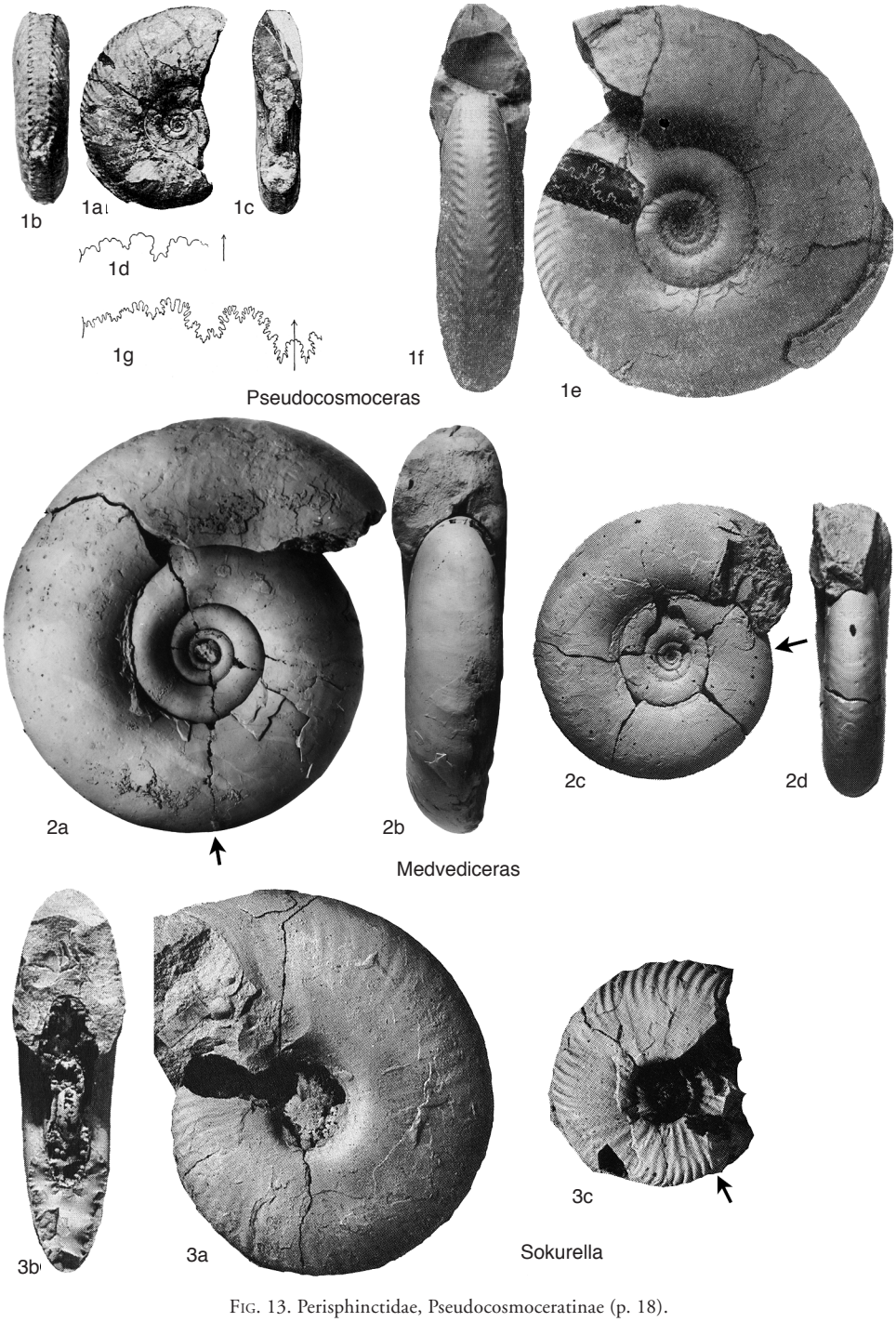

FIG. 13. Perisphinctidae, Pseudocosmoceratinae (p. 18).

Choffatia SIEMIRADZKI, 1898 in 1898–1899, p. 79 [**Perisphinctes cobra* WAAGEN, 1875, p. 174; SD BUCKMAN, 1920, p. 29 (note: COX, 1988, p. 26, as "first reviser" gave precedence to *Choffatia* over *Grossouvria,* according to the provisions of Article 24.2.2, ICZN Code, 1999)] [=*Grossouvria* SIEMIRADZKI, 1898 in 1898–1899, p. 76 (type, *Ammonites sulciferus* OPPEL, 1857 in 1856–1858, p. 555, *nom.*

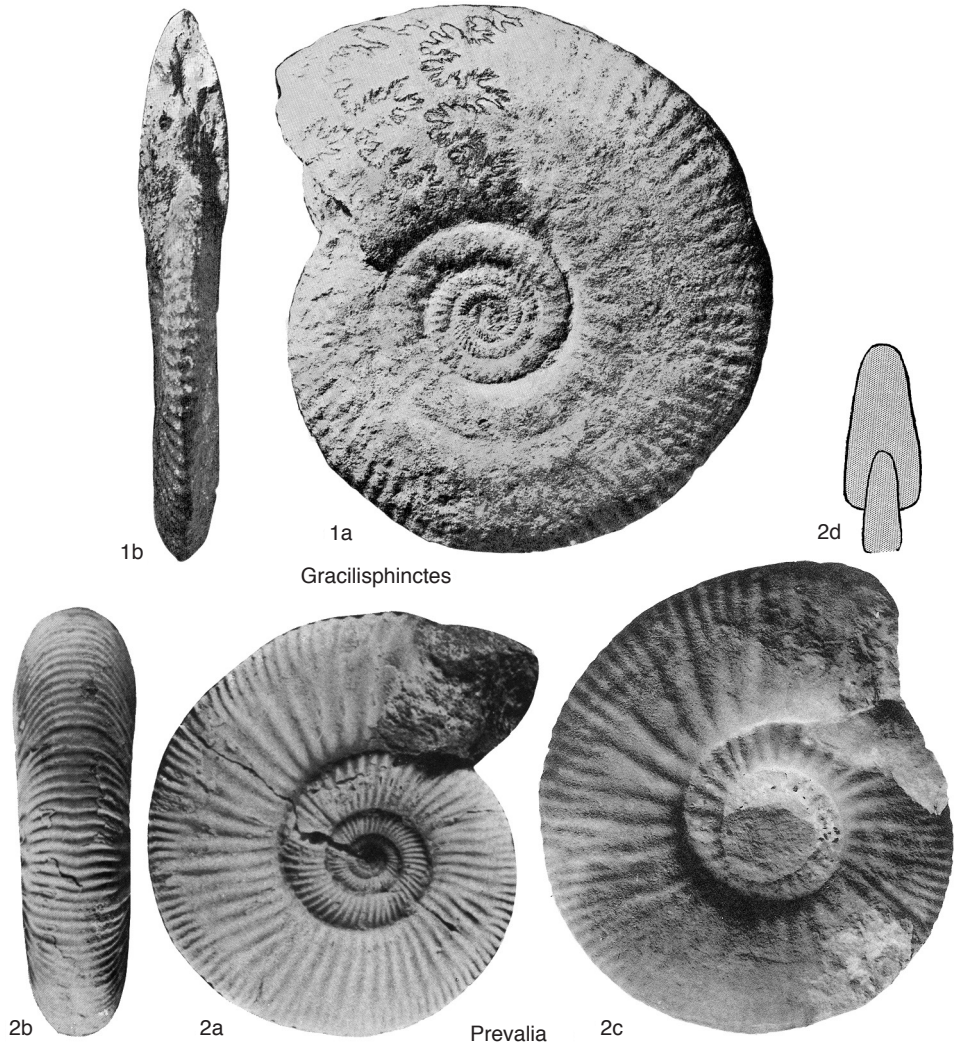

FIG. 14. Perisphinctidae, Grossouvrinae (p. 18).

nov. pro. Ammonites convolutus ornati QUENSTEDT, 1846 in 1845–1849, p. 169, *non Ammonites ornatus* PARKINSON, 1819, p. 58, *nec Ammonites convolutus* SCHLOTHEIM, 1820, p. 69, *nec Ammonites ornatus* SCHLOTHEIM, 1820, p. 75), SD BUCKMAN, 1920, p. 28; =*Poculisphinctes* BUCKMAN, 1920, pl. 185 (type, *Ammonites poculum* LECKENBY, 1859, p. 9, OD); =?*Trinisphinctes* BUCKMAN, 1922, pl. 332 (type, *T. trina,* OD); =*Klematosphinctes* BUCKMAN, 1922, pl. 333 (type, *Ammonites vernoni* YOUNG & BIRD, 1828, p. 264, OD); =?*Cutchisphinctes* SPATH, 1931, p. 283, 285 (type, *Perisphinctes altiplicatus* WAAGEN, 1875, p. 156, OD)]. Inner whorls evolute, depressed, with dense ribs, constrictions, some parabolae and nodes; thickening of the ribs at parabolae may give the impression of an initial zigzag state as in Zigzagiceratinae; middle whorls more involute, with strong, thickened primary ribs dividing into secondaries that are rursiradiate in some species; outer whorls become more evolute and compressed. Dimorphic: macroconchs have coarse, widely spaced ribs that may fade on the venter, and some species become wholly smooth on the body chamber; adult aperture simple; sutures moderately to highly incised, umbilical lobe elaborate and strongly retracted. Microconchs ribbed to the adult mouth border with lappets that are long in some species; sutures simple with thin lobes between broad saddles. Worldwide but restricted in latitudes to Tethyan and Submediterranean realms. The replacement names *Perisphinctes subtilis* NEUMAYR, 1870, p. 156, and *Perisphinctes artisulcus*

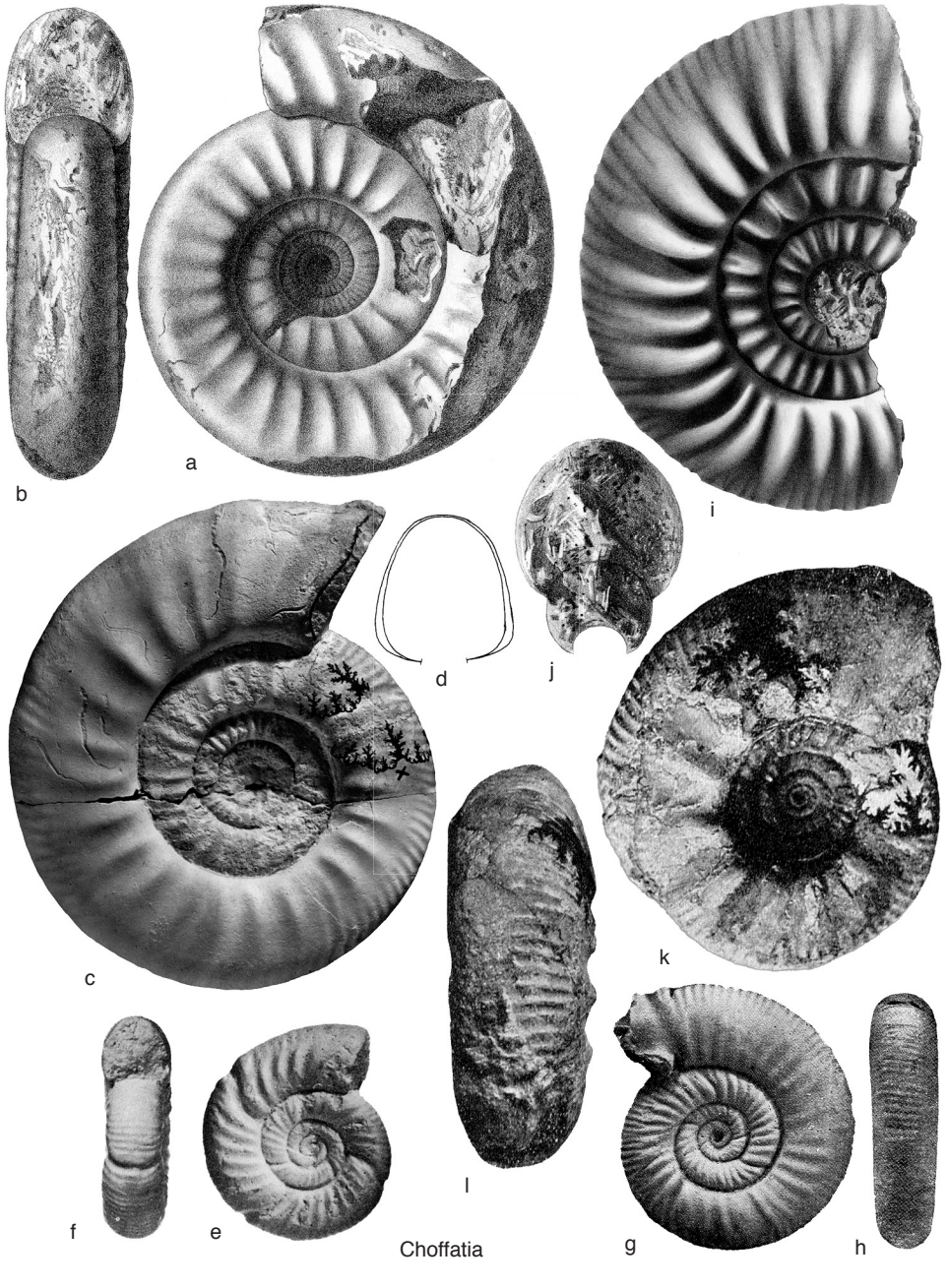

FIG. 15. Perisphinctidae, Grossouvrinae (p. 19–23).

TEISSEYRE, 1889, p. 590, for *Ammonites sulciferus* OPPEL, 1857 in 1856–1858, were not necessary because OPPEL's species is not a junior homonym of *Ceratites sulciferus* MÜNSTER, 1841, p. 134 (Middle Triassic, St. Cassian, Switzerland), as NEUMAYR and TEISSEYRE had supposed; see ARKELL (1959, p. 214) and MANGOLD (1970b, p. 163) for discussion of this complex type species designation for *Grossouvria*. *Middle Jurassic (upper Bathonian–lower Oxfordian):* Europe, northern and eastern Africa, Caucasus, Russia (region east of Caspian Sea), Syria, Iran, India (Kutch), Pakistan (Baluchistan),

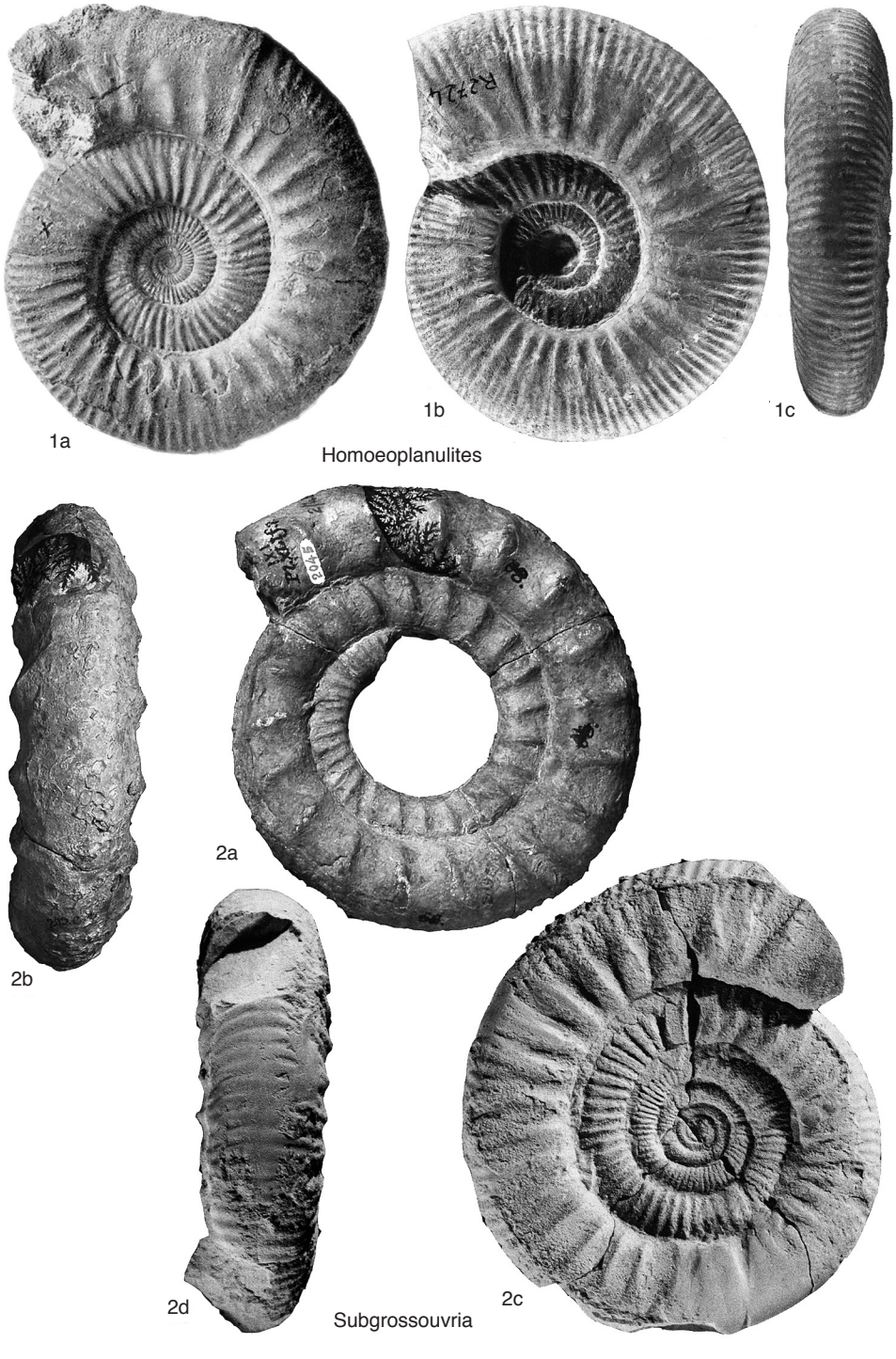

FIG. 16. Perisphinctidae, Grossouvrinae (p. 23).

Tajikistan (Pamirs), Nepal, Himalayas, Madagascar, USA (southern Alaska), Chile.——Fig. 15*a–b.* **C. cobra* (Waagen), holotype, macroconch, lower Callovian, south of Bhuj, Kutch, India, ×0.5 (Waagen, 1875, pl. 45,*1a–b*).——Fig. 15*c–d. C. vicenti* Mangold, 1970b, holotype, macroconch, possibly complete adult, upper Bathonian, Saint-Vincent-de-Jard, Vendée, France, ×0.45 (Mangold, 1970b, pl. 1,*2;* p. 135, fig. 99).——Fig. 15*e–h. C. sulcifera* (Oppel); *e–f,* lectotype, microconch, upper Callovian, Gammelshausen, Baden-Württemberg, Germany, ×1 (Cox, 1988, pl. 12,*1a–b;* original of Quenstedt 1846 in 1845–1849, pl. 13,*1a–b*); *g–h,* complete adult microconch, Łuków, Poland, ×1 (Makowski, 1952, pl. 8,*4a–b*).——Fig. 15*i–j. C. altiplicatus* (Waagen), holotype, macroconch, Golden Oolite, Keera Hill, Charee, Kutch, India, ×0.4 (Waagen, 1875, pl. 42,*1a–b*).——Fig. 15*k–l. P. poculum* (Leckenby), lectotype, Gristhorpe Bay, Scarborough, Yorkshire, England, ×1 (Buckman, 1920, pl. 185).

Homoeoplanulites Buckman, 1922, pl. 328 [**H. homoeomorphus;* OD] [=*Anaplanulites* Buckman, 1922, pl. 329 (type, *A. difficilis,* OD); =*Loboplanulites* Buckman, 1925b, pl. 596 (type, *L. longilobatus,* OD); =*Parachoffatia* Mangold, 1970b, p. 72 (type, *Ammmonites subbakeriae* d'Orbigny, 1846 in 1842–1851, p. 424, OD)]. Dimorphic: microconchs have rectiradiate to prorsiradiate primary ribs, with secondary ribs sometimes rursiradiate, and are ribbed up to the final adult aperture with a slight collar and lappets; macroconchs have variocostate ribs, including weak parabolic ribs and constrictions on inner and middle whorls, with progressive loss of ribbing on final whorls. Cox, 1988. *Middle Jurassic (upper Bathonian–lower Callovian):* Europe, Caucasus, Iran, eastern Africa, Madagascar, India (Kutch).——Fig. 16,*1a*. **H. homoeomorphus*, holotype, adult microconch with lappets, upper Bathonian, *Discus* Zone, Cornbrash, Stalbridge Weston, Dorset, England, ×0.6 (Buckman, 1922, pl. 328,*1*).——Fig. 16,*1b–c. H. subbakeriae* (d'Orbigny), lectotype (designated by Mangold, Gauthier, & Rioult in Fischer & others, 1994, p. 136–137; see also for discussion of an illegal lectotype designated previously by Arkell, 1959, p. 217), macroconch, lower Callovian, Niort, Deux-Sèvres, France, ×0.4 (Fischer & others, 1994, pl. 55,*1a–c*).

Subgrossouvria Spath, 1924, p. 13 [**Perisphinctes aberrans* Waagen, 1875, p. 175; OD]. Macroconchs; whorl section round and depressed at all stages; inner whorls densely ribbed with prominent constrictions, modifying rapidly on middle and outer whorls to coarse, strong, well-spaced primaries polyfurcating indistinctly into sheaves of subdued secondaries that merge together in some species. More depressed and more coarsely ribbed than *Choffatia. Middle Jurassic (upper Bathonian–upper Callovian):* Europe, eastern Africa, Madagascar, Iran, India (Kutch), Mexico.——Fig. 16,*2a–b.* **S. aberrans* (Waagen), lectotype (designated by Spath, 1924, p. 13), macroconch, middle or lowest upper Callovian, Keera Hill, Charee, Kutch, India, ×0.4 (Dutta & Bardhan, 2016, p. 3, fig. 1,*1,3*).——Fig. 16,*2c–d. S. recuperoi* (Gemmellaro, 1873), lectotype, lower Callovian, Rocca chi Parra, Calatafimi, Trapani, Sicily, ×0.8 (Pavia & Cresta, 2002, p. 265, fig. 181).

Indosphinctes Spath, 1930, p. 36 [**Ammonites calvus* J. de C. Sowerby, 1840b, p. 719; SD Roman, 1938, p. 275] [=*Elatmites* Shevyrev, 1960, p. 69 (type, *Perisphinctes submutatus* Nikitin, 1881b, p. 107, OD); =*Flabellisphinctes* Mangold & Elmi, 1966, p. 184, *non Flabellisphinctes* Mangold, 1970b, p. 191, invalid junior homonym, see *Flabellia* (type, *Perisphinctes joffrei* Lemoine, 1916, p. 56, *nom. nov. pro Perisphinctes rollieri* Petitclerc, 1915, p. 80, *non* De Loriol, 1902, p. 32, OD)]. Evolute, whorl section rounded to compressed; ribs somewhat irregular; short, nodular primaries bifurcate or trifurcate low on the whorl side into flexuous secondaries; parabolic ribs and constrictions occur on inner and middle whorls. Dimorphic: macroconchs have strong ribs on middle and outer whorls that may fade on the adult body chamber. Microconchs ribbed throughout, but ribs irregular, secondary ribs rursiradiate and interrupted at midventer in some forms; adult aperture has long, prominent lappets. More evolute and generally more strongly ribbed than *Homoeoplanulites,* from which the genus is probably derived. Sazonov, 1965; Mangold, 1970b. *Middle Jurassic (Callovian):* Europe, Turkey (Anatolia), Iran, Caucasus, Pakistan (Baluchistan), India (Kutch), Himalaya, eastern Africa, Madagascar, Japan.——Fig. 17*a–b.* **I. calvus* (J. de C. Sowerby), holotype, lower Callovian, Khera, Kutch, India; *a,* ×0.4 (Spath, 1931, pl. 52,*1*); *b,* ×0.43 (Waagen, 1875, pl. 56,*1b*).——Fig. 17*c–d. I. rustica* Spath, 1931, lower Callovian, upper *Gracilis* Zone (=*Calloviense* Zone, *Enodatum* Subzone), Cirque de Naves, Les Vans, Ardèche, France, ×0.5 (Mangold, 1970b, pl. 16,*1,* p. 89, fig. 77).——Fig. 17*e–h. I. submutata* (Nikitin), lower Callovian, *Jason* Zone, Elatma, Ryazan Oblast, Russia; *e–f,* lectotype, microconch, ×0.85 (Nikitin, 1881b, pl. 1,*4*); *g–h,* topotype, microconch, ×0.85 (Sazonov, 1965, pl. 17,*3a–b*).——Fig. 17*i–j. I. joffrei* (Lemoine), holotype, type species of *Flabellisphinctes* Mangold & Elmi, 1966, Prahecq, Deux-Sèvres, France, ×0.6 (Petitclerc, 1915, pl. 7,*4*; 14,*8*).

Binatisphinctes Buckman, 1921, pl. 261A [**B. binatus;* OD] [=*Hamulisphinctes* Buckman, 1921, pl. 262 (type, *H. hamulatus,* OD); =*Pseudopeltoceras* Spath, 1928, p. 255 (type, *Ammonites chauvinianus* d'Orbigny, 1847 in 1842–1851, p. 460, OD); =*Okaites* Sazonov, 1961, p. 28 (type, *Ammonites mosquensis* Fischer & others, 1843, p. 110, OD); =*Rugeticeras* Tintant, 1961, p. 183 (type, *R. cesaredense,* OD)]. Evolute, inner whorls rounded, later whorls more compressed; venter flattened with smooth band or sulcus; ribs dense, simple or bifurcating on inner and middle whorls,

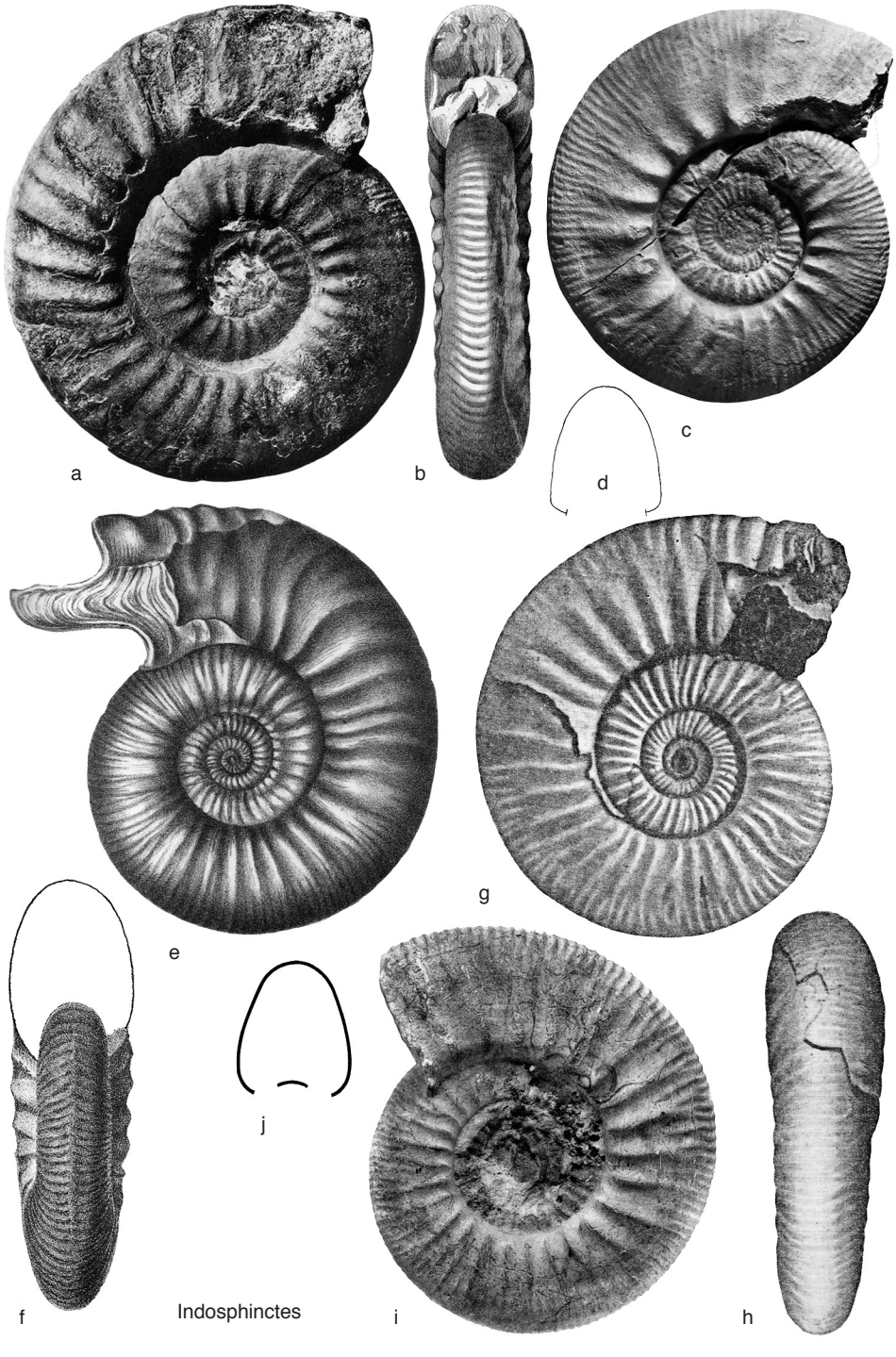

FIG. 17. Perisphinctidae, Grossouvrinae (p. 23).

with several intercalated secondary ribs; secondaries curve backwards on venter; weak constrictions; ventrolateral parabolae with long spines in some species. Dimorphic: macroconchs develop bold, widely spaced ribs on body chamber, with complete loss of secondary ribs in some, and a plain adult mouth border; microconchs also with widely spaced primary ribs, but secondary ribs remain fine, and adult mouth border with long, narrow lappets. Evolved from *Choffatia* in the *Coronatum* Zone, middle Callovian, differing in more evolute and more compressed whorls, and much longer lappets in microconchs. Cox, 1988. *Middle Jurassic (middle–upper Callovian):* Europe, northern Africa, Kenya, Tanzania, India (Kutch).——Fig. 18*a–b.* **B. binatus*, lectotype, microconch, *Athleta* Zone, Castle Rock, Scarborough, Yorkshire, England, ×0.75 (Buckman, 1921, pl. 261A).——Fig. 18*c. B. comptoni* (Pratt, 1842), topotype with long lappet, microconch, upper *Coronatum* Zone, Christian Malford, England, ×0.7 (new; The Natural History Museum, London, NHMUK 73891).——Fig. 18*d. B. rjasanensis* (Teisseyre, 1884), with spines preserved on the ventrolateral parabolae, upper *Coronatum* Zone, Christian Malford, England, ×1 (new; The Natural History Museum, London, NHMUK 37425).——Fig. 18*e. B. fluctuosus* (Pratt, 1842), topotype with aptychus in place in aperture, incomplete macroconch, upper *Coronatum* Zone, Christian Malford, England, ×0.25 (new; The Natural History Museum, London, NHMUK 32343).——Fig. 18*f–g. B. hamulatus* (Buckman), holotype, microconch, Castle Rock, Scarborough, Yorkshire, England, ×0.75 (Buckman, 1921, pl. 262A).——Fig. 18*h–i. B. chauvinianum* (d'Orbigny), lectotype (designated by Tintant, 1961, fig. 2), macroconch, upper Callovian, Dives, Calvados, France, ×0.5 (new, from cast; Muséum d'Histoire Naturelle, Paris, d'Orbigny Collection, IPM-R.4138).

Flabellia Mangold, 1970b, p. 191 (type, *F. lineata;* OD)] [=*Flabellisphinctes* Mangold, 1970b, p. 191, invalid junior homonym of *Flabellisphinctes* Mangold & Elmi, 1966, p. 184, see *Indosphinctes* (type, *Perisphinctes villanyensis* Till, 1910, p. 192, *nom. nov. pro Ammonites convolutus* Quenstedt, 1887 in 1882–1888, pl. 82,*66, non Ammonites convolutus* Schlotheim, 1820, p. 69, OD)]. Dimorphic; both dimorphs similar to *Indosphinctes,* but whorls more compressed; ribs on inner whorls bifurcate or trifurcate, then pseudovirgatotome on middle whorls, and polyschizotome or dischizotome on body chamber; macroconchs medium sized, strongly ribbed, with plain, adult mouth border; microconchs small, with irregular, subdued ribs, pseudovirgatotome secondaries and lappets on adult mouth border. *Middle Jurassic (middle–lower upper Callovian):* Europe.——Fig. 19,*1a–b.* **F. lineata,* holotype, middle Callovian, *Coronatum* Zone, Toulongeon, Germagnat, Jura, France, ×1 (Mangold, 1970b, pl. 16,*5–6*).——Fig. 19,*1c–d. F. tuberosa* Mangold, holotype, microconch, middle Callovian, *Coronatum* Zone, Toulongeon, Germagnat, Ain, France, ×1 (Mangold, 1970b, pl. 16,*3–4*).——Fig. 19,*1e–f. F. villanyensis* (Till), macroconch, middle Callovian, *Coronatum* Zone, Naves, Ardèche, France, ×0.7 (Mangold & Elmi, 1966, fig. 2,*2,* pl. 10,*1a*).

Volgaites Sazonov, 1965, p. 14 [**V. elatmaensis;* OD]. Small forms, finely and densely ribbed, tending to become smooth in midflank, secondary ribs rectiradiate on venter without interruption; parabolae and constrictions absent or inconspicuous. Microconchs only known. *Middle Jurassic (lower Callovian,* Jason *Zone):* Russia.——Fig. 19,*2a–b.* **V. elatmaensis,* holotype with one-third whorl body chamber, Elatma, Ryazan Oblast, Russia, ×1 (Sazonov, 1965, pl. 3,*1a–b*).

Orionoides Spath, 1931, p. 327 [**Perisphinctes pseudorion* Waagen, 1875, p. 160; OD]. Macroconchs, characterized by involute, inflated middle whorls, with blunt, subdued ribs, reverting to evolute, more compressed later whorls, with stronger ribs, and a contracted, final body chamber. Spath, 1931; Gérard & Contaut, 1936. *Middle Jurassic (upper Callovian):* Europe, Madagascar, India (Kutch).——Fig. 19,*3a–b.* **O. pseudorion* (Waagen), holotype, upper Callovian, Vanda (Wanda), Kutch, India, ×0.75 (Waagen, 1875, pl. 43,*3*).——Fig. 19,*3c–d. O. monestieri* Gérard & Contaut, holotype, *Athleta* Zone, 6 km southeast of Montreuil-Bellay, Maine et Loire, France, ×0.6 (Gérard & Contaut, 1936, pl. 7,*1,1a*).

?**Borneoceras** Schairer & Zeiss, 1992, p. 234 [**B. sanggauense;* OD]. Moderately involute, compressed whorls with rounded venter; primary ribs divide into secondaries or are intercalated on middle or upper part of the whorl side, then are prorsiradiate onto the venter and interrupted at a midventral smooth band; no tubercles. Similar to several other Grossouvrinae, but perhaps characterized by their prorsiradiate secondary ribs and the midventral smooth band. *Middle Jurassic (?middle–low upper Callovian):* Indonesia (west Kalimantan, Borneo).——Fig. 20*a–b.* **B. sanggauense,* holotype, 17 km south of Kembajan, on road to Tangjung, West Kalimantan, Borneo, Indonesia, ×0.6 (Schairer & Zeiss, 1992, pl. 3,*3*).

Subfamily PROPLANULITINAE Buckman, 1921

[*nom. transl.* Spath, 1931, p. 279, *ex* Proplanulitidae Buckman, 1921, p. 32]

Proplanulites, the only genus, is short lived and provincially restricted to the north side of Tethys in northern Eurasia. It appeared abruptly at the base of the *Koenigi* Zone, lower Callovian, probably descended from some Submediterranean *Procerites* when the habitat changed to the shallow,

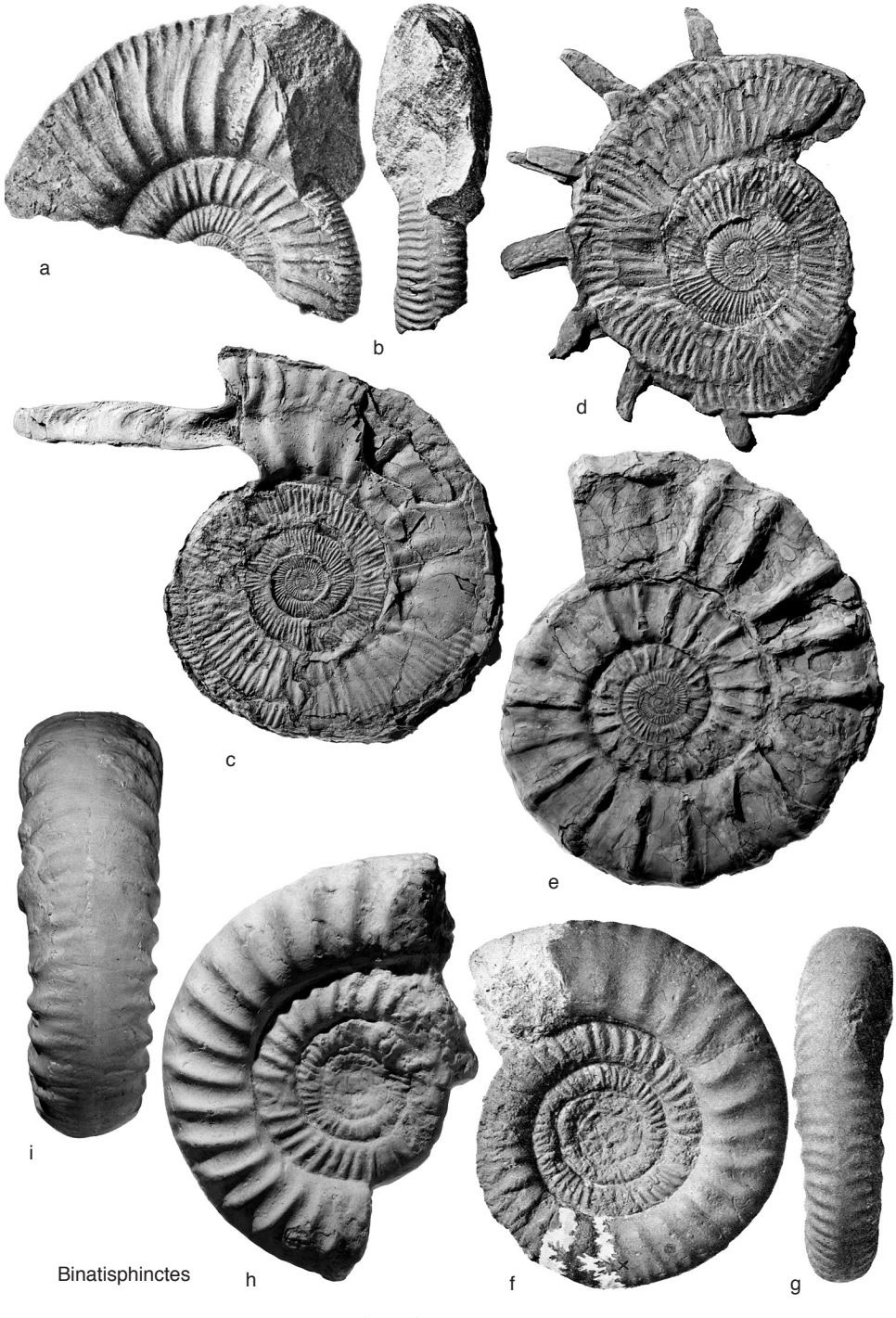

FIG. 18. Perisphinctidae, Grossouvrinae (p. 23–25).

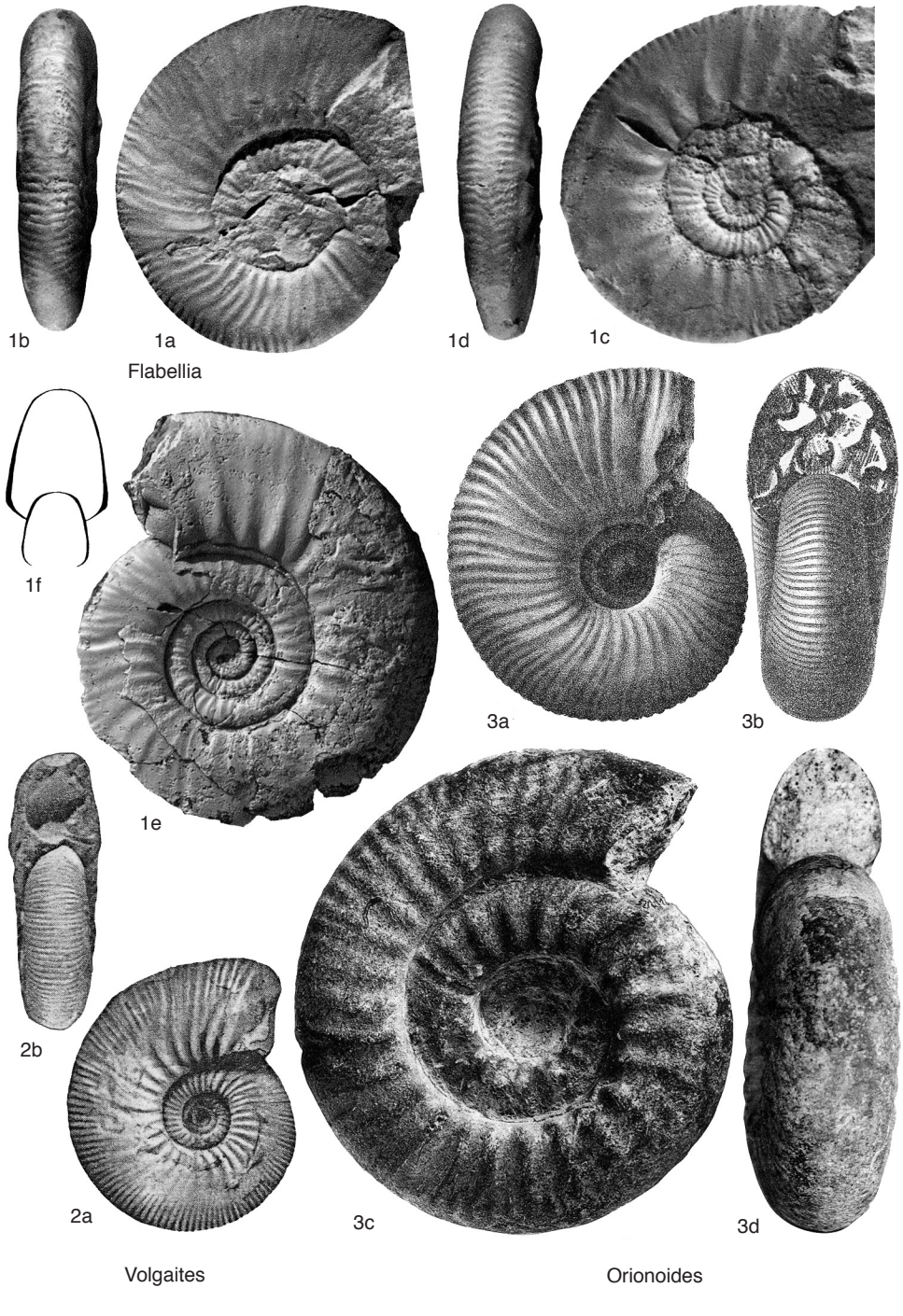

FIG. 19. Perisphinctidae, Grossouvrinae (p. 25).

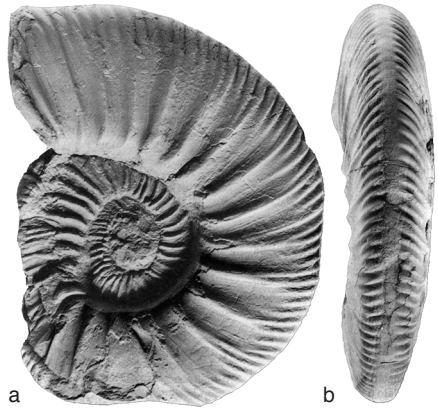

FIG. 20. Perisphinctidae, Grossouvrinae (p. 25).

epicontinental seas of the European Subboreal Platform. Many of the forms previously included in the subfamily—e.g., Subaustral *Obtusicostites* and *Kinkeliniceras*—are almost certainly unrelated and constitute a provincial assemblage, the Kinkeliniceratinae, restricted to the Indo-Ethiopian Province south of Tethys. BUCKMAN, 1909–1930; CORROY, 1932; TEISSEYRE, 1887b, 1888. *Middle Jurassic (lower Callovian):* northern Tethys, Subboreal Province.

Proplanulites TEISSEYRE, 1887a, p. 54 [**Ammonites koenigi* J. SOWERBY, 1820, p. 113; SD TEISSEYRE, 1887b, p. 79] [=*Crassiplanulites* BUCKMAN, 1921, p. 41, pl. 228 (type, *C. crassicosta;* OD]. Involute, discoidal, whorl section compressed, converging to rounded venter; short, blunt, bullate primary ribs polyfurcate indistinctly into subdued secondary ribs that fade at a smooth band on midventer; innermost whorls nearly smooth; sutures simplified with short, narrow lobes on a slightly curved baseline. Dimorphic: macroconchs large, becoming smooth on adult body chamber in early forms; microconchs with short lappets. Homeomorphic with the much younger *Ringsteadia.* TEISSEYRE, 1888; BUCKMAN, 1921, p. 33–41. *Middle Jurassic (lower Callovian,* Koenigi–Calloviense *Zones):* northwestern Europe, Poland, northern Caucasus, Russia (Russian Platform), Kazakhstan, eastern Greenland.——FIG. 21*a–b.* **P. koenigi* (J. SOWERBY), lectotype (designated by BUCKMAN, 1921, p. 36), microconch, *Calloviense* Zone, *Koenigi* Subzone, Rampisham, Dorset, England, ×0.8 (new; The Natural History Museum, London, NHMUK 43891c; original of Sowerby, 1820, pl. 263,*3*).——FIG. 21*c–d. P. capistratus* BUCKMAN, 1921, microconch with lappet, *Koenigi* Subzone, Chippenham, Wiltshire, England, ×1 (Buckman 1921, pl. 213).——FIG. 21*e–f. P. crassicosta* (BUCKMAN), holotype, macroconch, *Calloviense* Zone and Subzone, Kellaways, Wiltshire, England, ×0.5 (Buckman, 1921, pl. 228A–228B,*1*).

Subfamily KINKELINICERATINAE Krishna & Ojha, 1996

[Kinkeliniceratinae Krishna & Ojha, 1996, p. 151] [=Sivajiceratinae DUTTA & BARDHAN, 2015, p. 25]

A monophyletic group restricted to the Indo-Ethiopian Province, south of Tethys. The more compressed forms (*Kinkeliniceras*) bear an undoubted resemblance to *Proplanulites,* due to their common derivation from *Procerites* of the Grossouvrinae in the upper Bathonian and lower Callovian. Thereafter, the two subfamilies evolved in different provinces, leading to the simplified sutures of the Proplanulitinae, while the Kinkeliniceratinae retain the more complicated sutures of their ancestral *Procerites.* CALLOMON, 1993; DUTTA & BARDHAN, 2015. *Middle Jurassic (upper Bathonian–upper Callovian):* eastern Africa, Madagascar, India, Pakistan.

Sivajiceras SPATH, 1928, p. 205; 1931, p. 282, 284 [**Ammonites fissus* J. de C. SOWERBY, 1840b, p. 719, pl. 61,*11;* SD HOWARTH, herein; note: ROMAN's (1938, p. 265) statement that *Perisphinctes congener* WAAGEN, 1875, is the type species of *Sivajiceras* was not a valid subsequent designation of the type species, because it was not a species originally included by SPATH (1928, p. 205) when he first proposed the new genus with the words "the holotype of *Amm. fissus* (pl. LVI, fig. 6) is a form of the *paramorphum* group (*Sivajiceras,* gen. n.)." Other species included subsequently in an existing genus (as by SPATH, 1931, p. 282, 284, in *Sivajiceras*) are not available for subsequent designation as type species (ICZN Code, 1999, Articles 67.2 and 67.2.1)]. Moderately evolute; whorl section oval to circular, slightly compressed to rounded; primary ribs bold, simple or bifurcate on middle to high whorl side, and intercalatory secondary ribs common; sutures complex and incised, with moderately retracted umbilical lobes. Dimorphic: macroconchs large, up to 205 mm, with plain mouth border, and secondary ribs disappear on adult whorl; microconchs up to 60 mm, with terminal constriction and small lappets. Early forms of the subfamily. *Middle Jurassic (upper Bathonian–middle Callovian):* Somalia, Kenya, Tanzania, Madagascar, India (Kutch).——FIG. 22*a–d.* **S. fissum* (J. de C. SOWERBY), holotype, microconch, lower Callovian, Kutch, India; *a–c,* ×0.7 (new; The Natural History Museum,

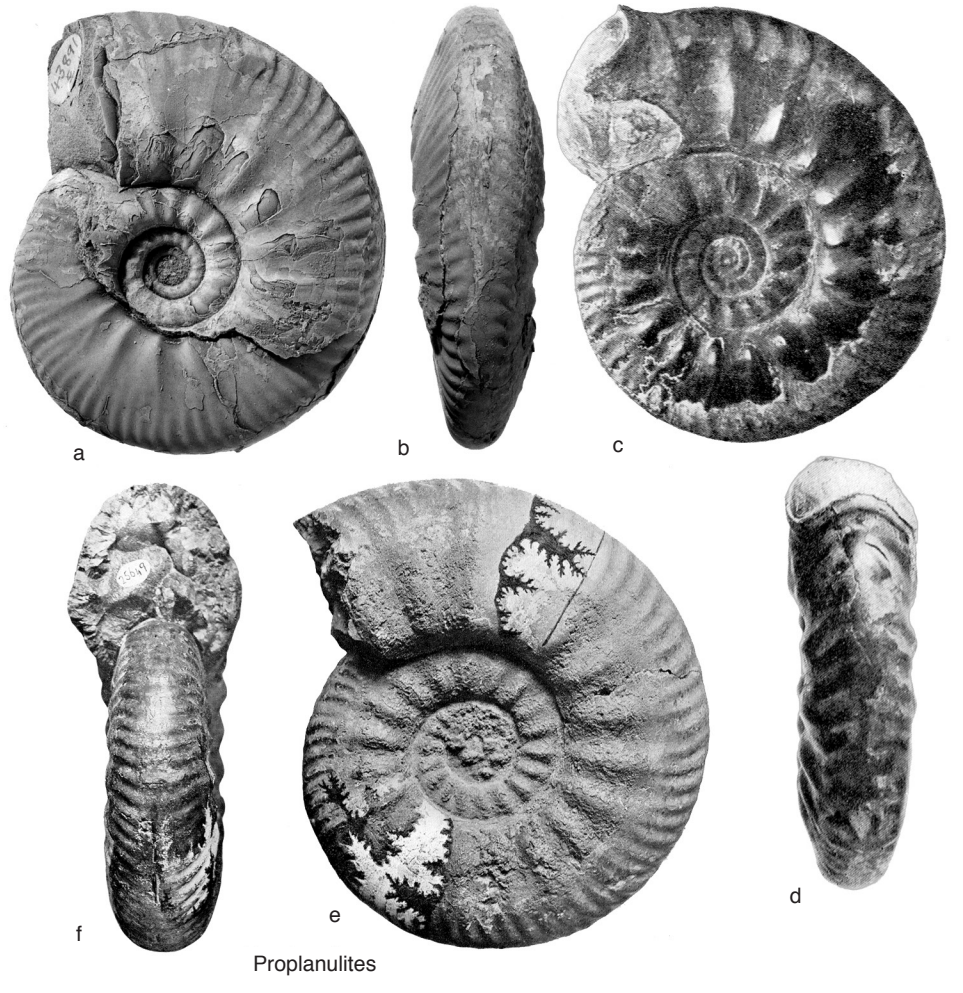

FIG. 21. Perisphinctidae, Proplanulitinae (p. 28).

London, England, NHMUK C.25433); *d,* suture, ×1.5 (Spath, 1931, pl. 56,*6a–c*).——FIG. 22*e–j. S. congener* (WAAGEN), upper Patcham Limestone, uppermost Bathonian, northwest of Jumara, Kutch, India; *e–f,* holotype, macroconch, ×0.35 (Waagen, 1875, pl. 57,*1a–b*); *g–j,* topotypes; *g–h,* macroconch, ×0.5; *i–j,* microconch, ×1 (Callomon, 1993, pl. 23, pl. 24,*1,2a–b*).

Obtusicostites BUCKMAN, 1921, p. 42 [**Perisphinctes obtusicosta* WAAGEN, 1875, p. 146; OD] [=*Hubertoceras* SPATH, 1930, p. 35 (type, *Perisphinctes omphalodes* WAAGEN, 1875, p. 150, OD)]. Moderately involute; whorl section circular, rounded to slightly compressed; primary ribs bold, bullate, simple or bifurcate on middle to high whorl side, and intercalatory secondary ribs are common; constrictions occur in some. Dimorphic: macroconchs up to 165 mm, with plain mouth border; microconchs small, with terminal collar and short lappets. More involute and more depressed whorls than *Sivajiceras,* with coarser, bullate primary ribs, and somewhat younger. *Middle Jurassic (upper Bathonian–upper Callovian,* Athleta *Zone):* Somalia, Tanzania, Kenya, Madagascar, India (Kutch), northern Pakistan.——FIG. 23*a–c.* **O. obtusicosta* (WAAGEN); *a–b,* lectotype (designated by BUCKMAN, 1921, p.42), macroconch, phragmocone, *Anceps* Zone, north of Dhosa, Kutch, India, ×0.45 (Dutta & Bardhan, 2015, fig. 11*a,c*); *c,* suture at 140 mm diameter, ×0.6 (Spath, 1931, pl. 55,*2*).——FIG. 23*d–e. O. buckmani* SPATH, microconch, *Anceps* Zone, Walakhavas, Kutch, India, ×0.8 (Spath, 1931, pl. 53,*3a–b*).——FIG. 23*f–g. O. omphalodes* (WAAGEN), holotype, microconch, middle Callovian, Vanda (Wanda), Kutch, India, ×1 (Waagen, 1875, pl. 37,*2a–b*).——FIG. 23*h–j. O. hubertus* (SPATH), microconch, *Athleta* Zone, Fakirwadi, Kutch, India; *h–i,* microconch,

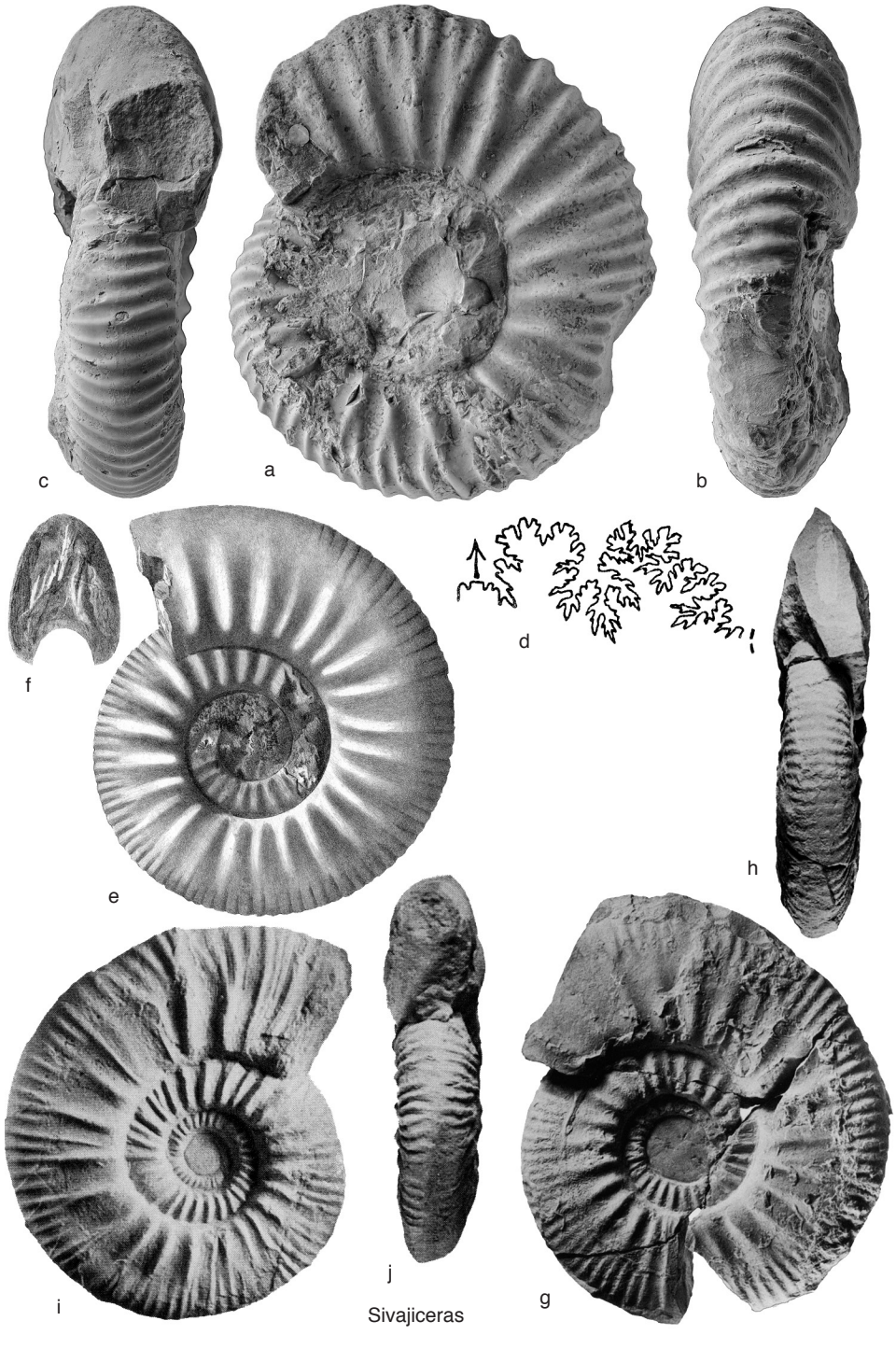

FIG. 22. Perisphinctidae, Kinkeliniceratinae (p. 28–29).

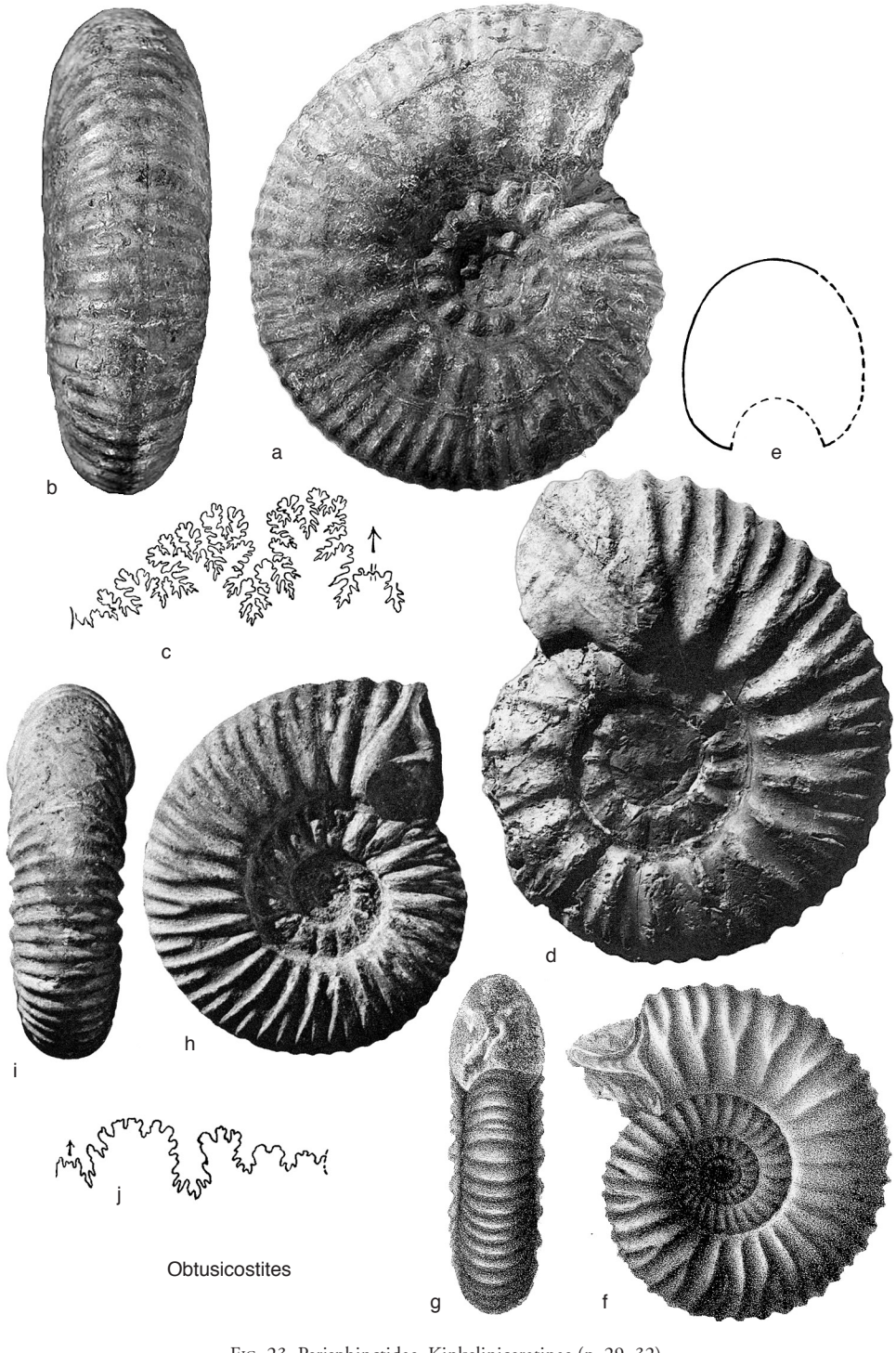

FIG. 23. Perisphinctidae, Kinkeliniceratinae (p. 29–32).

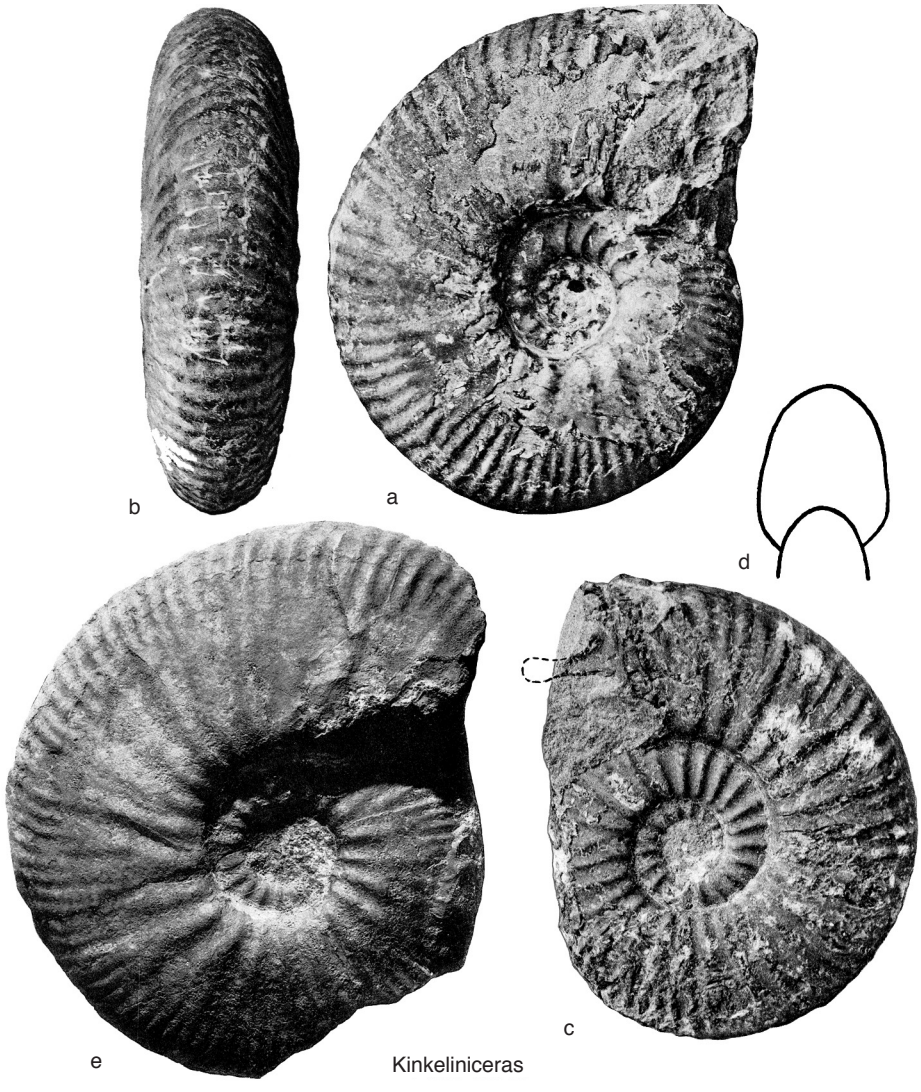

FIG. 24. Perisphinctidae, Kinkeliniceratinae (p. 32).

×1 (Spath, 1931, pl. 69, *4a–b*); *j,* suture of another specimen, ×2 (Spath, 1931, pl. 59,*1*).

Kinkeliniceras BUCKMAN, 1921, p. 42 [**Proplanulites kinkelini* DACQUÉ, 1910, p. 36; OD]. Involute, whorls oval, compressed with arched venter; strong, straight primary ribs, somewhat bullate at the umbilical edge, bifurcate into secondary ribs that may fade on the venter; intercalated secondary ribs and occasional constrictions occur in some species. Dimorphic: macroconchs are up to 140 mm in diameter, with a plain mouth border; microconchs are up to 70 mm in diameter, with narrow lappets. More involute and compressed than *Obtusicostites,* and ribbing is generally weaker. *Middle Jurassic (middle Callovian,* Anceps *Zone–upper Callovian,* Athleta *Zone):* Tanzania, Madagascar, India (Kutch).——FIG. 24*a–b. *K. kinkelini* (DACQUÉ), lectotype (designated by BUCKMAN, 1921, p. 42), macroconch, Upper Callovian, railway 127 km post at Pandambili (Pendambili), 6°49′S, 38°16.5′E, 8 km east of Kidugallo, Morogoro Region, Tanzania, ×0.75 (Dacqué, 1910, pl. 5,*1*, 6,*3*).——FIG. 24*c–d. K. pendambilianus* (DACQUÉ), microconch with lappet, same locality, ×1 (Dacqué, 1910, pl. 6,*4*, p. 37, fig. 18).——FIG. 24*e. K. discoideum* SPATH, 1931, macroconch, *Anceps* Zone, Khera, Kutch, India, ×0.55 (Spath, 1931, pl. 55,*3*).

Subfamily PERISPHINCTINAE Steinmann, 1890

[Perisphinctinae Steinmann in Steinmann & Döderlein, 1890, p. 441]

Successors of Grossouvrinae characterized by evolute coiling and regular, straight primary ribbing, bifurcating on the ventrolateral shoulders in microconchs and the inner whorls of macroconchs, the outer whorls of which become slowly or quickly variocostate. Prominent constrictions throughout, and parabolic nodes in some early forms; septa complex usually with strongly retracted umbilical lobes; rarely preserved aptychi (*Praestriaptychus*).

The diversity of the Perisphinctidae in the Callovian was followed by a marked contraction in the lower Oxfordian before a further burst of diversification in the upper Oxfordian, probably associated with worldwide changes in facies on both north and south sides of Tethys. The lower Oxfordian contraction coincided with the Boreal spread of Cardioceratidae southwards in the northern hemisphere. Perisphinctinae again expanded north into the Boreal realm in the upper Oxfordian without any simultaneous retreat of the Cardioceratinae. These northerly migrants subsequently founded several lines of successors that flourished in restricted Boreal provinces into the Cretaceous.

Because of their abundance and often-good preservation, the Perisphinctinae are one of the most intensively studied groups, giving insights of general interest into ammonite taxonomy and phylogeny. A valuable aid to species classification is found to be the ontogeny of rib density plotted as a function of diameter (Arkell, 1935–1948). Dimorphism is widespread and associated dimorphs are widely referred to the same genus. For this purpose, attention to biostratigraphy has been shown to be of great importance. Arkell, 1935–1948; Énay, 1966; Geyer, 1961; Głowniak & Wierzbowski, 2007; Siemiradzki, 1891, 1898 in 1898–1899; Simionescu, 1907; Spath, 1927–1933; Wegele, 1929. *Middle Jurassic (upper Callovian)–Upper Jurassic (lower Kimmeridgian):* worldwide.

Alligaticeras Buckman, 1923a, p. 57 [**Ammonites alligatus* Leckenby, 1859, p. 9; OD] [=*Properisphinctes* Spath, 1931, p. 403 (type, *Perisphinctes bernensis* de Loriol, 1898, p. 76); =*Loriolites* Sazonov, 1965, p. 24 (type, *Perisphinctes moeschi* de Loriol, 1898, p. 81)]. Small, evolute, round whorled, with quadrate and depressed whorl section; ribs dense, regular, bifurcating high on side of whorl, with nodes of variable frequency at point of bifurcation; secondaries pass over venter with slight weakening at midventer; 2 or 3 deep constrictions per whorl, followed by collars. Dimorphic: microconchs 40–60 mm in diameter, with lappets; macroconchs more than 100 mm in diameter, with more widely spaced primary ribs on outer whorls. Probably derived from *Choffatia* in the late Callovian. Cox, 1988. *Middle Jurassic (upper Callovian, upper* Athleta *Zone)–Upper Jurassic (lower Oxfordian,* Cordatum *Zone–?middle Oxfordian,* Transversarium *Zone):* Europe, western Caucasus, Russia (Dagestan, Lake Elton, Volgograd), Syria, India (Kutch), Madagascar.——Fig. 25*a–d.* **A. alligatus* (Leckenby); *a–b,* holotype, complete microconch except for lappets, *Lamberti* Zone, Castle Rock, Scarborough, Yorkshire, England, ×1 (Cox, 1988, pl. 23,*3a–c*); *c–d,* macroconch, probably complete, Cunstone Nab, Cayton Bay, north Yorkshire, England, ×0.67 (Cox, 1988, pl. 23,*5a–b*).

Kranaosphinctes Buckman, 1921, pl. 243 [**K. kranaus;* OD] [=*Toxosphinctes* Buckman, 1923b, pl. 448 (type, *Ammonites pickeringius* Young & Bird, 1822, p. 251, OD), suppressed for priority by ICZN Opinion 306, 1954d, p. 315; =*Cymatosphinctes* Buckman, 1923b, pl. 450 (type, *C. cymatophorus,* OD); =*Arisphinctes* Buckman, 1924, p. 33, pl. 511 (type, *A. ariprepes,* OD); =*Otosphinctes* Buckman, 1926, pl. 649 (type, *O. ouatius,* OD); =?*Pachyplanulites* Spath, 1930, p. 42 (type, *Perisphinctes subevolutus* Waagen, 1875, p. 179, OD); =*Germanosphinctes* Arkell, 1935c, p. xxv (type, *Perisphinctes indogermanus* Waagen, 1875, p. 185; OD); =*Mologaites* Sazonov, 1965, p. 19, *non* Sazonov, 1961, p. 28, *nom. nud.,* no description or differentiating characters given (type, *Perisphinctes bolobanowi* Nikitin, 1881a, p. 301, OD)]. Large, evolute serpenticones, with round or depressed whorl section, especially on inner whorls; ribs strong, fairly coarse, curving forwards, dividing at ventrolateral angle into 2–4 subdued secondaries interrupted by smooth midventral band; deep, oblique constrictions, some with parabolic nodes, are followed by enlargement of the whorl giving the appearance of segmental growth; sutures elaborate with highly retracted umbilical lobes carrying many auxiliaries. Dimorphic: macroconchs large, adult at 240–590 mm in diameter, primary ribs gradually become coarse and very widely spaced, with ventrolateral nodes; secondary ribs fade on venter of final whorls; adult mouth border plain, curved. Microconchs adult at 40–105 mm in diameter, with moderately strong primary ribs, parabolic constrictions, deep terminal constriction and large, spatulate lappets.

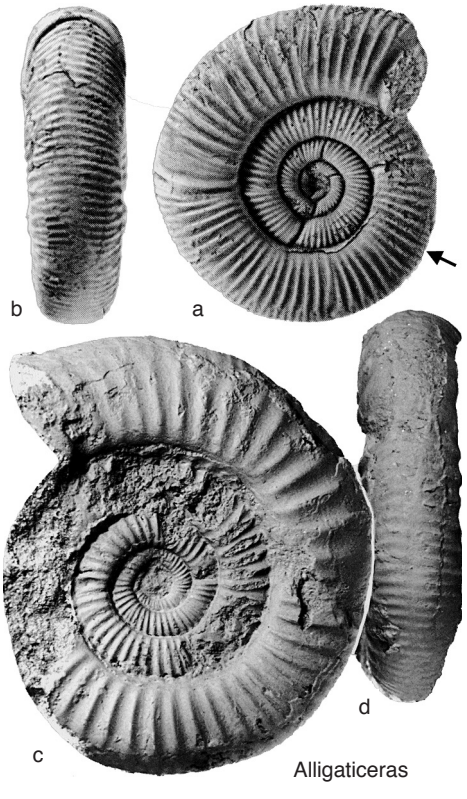

FIG. 25. Perisphinctidae, Perisphinctinae (p. 33).

Probably successors of *Alligaticeras* in the upper part of the *Cordatum* Zone, they are characteristic of the *Plicatilis* Zone and retain the parabolae of *Alligaticeras,* but are much larger, especially in the macroconchs; generally more evolute than *Perisphinctes* and more coarsely ribbed on the inner and middle whorls. *Upper Jurassic (?lower Oxfordian,* Cordatum *Zone–middle Oxfordian,* Plicatilis *Zone,* Vertebrale *Subzone):* Europe, Ukraine (Donetsk), Caucasus, Russia, northern Africa, Egypt (Sinai), Ethiopia, Kenya, Tanzania, Madagascar, India (Kutch), northern Pakistan, Japan, Indonesia, Papua New Guinea, Cuba, Argentina, ?Chile.——FIG. 26*a–b. *K. kranaus,* holotype, macroconch, *Plicatilis* Zone, Temple Cowley, Oxford, England, ×0.25 (Arkell, 1939, pl. 38,*1a–b*).——FIG. 26*c–d. K. ariprepes* (BUCKMAN), holotype, complete adult macroconch with mouth border at 417 mm in diameter, *Plicatilis* Zone, lower Calcareous Grit, Horspath Quarry, Oxfordshire, England, ×0.16 (Arkell, 1939, pl. 24,*5a–b*).——FIG. 26*e–h. K. ouatius* (BUCKMAN); *e–f,* holotype, complete microconch with lappet, Cowley, Oxford, England, ×1 (Arkell, 1938, pl. 17,*5a–b*); *g–h,* topotype, *Vertebrale* Subzone, Bullingdon Green, Oxford, England, ×1 (Arkell, 1938, pl. 17,*6a–b*).——FIG. 26*i–j. K. paturattensis* DE LORIOL, adult microconch with parabolic constrictions and large lappets, *Cordatum* Zone, Herznach, Aagau, Switzerland, ×1 (Énay, 1966, p. 432, fig. 123,*6b,d*).

Perisphinctes WAAGEN, 1869, p. 248 [**Ammonites variocostatus* BUCKLAND, 1836, pl. 42,*7;* SD ICZN Opinion 303, 1954c, p. 275] [=*Martelliceras* SCHINDEWOLF, 1925, p. 326 (type, *Ammonites martelli* OPPEL, 1863 in 1862–1863, p. 247, *nom. nov. pro Ammonites biplex* D'ORBIGNY, 1849 in 1842–1851, p. 509, pl. 191, *non Ammonites biplex* J. SOWERBY, 1821a, p. 168, OD); =*Dichotomosphinctes* BUCKMAN, 1926, pl. 650 (type, *Perisphinctes antecedens* SALFELD, 1914a, p. 137, OD); =*Beraketites* HAAS, 1963, p. 277, *non Beraketites* COLLIGNON, 1959, pl. 59,*275* (see COLLIGNON, 1960, p. 3, Erratum II), *nom. nud.,* type species not fixed in original publication (type, *Orionoides alloiteaui* COLLIGNON, 1959, pl. 59,275, OD); ?=*Moskvaites* SAZONOV, 1961, p. 34, *nom. nud.*, no description or differentiating characters given (type, *Ammonites chloroolithicus* GÜMBEL, 1865, p. 799, 805, M; holotype figured by REUTER, 1910, p. 86, fig. 2, and KLEBELSBERG, 1912, p. 197, pl. 18,*4a–b*)]. Inner and middle whorls evolute, with quadrate to compressed whorl section, and flat whorl sides and venter; primary ribs sharp, straight, dividing high on the whorl side into mainly biplicate secondary ribs, with rare intercalatory ribs, continuous across the venter; occasional constrictions, no parabolae. Dimorphic: macroconchs large, adult at up to 500 mm in diameter, and modify suddenly to a depressed, flat-ventered whorl section on the adult body chamber with very large, swollen, wedge-shaped primary ribs and total loss of secondary ribs; the final aperture is constricted with a simple mouth border. Microconchs (*Dichotomosphinctes*) are adult at 95–200 mm in diameter and maintain this morphology to the final mouth border with a terminal constriction and relatively short lappets. *Perisphinctes* is one of the best-known and most widely distributed ammonites in the Jurassic. Species range through parts of four zones from the *Plicatilis* Zone, *Antecedens* Subzone, and the *Transversarium* Zone of the middle Oxfordian up into the lower part of the *Bimammatum* Zone of the upper Oxfordian (equivalent to the *Cautisnigrae* Zone, *Variocostatus* Subzone, in the Northwest European Province). The holotype of the type species *P. variocostatus* is a macroconch derived from the top subzone of this range, and it bears much resemblance to the macroconchs throughout the full range of the genus. *Perisphinctes* differs from *Kranaosphinctes* in being less evolute, less serpenticone, with higher and more rapidly increasing whorl height, no parabolae, and finer ribbing on inner and middle whorls, which quickly changes on the adult body chamber of the macroconchs into coarse, widely spaced primary ribs or large, wide folds on the side of the whorl in some species. *Upper Jurassic (middle Oxfordian,* Plicatilis *Zone,* Antecedens *Subzone to* Transversarium *Zone–upper Oxfordian,* Bimammatum *Zone,* Variocostatus *Subzone):* Europe, Russia, India (Kutch), northern

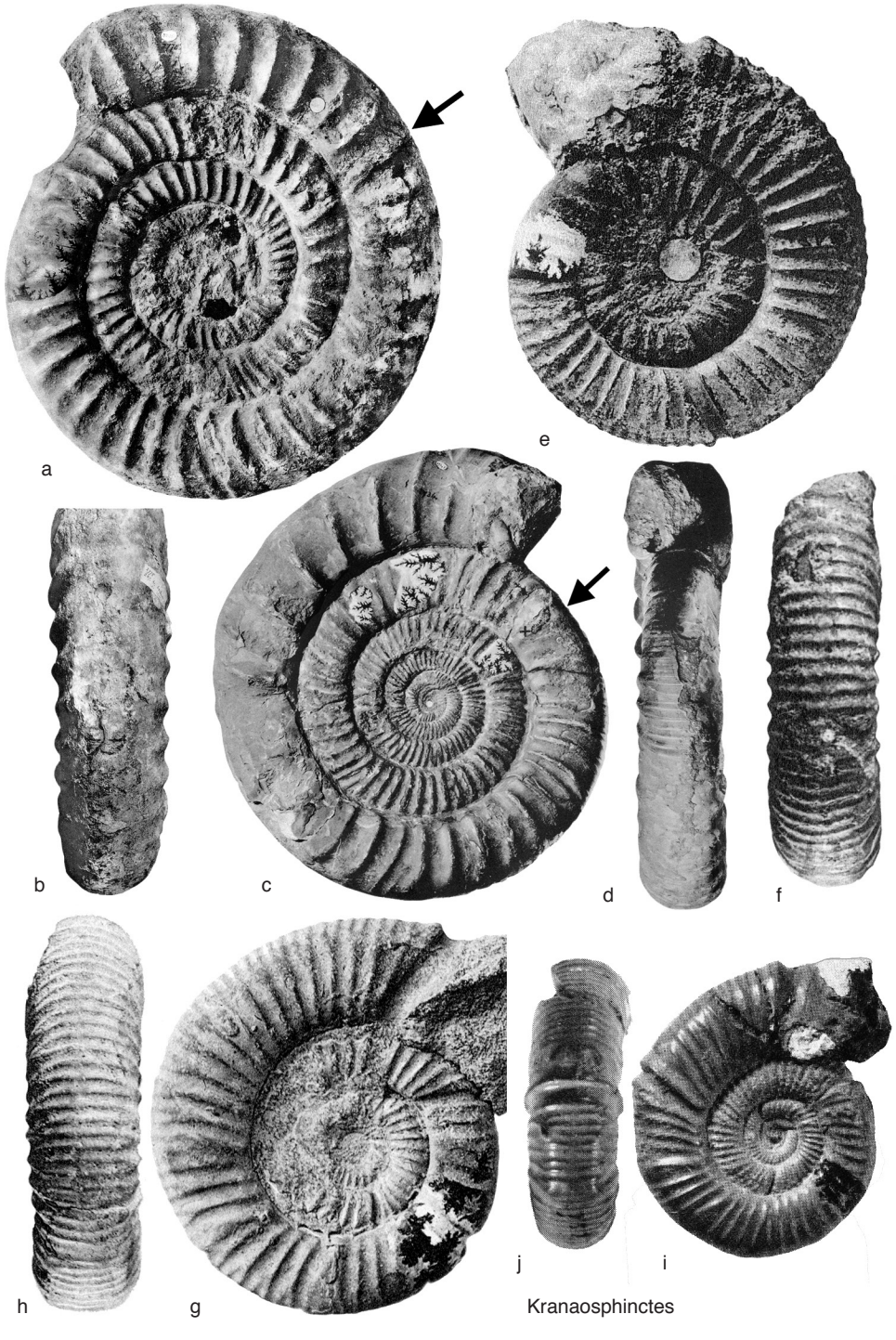

FIG. 26. Perisphinctidae, Perisphinctinae (p. 33–34).

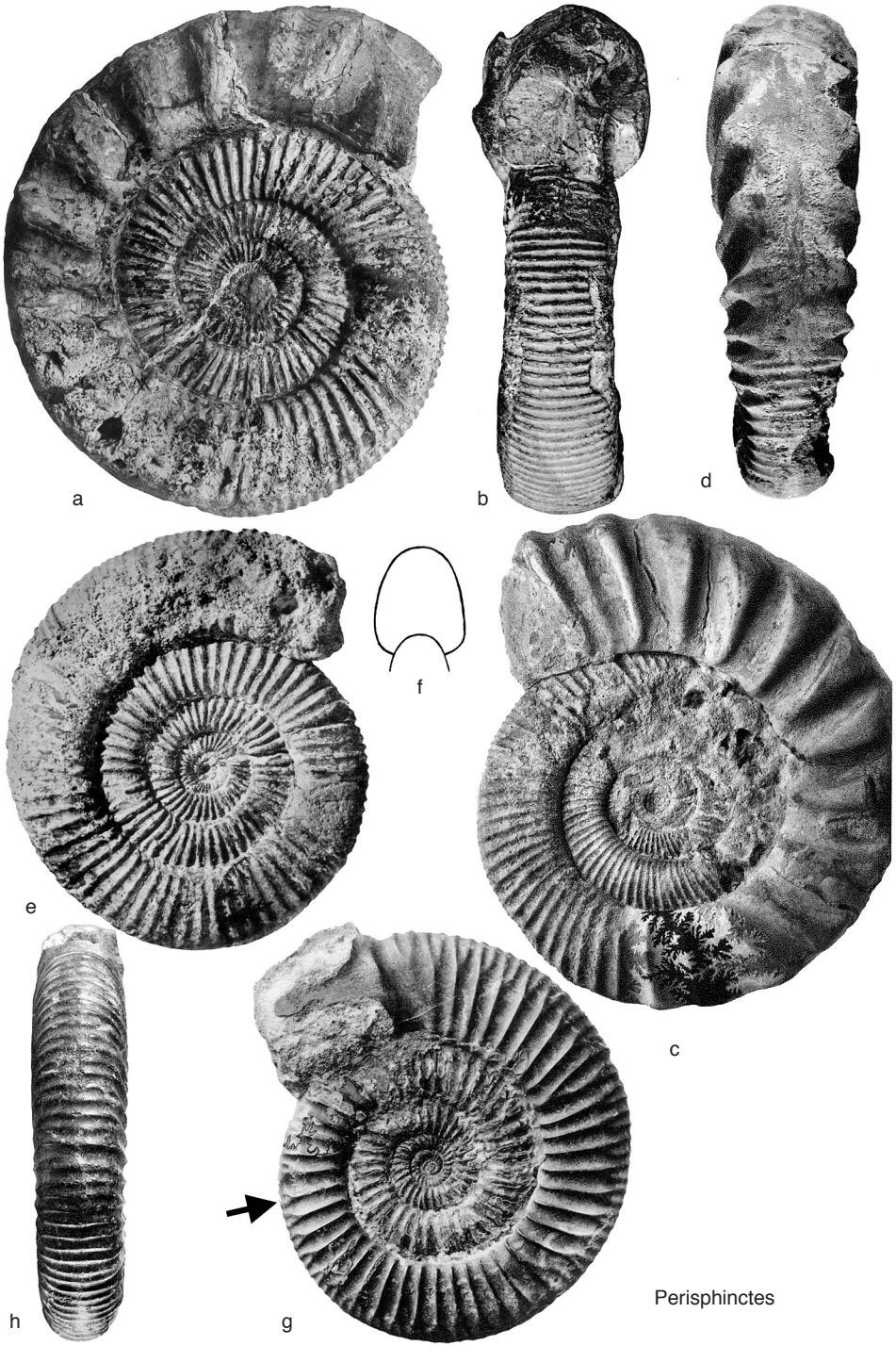

FIG. 27. Perisphinctidae, Perisphinctinae (p. 34–37).

Pakistan, Japan, Indonesia, northern Africa, Ethiopia, Kenya, Tanzania, Madagascar, eastern Greenland, USA (Alaska, Oregon, California), Mexico, Cuba, Chile.——Fig 27*a–b. *P. variocostatus* (Buckland), holotype, adult macroconch with about one-sixth of a whorl of body chamber, glacial drift from Ampthill Clay, Haynes, Bedfordshire, England, ×0.33 (*a,* Healey, 1904, pl. 11; *b,* Arkell, 1947, pl. 76,*3b*).——Fig. 27*c–d. P. panthieri* Énay, holotype, adult macroconch, *Transversarium* Zone, Nevers, Nièvre, Burgundy, France, ×0.25 (Énay, 1966, pl. 12,*1a,2*).——Fig. 27*e–f. P. antecedens* (Salfeld), holotype, microconch, *Plicatilis* Zone, *Antecedens* Subzone, Mönkeberg, Lower Saxony, Germany, ×0.6 (Salfeld, 1914b, pl. 12,*3*).——Fig 27*g–h. P. arkelli* Głowniak (2000, p. 153), adult microconch with lappet, Shotover, 5 km east of Oxford, England, ×0.6 (Arkell, 1938, pl. 16,*1a–b*).

Dichotomoceras Buckman, 1919, pl. 139A [**D. dichotomum;* OD] [=*Divisosphinctes* Beurlen, 1925, p. 27 (type, *Ammonites biplex bifurcatus* Quenstedt, 1846 in 1845–1849, p. 163, SD Spath, 1931, p. 470, *non Ammonites bifurcatus* Roissy, 1805, p. 25, *nec Ammonites bifurcatus* Schlotheim, 1820, p. 73, *nom. conserv.,* ICZN Opinion 2123, 2005, p. 158); =*Divisoceras* von Bubnoff, 1935, p. 872; misspelling of *Divisosphinctes* (see Arkell, 1936, p. xxxv)]. Moderately evolute inner and middle whorls, with quadrate whorl section, flat whorl sides and venter; primary ribs sharp, dense, prorsiradiate, bifurcating at ventrolateral edge; secondaries continuous across venter; occasional single ribs and constrictions. Dimorphic: microconchs adult at 135–190 mm in diameter, with dense, sharp ribs throughout; macroconchs up to 360 mm in diameter, ribs quickly become widely spaced, thick, and bullate on adult whorl, before reducing shortly before the mouth border. More involute than *Perisphinctes,* whorl section higher and more compressed, and ribs more dense and sharp on inner and middle whorls. *Upper Jurassic (upper Oxfordian,* Bifurcatus *Zone):* England, France, Germany, Switzerland, Poland, India (Kutch), Ethiopia, Kenya, Japan.——Fig. 28*a–b. *D. dichotomum,* holotype, complete adult microconch, Brill, Buckinghamshire, England, ×0.45 (Arkell, 1947, pl. 75,*1a–b*).——Fig. 28*c–e. D. cautisnigrae* (Arkell); *c–d,* holotype, adult macroconch, Osmington, Dorset, England, ×0.2 (Arkell, 1935c, pl. 1,*1a–b*); *e,* adult macroconch showing reduction of ribs before the complete mouth border, Zawodzie quarry, Częstochowa, Poland, ×0.25 (Głowniak, 2006, fig. 6).——Fig. 28*f–g. D. bifurcatus* (Quenstedt), lectotype, Nusplingen, Württemberg, Germany, ×1 (Énay, 1966, pl. 33,*1a,1c;* originally figured by Quenstedt, 1846 in 1845–1849, pl. 12,*11,* and 1887 in 1882–1888, pl. 101,*9*).

Pseudarisphinctes Arkell, 1935c, p. 21 [**P. shortlakensis;* OD]. Differs from *Perisphinctes* and *Dichotomoceras* in more rounded inner whorls, with primary ribs becoming more widely spaced, large and blunt at an earlier stage on the middle and outer whorls and final body chamber, and has simpler suture throughout. Less evolute, less serpenticone, and more quickly expanding whorl height than *Kranaosphinctes*. Macroconchs only; associated microconchs not identified. *Upper Jurassic (upper Oxfordian,* Bifurcatus *Zone):* England.——Fig. 29,*1a–b*. **P. shortlakensis*, holotype, complete adult macroconch, *Cantisnigrae* Zone (=*Bifurcatus* Zone), Black Head, Osmington, Dorset, England, ×0.24 (Arkell, 1935c, pl. 5,*1a–b*).

Ampthillia Arkell, 1947, p. 359 [**A. ampthillensis;* M]. Inner and middle whorls quadrate with strong, straight, biplicate ribs as in *Perisphinctes;* outer whorl changes quickly to rounded or oval whorl section with sharp, simple ribs that are continuous onto the arched venter; ribs are much reduced on the final part of the body chamber, with a simple adult peristome. The holotype is apparently a complete adult macroconch at 225 mm diameter; associated microconchs are not known. *Upper Jurassic (upper Oxfordian,* Serratum *Zone):* England, France, ?Cuba.——Fig. 29,*2 a–b. *A. ampthillensis,* holotype, Drift, Lincolnshire, England, ×0.36 (Arkell, 1947, pl. 75,*8a–b*).

Neomorphoceras Arkell, 1953, p. 38 [**Ammonites chapuisi* Oppel, 1857, p. 605; OD] [=*Ammonites microstoma impressae* Quenstedt, 1847, p. 186, pl. 15,*6,* and 1887, p. 685–686, pl. 93,*62–65*; SD Arkell, 1953, p. 38]. *Morphoceras*-like perisphinctids; dwarf sphaerocone microconch, narrow umbilicate inner whorls, evolute outer whorl, with more or less excentric coiling, subcircular whorl section; biplicate ribbing with intercalatories; contracted aperture, but lappet unknown. The microconch *N. chapuisi* could be the contemporary of and allied to the macroconch *N. collinii* (Oppel), which has a very short or vestigial *Morphoceras*-like stage, evolute coiling, bifurcate and simple ribs, more or less strong and coarse to fine and dense, and a contracted aperture. *Upper Jurassic (middle Oxfordian,* Plicatilis *Zone,* Antecedens *Subzone to* Transversarium *Zone,* Luciaeformis *Subzone):* western and southeastern France, Switzerland, southern Germany.——Fig. 30,*3a–b. N. chapuisi* (Oppel), holotype (original of *Ammonites microstoma impressae* Quenstedt, 1847, p. 186), microconch, Weisse Jura α, Deggingen Reichenbach, Germany, ×2 (Schlegelmich, 1994, pl. 21,*4*).——Fig. 30,*3c–d. N. collinii* (Oppel), lectotype (original of Oppel 1863, pl. 65,*3*), probable macroconch, middle Oxfordian, Birmenstorf, Aargau, Switzerland, ×1 (Schlegelmich, 1994, pl. 21,*10*).

Liosphinctes Buckman, 1925a, pl. 566 [**L. apolipon;* OD] [=*Platysphinctes* Tintant, 1960, p. 112 (type, *P. perplanatus,* OD); =*Tenuisphinctes* Gygi, 1998, p. 5 (type, *T. kruegeri,* OD); =*Eichiniceras* Gygi, 1998, p. 8 (type, *E. rolandi,* OD)]. Evolute, compressed, oval whorls; primary ribs moderately fine, bifurcating high on the whorl side with a few intercalatories; secondary ribs continuous across venter. Dimorphic: macroconchs become almost smooth on the final part of the adult body chamber; microconchs ribbed throughout with lappets in final adult mouth border. *Upper Jurassic (middle Oxfordian):* England, Spain, France, Switzerland, Germany, Poland, Madagascar.——Fig. 30,*1a–b*.

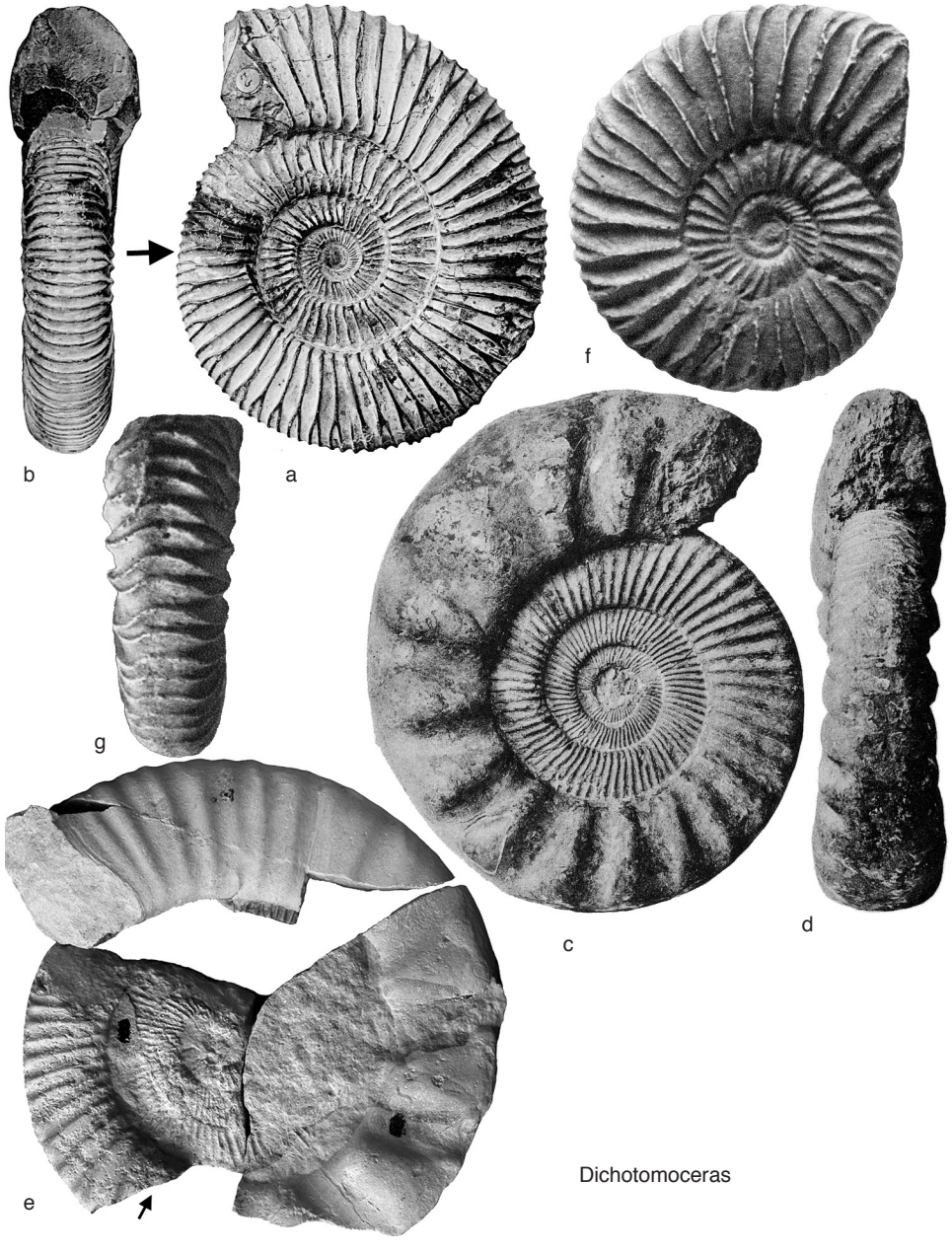

FIG. 28. Perisphinctidae, Perisphinctinae (p. 37).

**L. apolipon,* holotype, macroconch, Cowley, Oxford, England, ×0.5 (Buckman, 1925a, pl. 566).——FIG. 30,*1c–d. L. kruegeri* (GYGI), holotype, complete adult macroconch, Herznach, Aargau, Switzerland, ×0.33 (Gygi, 1998, pl. 1,*1*).——FIG. 30,*1e. L. rolandi* (GYGI), holotype, microconch, Herznach, Aargau, Switzerland, ×0.75 (Gygi, 1998, pl. 11,*4*).

Subdiscosphinctes MALINOWSKA, 1972, p. 217 [**Perisphinctes kreutzi* SIEMIRADZKI, 1891, p. 41; OD] [=*Aureimontanites* BROCHWICZ-LEWIŃSKI, 1975, p. 91 (type, *Lithacoceras (Subdiscosphinctes) boreale* MALINOWSKA, 1972, p. 219, OD)]. Discoidal inner whorls moderately involute, with compressed, oval whorl section and fine, dense ribs, dividing into 2 to

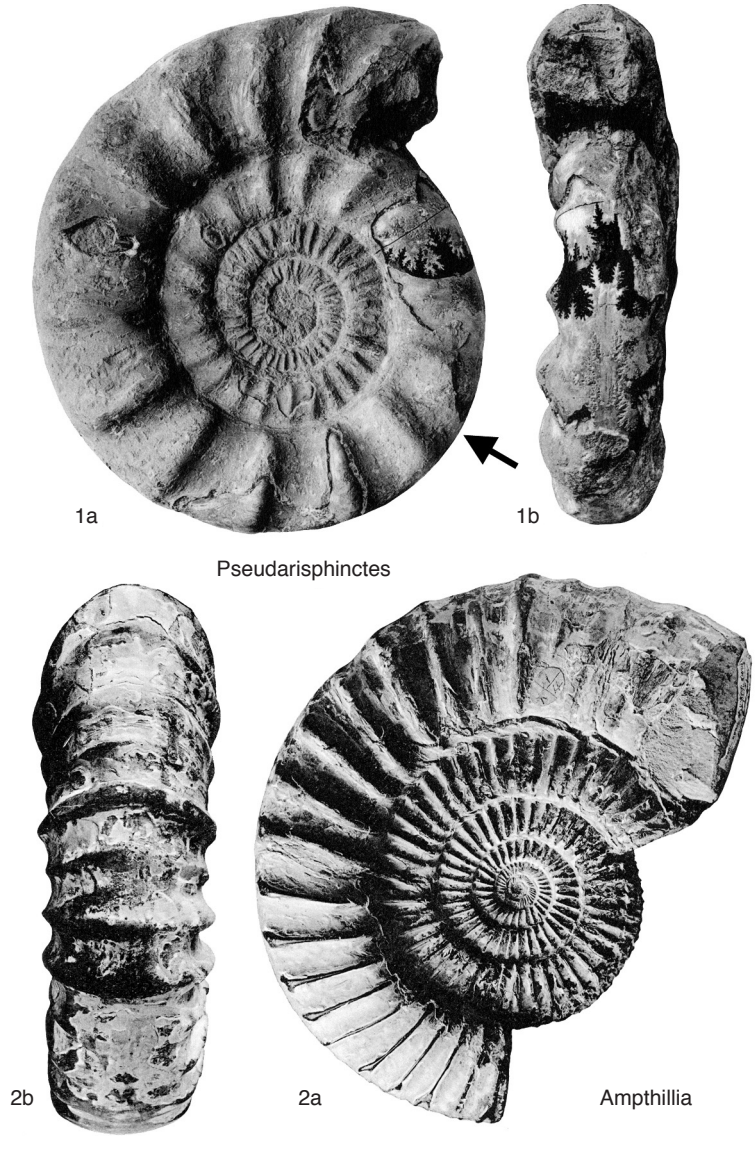

FIG. 29. Perisphinctidae, Perisphinctinae (p. 37).

4 secondaries that sweep forwards on the venter; occasional single ribs and 2 to 3 constrictions per whorl. Dimorphic: microconchs maintain this morphology up to the adult mouth border, with lappets, at 100–180 mm in diameter. Macroconchs become evolute on middle and outer whorls, with subquadrate whorl section, and primary ribs becoming more widely spaced and blunt; adult size 180–380 mm in diameter, with simple mouth border. *Upper Jurassic (middle Oxfordian–upper Oxfordian,* Bifurcatus *Zone):* France, Portugal, Germany, Switzerland, Poland, Iran, Russia, ?northern Africa, eastern Africa, Madagascar, India (Kutch), Cuba, ?Argentina.——FIG. 30,*2a–b.* **S. kreutzi* (SIEMIRADZKI), lectotype (designated by GŁOWNIAK IN GŁOWNIAK & WIERZBOWSKI, 2007, p. 40), adult microconch with half a whorl of incomplete body chamber, Rudno, Poland, ×0.6 (Głowniak in Głowniak & Wierzbowski, 2007, fig. 7,*1–2*).—— FIG. 30,*2c–d. S. borealis* (MALINOWSKA), holotype, complete adult macroconch with half a whorl of body chamber, Zawodzie, Poland, ×0.2 (Malinowska, 1972, pl. 25).

Praekossmatia ÉNAY, 2009, p. 104 [**P. dangarensis;* OD]. Medium-sized, evolute, whorl section rounded on

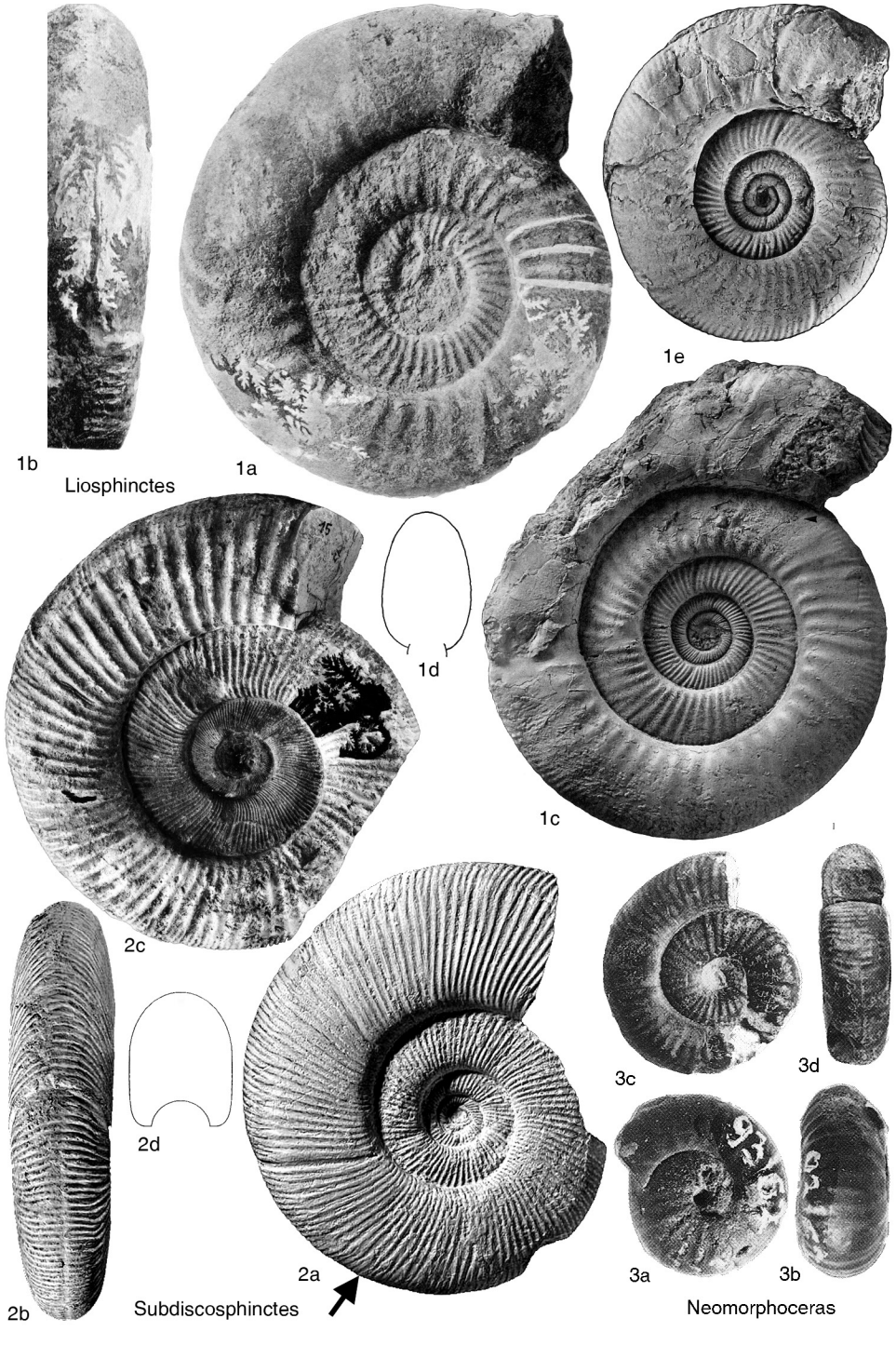

FIG. 30. Perisphinctidae, Perisphinctinae (p. 37–39).

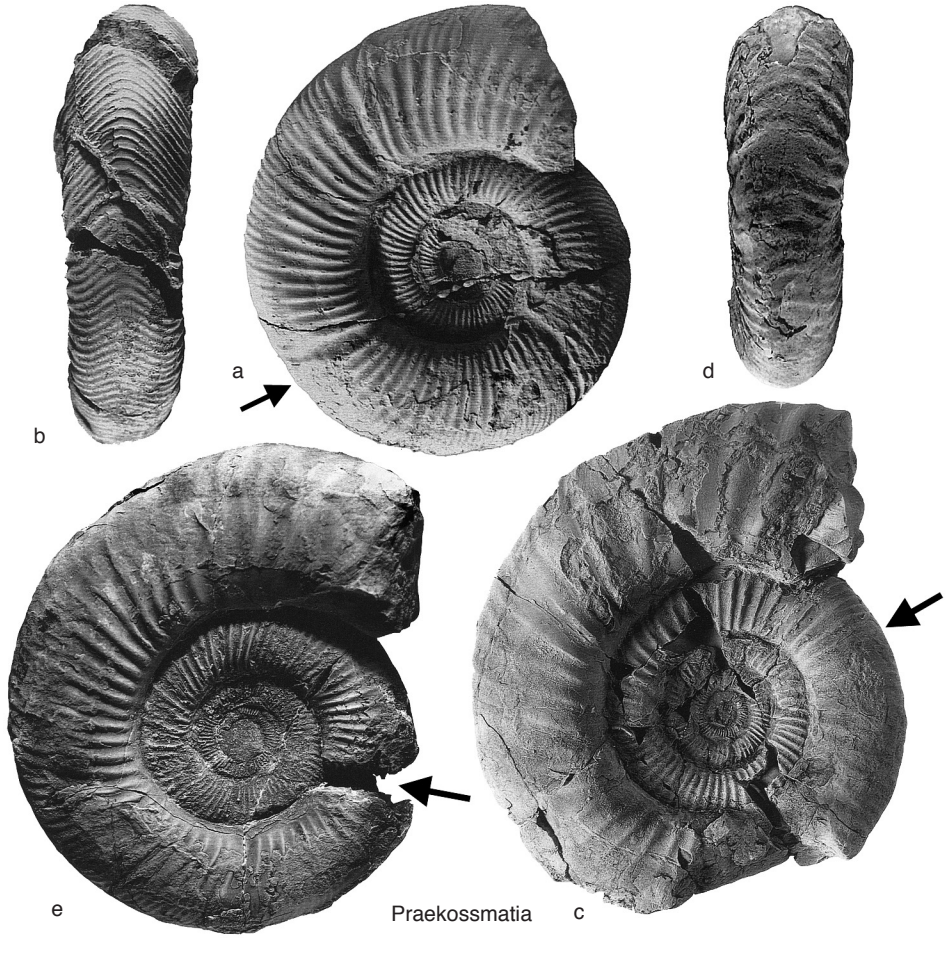

FIG. 31. Perisphinctidae, Perisphinctinae (p. 39–41).

inner whorls, oval on later whorls; ribs slightly prorsiradiate, dividing at small tubercles at ventrolateral angle into secondaries that are interrupted at a midventer on inner whorls, and form forwardly pointing chevrons on outer and adult whorls; several deep constrictions per whorl. Dimorphic: macroconchs are adult at sizes up to 245 mm in diameter, with ribs fading on the final whorl and a simple adult mouth border; microconchs are adult at 50–100 mm in diameter, probably without final lappets. Similar to *Sulaites,* but differs in larger size and absence of parabolae and parabolic ribs. *Upper Jurassic (upper middle Oxfordian–lower Kimmeridgian):* Nepal, Indonesia (Sula Islands).——FIG. 31*a–d. *P. dangarensis; a,* holotype, microconch, ravine north-northeast of Dangarjong (Dangardzong), Nepal, ×0.8 (Énay, 2009, pl. 7,*5a*); *b,* venter of another specimen, upper valley of Nupra Khola River, 6 km northeast of Jomsom (Jomosom), Nepal, ×0.8 (Énay, 2009, pl. 7,*3b*); *c–d,* paratype, macroconch, ravine north-northeast of Dangarjong (Dangardzong), Nepal, ×0.65 (Énay, 2009, pl. 7,*4a–b*).——FIG. 31*e. P. thakkholensis* ÉNAY, 2009, holotype, complete adult macroconch, arrow marks probable end of phragmocone, ravine north-northeast of Dangarjong (Dangardzong), Nepal, ×0.6 (Énay, 2009, pl. 10,*3*).

Sulaites OLÓRIZ & WESTERMANN, 1998, p. 232 [**Perisphinctes sularus* BOEHM, 1907, p. 100; OD]. Small-sized, evolute, whorl section rounded, depressed on inner whorls, compressed oval on later whorls; ribs slightly prorsiradiate, dividing at small tubercles at ventrolateral angle into secondaries that are interrupted at a midventer on inner whorls, and form forwardly pointing chevrons on outer and adult whorls; some parabolic ribs on inner whorls, and ventrolateral parabolae on outer whorls; occasional constrictions. Dimorphic: macroconchs are known up 140 mm in diameter, with coarsening primary

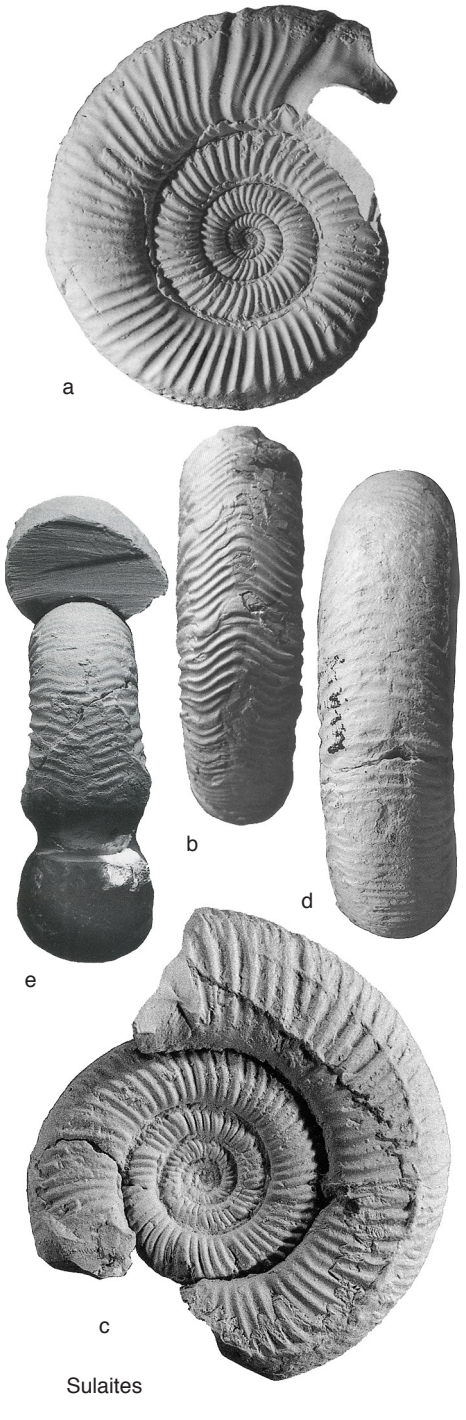

FIG. 32. Perisphinctidae, Perisphinctinae (p. 41–42).

ribs and several intercalated ribs, but the adult mouth border is unknown; microconchs are adult at 60–80 mm in diameter, with final lappets known only in the neotype of the type species. ÉNAY, 2009. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian):* Indonesia (Sula Islands, West Papua), Papua New Guinea, Nepal, ?New Zealand.——FIG. 32*a–e.* **S. sularus* (BOEHM), 40 km northeast of Telefomin, West Papua; *a,* neotype, adult microconch with lappets, ×0.8; *b,* venter of another specimen; *c–e,* macroconch, ×0.67 (Olóriz & Westermann, 1998, fig. 1C–D; fig. 2B–C).

Subfamily PROSOSPHINCTINAE Głowniak, 2012

[Prososphinctinae GŁOWNIAK, 2012, p. 131]

Medium-sized perisphinctids characterized by compressed oval whorls with fine ribs, parabolae and constrictions. The earliest genus *Prososphinctoides* gave rise to *Larcheria.* Dimorphic: microconchs with lappets. *Upper Jurassic (lower Oxfordian,* Mariae *Zone–upper Oxfordian,* Bimammatum *Zone:* Europe, Caucasus, India, Madagascar, ?Argentina, ?Chile.

Prososphinctes SCHINDEWOLF, 1925, p. 325 [**Perisphintes mazuricus* BUKOWSKI, 1887, p. 157; OD; =*Perisphinctes consociatus* BUKOWSKI, 1887, p. 155, see GŁOWNIAK, 2012, p. 141] [=*Prososphinctoides* SPATH, 1928, pl. 42,*4* (legend), also SPATH, 1931, p. 393 (type, *P. manialensis,* M)]. Relatively small, early forms; inner whorls compressed, subquadrate with fine, dense, prorsiradiate primary ribs; secondary ribs numerous, periodically looped from parabolic nodes on ventrolateral shoulder and interrupted at midventer; later whorls with compressed ovoid whorl section; numerous, curved constrictions; body chamber up to one whorl long. Dimorphic: microconchs ribbed throughout with final lappet; macroconchs tend to become smooth on midwhorl side of adult body chamber, with deep constrictions at, and just before, the final aperture. *Upper Jurassic (lower Oxfordian,* Mariae *Zone–middle Oxfordian,* Plicatilis *Zone):* Spain, France, Poland, Caucasus, India (Kutch), Madagascar, ?Argentina, ?Chile.——FIG. 33,*1a–d.* **P. mazuricus* (BUKOWSKI), Częstochowa, Poland; *a–b,* lectotype (designated by MALINOWSKA & others, 1988, p. 338), macroconch, phragmocone, ×1 (Głowniak, 2012, fig. 19,*1b–c*); *c,* lectotype of *P. consociatus* (BUKOWSKI) (designated by MALINOWSKA & others, 1988, p. 338), macroconch, ×0.6 (Głowniak, 2012, fig. 17,*1a*); *d,* complete adult macroconch, Ogrodzieniec, Poland, ×0.75 (Głowniak, 2012, fig. 18,*2*).——FIG. 33,*1e–f. P. claromontanus* (BUKOWSKI), lectotype (designated by MALINOWSKA & others, 1988, p. 338), microconch, complete adult with basal part of lappet, Częstochowa, Poland, ×1 (Głowniak, 2012, fig. 14,*8a,c*).

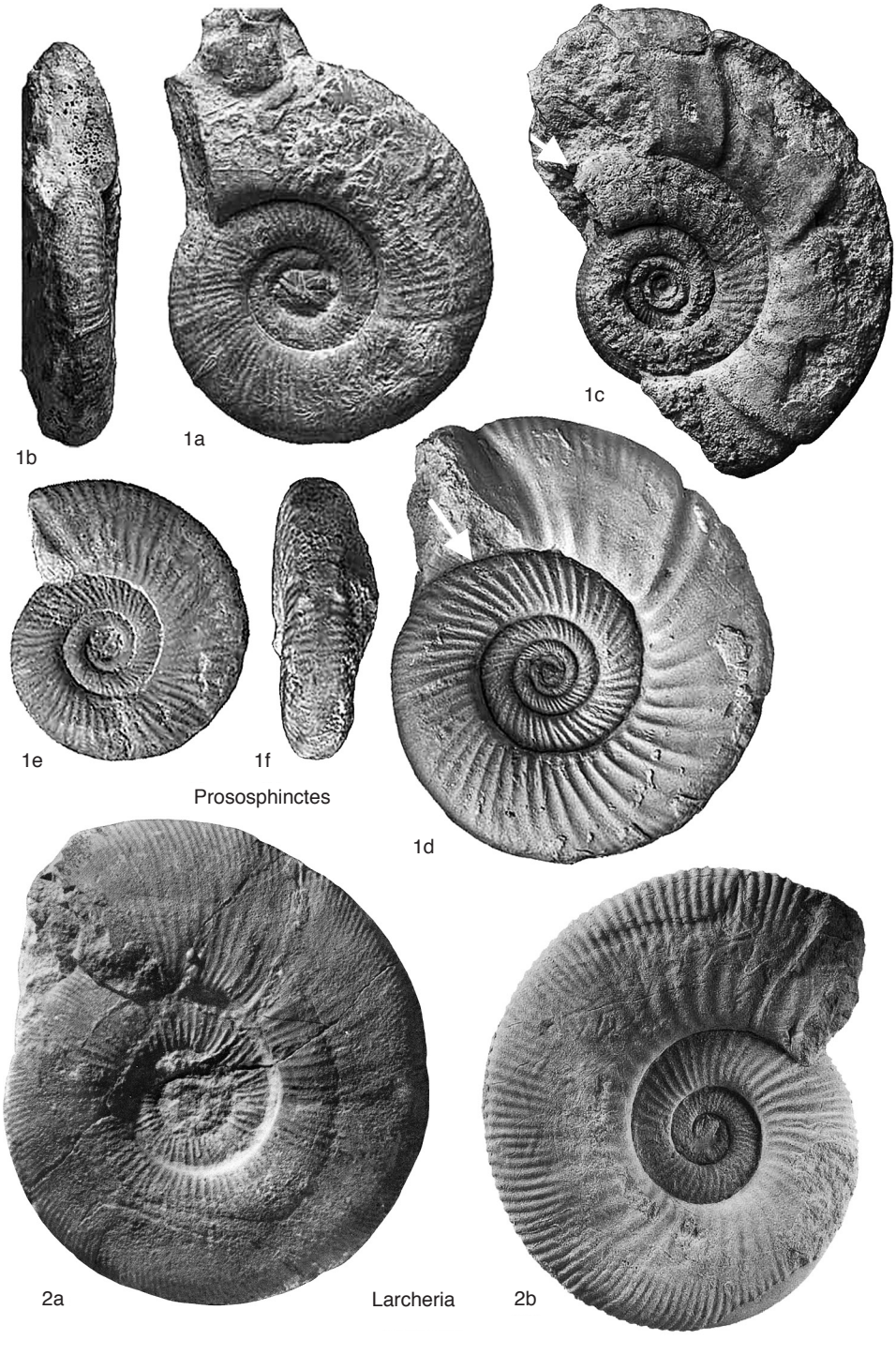

FIG. 33. Perisphinctidae, Prososphinctinae (p. 42–44).

Larcheria Tintant, 1960, p. 123 [**L. larcheri;* OD] [=*Wegelea* Gygi, 2000, p. 92 (type, *Perisphinctes gredingensis* Wegele, 1929, p. 49, OD)]. Medium sized with compressed, high, oval whorl section; ribs dense and fine, splitting into many secondaries on upper half of whorl; ribs remain throughout, but middle of whorl side tends to become smooth; oblique constrictions in some. Macroconchs only known. *Upper Jurassic (middle Oxfordian (*Transversarium *Zone–upper Oxfordian,* Bimammatum *Zone):* Spain, Portugal, France, Switzerland, Poland.——Fig. 33,*2a. *L. larcheri,* holotype, Les Rampots, Fontaine, Côte d'Or, France, ×0.4 (Tintant, 1960, pl. 1,*4*).——Fig. 33,*2b. L. gredingensis* (Wegele), complete adult macroconch, Beggingen, Switzerland, ×0.45 (Gygi, 2000, pl. 13,*1*).

Subfamily VINALESPHINCTINAE Meléndez & Myczynski, 1987

[Vinalesphinctinae Meléndez & Myczynski, 1987, p. 12]

A localized group of perisphinctinids confined to the Caribbean and western South America, differing from other perisphinctinids in their small to medium size; long body chambers; loss of ornament on the outer whorls of macroconchs; complex, irregular ribbing; marked constrictions; and suture with simplified suspensive lobe. Dimorphic, with short lappets in the microconchs. A possible record from Portugal (Atrops & Marques, 1988; see Parent, Schweigert, & Meléndez, 2006, p. 316) is probably an unrelated homeomorph. The earliest forms appear near the base of the Lower Oxfordian in Argentina, possibly derived from an earlier perisphinctid. Alternatively, derivation from *Prososphinctes* (Prososphinctinae) has been suggested by Głowniak (2012, p. 167). Wierzbowski, 1976; Parent, Schweigert, & Meléndez, 2006; Parent & Garrido, 2015. *Upper Jurassic (lower–upper Oxfordian,* Bifurcatus *Zone):* Argentina, Chile, Cuba, Mexico.

Subvinalesphinctes Wierzbowski, 1976, p. 179 [**Perisphinctes (?Ampthillia) corrali* Judoley & Furrazola-Bermúdez, 1968, p. 95; OD]. Highly evolute, oval or rounded whorl section; ribs strong and widely spaced, bifurcating or trifurcating on inner and middle whorls; body chamber up to one whorl long; occasional, prominent constrictions. Dimorphic: ribbing weakens on outer whorls of macroconchs leaving a smooth venter; adult mouth border unknown; in microconchs ribs remain throughout, and secondary ribs are interrupted at a midventral smooth band; adult mouth border with final constriction and short lappets. The earliest genus arising at the bottom of the Lower Oxfordian in northwest Argentina. *Upper Jurassic (lower–middle Oxfordian)*: Argentina, Chile, Cuba.——Fig. 34,*1a–c. *S. corrali* (Judoley & Furrazola-Bermúdez), Jagua Formation, Sierra de los Organos, Pinar del Rio, western Cuba; *a–b,* holotype, macroconch, ×0.4 (Judoley & Furrazola-Bermúdez, 1968, pl. 41,*1a*, 42,*1a*); *c,* almost complete microconch, La Jutia, Sierra de los Organos, Pinar del Rio, western Cuba, ×0.5 (new; also figured by Wierzbowski, 1976, pl. 2,*3*).

Vinalesphinctes Spath, 1931, p. 400. [**V. roigi;* OD] [=*Roigites* Wierzbowski, 1976, p. 182 (type, *Prososphinctes subconsociatus* Spath, 1931, p. 400, OD)]. Medium to small; evolute with dense, prorsiradiate, bifurcating ribs on inner and early middle whorls. Dimorphic: macroconchs (*Vinalesphinctes*) medium sized, with ribs fading, leaving outer whorls entirely smooth except for constrictions followed by collars; plain mouth border. Microconchs (*Roigites*) small, with ribs and constrictions retained throughout; adult mouth border with lappets. Differs from *Subvinalisphinctes* in denser, more irregular, prorsiradiate ribs; entirely smooth final whorls of macroconchs; and more frequent, collared constrictions. *Upper Jurassic (lower–upper Oxfordian,* Bifurcatus *Zone):* Argentina, Cuba.——Fig. 34,*2a–c. *V. roigi*, Jagua Formation, San Carlos Valley, Sierra de los Organos, Pinar del Rio, western Cuba; *a–b,* holotype, macroconch, ×0.75 (Judoley & Furrazola-Bermúdez, 1968, pl. 61,*2c–d*); *c,* topotype, macroconch, ×0.5 (new; also figured by Wierzbowski, 1976, pl. 1,*6*).——Fig. 34,*2d. V. subconsociatus* (Spath), topotype, complete microconch with lappet, Jagua Formation, Sierra de los Organos, Pinar del Rio, western Cuba, ×1 (new; also figured by Wierzbowski, 1976, pl. 2,*7*).

Cubasphinctes Judoley & Furrazola-Bermúdez, 1968, p. 90 [**Perisphinctes (Cubasphinctes) jaworskii*; OD] [=*Antilloceras* Wierzbowski, 1976, p. 216 (type, *Perisphinctes antillarum* Jaworski, 1940, p. 114, OD)]. Inner whorls moderately involute, with oval whorl section narrowing towards venter; dense, rather irregular, prorsiradiate ribs divide at mid to high whorl side into several secondaries that are continuous across the venter; several prominent, deep constrictions per whorl. Microconchs (*Antilloceras*) maintain this morphology to the adult mouth border, ending in a constriction and a short lappet at a maximum size of 40–100 mm in diameter; macroconchs (*Cubasphinctes*) become more evolute on middle and outer whorls, with widely spaced primary and many secondary and intercalated ribs on the venter, fewer constrictions, and a plain adult mouth border, reaching 100–250 mm in diameter. Differs from perisphinctinid genera such as *Arisphinctes* or *Orthosphinctes*, in the much smaller maximum size of both dimorphs, retention of secondary ribs on the venter of macroconchs, and its generally more

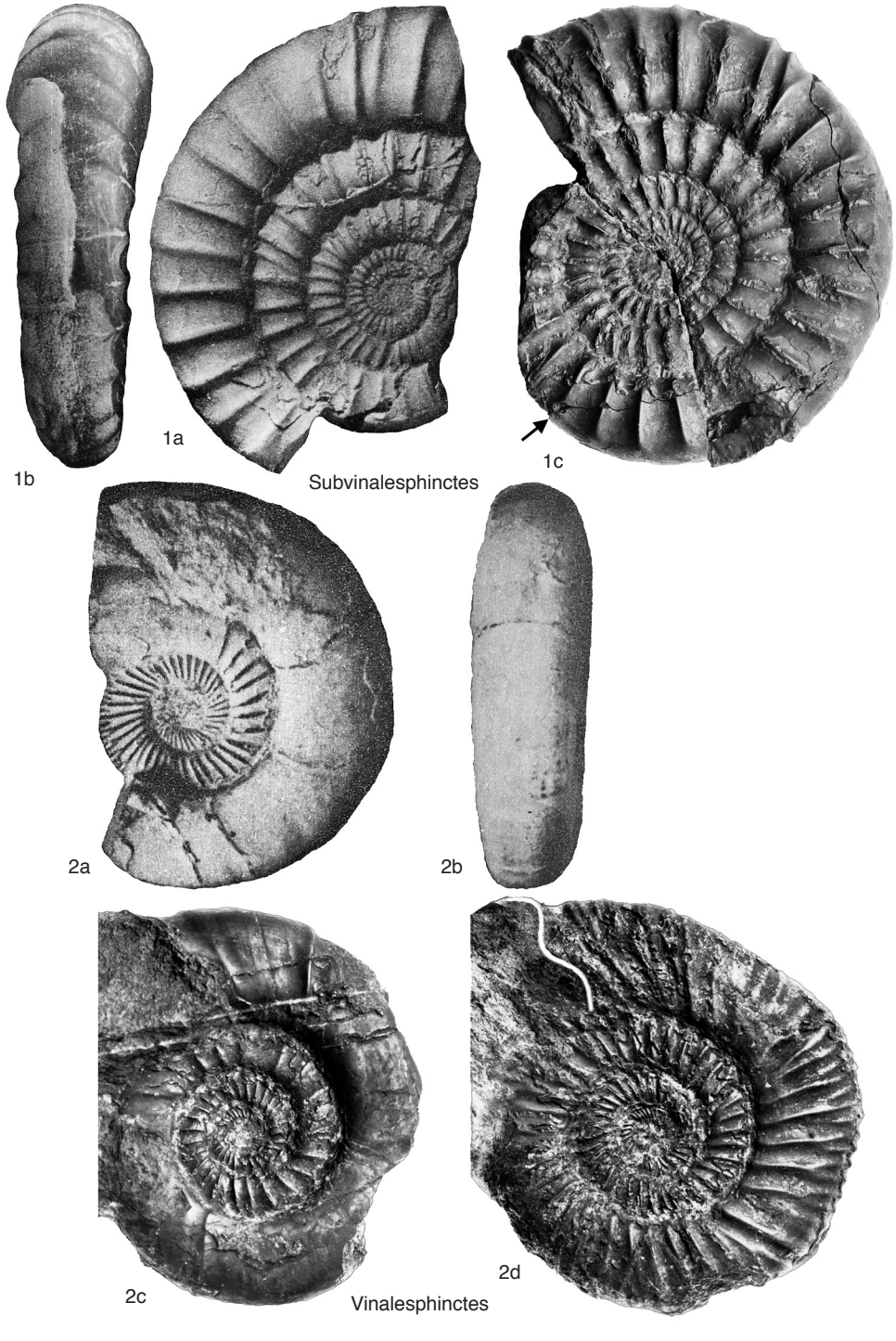

FIG. 34. Perisphinctidae, Vinalesphinctinae (p. 44).

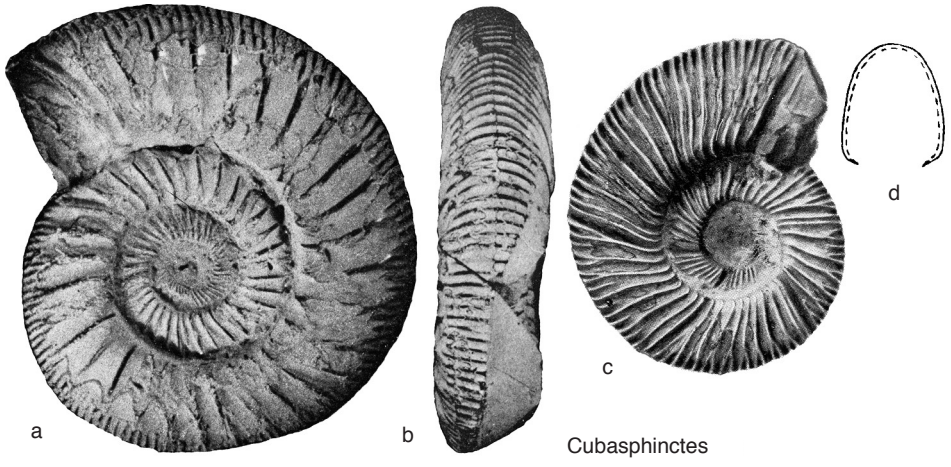

FIG. 35. Perisphinctidae, Vinalesphinctinae (p. 44–46).

irregular, polyfurcate ribbing. *Upper Jurassic (lower–upper Oxfordian,* Bifurcatus *Zone):* Argentina, Cuba, Mexico.——FIG. 35*a–b*. **C. jaworskii,* holotype, Jagua Formation, Sierra de los Organos, Pinar del Rio, western Cuba, ×0.5 (Judoley & Furrazola-Bermúdez, 1968, pl. 37,*1a–b*).——FIG. 35*c–d*. *C. antillarum* (JAWORSKI), lectotype (designated by WIERZBOWSKI, 1976, p. 219), adult microconch with constriction followed by a short lappet, Puerto Ancon, Cuba, ×1 (Jaworski, 1940, pl. 5,*4*, 3,*7*).

Subfamily PASSENDORFERIINAE Meléndez, 1989

[Passendorferiinae MELÉNDEZ, 1989, p. 127] [=Nebroditidae CANTÚ CHAPA, 2009, p. 9]

The Kimmeridgian genus *Nebrodites* is a well-known member of the subfamily as understood herein, but for a long time it was included in the subfamily Idoceratinae (ZIEGLER, 1959; GEYSSANT, 1966; BROCHWICZ-LEWIŃSKI, 1973; BROCHWICZ-LEWIŃSKI & ROZAK, 1976; DONOVAN, CALLOMON, & HOWARTH, 1981; SARTI, 1988, 1993, 1994, MELÉNDEZ & others, 2009). The recently proposed family name Nebroditidae CANTÚ CHAPA (2009) is here considered to be a junior synonym of Passendorferiinae, based on the genus *Passendorferia* BROCHWICZ-LEWIŃSKI, 1973. These two genera dominated the subfamily, and succeeded each another during the Oxfordian (*Passendorferia*) and Kimmeridgian (*Nebrodites*). They are the rootstocks of various genera of more restricted geographical range and geographical distribution, even endemic.

Passendorferia branched off late Callovian Grossouvrinae (e.g., *Alligaticeras*) in the upper lower Oxfordian, at about the same time as the Submediterranean-Subboreal Perisphinctinae. *Passendorferia* and related genera evolved side by side with the Perisphinctinae during the Oxfordian, but they have a Tethyan distribution, occurring in the Submediterranean Province only as opportunistic invaders of short duration. Other occurrences are in Argentina (PARENT, 2006), Nepal (ÉNAY, 2009) and Madagascar (COLLIGNON, 1959). They display serpenticone coiling, rounded whorls, dominant simple ribs and parabolic nodes. But in the late Oxfordian forms occur that suggest relationships with the Ataxioceratidae (e.g., *Graefenbergites*).

By the beginning of the Kimmeridgian, via *Geyssantia*, *Passendorferia* gave rise to *Nebrodites* and related genera that lasted until the bottom of the lower Tithonian. With certain exceptions, they preserved their Tethyan distribution and the major features of the Passendorferiinae (serpenticone coiling, rounded whorls, ribbing with dominating simple ribs), though some developed ventrolateral tubercles or hornlike extension of the ribs.

SCHWEIGERT and SCHERZINGER (1995) tentatively referred the genus *Protancyloceras* to the Idoceratinae (*sensu* Passendorferiinae). Later SCHWEIGERT and ZEISS (1998), without referring to CECCA's (1997) previous hypothesis that Hybonoticeratinae were possible ancestors, proposed the new genus *Berckhemeria* (Passendorferiinae) as the possible ancestor of *Protancyloceras* and the late Jurassic–early Cretaceous uncoiled ammonites of the subfamily Protancyloceratinae. SARTI (1999) did not come to a decision on these phyletic relationships, which he said are not well established. *Upper Jurassic (lower Oxfordian–lower Tithonian):* mainly Tethyan (Europe, Nepal, Madagascar, Argentina).

Passendorferia BROCHWICZ-LEWIŃSKI, 1973, p. 304 [**P. teresiformis;* OD] [=*Enayites* BROCHWICZ-LEWIŃSKI & ROZAK, 1976, p. 382 (type, *Ammonites birmensdorfensis* MOESCH, 1867, p. 291, OD); =*Neumannia* GŁOWNIAK, 2002, p. 354, *non Neumannia* TROUESSART, 1888 (Arachnida), *nec* WEISE, 1907 (Coleopterida), *nec* UCHIDA, 1926 (Mallophaga) (type, *Perisphinctes cyrilli* NEUMANN, 1907, p. 34, OD)]. Dimorphic; small to large size; coiling evolute, umbilicus large and shallow; whorl section subcircular at first, then subquadrate, and finally suboval; ribs rectiradiate, at first both simple and bifurcating near the ventral margin, then only simple; the furcation points and ribs are more prominent on the ventral margin; ribs sometimes alternate across the venter; constrictions on the inner whorls. Microconchs (*Enayites*) with lappets. *Upper Jurassic (lower Oxfordian,* Cordatum *Zone,* Claromontanus *Subzone–upper Oxfordian,* Bimammatum–Hauffianum *Zones)*: southeastern France, Switzerland, Spain, Sicily, Italy, Poland, Hungary, Romania, northern Turkey, Uzbekistan, Algeria, Tunisia, Nepal, Madagascar, ?Argentina.——FIG. 36,*1a–b*. **P. teresiformis*, holotype, complete specimen but without aperture, upper Oxfordian, *Bifurcatus* Zone, Zawodzie, Poland, ×0.39 (Brochwicz-Lewiński, 1973, pl. 13,*1,2*).——FIG. 36,*1c*. *P. cyrilli* NEUMANN, 1907, holotype by monotypy, "Cordatus Schichten," middle Oxfordian, Cetechovice, Moravia, Czech Republic, ×0.34 (Neumann, 1907, pl. 4,*12*).——FIG. 36,*1d–g*. *P. birmensdorfensis* (MOESCH); *d,* holotype, wholly septate, Birmensdorfer Schichten, middle Oxfordian, Birmensdorf, Aargau, Switzerland, ×1 (Énay, 1966, pl. 27,*2*); *e–f,* inner whorls, very similar to the holotype, Trept, Isère, France, ×1 (Énay, 1966, pl. 27,*3a–b*); *g,* complete specimen but without aperture, condensed horizon below the Birmensdorf Beds, Trept, Isère, France, ×1 (Énay, 1966, pl. 27,*1a*).

Sequeirosia MELÉNDEZ, 1989, p. 186 [**Passendorferia brochwiczi* SEQUEIROS, 1977, p. 364; OD] [=*Gemmellarites* MELÉNDEZ 1989, p. 192 (type, *Perisphinctes trichoplocus* GEMMELLARO, 1877, p. 89, OD)]. Medium to large size; evolute but not so slowly coiled as *Passendorferia* and whorl section quadrate-rounded to subrectangular-oval shaped, the sides fairly parallel or slightly rounded; fine and dense ribbing, rectiradiate to slightly prorsiradiate; ribs bifurcate and simple, progressively more distant and stronger on the last whorl of the macroconch. *Upper Jurassic (middle Oxfordian,* Transversarium *Zone–upper Oxfordian,* Bifurcatus *Zone):* Spain, southeastern France, Switzerland, Poland, Bulgaria, Algeria.——FIG. 37,*1a*. **S. brochwiczi* (SEQUEIROS), holotype, complete macroconch, middle Oxfordian, Cortijo del Navazo, Camorro Alto, Torcal de Antequera, Malaga, Spain, ×0.38 (Sequeiros, 1977, pl. 4,*2*).——FIG. 37,*1b–e*. *S. trichoplocus* (GEMMELLARO); *b–c,* a wholly septate specimen, holotype of the type species of *Gemmellarites* MELÉNDEZ, 1989, originally described as a microconch, but later reconsidered as being the nucleus of a macroconch (MELÉNDEZ in PAVIA & CRESTA, 2002, p. 278), Monte Erice area, Trapani, Sicily, ×1 (Pavia & Cresta, 2002, fig. 189); *d–e,* nearly complete microconch, with half a whorl of body chamber, Sponge Limestones Formation, middle Oxfordian, Évosges, Ain, France, ×0.75 (Énay, 1966, pl. 27,*7a–b*).

Zeissia ÉNAY, 2009, p. 124 [**Z. simoceroides;* OD]. Small to medium sized; fairly evolute; whorl section quadrate-rounded, hardly higher than thick, the sides and venter rounded; dense ribbing on the inner whorls, bifurcate and a few simple, the secondaries not so strong; primary ribs progressively more distant and prorsiradiate on the end of the septate whorls and the beginning of the body chamber, changing on the final half whorl to prominent and crested rectiradiate ribs; body chamber about half a whorl long; aperture simple but not well preserved. Microconch has the same variocostate evolution of the ribbing, but at smaller diameter, similar to the Kimmeridgian Tethyan genus *Ceratosphinctes. Upper Jurassic (middle Oxfordian):* Nepal.——FIG. 37,*2a–d*. **Z. simoceroides; a–b,* holotype, nearly complete macroconch, Spiti Shales, Mayaitids Beds, anticline west-southwest of the 4000 m pass, upper Nupra Khola River, Nupra, Nepal, ×0.5 (Énay, 2009, pl. 14,*1a–b*); *c–d,* paratype, microconch, same beds, Nupra village, Nepal, ×0.6 (Énay, 2009, p. 124, pl. 13,*4a–b*).

Geyssantia MELÉNDEZ, 1989, p. 202 [**G. geyssanti;* OD]. Probably dimorphic; small and medium sized; evolute, large and shallow umbilicus; slow coiling; whorl section quadrate and depressed in the inner whorls, progressively compressed with fastigate venter; isocostate ribbing, the ribs strong and distant along the whole growth; primary ribs bifurcate and simple; on the body chamber, intercalatory ribs more or less connected to the normal furcation forming false trifurcation; secondary ribs strong and

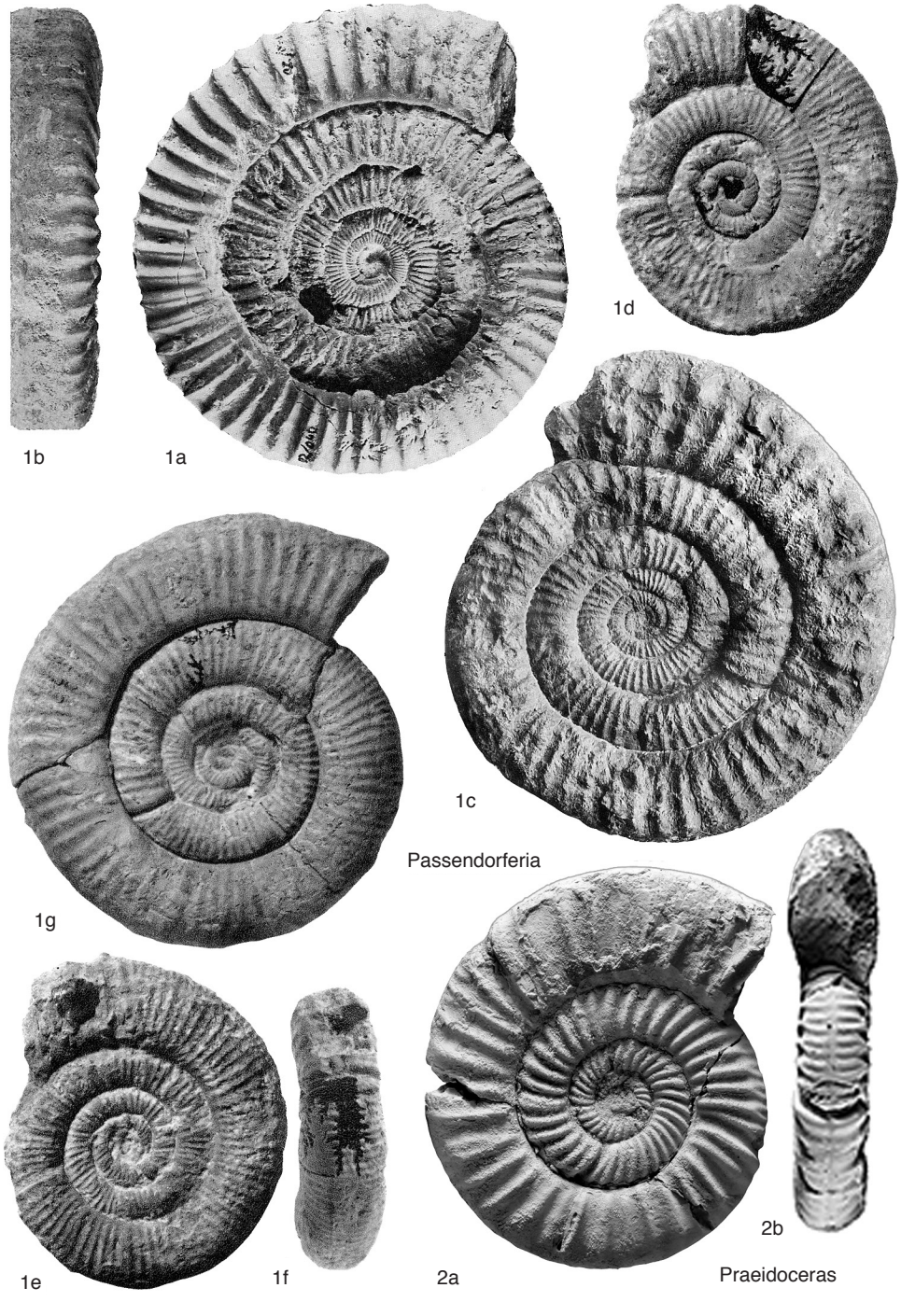

FIG. 36. Perisphinctidae, Passendorferiinae (p. 47–51).

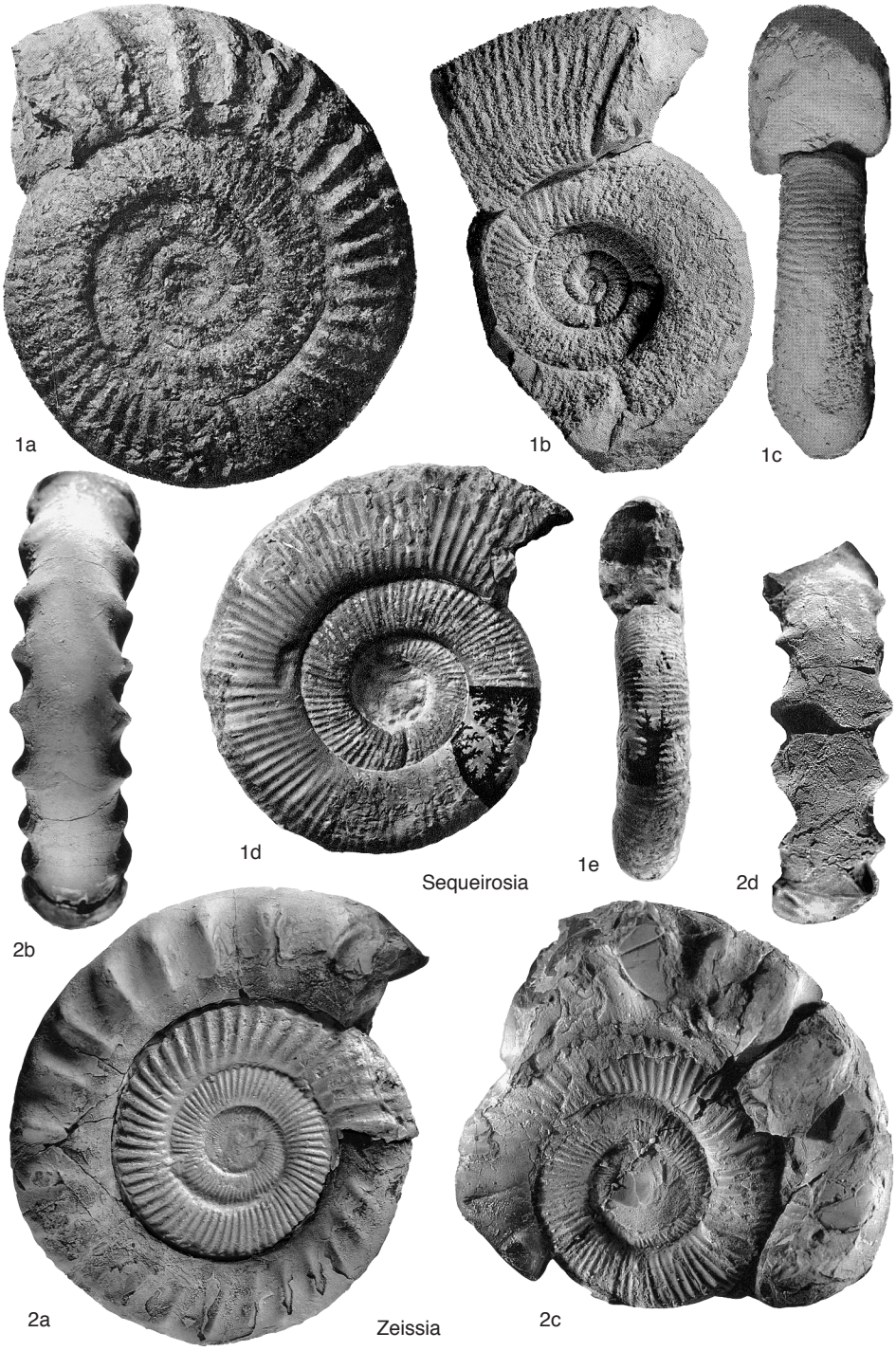

FIG. 37. Perisphinctidae, Passendorferiinae (p. 47).

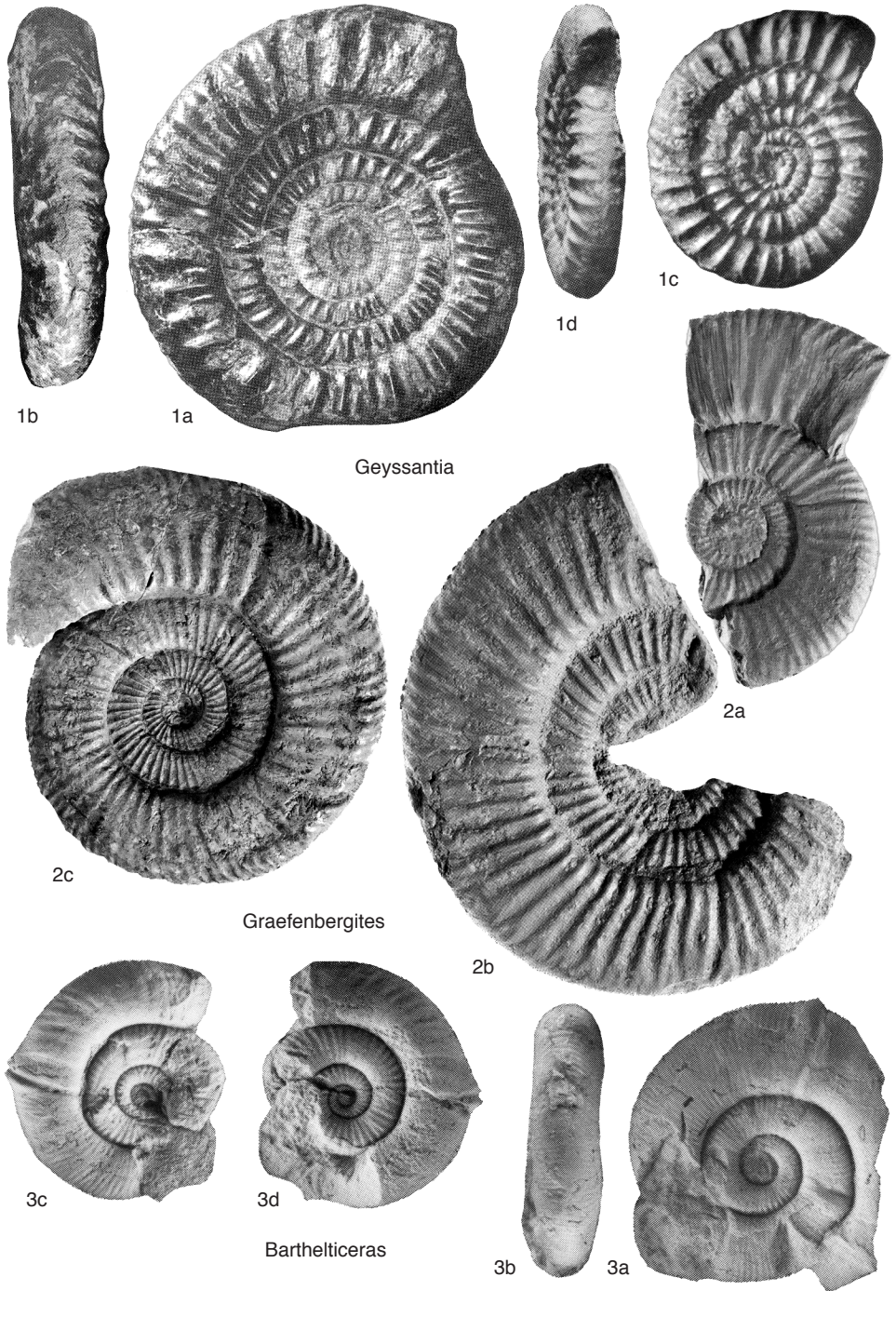

FIG. 38. Perisphinctidae, Passendorferiinae (p. 47–51).

projected forwards on shoulders, forming a chevron on the venter; possible ventral furrow on the inner whorls only; microconch differs only in smaller size. *Upper Jurassic (upper Oxfordian,* Bimammatum *Zone and Subzone–lowermost* Planula *Zone):* Spain, Sicily, Algeria, southern Germany, Hungary.——Fig. 38,*1a–d*. **G. geyssanti; a–b,* holotype, macroconch, probably adult, upper Oxfordian, ?*Planula* Zone and Subzone, Ricla, Zaragoza, Spain, ×0.75 (Meléndez, 1989, pl. 19,*2a–b*); *c–d,* small specimen with body chamber one whorl long, not fully grown or ?microconch, upper Oxfordian, *Bimammatum* Zone, Gea de Albarracin, Spain, ×0.84 (Meléndez, 1989, pl. 19,*5a–b*).

Barthelticeras Schairer, 1989, p. 120 [**B. enayi;* OD]. Small size; evolute; whorl section of the inner whorls thick, more or less rectangular to trapeziform; outer whorl compressed and high oval; body chamber three-quarters of a whorl long; ribs fine and dense, simple or bifurcate, the furcation point high on the sides, a very few on the umbilical half, normally rectiradiate to slightly prorsiradiate on the first half of the body chamber and then rursiradiate on the end part, after a well-marked constriction; some intercalatory ribs; probably a microconch, the macroconch counterpart unknown. *Upper Jurassic (upper Oxfordian,* Bimammatum *Zone,* Hypselum *Subzone):* France (southern Jura Mountains), southern Germany.——Fig. 38,*3a–d*. **B. enayi,* Weisse Jura α, Sengenthal, Bavaria, Germany; *a–b,* holotype, ×0.87; *c–d,* paratype, ×1 (Schairer, 1989, pl. 3,*1a–b*, pl. *2a,c*).

Graefenbergites Schairer & Schlampp, 2003, p. 32 [**Perisphinctes idoceroides* Dorn, 1930, p. 168 (62); OD]. Dimorphic; small to medium sized, evolute; inner whorls thick, rounded to oval shaped; ribs biplicate and a few simple; strong constrictions and parabolae; adult whorl with compressed, high-oval whorl section; slightly concave prorsiradiate ribs are mainly bifurcate, trifurcate, or polygyrate, with a few single intercalatories; numerous secondary ribs more or less markedly projected and strong prorsiradiate constrictions; aperture with lappet in the microconch, simple and flexuous in the macroconch. Inner whorls confirm that the genus belongs to the Passendorferiinae, but the adult whorl is *Subnebrodites*-like, so *Graefenbergites* appears to be intermediate between Passendorferiinae and Ataxioceratinae (e.g., *Subnebrodites*), but that does not prove they are phyletically related. *Upper Jurassic (upper Oxfordian,* Bimammatum *Zone,* Hypselum *Subzone,* Semimammatum *Horizon):* France (southern Jura Mountains), southern Germany, ?Spain.——Fig. 38,*2a–c*. **G. idoceroides* (Dorn), Weisse Jura α, Gräfenberg, Bavaria, Germany; *a,* lectotype (designated by Meléndez, 1989, p. 179), microconch, ×1; *b,* paralectotype, macroconch, ×1 (Schairer & Schlampp, 2003, pl. 4,*3–4*); *c,* nearly complete and better-preserved macroconch, ×0.76 (Schairer & Schlampp, 2003, pl. 6,*6*).

Praeidoceras Collignon, 1959, pl. 63,*285* [**Idoceras* (*Praeidoceras*) *madagascariense;* OD]. Another offshoot with endemic distribution similar to *Subnebrodites*. Very evolute; whorl section quadrate, hardly as high as thick in the inner whorls, the outer whorl more compressed; sides flat and parallel, the venter rounded; rib density increases regularly with growth; radial, prominent, and bifurcate primary ribs, the furcation point high on the side and not visible on the inner whorls, small strengthenings on the ventral margin of both inner and outer whorls suggest absence of simple ribs; prominent, oblique constrictions are followed by a strong, simple rib. *Upper Jurassic (middle Oxfordian,* Wartae *and* Anar *Zones):* Madagascar.——Fig. 36,*2a–b*. **Praeidoceras madagascariense* (Collignon), holotype, wholly septate, Bedoa, Befandriana Sud, Madagascar; *a,* ×1 (Collignon, 1959, pl. 63,*285*); *b,* ×1 (new; Université de Bourgogne, Dijon, UBGD 10285).

Ceratosphinctes Ziegler, 1959, p. 50 [**Ammonites septenarius* Quenstedt, 1857 in 1856–1858, p. 614; OD]. Dimorphic; small to medium sized; inner whorls rounded with fine and dense ribbing, ribs mainly simple, a very few bifurcate, interrupted or fading on the venter; then follow coarse and strong ribs with marginal hornlike extension, longer in the macroconch than in the microconch; aperture unknown. The fine and densely ribbed stage, well developed in the microconch, is shorter and reduced to the innermost whorl in the macroconch. *Upper Jurassic (lower Kimmeridgian,* Divisum *Zone–upper Kimmeridgian,* Acanthicum *Zone):* southern Germany, Italy (Sicily, Marche, Apennines), southern Spain, Morocco (Prerif), Mexico.——Fig. 39,*1a*. **C. septenarius* (Quenstedt), holotype, incomplete adult microconch, lower Weisse Jura δ, Bosler, Germany, ×1 (Ziegler, 1959, pl. 1,*2*).——Fig. 39,*1b–c*. *C. rachistrophus* (Gemmellaro, 1872), lectotype (designated by Cecca in Pavia & Cresta, 2002, p. 294), nearly complete macroconch without the aperture, from olistoliths embedded in tectonized Neogene marls, Burgilamuni, near Favara, Agrigento, Sicily, ×0.5 (Pavia & Cresta, 2002, p. 295, fig. 197*a–b*).

Nebrodites Burckhardt, 1910, p. 626 [**Simoceras agrigentinum* Gemmellaro, 1872, p. 153; SD Spath, 1925a, p. 130] [=*Neobrites* Albritton, 1937, p. 407, misspelling of *Nebrodites*]. Dimorphic; small to fairly large; slow coiling, but whorls grow and overlap more rapidly in some species; whorl section rounded to subrectangular; ribbing well defined, mainly bifurcate, a few simple on the inner whorls, the latter dominating on the adult whorl in some species with intercalatories more or less numerous; ribs interrupted on the venter with a large, smooth band and more pronounced on the inner whorls; constrictions not rare on the inner whorls; macroconchs with simple aperture; microconchs smaller with lappets. *Upper Jurassic (lower and upper Kimmeridgian,* Platynota–Acanthicum

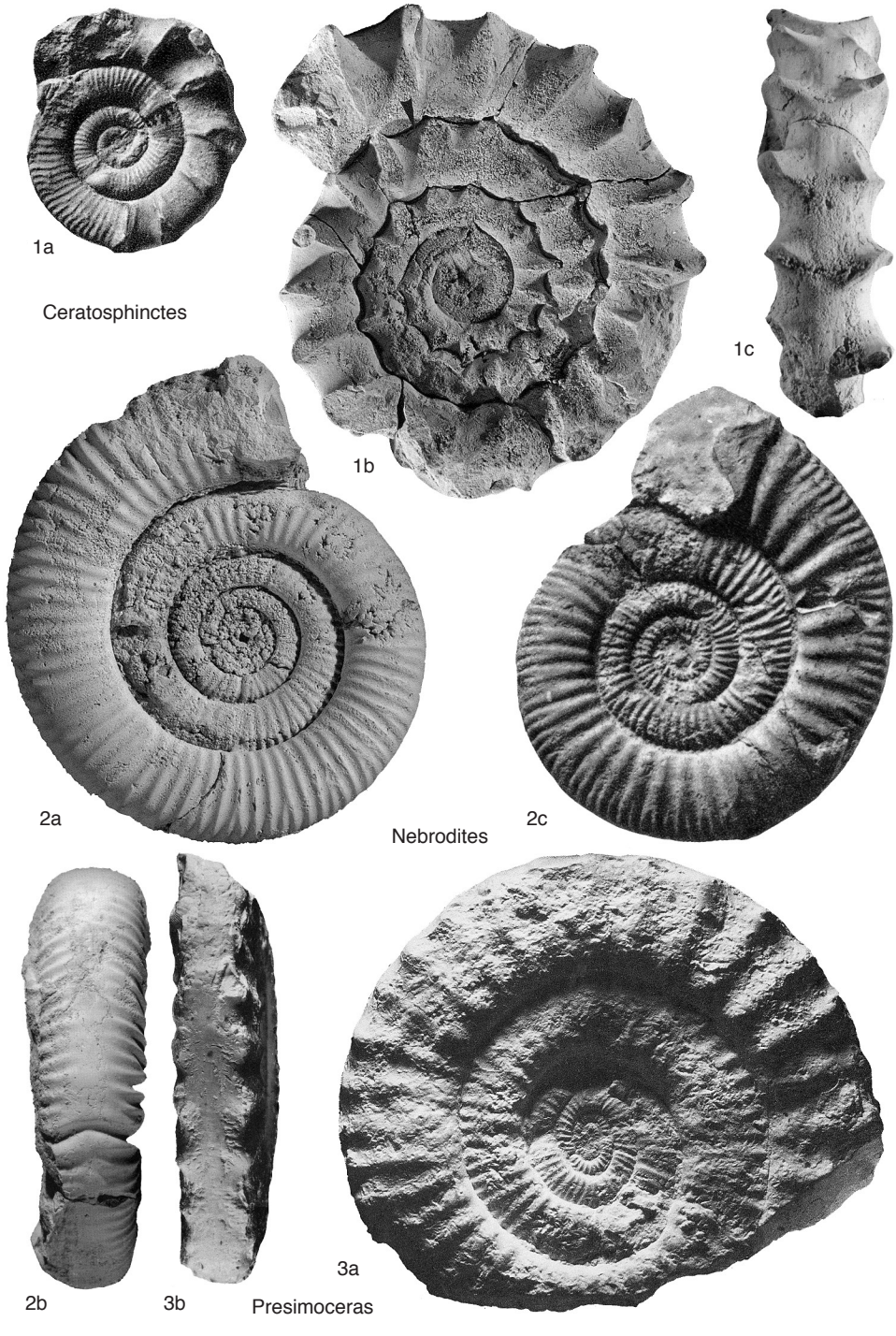

FIG. 39. Perisphinctidae, Passendorferiinae (p. 51–53).

Zones): southern Germany, France, Switzerland, Italy, Hungary, Bulgaria, Romania, Turkey, northern Africa, Tanzania, USA (Texas), Mexico, Argentina.——Fig. 39,*2a–b*. **N. agrigentinum* (Gemmellaro); lectotype (designated by Sarti in Pavia & Cresta, 2002, p. 303), incomplete macroconch with body chamber three-quarters of a whorl long, from olistoliths embedded in tectonized Neogene marls, Burgilamuni, near Favara, Agrigento, Sicily, ×0.77 (Pavia & Cresta, 2002, p. 303, fig. 201).——Fig. 39,*2c*. *N. hospes minor* (Quenstedt, 1888 in 1882–1888), complete microconch, Weisse Jura δ, Bosler, Bavaria, Germany, ×1 (Ziegler, 1959, pl. 1,*17*).

Presimoceras Sarti, 1990, p. 44 [**Ammonites nodulatus* Quenstedt, 1888 in 1882–1888, p. 981; OD]. Evolute with large, shallow umbilicus; whorl section oval to subquadrate and depressed; numerous primary ribs on the inner whorls, simple or bifurcate, become more widely spaced with growth; ribs more prominent and widely spaced on the outer whorl, mainly simple, rarely biplicate, ending with ventrolateral tubercles more or less elongated as clavi; venter smooth, but weakened ribs cross the venter in some specimens; constrictions rare or absent. *Upper Jurassic (lower and upper Kimmeridgian,* Strombecki–*lower* Acanthicum *Zones):* southern Germany, southeastern France, Spain, Italy, Serbia, Bulgaria.——Fig. 39,*3a–b*. **P. nodulatus* (Quenstedt), holotype, incomplete macroconch with the very beginning of the body chamber, Weisse Jura γ, Laufen, Bavaria, Germany, ×0.5 (Sarti, 1990, p. 48, fig. *7a–b*).

Mesosimoceras Spath, 1925a, p. 131 [**Simoceras cavouri* Gemmellaro, 1872, p. 151; OD]. Moderately large size, very evolute coiling, whorl height increasing slowly; whorl section compressed, oval; ribs dense, mainly simple, rarely bifurcate on the inner whorls, becoming more numerous on middle and outer whorls; some ribs end at radially elongated ventrolateral tubercles that are less prominent than in *Presimoceras;* numerous, deep constrictions; venter with median smooth band. *Upper Jurassic (upper Kimmeridgian,* Cavouri *Zone (more or less equivalent to* Eudoxus *Zone):* southern Germany, southeastern France, Spain, Italy, Serbia, Bulgaria, Tunisia.——Fig. 40,*1a–b*. **M. cavouri* (Gemmellaro), lectotype (designated by Sarti in Pavia & Cresta, 2002, p. 294), complete macroconch, from olistoliths embedded in tectonized Neogene marls, Burgilamuni, near Favara, Agrigento, Sicily, ×0.5 (Pavia & Cresta, 2002, p. 298, fig. 199; originally figured by Gemmellaro, 1872, pl. 2,*3a–b*).

Benacoceras Spath, 1925a, p. 131 [**Simoceras heteroplocum* Gemmellaro, 1876, p. 243; M]. Moderately large, evolute, rounded whorl; wide venter; ribs dense on inner whorls, decreasing regularly during growth; primary ribs arched and prorsiradiate, bifurcate, with furcation points high on the sides, and a few simple ribs on the body chamber; secondary ribs cross the venter, slightly weakened on the median line; prorsiradiate constrictions forwardly arched with ventral flares. *Upper Jurassic (lower Kimmeridgian,* Silenum *Zone,* Trenerites *Subzone, more or less equivalent to uppermost* Platynota, *Zone):* southern Germany, southeast France, Spain, Italy, Serbia, Bulgaria.——Fig. 40,*2. *B. heteroplocum* (Gemmellaro), lectotype (Gemmellaro 1878, pl. 1,*6–7;* 1882, pl. 15,*6–7;* designated by Sarti in Pavia & Cresta, 2002, p. 287), Rosso Ammonitico nodular limestones, Rocca chi Parra, Calatafimi, Trapani, Sicily, ×0.5 (Pavia & Cresta, 2002, fig. 194).

Trenerites Sarti, 1993, p. 105 [**Simoceras evolutus* Gemmellaro, 1876, p. 243; 1878, p. 219; OD]. Dimorphic, small to medium sized, evolute, slow coiling; large, shallow umbilicus; whorl section compressed, subrectangular to rectangular on the inner whorls, oval shaped in the outer whorl; ribs rectiradiate, simple and bifurcate, the latter rare to more or less numerous, progressively more distant and less numerous on the outer whorl; the furcation point a little above the mid-side; sometimes reinforced on the ventral margin and crossing the venter with a forward bend or interrupted by a ventral smooth band; deep, prorsiradiate constrictions on all whorls; supposed microconch similar to those of *Passendorferia. Upper Jurassic (upper Oxfordian, upper* Planula *Zone–lower Kimmeridgian*, Platynota *Zone):* Sicily, northern Italy, Spain, France, southern Germany.——Fig. 40,*3a–b. *T. evolutus* (Gemmellaro), holotype by monotypy, macroconch with part of the body chamber, Rosso Ammonitico Veronese, Col Santino, Monte Pasubio, Trento, Italy, ×0.5 (Pavia & Cresta, 2002, fig. 200).——Fig. 40,*3c. Trenerites* sp., possible microconch of *T. sartii* Énay & Debrand-Passard, 2005, Calcaires de Levroux Formation, Villegongis, Indre, France, ×1 (Énay & Debrand-Passard, 2005, pl. 1,*3a*).

Lessiniceras Pavia, Benetti, & Minetti, 1987, p. 74 [**Perisphinctes ptychodes* Neumayr, 1873, p. 175; OD]. Large size, evolute, umbilicus enlarging progressively; whorl section circular, with flat venter; inner whorls with arcuate primary ribs, with secondaries projected ventrally and interrupted on the venter by a smooth band; primary ribs progressively more widely spaced and become strong, coarse, distant, ridge shaped or wedge shaped on the body chamber. Macroconchs; accompanying microconchs unknown. *Upper Jurassic (lower Kimmeridgian,* Platynota–Divisum *Zones):* northern Italy, Austria.——Fig. 41,*1a–b*. **L. ptychodes* (Neumayr); *a,* holotype by monotypy, nearly complete specimen, Sulzbad, Salzkammergut, Styria, Austria, ×0.25 (Neumayr, 1873, pl. 36); *b,* nearly complete specimen, *Strombeki* Zone, Bocca di Selva section, Monte Lessini Verona, Italy, ×0.27 (Pavia, Benetti, & Minetti, 1987, pl. 2,*1*).

Berckhemeria Schweigert & Zeiss, 1998, p. 560 [**B. scherzingeri;* OD]. Very small microconchs; evolute; slight uncoiling of the body chamber; whorl section rounded quadrate; ribs simple, prominent, rectiradiate to prorsiradiate; possible furrow on ventral median line. *Upper Jurassic (lower Tithonian,* Hybonotum *Zone):* southern Germany.——Fig. 41,*2a–d*. **B. scherzingeri,* basal

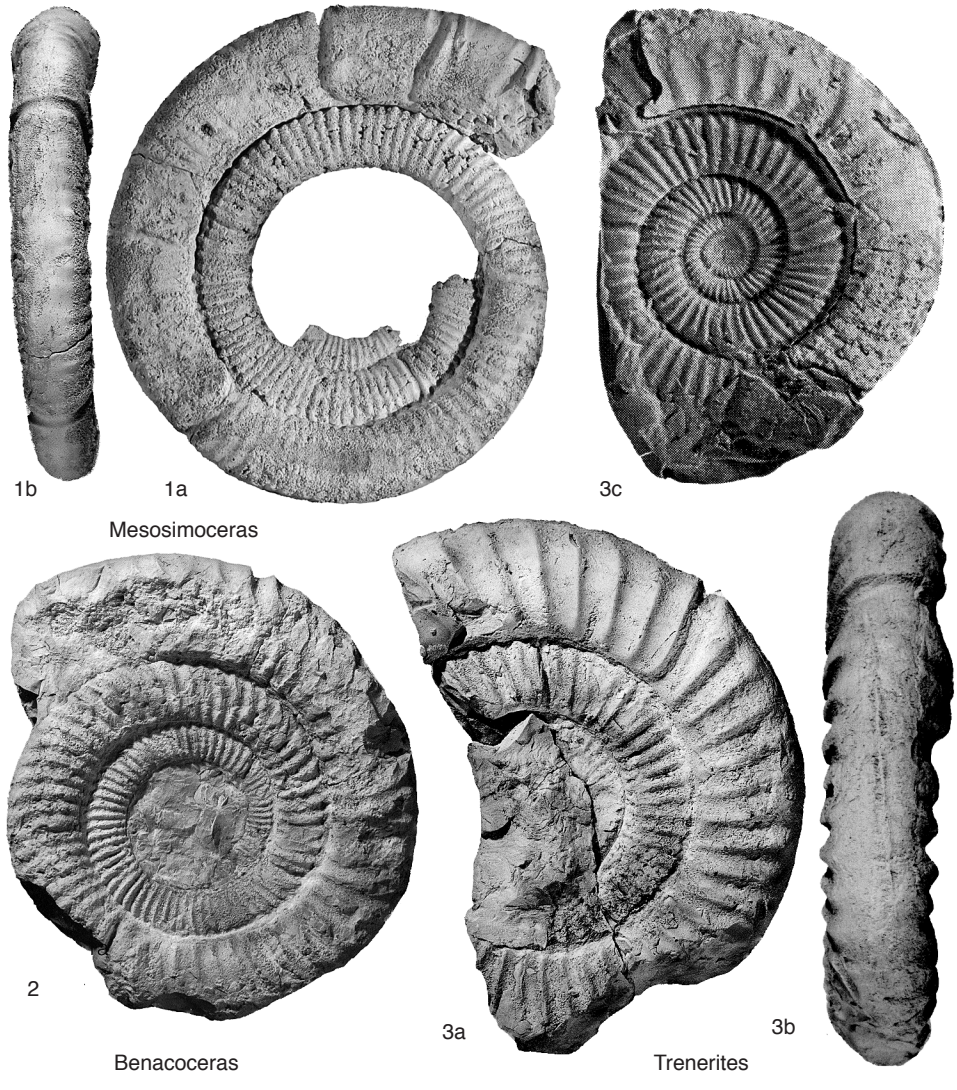

FIG. 40. Perisphinctidae, Passendorferiinae (p. 53).

Hangende Bankkalke Formation; *a,* holotype, complete with aperture and lappet, northwest of Biesendorf, Bavaria, Germany, ×1; *b,* paratype 1, Grabenstetten, Bavaria, Germany, ×1; *c,* venter, Buchleim, Bavaria, Germany, ×1; *d,* paratype 2, venter, Buchleim, Bavaria, Germany, ×1 (Schweigert & Zeiss, 1998, p. 563, fig. 2*a–d*).

?Hoelderia OHMERT & ZEISS, 1980, p. 35 [**H. schreineri;* OD]. Medium-sized macroconchs; evolute; whorl section thick, becoming oval shaped to nearly circular on the outer whorl; strong, distant ribs, rectiradiate at first, becoming slightly prorsiradiate, mostly bifurcate with very few simple and intercalatory ribs, passing across the venter without weakness or smooth band. Known from only two incompletely preserved specimens; original reference to the Lithacoceratinae is curious, and assignment here to the Passendorferiinae is only tentative. *Upper Jurassic (lower Tithonian,* Hybonotum *Zone):* southern Germany.——FIG. 41,*3*. **H. schreineri,* holotype, upper Hangende Bankkalke Formation, Neuhausen ob Eck, Bavaria, Germany, ×0.33 (Ohmert & Zeiss, 1980, p. 35, pl. 11,*1*).

Family REINECKEIIDAE Hyatt, 1900

[*nom. correct.* ARKELL, 1957, p. 311, *pro* Reineckidae HYATT, 1900, p. 583]

Mainly evolute with round to depressed whorls, but some are more involute and compressed; innermost whorls perisphinc-

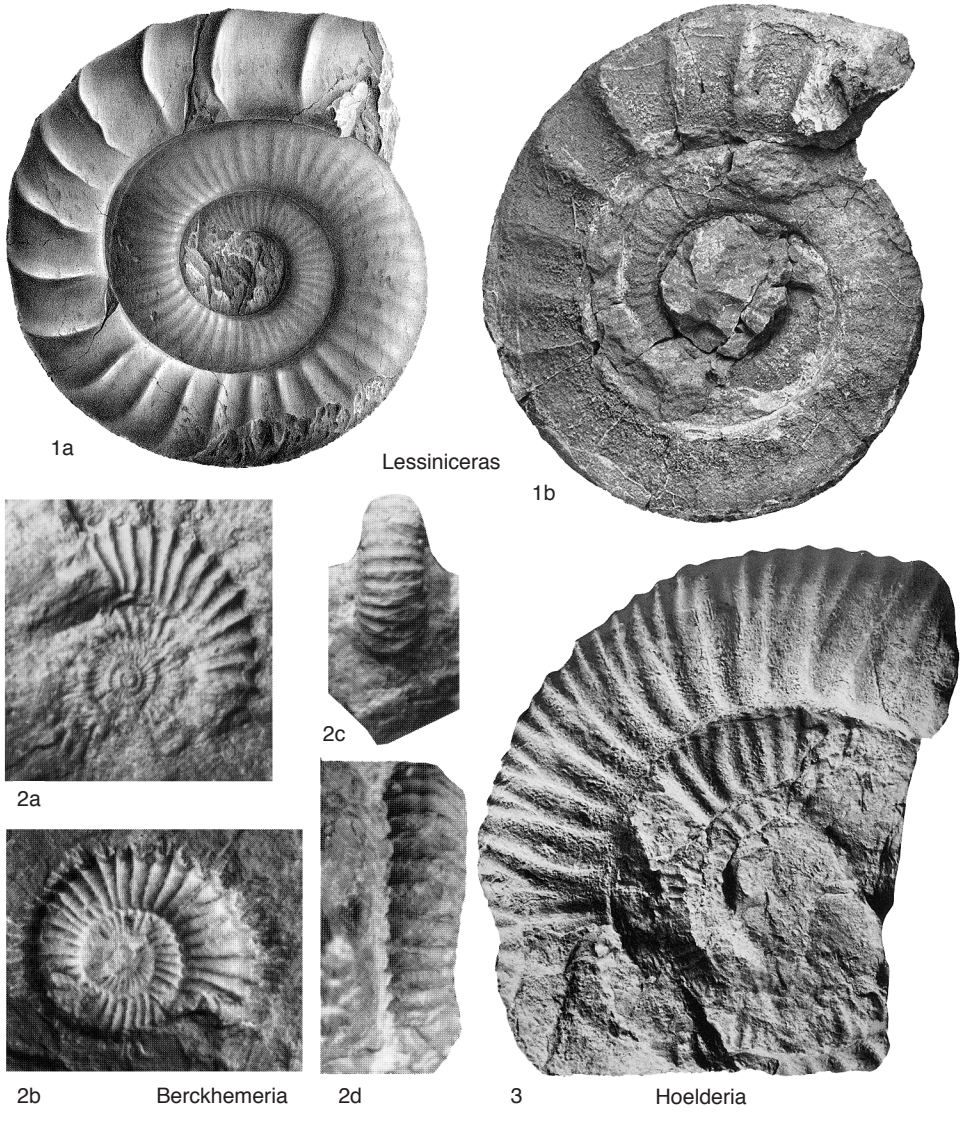

FIG. 41. Perisphinctidae, Passendorferiinae (p. 53–55).

toid in early forms, coronate in later forms; most are characterized by large lateral tubercles or spines, ventrolateral tubercles in some, and a midventral smooth band or groove. Dimorphic: macroconchs can attain very large sizes; microconchs have lappets in adult mouth border. Derived from Perisphinctidae. Two subfamilies are recognized: the earliest, Neuqueniceratinae, appeared in the top of the upper Bathonian in the Andes and central America, while the Reineckeiinae appeared slightly later, in the lower Callovian, and became widespread, especially in Tethys. Some genera of the two subfamilies (e.g., *Neuqueniceras* and *Reineckeia*) are closely homeomorphic. CARIOU, 1984; RICCARDI & WESTERMANN, 1991. *Middle Jurassic (upper Bathonian–basal middle Oxfordian):* worldwide except Boreal.

Subfamily NEUQUENICERATINAE Cariou, 1984

[Neuqueniceratinae, CARIOU, 1984, p. 36]

An early subfamily of Reineckeidae occurring in the Andes of South America, Japan, and possibly in Tibet, and characterized by perisphinctid innermost whorls that reflect its ancestry in the Perisphinctidae. RICCARDI & WESTERMANN, 1991. *Middle Jurassic (upper Bathonian–lower Callovian):* Argentina, Chile, Japan, Mexico, Peru, ?China.

Neuqueniceras STEHN, 1924, p. 134 [**N. steinmanni;* OD]. Evolute to serpenticone, whorls rounded to depressed; primary ribs divide into 2 or 3 secondaries on outer half of whorl side, which pass over the venter with a midventral interruption or depression; ribs tend to fade on outer whorls; no tubercles on the perisphinctid, innermost whorls, then midlateral tubercles or large, widely spaced spines on middle and outer whorls; occasional constrictions. Dimorphic: macroconchs with plain mouth border, microconchs with small lappets. Probably derived from a perisphinctid ancestor such as *Choffatia.* See YIN (2005) for possible occurrences in China (Tibet). *Middle Jurassic (upper Bathonian–lower Callovian,* Macrocephalus *Zone):* Argentina, Chile, Mexico, Peru, ?China (Tibet).

N. (Neuqueniceras). Whorl section round; weak, midwhorl tubercles become stronger on middle and adult whorls. *Middle Jurassic (upper Bathonian–lower Callovian,* Macrocephalus *Zone):* Argentina, Chile.——FIG. 42,*1a–d*. **N. (Neuqueniceras) steinmanni* (STEHN), Chacay Melehue, Neuquén Province, Argentina; *a–b,* lectotype (designated by RICCARDI & WESTERMANN, 1991, p. 131), macroconch, ×0.65 (Stehn, 1924, pl. 4,*3a–b*); *c–d,* complete microconch with base of lappet in aperture, ×1 (Riccardi & Westermann, 1991, pl. 14,*4*).

N. (Frickites) JEANNET, 1951, p. 145 [**Reineckeia bodenbenderi* TORNQUIST, 1898, p. 51(183); OD]. Larger, and whorls more depressed than *N. (Neuqueniceras),* with a short, perisphinctid stage on inner whorls; large midlateral tubercles on intermediate whorls, becoming large, widely spaced spines on outer whorls; younger than *N. (Neuqueniceras). Middle Jurassic (lower Callovian):* Argentina, Chile, Mexico, Peru.——Fig. 42,*2a–d*. **N. (Frickites) bodenbenderi* (TORNQUIST), Chacay Melehue, Neuquén Province, Argentina; *a–b,* lectotype (designated by RICCARDI & WESTERMANN, 1991, p. 136), macroconch, ×0.4 (Riccardi & Westermann, 1991, pl. 16,*1a–b*); *c–d,* ?microconch, ×0.8 (Riccardi & Westermann, 1991, pl. 16,*2b–c*).

Pseudoneuqueniceras RICCARDI & WESTERMANN, 1991, p. 130 [**Katroliceras yokoyamai* KOBAYASHI & FUKADA, 1947, p. 50]. Similar to *Neuqueniceras,* but has more involute inner whorls with dense, prorsiradiate ribs; primary ribs widely spaced on middle whorls, dividing into secondary ribs at ventrolateral tubercles or spines that tend to fade on the outer whorl. Possibly derived from Morphoceratidae rather than Perisphinctidae. HANDA & others, 2014. *Middle Jurassic (upper Bathonian):* Japan.——FIG. 42,*3a–d*. **P. yokoyamai* (KOBAYASHI & FUKADA), Kaizara, Kuzuryu River, Fukui, Honshu, Japan; *a–b,* holotype, ×0.6 (Kobayashi & Fukada, 1947, pl. 12,*1a–b,d*); *c–d,* topotype, ×0.6 (Sato, 1962, pl. 5,*8a–b*).

Subfamily REINECKEIINAE Hyatt, 1900

[*nom. transl. et correct.* ARKELL, 1957, p. 311, *pro* Reineckidae HYATT, 1900, p. 583]

Reineckeiinae were either derived from early Neuqueniceratinae in Central or South America and then migrated eastwards and became widespread in Tethys (WESTERMANN & RICCARDI, 1985; RICCARDI & WESTERMANN, 1991, p. 116), or they were derived directly from the grossouvrinid *Homoeoplanulites* in the Tethyan area (CARIOU, 1984, p. 394, fig. 233). *Middle Jurassic (lower Callovian–basal middle Oxfordian):* worldwide, except Boreal.

Reineckeia BAYLE, 1878, pl. 56 [**Nautilus anceps* REINECKE, 1818, p. 82; M]. Evolute planulates, with rounded whorl section and rounded umbilical edge; inner whorls perisphictid with fine, bifurcating ribs in some forms, or depressed and coronate with short, well-spaced ribs in others; primary ribs end at large midlateral tubercles, bullae, or spines; and 2–4 prorsiradiate secondary ribs and intercalated ribs cross the arched venter, interrupted by a smooth midventral band or groove; large outer whorls may develop additional ventrolateral tubercles; occasional constrictions. Dimorphic: macroconchs large with flared collar at plain adult mouth border; microconchs small with more regular bifurcating ribs and reduced tubercles on adult whorl with small lappets. REINECKE's (1818, pl. 7,*61*) species is hardly interpretable from his poor figure of a small, pyritized ammonite from Germany, which is now lost; consequently, the species has usually been interpreted from the specimen figured by BAYLE (1878, pl. 56); a type specimen for *R. anceps* has yet to be selected (FISCHER & others, 1994, p. 149). CARIOU, 1984. *Middle Jurassic (lower Callovian, top* Herveyi *Zone–upper Callovian, basal* Lamberti *Zone):* Europe (mainly the Submediterranean Province), North Africa, Turkey, Caucasus,

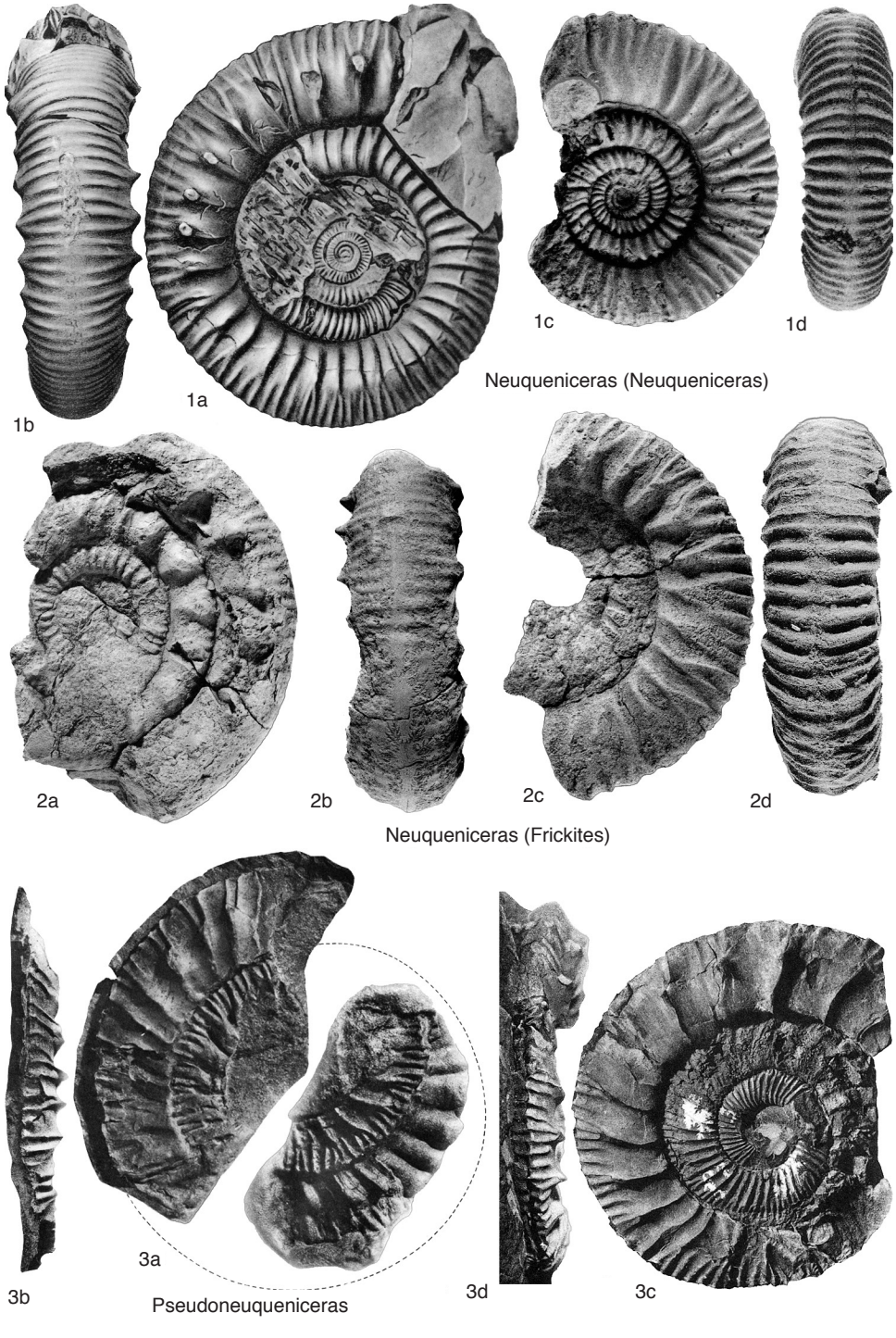

FIG. 42. Reineckeiidae (p. 56).

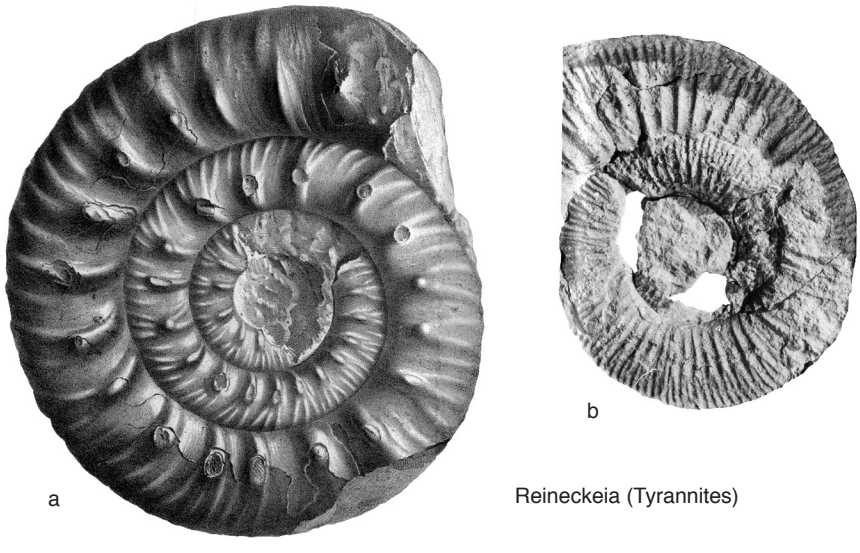

FIG. 43. Reineckeiidae (p. 56–58).

Israel, Iran, TransCaspia, Pakistan (Pamirs), India (Kutch, Himalayas), Madagascar, USA (California), Mexico, Argentina, Chile.

R. (Tyrannites) CARIOU, 1984, p. 182 [**Perisphinctes tyrannus* NEUMAYR, 1870, p. 150; OD]. Differs from *R. (Reineckeia)* in its perisphinctoid inner whorls, with fine, bifurcating ribs without tubercles; middle and larger whorls like *R. (Reineckeia),* but tuberculation less prominent and ventrolateral tubercles absent. Dimorphic: macroconchs with ornament on large outer whorls reduced to widely spaced ribs and large lateral tubercles; microconchs with small lappets. *Middle Jurassic (lower Callovian):* France, Germany, Austria, Hungary.——FIG. 43*a*. **R. (Tyrannites) tyrannus* (NEUMAYR), holotype, Gosau, Saltzkammergut, Austria, ×0.42 (Neumayr, 1870, pl. 9,*1*).——FIG. 43*b*. *R. (Tyrannites) pictava* (BOURQUIN), macroconch showing perisphinctoid inner whorls, Pamproux, Deux-Sèvres, France, ×05 (Cariou, 1984, pl. 26,*1b*).

R. (Reineckeia) [=*Reineckeites* BUCKMAN, 1924, pl. 522 (type, *R. duplex,* OD)]. Inner whorls coronate; large lateral tubercles throughout growth. Dimorphic: macroconchs large, with some ventrolateral tubercles on outer whorls; microconchs with small lappets. Younger and more strongly tuberculate than *R. (Tyrannites). Middle Jurassic (lower Callovian, top* Gracilis *Zone–upper Callovian, basal* Lamberti *Zone).*——FIG. 44*a–c*. **R. (Reineckeia) anceps* (REINECKE); *a,* Marolles-les-Braults, Sarthe, France, ×0.65 (BAYLE, 1878, pl. 56,*1*); *b–c,* La Grimaudière, Vienne, France, ×1 (Cariou, 1984, pl. 33, *4a–b*).——FIG. 44*d–e*. *R. (Reineckeia) stuebeli* (STEINMANN), holotype of *Reineckeites duplex* BUCKMAN, microconch with lappet, Weymouth, Dorset, England, ×1 (Buckman, 1924, pl. 522).——FIG. 44*f–g*. *R. (Reineckeia) nodosa* TILL, macroconch, showing depressed, coronate inner whorls, Pas-de-Jeu, Deux Sèvres, France, ×1 (Cariou, 1984, pl. 37,*5a,c*).

Rehmannia SCHIRARDIN, 1956, p. 75 [**R. petitclerci;* OD; ?=*Ammonites rehmanni* **OPPEL**, 1857 in 1856–1858, p. 551; 1862 in 1862–1863, p. 153]. Evolute, whorl section compressed, subrectangular or trapezoidal; inner whorls perisphinctid or cadiconic, with narrow ribs and small lateral tubercles; middle and outer whorls with primary ribs dividing into 2–4, prorsiradiate secondary ribs ending at midventral smooth band in some forms. Dimorphic: macroconchs develop large lateral tubercles or spines; microconchs retain closely spaced ribs and lose the tubercles on adult whorl, with small lappets. Whorls generally more compressed and higher, and less strongly tuberculate than *Reineckeia. Middle Jurassic (lower–basal upper Callovian):* Europe, Algeria, Iran, Madagascar, India, ?Mexico, Argentina, Chile.

R. (Rehmannia) [=*Egabrensiceras* ELMI & MANGOLD in BUSNARDO, ELMI, & MANGOLD, 1964, p. 54 (type, *E. egabrense,* OD); =*Reineckeiceras* BOURQUIN, 1968 in 1967–1968, p. 66 (type, *Reineckeia grossouvrei* PETITCLERC, 1915, p. 96, OD); =*Kellawaysiceras* BOURQUIN, 1968 in 1967–1968, p. 128 (type, *K. vestuntianum,* OD)]. Inner whorls perisphinctoid with narrow, bifurcating ribs; middle and outer whorls with large lateral tubercles or spines. Dimorphic. *Middle Jurassic (lower Callovian):* France, Switzerland, Germany. Spain, Portugal, Italy, Hungary, Algeria, ?Mexico.——FIG. 45,*1a*. **R. (Rehmannia) petitclerci* SCHIRARDIN, lectotype

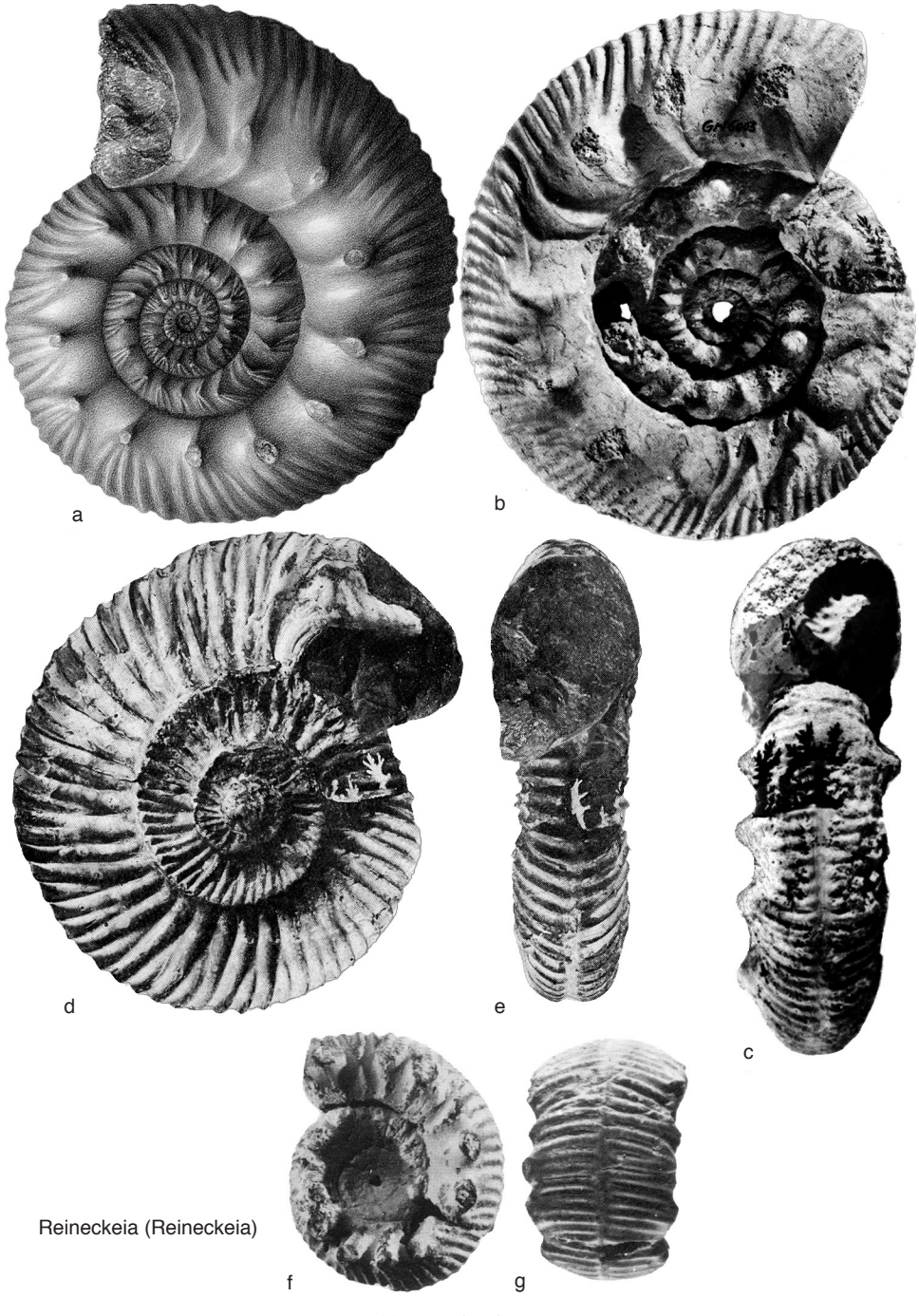

FIG. 44. Reineckeiidae (p. 58).

(designated by HOWARTH, herein), Prahecq, Deux-Sèvres, France, ×0.65 (Petitclerc, 1915, pl. 10,*1*).——FIG. 45,*1b–e. R. (Rehmannia) rehmanni* (OPPEL), Limalonges, Deux-Sèvres, France; *b–c,* macroconch, ×0.5 (Cariou, 1984, pl. 3,*4*); *d–e,* microconch, ×0.5 (Cariou, 1984, pl. 5,*1*).

R. (Loczyceras) BOURQUIN, 1968 in 1967–1968, p. 141 [**L. sequanicum;* OD] [= *Tintanticeras*

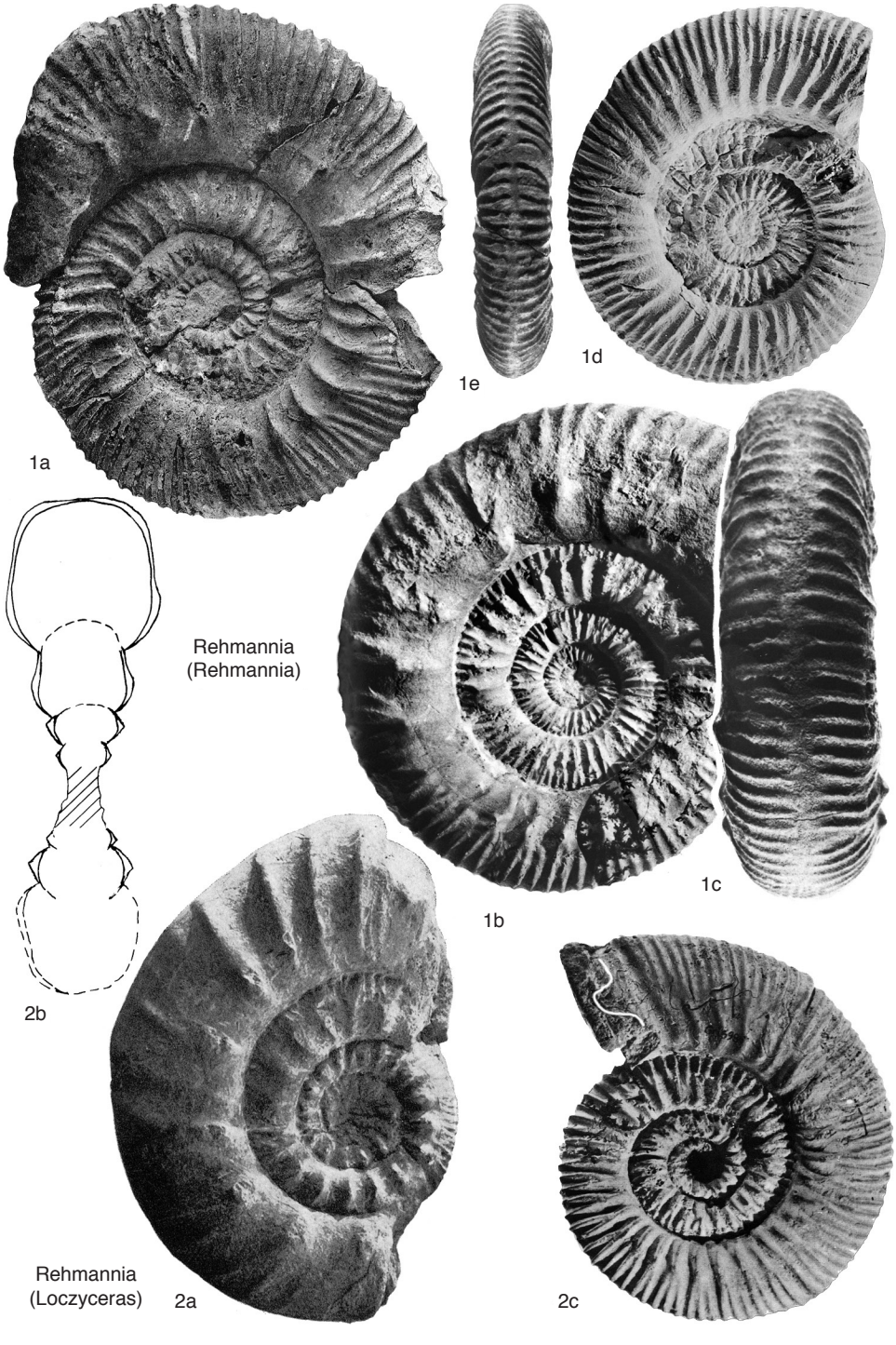

FIG. 45. Reineckeiidae (p. 58–61).

Bourquin, 1971, p. 56 (*non Tintanticeras* Blaison & Bourquin, 1966, p. 72, *nom. nud.,* type species not designated) (type, *T. reineckeiforme* Blaison & Bourquin, 1966, p. 72); =*Alborzites* Schairer, Seyed-Emami, & Zeiss, 1991, p. 57 (type, *A. semnanensis,* OD)]. Younger than *R. (Rehmannia),* and has more depressed, cadiconic inner whorls with lateral tubercles, and middle and outer whorls have an additional row of ventrolateral tubercles in some species. *Middle Jurassic (middle Callovian–upper Callovian, basal* Athleta *Zone):* France, Spain, Switzerland, Hungary, Italy, Algeria, Turkey, Iran, India (Kutch), Madagascar, ?Mexico, Argentina, Chile.——Fig. 45,*2a–b*. **R. (Loczyceras) sequanicum,* holotype, macroconch, Palente, Besançon, France, ×0.6 (Bourquin, 1967 in 1967–1968, pl. 19,*7;* pl. XXVI,*1*).——Fig. 45,*2c. R. (Loczyceras) britannica* (Zeiss), microconch with lappet, La Grimaudière, Vienne, France, ×0.6 (Cariou, 1984, pl. 18,*4*).

Collotia de Grossouvre, 1917, p. 69 [**Ammonites fraasi* Oppel, 1857 in 1856–1858, p. 556; M] [=*Kellawaysites* Buckman, 1925b, pl. 587 (type, *K. multicostata* Petitclerc, 1915, p. 98, OD); =*Collotites* Jeannet, 1951, p. 149 (type, *Peltoceras angustilobatus* Brasil, 1896, p. 39, OD); =*Kellawaysia* Bourquin, 1968 in 1967–1968, p. 103 (type, *K. spathi,* OD)]. Very large, evolute; inner whorls compressed, with fine ribs and small lateral tubercles; middle and outer whorls rounded, with primary ribs becoming widely spaced, many prorsiradiate secondary ribs continuous up to the midventral interruption, and large umbilical and lateral tubercles; very large ventrolateral tubercles or spines as well as smaller tubercles bordering the midventral interruption occur in some forms; up to six prominent constrictions per whorl. Dimorphic: macroconchs up to 835 mm in diameter, with large, widely spaced ribs and tubercles; microconchs up to 160 mm, are finely ribbed to end of adult body chamber, with lappets in the mouth border. *Middle Jurassic (lower Callovian, upper* Gracilis *Zone–upper Callovian, basal* Lamberti *Zone):* England, France, Germany, Switzerland, Austria, Italy, Hungary, Poland, Caucasus, Iran, India (Kutch), Algeria, Mexico.——Fig. 46*a–d*. **C. fraasi* (Oppel); *a–b*, lectotype, macroconch, inner whorls, Oeschingen, south of Tübingen, Germany, ×1 (Oppel, 1862 in 1862–1863, pl. 48,*4*); *c–d,* ?microconch, La Grimaudière, Vienne, France, ×0.85 (Grossouvre, 1917, pl. 10,*20–21*).——Fig. 46*e–f. C. angustilobatus* (Brasil), lectotype (designated by Howarth, herein), macroconch, 350 mm in diameter, with adult body chamber slightly more than one whorl long, with coarse ribs, and large tubercles and spines, Villers-sur-Mer, Normandy, France, ×0.2 (Brasil, 1896, pl. 3,*1–2*).

Epimorphoceras Spath, 1928, p. 163, 252, 257 [**Perisphinctes decorus* Waagen, 1875, p. 208; OD]. Innermost whorls evolute and coronate with small lateral tubercles; middle and outer whorls moderately involute, compressed with flat sides, a rounded venter, and no tubercles; fine primary ribs are single or bifurcate at midwhorl, and are interrupted at midventral smooth band or groove. In the type area in Kutch, *Epimorphoceras* is known only from the holotype collected before 1875, and consequently its taxonomic position has been much debated. Spath (1928, p. 254) concluded that it was probably "an early reineckeid." Arkell (1957, p. 312) included it in the Reineckeiidae. Cariou (1984, p. 374) described identical or very closely similar specimens from the *Athleta* Zone, upper Callovian, of western France, and determined them as *Collotia* aff. *decora* (Waagen), with *Epimorphoceras* placed as a junior synonym of *Collotia.* Bardhan and Kayal (1999) concluded that comparison of the matrix of the holotype of *Epimorphoceras* with the succession at the type locality showed that it came from a horizon near the top of the upper Bathonian and that therefore it was a morphoceratid, an opinion that was backed up by the discovery of a small *Epistrenoceras* in the same bed, a genus that does not extend above the upper Bathonian (Kayal & Bardhan, 1998). It is clear, however, that the holotype of Waagen's species is virtually identical with Cariou's specimens from the *Athleta* Zone of France, and until further well-preserved specimens are found *in situ* in the succession in Kutch, thus proving their biostratigraphical age, *Epimorphoceras* is considered here to be closely related to *Collotia,* differing in its more compressed, flat-sided whorls, fine ribbing, and lack of tubercles and spines except on the innermost whorls. *Middle Jurassic (?middle Callovian):* India (Kutch), France (Deux-Sèvres, Maine-et-Loire).——Fig. 47,*1a–d*. **E. decorum* (Waagen), holotype, part of phragocone, northwest of Jumara, Kutch, northern Gujarat, India; *a–b,* ×0.7 (Bardhan & Kayal, 1999, fig. 3,*1–2*); *c,* ×0.7 (Waagen, 1875, pl. 57,*3b*); *d,* suture, ×1 (Bardhan & Kayal, 1999, fig. 4).——Fig. 47,*1e–f. E.* aff. *decorum* (Waagen), adult microconch with lappet, Montreuil-Bellay, Maine-et-Loire, France, ×0.5 (Cariou, 1984, pl. 62,*3a–b*).——Fig. 47,*1g–h*. *E. oxyptychoides* (Spath), phragmocone of ?macroconch, Pas-de-Jeu, Deux-Sèvres, France, ×0.7 (Cariou, 1984, pl. 63,*3a–b*).

Jaspeiceras Gröschke & Kossler, 1999, p. 35 [**J. philippi;* OD]. Evolute, rounded whorls section; inner whorls perisphinctoid; ribs fine, single or bifurcating on inner whorls, becoming stronger on middle whorls with lateral tubercles at furcation point; outer whorls with stronger ribs, but without tubercles; indistinct midventral smooth band tends to disappear on outer whorls. Probably dimorphic: macroconchs with coarsening ribs on final part of uncoiling adult body chamber; microconchs not clearly identified. Probably evolved from *Rehmannia. Middle Jurassic (top upper Callovian–basal lower Oxfordian):* northern Chile.——Fig. 47,*2a–c.*

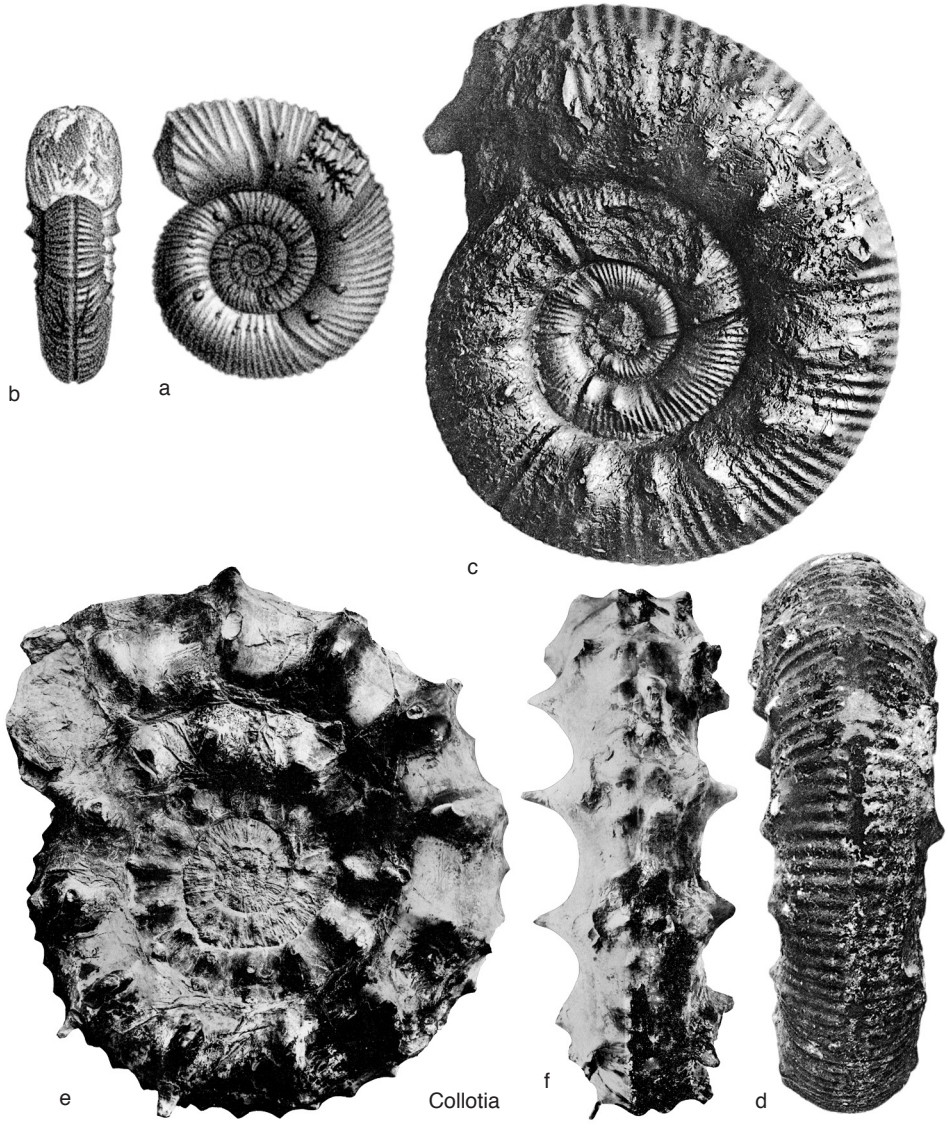

FIG. 46. Reineckeiidae (p. 61).

**J. philippii,* holotype, possibly a microconch, 21°45′S, 68°59′W, 10 km northwest of Cerro Jaspe, Sierro Moreno, Antofagasta, Chile, ×0.75 (Gröschke & Kossler 1999, fig. 3*a–c*).——FIG. 47,*2d. J. enode* (GRÖSCHKE & KOSSLER), holotype, complete macroconch, Cerro 1170er, 2.5 km south of Negreiros, Tarapacá Region, northern Chile, ×0.7 (Gröschke & Kossler, 1999, fig. 5*a*).

Caracoliceras HILLEBRANDT, KOSSLER, & GRÖSCHKE, 2000, p. 69 [**Cosmoceras dunkeri* STEINMANN, 1881, p. 272; OD]. Moderately involute, whorl section round to slightly depressed with arched venter; fine, sinuous ribs divide about midwhorl into 2, 3, or 4 secondaries that are continuous across the venter or diminished by traces of a midventral smooth band; occasional constrictions occur. Probably dimorphic: macroconchs with ribs fading outer whorls; microconchs not identified. Derived from and younger than *Jaspeiceras,* differing in being more involute, with weak or absent midventral smooth band, dense ribbing, and lack of tubercles. *Middle Jurassic (lower Oxfordian,* Dunkeri *Zone–?middle*

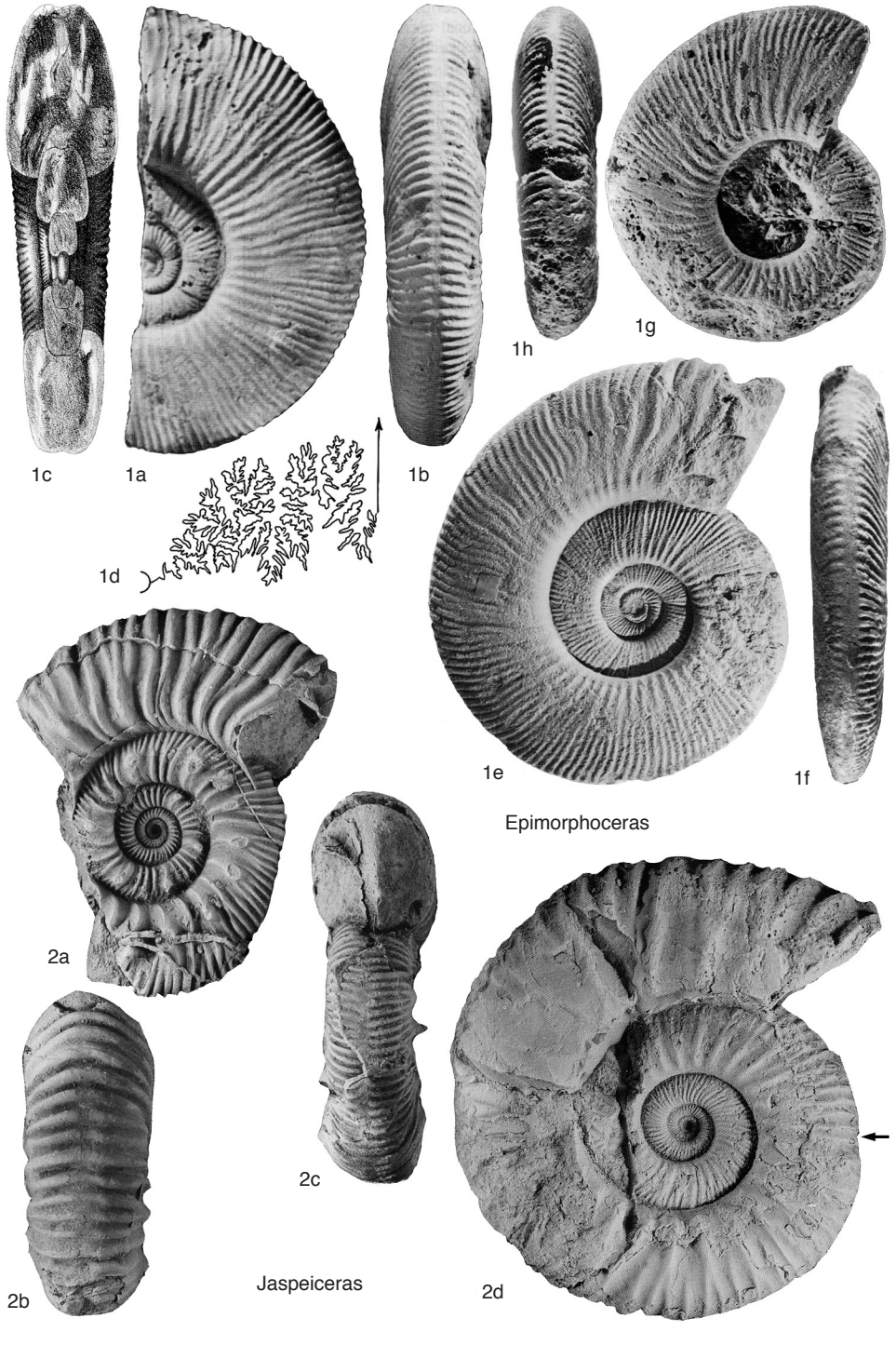

FIG. 47. Reineckeiidae (p. 61–62).

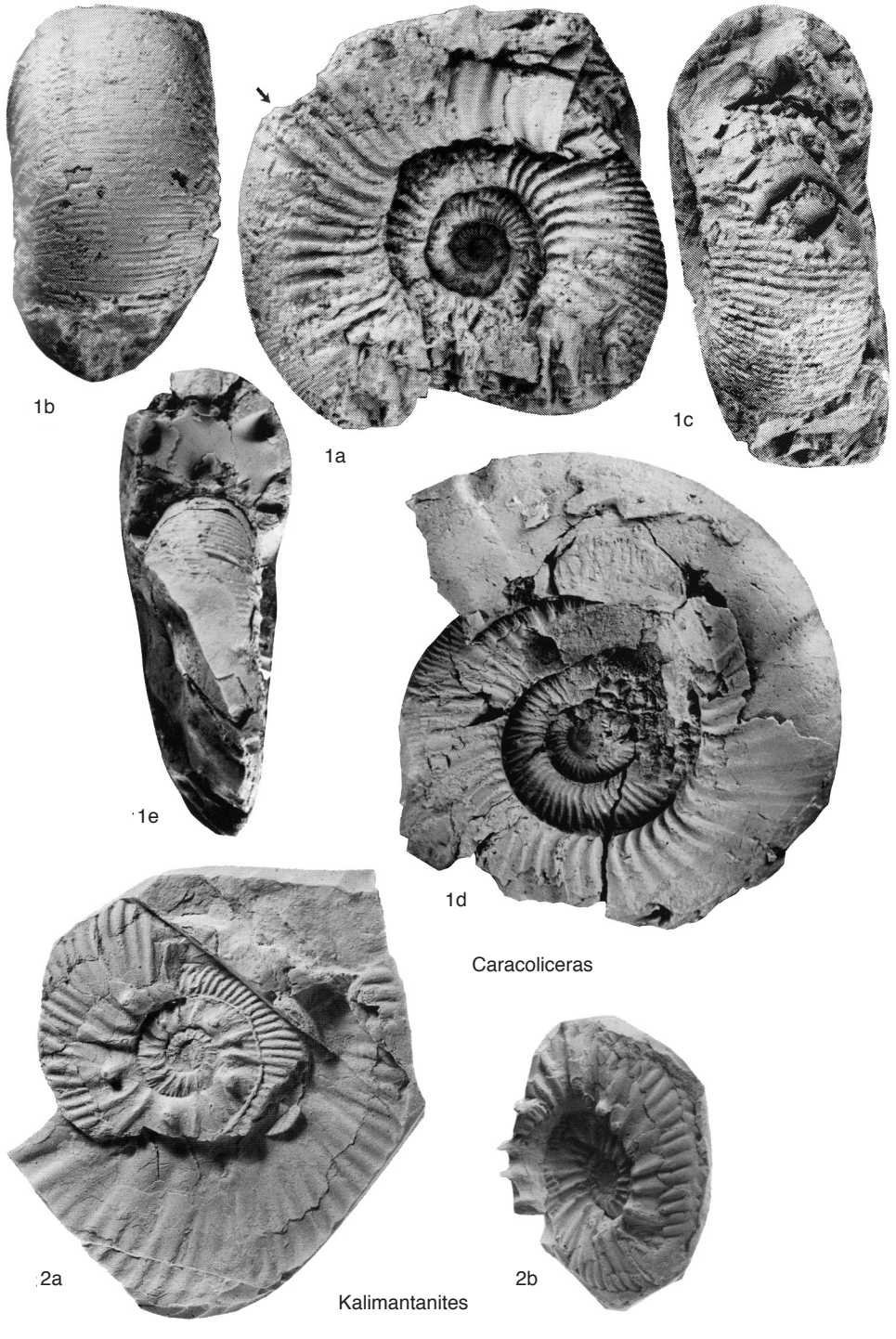

FIG. 48. Reineckeiidae (p. 62–65).

Oxfordian): northern Chile.——Fig. 48,*1a–e. *C. dunkeri* (Steinmann); *a–c,* holotype, Caracoles, 22°59′S, 69°0′W, 56 km south of Calama, Antofagasta, Chile, ×1 (Hillebrandt, Kossler, & Gröschke, 2000, pl. 1,*1a–c*); *d–e,* paratype, macroconch phragmocone, Aguada El Oro, 24°38′S, 69°12′W, 162 km southeast of Antofagasta, Chile, ×0.6 (Hillebrandt, Kossler, & Gröschke, 2000, pl. 2,*4a–b*).

Kalimantanites Schairer & Zeiss, 1992, p. 231 [**K. nodosospinatus;* OD]. Moderately involute; compressed whorl section with rounded venter; ribs on inner whorls biplicate, triplicate, and intercalatory at midwhorl, with small lateral tubercles; ribs on middle and outer whorls are bundled from tubercles or spines at umbilical edge or low on whorl side; ribs are interrupted at midventer; occasional constrictions on inner whorls. Apparently more involute than any other reineckeiinid, but difficult to compare due to poor, fragmentary preservation. *Middle Jurassic (middle Callovian–low upper Callovian):* Indonesia (west Kalimantan, Borneo).——Fig. 48,*2a–b. *K. nodosospinatus,* 0°25′N, 110°23′E, 40 km northwest of Sanggau, West Kalimantan, Borneo, Indonesia; *a,* holotype, ×0.7; *b,* paratype, ×0.7 (Schairer & Zeiss, 1992, pl. 2,*1–2*).

Family MORPHOCERATIDAE Hyatt, 1900

[Morphoceratidae Hyatt, 1900, p. 583] [=Berbericeratidae Westermann, 1956, p. 263]

Ontogenetic studies support an origin from perisphinctids (e.g., Spath, 1927 in 1927–1933; Arkell, 1955; Sturani, 1964, 1966, 1971; Mangold, 1970a; Galácz, 1980; Callomon in Donovan, Callomon, & Howarth, 1981,) rather than from stephanoceratids (Buckman, 1920; Wetzel, 1937; Sandoval, 1983). A stephanoceratid origin proposed by Schindewolf (1965) and Tintant and Mouterde (1981) is a result of their placement of the Parkinsoniidae within the Stephanoceratoidea. Significant features are the presence or absence of a ventral groove or smooth band; variation of the coiling, evolute or involute; occurrence and location of constrictions in some forms; and various style of ribbing. But these are not present in all the members of the family, especially the macroconchs: involute morphology with uncoiling of the last whorl, known as "morphoceratoid," is well developed in *Morphoceras* (also *Dimorphinites* and *Pseudodimorphinites*), but it is lacking in *Asphinctites* and *Berbericeras;* constrictions and the ventral groove are well developed in the former genus (and in the corresponding microconch *Ebrayiceras*), but constrictions occur only as remnants or are absent in other macroconchs; microconchs are evolute and have constrictions at all the growth stages. From the late Bajocian *Dimorphinites,* four evolutionary trends can be distinguished in the early Bathonian. In the middle and upper Bathonian (western Europe, Sicily, Hungary, ?Romania, ?Peru), so-called *"Morphoceras," "Berbericeras,"* and *"Dimorphinites"* occur, but transitional forms from the early Bathonian genera are unknown and they are considered as Lazarus taxa—that is, they have a dubious systematics position and are morphologically like earliest taxa but without known connecting forms that look near a revival (e.g., Lazarus) (Mangold, 1997; Dietze, Mangold, & Chandler, 2002). Some are offshoots of Cadomitinae. New data from Galácz (2016) suggests that Morphoceratidae may range through the whole Bathonian Stage (*Tenuiplicatus* Zone up to *Retrocostatum* Zone), as, for example, the new genus *Mangoldiceras,* recently described from Sicily and Hungary (Galácz, 2016), though forms have not yet been discovered in the middle Bathonian. So, where necessary, the apparently unconnected stratigraphical and geographical ranges of the genera and subgenera are indicated separately. *Middle Jurassic (upper Bajocian–upper Bathonian):* Europe, northern Africa, Iran, Chile, Indonesia (Sula Islands).

Dimorphinites Buckman, 1923a, pl. 377 [**Ammonites dimorphus* d'Orbigny, 1846 in 1842–1851, p. 410; OD] [=*Vigoriceras* Rioult in Fischer & others, 1994, p. 115 (type, *Ammonites defrancii* d'Orbigny, 1846 in 1842–1851, p. 389, OD)]. Macroconchs. Inner and middle whorls involute, umbilicus occluded; ventral smooth band indistinct or absent; 3 or 4 curved constrictions per whorl; final half whorl of body chamber uncoils and has collared and lipped aperture. Microconchs (*Vigoriceras*) of small size, inflated inner whorls with deep constrictions that transect the ribbing; evolute, compressed outer whorls; moderate ribs (weak on the internal mold), are continuous across the venter of the shell, but a ventral smooth band occurs on the internal mold; body chamber

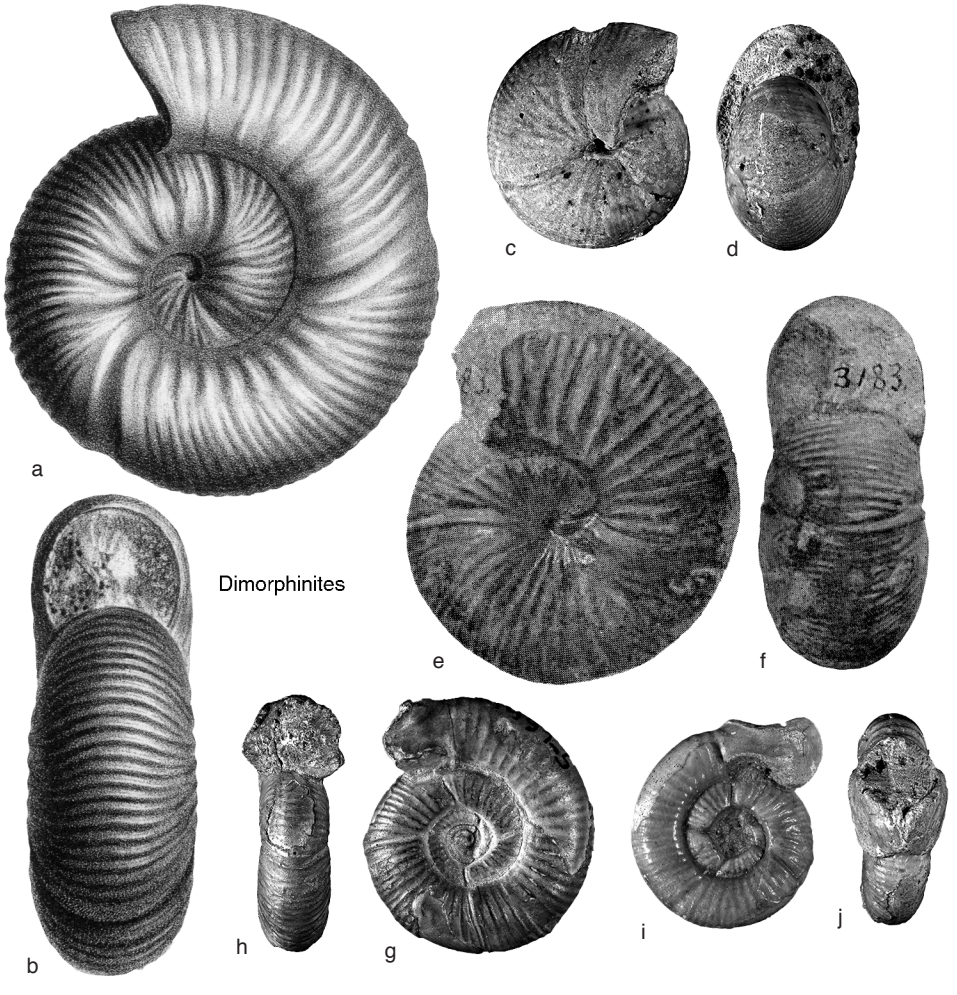

FIG. 49. Morphoceratidae (p. 65–66).

half a whorl long, peristome with inflated collar and spatulate lappets. *Middle Jurassic (upper Bajocian, ?upper* Niortense–Parkinsoni *Zones):* France, Italy (Sicily), southern Spain, Germany, Poland, Slovakia, Hungary, northern Africa, Azerbaijan, Iran, Chile.——FIG. 49*a–f.* **D. dimorphus* (D'ORBIGNY); *a–b,* D'ORBIGNY's largest syntype, destroyed in 1944 (Rioult in Fischer & others, 1994, p. 130), *Oolithe ferrugineuse* Beds, upper Bajocian, Bayeux, Normandy, France, ×1 (d'Orbigny, 1846 in 1842–1851, pl. 141); *c–d,* neotype (designated by ÉNAY, herein), same bed and locality, ×1 (new; Muséum National d'Histoire Naturelle, Paris, MNHN B46074; figured by Rioult in Fischer & others, 1994, pl. 50,*7a–b*); *e–f,* upper Bajocian, Burton Bradstock, England, ×1 (Buckman, 1923a, pl. 377).——FIG. 49*g–j. D. defrancii* (D'ORBIGNY); *g–h,* holotype, Saint-Vigor, Calvados, France, ×1 (new; The Natural History Museum, London, BM 37259; also figured by Rioult in Fischer & others, 1994, pl. 50,*5*); *i–j,* complete specimen with aperture preserved, Saint-Honorine-des-Pertes, Calvados, France, ×1 (new; Rioult collection, Muséum National d'Histoire Naturelle, Paris, IPM-B B46073; also figured by Rioult in Fischer & others, 1994, pl. 50,*6a–b*).

Morphoceras DOUVILLÉ, 1881, p. 242 [**Ammonites polymorphus* D'ORBIGNY, 1846 in 1842–1851, p. 379, *non* QUENSTEDT, 1845 in 1845–1849, p. 86; =*Morphoceras multiforme* ARKELL, 1951a, p. 17; OD][=*Ebrayiceras* BUCKMAN, 1920, p. 22 (type, *E. ocellatum* BUCKMAN, 1920, p. 23, OD, =*Ammonites sulcatus* ZIETEN, 1830 in 1830–1833, p. 6, *non* LAMARCK, 1822, *nec* RISSO, 1826; =*Ammonites pseudoanceps* EBRAY, 1858a, p. 263); =*Patemorphoceras* BUCKMAN, 1922, pl. 351 (type, *P. patescens,* OD)]. Inner whorls evolute, becoming involute or sphaerocone; numerous, deep,

oblique constrictions transecting the ribs and ventral smooth band are typical of the genus but are absent in some species. Macroconch: becomes more evolute, with a simple final aperture. Microconch (*Ebrayiceras*): adult at the planulate, evolute, flat-sided stage, and is *Reineckeia*-like; deep ventral groove; long secondary ribs; adult aperture has elaborate lappets that may join each other and almost close the aperture. *Middle Jurassic (lower Bathonian,* Zigzag *Zone–middle Bathonian,* Morrisi *Zone):* England, France, Germany, Spain, Portugal, Italy, Hungary, northern Africa, Iran; *Middle Jurassic (upper Bathonian,* Retrocostatum *Zone):* Italy (Sicily), Hungary.——Fig. 50,*1a–c. *M. polymorphus* (d'Orbigny), lectotype (selected by Buckman, 1920, p. 22, pl. 173), Port-en-Bessin, Normandy, France; *a,* ×1 (d'Orbigny, 1846 in 1842–1851, pl. 129,*4*); *b–c,* ×1 (new; Muséum National d'Histoire Naturelle, Paris, MNHN B46076; figured by Rioult in Fischer & others, 1994, pl. 51,*2a–b*).——Fig. 50,*1d. M. pseudoanceps* (Ebray), Broad Windsor, Dorset, England, ×1 (Buckman, 1920, pl. 173).——Fig. 50,*1e–g. M. sulcatum* (Zieten); *e–f,* holotype, Gammelshausen, Germany, ×1 (Hahn, 1970, pl. 6,*1*); *g,* Lochen near Balingen, Germany, ×1 (Hahn, 1970, pl. 6,*4a*).

Polysphinctites Buckman, 1922, pl. 322 [**P. polysphinctus;* OD] [=*Asphinctites* Buckman, 1924, pl. 484 (type, *A. recinctus;* OD)]. Evolute, perisphinctoid coiling of all whorls; no ventral smooth band; straight, bifurcating ribs continuous across the venter; a few feeble constrictions. Previously considered a synonym of *Morphoceras,* but more evolute and perisphinctid, without ventral smooth band. Macroconch (*Asphinctites*): regularly ribbed to the end with simple aperture. Microconch (*Polysphinctites*): dwarf, evolute, inner whorls smooth or faintly ribbed, outer whorls with prominent constrictions, and lappets in the final mouth border. *Middle Jurassic (lower Bathonian,* Aurigerus *Zone):* England, France, Germany, Spain, Portugal, Italy, Poland, Hungary, Romania, Iran; *Middle Jurassic (upper Bathonian,* Retrocostatum *Zone):* Italy (Sicily).——Fig. 50,*2a–d. *P. polysphinctus; a,* holotype, Burton Bradstock, Dorset, England, ×2 (Buckman, 1922, pl. 322); *b–d,* Sengenthal, Bavaria, Germany, ×1 (Schairer, 1994, fig. 1).——Fig. 50,*2e–f. P. recinctus* (Buckman), holotype, Midfort, Somerset, England (now destroyed), ×1 (Buckman, 1924, pl. 484).

Pseudodimorphinites Seyed-Emami in Seyed-Emami, Schairer, & Alavi-Naïni, 1989, p. 85 [**P. komsi;* OD]. Small or medium size, similar to *Dimorphinites* and *Morphoceras,* but inner whorls less involute and sphaeroconic, no ventral smooth band, and few constrictions; differs from *Asphinctites* by more involute inner whorls and more prominent constrictions. Described specimens are probably macroconchs; microconchs unknown. *Middle Jurassic (lower Bathonian,* Zigzag–Aurigerus *Zones,* Recinctus *Subzone):* Iran; *Middle Jurassic (upper Bathonian,* Retrocostatum *Zone):* Italy (Sicily), Indonesia (Sula Islands).——Fig. 50,*3a–b. *P. komsi,* holotype, southwest of Koms, E-Alborz, Iran, ×1 (Seyed-Emami, Schairer, & Alavi-Naïni, 1989, pl. 1,*15*).

Berbericeras Roman, 1933, p. 67 [**B. sekikense;* OD] [=*Praesutneria* Schmidtill & Krumbeck, 1931, p. 851, *nom. nud.*]. Very small, evolute and planulate morphoceratids, with dense, fine ribbing, thickened towards the umbilical seam, constrictions, and sometimes a ventral smooth band; peristome simple. *Middle Jurassic (lower Bathonian,* Zigzag *Zone):* England, France, Hungary, northern Africa.——Fig. 51,*1a–b. *B. sekikense,* holotype, Djebel-es-Sekika, Algeria, ×1 (Roman, 1933, pl. 2,*15*).——Fig. 51,*1c–e. B. udalli* Dietze, Mangold, & Chandler, 2002, Broadwindsor, England, ×1 (Dietze, Mangold, & Chandler, 2002, fig. 1*a–c*).

?Microberbericeras Geczy & Galácz, 1998, p. 499 [**Berbericeras (M.) kopeki;* OD]. Small, lappeted microconch with evolute coiling, rounded whorls and dense ribbing, consisting of fine, prorsiradiate primaries and forward-curving secondaries, the ribs stronger on the last part of the living chamber with tubercle-like points at the furcation. Supposed microconch dimorph of *Berbericeras,* but not associated with the true early Bathonian *Berbericeras,* but with so-called "*Berbericeras*" (?Lazarus taxa). From mixed fauna of Villany, bed 2 (Geczy & Galácz, 1998); exact age poorly known. *Middle Jurassic (middle–upper Bathonian,* Morrisi *to* Retrocostatum *Zones):* Hungary.——Fig. 51,*2. *M. kopeki*, holotype, Villany, Hungary, ×1 (Geczy & Galácz, 1998, pl. 2,*18*).

Mangoldiceras Galácz, 2016, p. 215 [**M. distefanoi;* OD]. Small size and globular shaped; closed umbilicus on the inner whorls; eccentric coiling of the outer whorl resulting in constricted living chamber; dense ribbing cut at intervals by narrow prorsiradiate constrictions, the last one corresponding to the beginning of the body chamber; shorter primary and longer secondary ribs cross the venter without interruption; body chamber one whorl long with collared aperture; lappet not preserved or absent, but sphaeroidal coiling with closed umbilicus suggests that it is a macroconch. *Middle Jurassic (upper Bathonian):* Italy (Sicily), Hungary.——Fig. 51,*3a–d. *M. distefanoi,* upper Bathonian, Monte Kumeta, Piana degli Albanesi, western Sicily; *a–b,* holotype, ×2; *c–d,* paratype, ×2 (Galácz, 2016, p. 215, fig. 6*a–d*).

Family TULITIDAE Buckman, 1921

[Tulitidae Buckman, 1921, p. 43] [=Morrisiceratidae Westermann, 1956, p. 262; =Bullatimorphitinae Callomon, Dietl, & Niederhöfer, 1992, p. 40]

Cadicone and sphaerocone derivatives of perisphinctids, not from Sphaeroceratidae as previously assumed, on account of: (1) perisphinctid-like inner whorls—costate, evolute with or without (*Tulites*) parabolae—bridge the gap between Tulitidae and Zigzagiceratinae and (2) the form of the dimorphism reveals perisphinctid connection: the

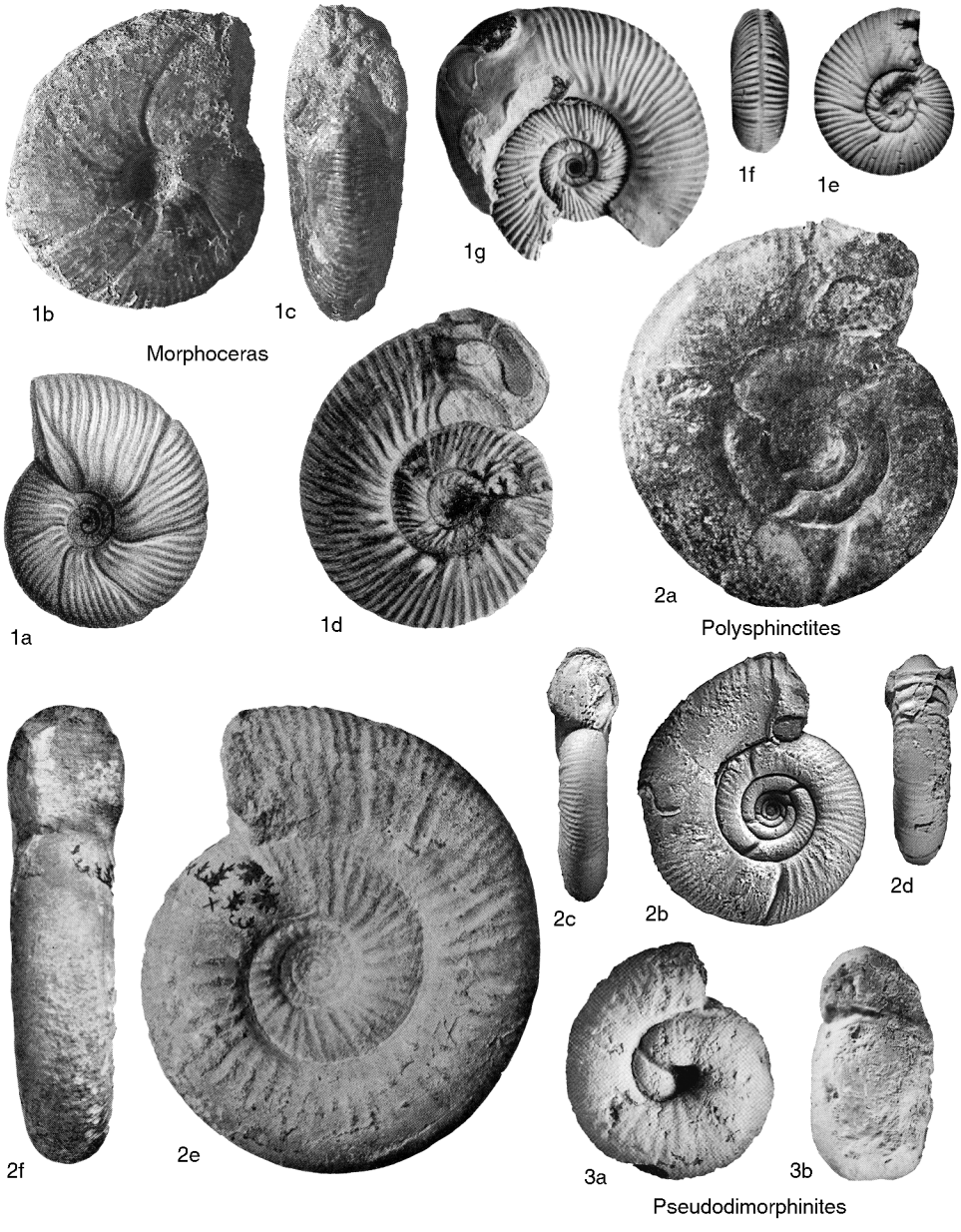

FIG. 50. Morphoceratidae (p. 66–67).

microconchs are small, lappeted serpenticones (e.g., *Trolliceras* TORRENS, 1971; *Holzbergia* TORRENS, 1971; *Sphaeroptychius* LISSAJOUS, 1923; and *Bomburites* ARKELL, 1952). During Bathonian and early Callovian, they realized various morphologies, eccentric coiling, contracted body chamber, and the common tendency of macroconchs to lose ribbing on the outer whorl. Suture simplified compared with the perisphinctid ancestors, with broad, bifid or multifid 2nd lateral lobe. Small size and other features of the Saudi Arabian

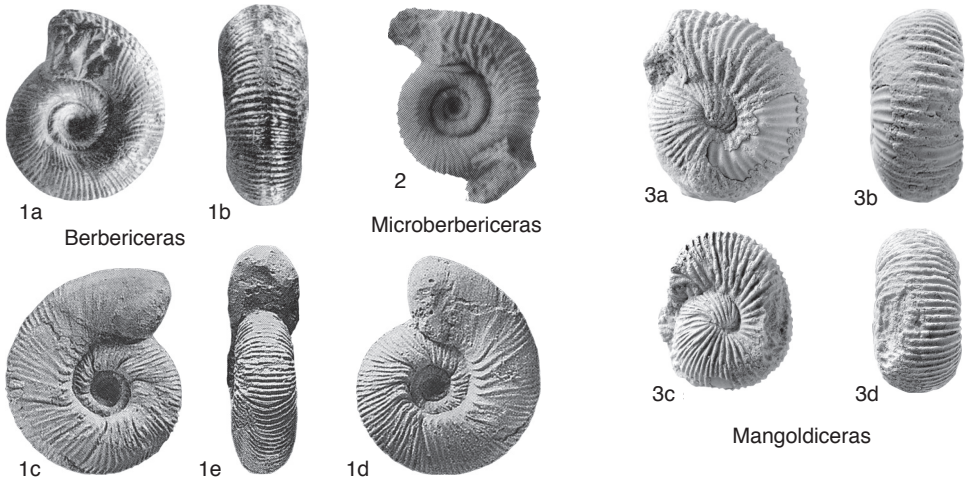

FIG. 51. Morphoceratidae (p. 67).

Tulites are in good agreement with their new dating as early Bathonian (*Tuwaiqensis* Zone). ARKELL, 1952; ÉNAY & MANGOLD, 1985, 1994; ÉNAY & others, 1987. *Middle Jurassic (lower Bathonian,* Zigzag *Zone–upper Callovian,* Athleta *Zone):* worldwide, except Boreal.

Tulites BUCKMAN, 1921, p. 44 [**T. tula;* OD] [=*Tulophorites* BUCKMAN, 1921, p. 45 (type, *T. tulotus,* OD); =*Madarites* BUCKMAN, 1921, p. 45 (type, *M. madarus,* OD); =*Pleurophorites* BUCKMAN, 1921, p. 46 (type, *P. pleurophorus,* OD); =*Sphaeromorphites* BUCKMAN, 1921, p. 49 (type, *S. sphaeroidalis,* OD); =*Trolliceras* TORRENS, 1971, p. 136, *nom. nov. pro Krumbeckia* ARKELL, 1951a, p. 10, obj., *non* DIENER, 1915 (type, *Krumbeckia reuteri* ARKELL, 1951a, p. 10, OD)]. Dimorphic. Macroconch (*Tulites*) with evolute, costate inner whorls but without parabolae, then middle whorls *Erymnoceras*-like, with thickened umbilical ribs and more involute, *Cadoceras*-like outer whorls with depressed whorl section and with the ribbing fading on the body chamber. Microconch (*Trolliceras*), small-sized tulitid with costate inner whorls, evolute coiling, and depressed whorl, the body chamber circular and smooth, three-quarters of a whorl in length; constricted peristome with ventrally flared collar, lappets long and dorsally inclined; suture line as in the macroconch, the second lobe with bifid second lateral lobe. *Middle Jurassic (lower Bathonian,* Zigzag *Zone*: (Arabian forms) Italy (Sicily), Saudi Arabia. *Middle Jurassic (?lower–middle Bathonian,* Zigzag *to* Subcontractus *Zones):* England, France, Switzerland, Germany, Spain, Italy (Sicily), northern Africa.——FIG. 52,*1a–b.* **T. tula*, holotype, Fuller'Earth Rock, Milborne, Wick, Somerset, England, ×0.5 (Buckman, 1922, pl. 269).——FIG. 52,*1c–f. T. reuteri* (ARKELL); *c–d,* holotype, condensed bed of lower–middle Bathonian age, Holzberg, Schwandorf, Bavaria, Germany, ×1 (Arkell, 1951a, pl. 2,*7*); *e–f,* condensed lower and middle Bathonian, Ipf near Bopfingen Swabia, Germany, ×1 (Hahn, 1971, pl. 3,*2*).

Morrisiceras BUCKMAN, 1920, pl. 167 (legend) , 1921, p. 47 [**M. sphaera;* OD] [=*Morrisites* BUCKMAN, 1921, p. 48 (type, *Ammonites morrisi* OPPEL, 1857 in OPPEL, 1856–1858, p. 478, OD); =*Pionoceras* LISSAJOUS, 1923, p. 103 (type, *Ammonites morrisi* OPPEL, 1857 in OPPEL, 1856–1858, p. 478; OD); =*Lycetticeras* ARKELL, 1953, p. 37 (type *L. lycetti,* OD); =*Holzbergia* TORRENS, 1971, p. 138, *nom. nov. pro Berbericeras* ARKELL, 1951a, p. 12 (type, *B. schwandorfense;* OD), *non* ROMAN, 1933]. Dimorphic. Macroconch resembles small or large-sized *Macrocephalites*-like sphaerocones previously ascribed to Macrocephalitidae (SPATH, 1928; ARKELL, 1957); regular involute coiling, narrow and deep umbilicus, with depressed and overlapping whorls and rounded umbilical wall; inner half of whorl nearly smooth, with the more or less strong secondaries lasting later on the venter. Forms or specimens with strong egression of the living chamber were sometimes separated as *Lycetticeras.* Microconch: small tulitid with distinctive ribbing style, with primaries (when visible in well-preserved specimens), first vertically or slightly backwards on the umbilical wall, then forming small but distinct bullae on the umbilical margin, thereafter they run on the side in a gentle arc and cross the venter and bifurcate on the middle of the side with frequent intercalatories and some simple ribs. The adult stage is indicated by coarsening of the ventral ribs and uncoiling of the umbilical seam. Flared aperture with large lateral lappets. ZATON, 2008 (see Tethyan distribution map, fig. 10). *Middle Jurassic (middle Bathonian,* Morrisi

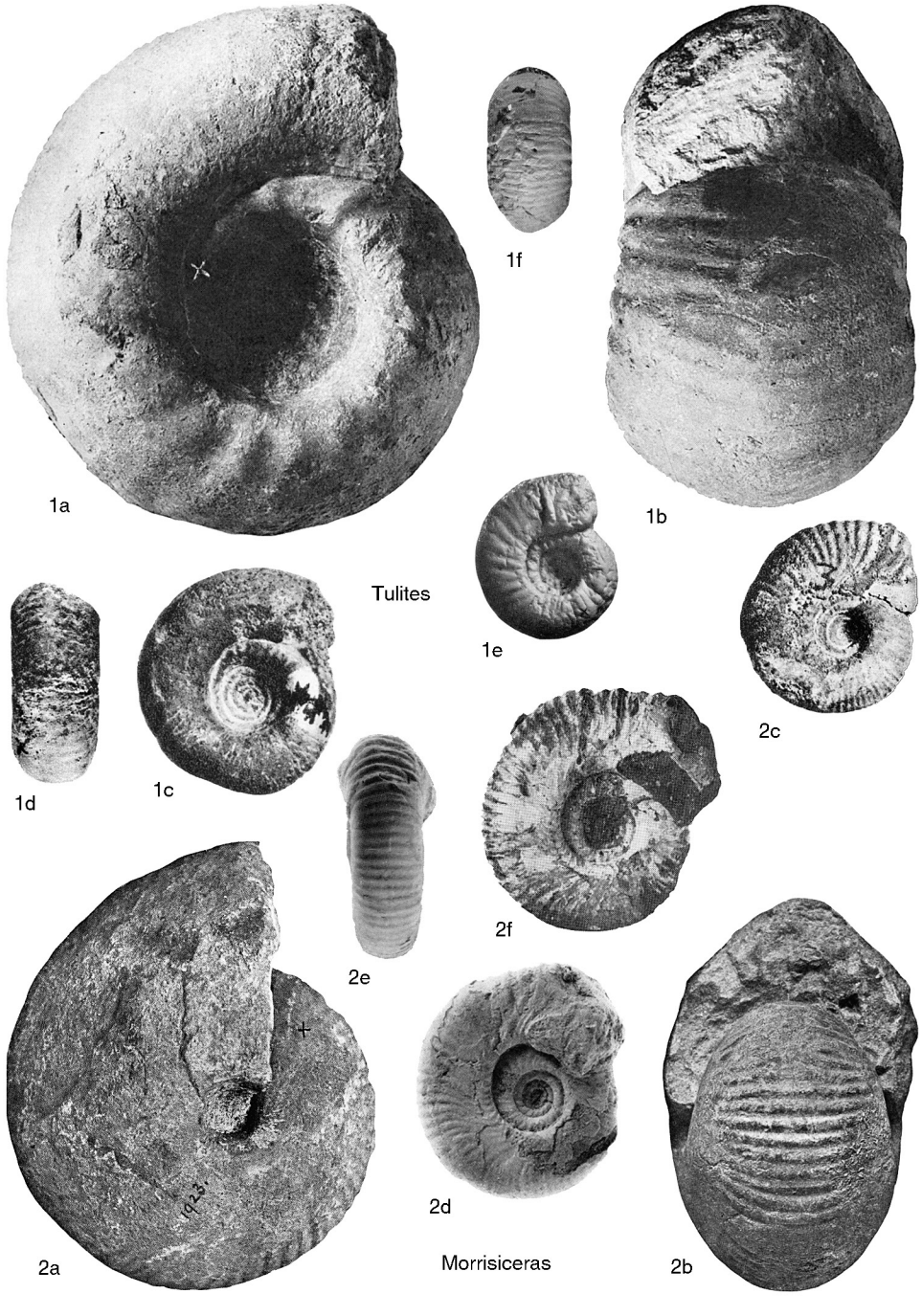

FIG. 52. Tulitidae (p. 69–71).

Zone): England, France, Germany, Switzerland, Poland, Italy, Turkmenistan or Uzbekistan.——FIG. 52,*2a–b.* **M. sphaera,* holotype, Fuller's Earth Rock, Sherborne area, Dorset, England, ×1 (Buckman, 1920, pl. 167).——FIG. 52,*2c–f. M. schwandorfense* (ARKELL); *c,* holotype, condensed bed of lower–middle Bathonian age, Holzberg, Schwandorf, Bavaria, Germany, ×1 (Arkell, 1951a, pl. 1,*8*); *d–e,* Cliff Hill

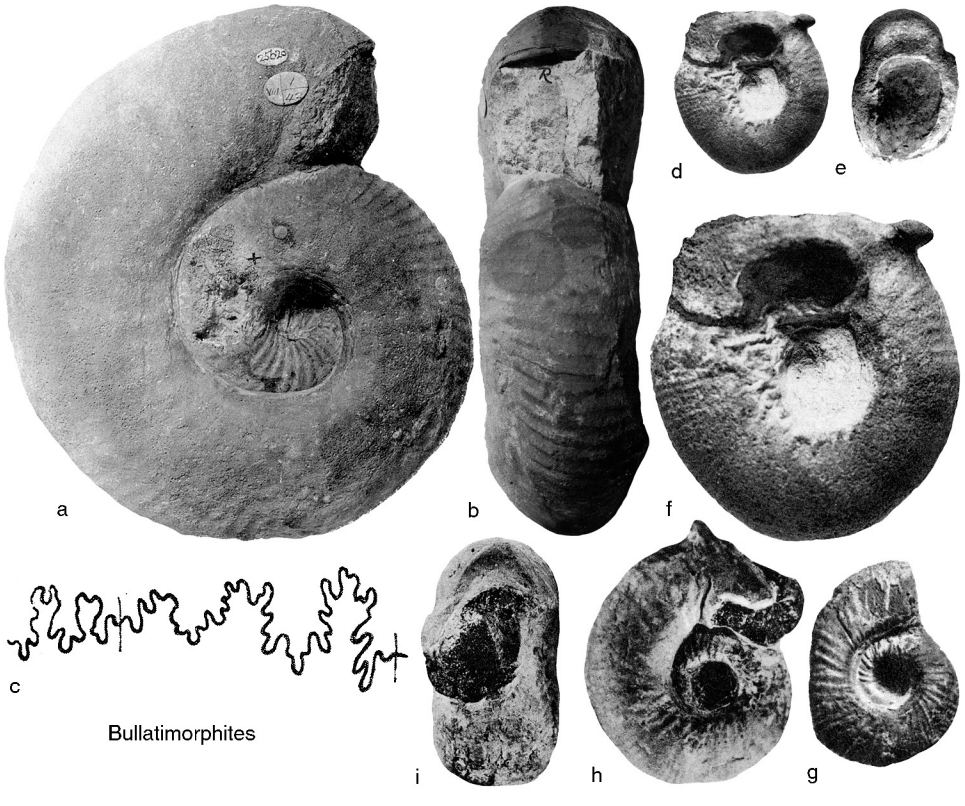

FIG. 53. Tulitidae (p. 71).

quarry, Shepton Montague, Somerset, England, ×1 (Torrens, 1971, pl. 36,*5*); *f,* coarse, ribbed form, resembling holotype, Löwenstein clay pit, Kromolow, near Zawiercie, Poland, ×1 (Torrens, 1971, pl. 36,*1*).

Bullatimorphites BUCKMAN, 1921, p. 47 [**B. bullatimorphus;* OD] [=*Rugiferites* BUCKMAN, 1921, p. 46 and 1923a, pl. 338A (type, *R. rugifer,* OD); =*Sphaeroptychius* LISSAJOUS, 1923, p. 101 (type, *S. buckmani,* OD); =*Schwandorfia* ARKELL, 1951a, p. 10 (type, *S. marginata,* OD)]. Dimorphic. Macroconch (*Bullatimorphites*): middle to large forms (160–200 mm). Perisphinctid-like inner whorls, evolute and costate as in *Tulites* but with parabolae; then sphaerocone with radiate or slightly rursiradiate and little-thickened primaries, divided into 2 or 3, slightly prorsiradiate secondaries that last to the end; adult stage with ellipticone coiling more pronounced than it is in *Tulites,* contracted body chamber and simple contracted aperture. Microconch (*Sphaeroptychius*): small sphaerocone with evolute coiling and depressed whorl, bifurcated primary ribs, and a few intercalatories; differs from *Bomburites* by its distinct umbilical wall, sharp umbilical margin, and normal coiling of the living chamber; ending with a collared peristome with ventral flare, more or less pronounced, and lappets. *Middle Jurassic (lower–upper Bathonian,* Aurigerus *to* Retrocostatum *Zones):* England, France, Germany, Austria, Switzerland, Portugal, Spain, Georgia, Azerbaijan, Turkey, Iran, Pakistan (Baluchistan), Tajikistan (Pamir Mountains), Madagascar, Indonesia (West Papua).——FIG. 53*a–b.* **B. bullatimorphus,* holotype, Great Oolite, White Limestone, Tiltups Inn, near Nailsworth, Gloucestershire, England, lateral and ventral views, ×0.4 (Buckman, 1922, pl. 272A–B).——FIG. 53*c. B. suevicus* ROEMER, 1911, suture line, ×1 (Arkell, 1952, fig. 24).——FIG. 53*d–f. B. buckmanni* (LISSAJOUS), holotype, Verzé, Saône and Loire, France; *d–e,* ×1; *f,* ×2 (Lissajous, 1923, pl. 22,*3,4,4b*).——FIG. 53*g–i. B. (Schwandorfia) marginatus* (ARKELL), type species of *Schwandorfia; g,* holotype, condensed bed of lower–middle Bathonian age, Holzberg, Schwandorf, Bavaria, Germany, ×1 (Arkell, 1951a, pl. 1,*9*); *h–i,* complete specimen with lappet, Couche ocreuse, Mount Crussol, Ardèche, France, ×1 (Énay, 1960a, pl. 7b,*1a–b*).

Kheraiceras SPATH, 1924, p. 7 [**Sphaeroceras cosmopolita* PARONA & BONARELLI, 1897, p. 114; OD; =*Stephanoceras bullatum* WAAGEN, 1875, p. 129, *non* D'ORBIGNY, 1846 in 1842–1851, p. 413] [=*Bomburites* ARKELL, 1952, p. 90 (type, *Ammonites devauxi* DE GROSSOUVRE, 1891, p. 261, OD); =*Treptoceras* ÉNAY, 1960a, p. 254, *non* FLOWER, 1942, p. 15 (Ordovician

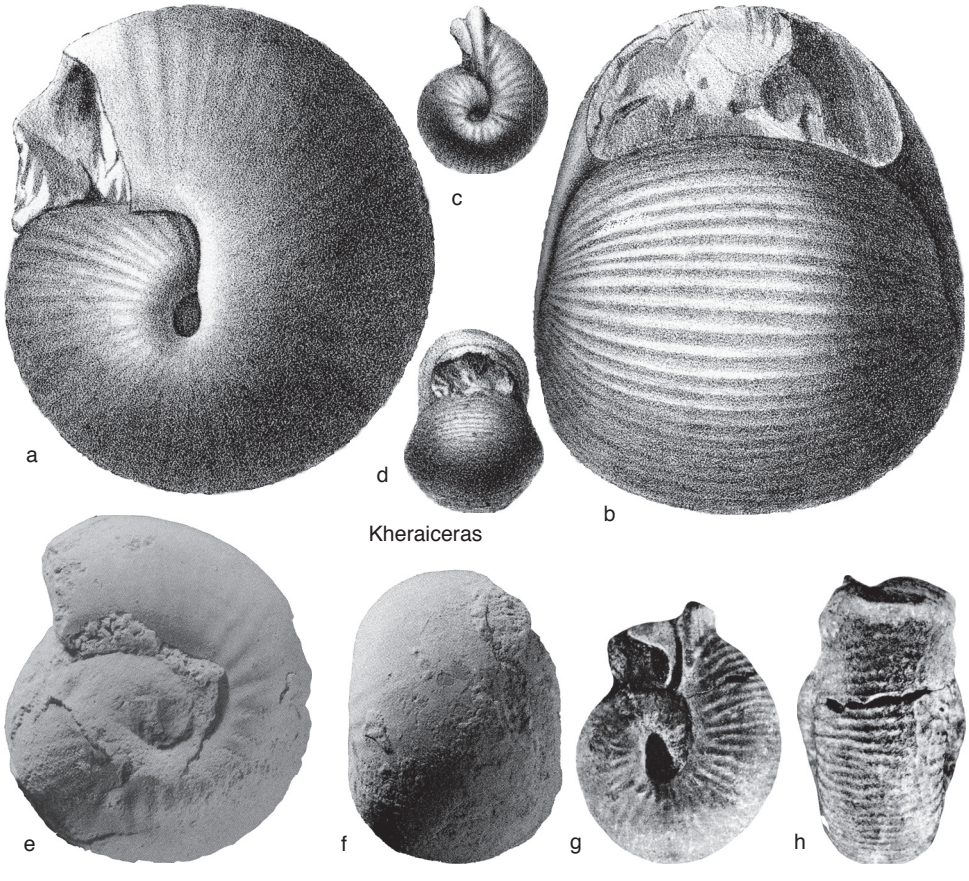

FIG. 54. Tulitidae (p. 71–72).

Actinoceratoidea) (type, *T. laurenti* ÉNAY, 1960a, p. 254, OD)]. Dimorphic. Macroconch (*Kheraiceras*) sometimes regarded as a subgenus of *Bullatimorphites;* it differs by its smaller size, the suddenly highly eccentric last half whorl with the umbilical seam first running out radially and then turning at right angle near the last part of the whorl; extremely depressed, spingle-shaped inner whorls, as the result of both centrifugal and centripetal increasing of the sphaerocone stage, and occluded umbilicus; radial fold-like ribs fading on the body chamber; simple, gently contracted aperture; suture line with the second lateral lobe typical of the Tulitidae. Microconch (*Bomburites*): dwarf globular shells characterized by sphaerocone inner whorls and highly ellipticone coiling of the last whorl; umbilical edge sharp on the inner whorls, rounded and fading on the last whorl; constricted peristome with collar that transects the ribbing; ventral flare or liplike extension of the ventral area and small, rounded lappets when preserved. *Middle Jurassic (upper Bathonian–upper Callovian (*Retrocostatum *and* Discus–Athleta *Zones):* England, France, Germany, Switzerland, Portugal, Spain, Italy, Hungary, Romania, Bulgaria, Georgia, ?Iran, Afghanistan, Tanzania (Lake Tanganyika), Madagascar, India (Kutch), Japan, USA (southern Alaska), Mexico.——FIG. 54*a–b. *K. cosmopolita* (PARONA & BONARELLI), holotype, Golden Oolite, Keera hill, near Charee, Kutch, India, ×1 (Waagen, 1875, pl. 32,*1*).——FIG. 54*c–d. K. (B.) devauxi* (DE GROSSOUVRE), holotype, Montreuil-Bellay, Deux-Sèvres, France, ×1 (de Grossouvre, 1891, pl. 9,*6*).——FIG. 54*e–f. K. (B.) globuliforme* (GEMMELLARO), holotype, Rocca chi Parra, near Calatafimi, Trapani, Sicilia, ×1 (Pavia & Cresta, 2002, p. 257, fig. 176).——FIG. 54*g–h. K. (B.) laurenti* (ÉNAY), holotype, Couche ocreuse, Mount Crussol, Ardèche France, ×1 (Énay, 1960a, pl. 7b,*4*).

Family PACHYCERATIDAE Buckman, 1918

[Pachyceratidae BUCKMAN, 1918, p. *xiii,* pl. 115B] [=Erymnoceratidae BREISTROFFER, 1947, p. 101]

The family displays various morphologies, from typical cadicones and coronates to evolute planulates. That is probably one reason why the systematic position has been

variously assigned by different authors. Another reason is that the origin of the Pachyceratidae was a long time obscure and various ancestors have been suggested including the Stephanoceratidae, Macrocephalitidae, Cardioceratidae, and Tulitidae. From the suture pattern and other considerations on morphology, it seems that they can be derived from some Pseudoperisphinctinae (=Grossouvriinae) such as *Subgrossouvria.* So, according to WESTERMANN (1964) and CALLOMON in DONOVAN, CALLOMON, & HOWARTH (1981), they are transferred from the Stephanoceratoidea to the Perisphinctoidea and they are no longer considered as transitional to Mayaitidae. *Middle Jurassic (middle Callovian)–upper Jurassic (middle Oxfordian):* worldwide.

Erymnoceras HYATT, 1900, p. 580 [**Ammonites coronatus* BRUGUIÈRE, 1789, p. 43; OD] [=*Doliolumites* BREISTROFFER, 1947, p. 101 (type, *Stepheoceras doliforme* SAYN & ROMAN, 1930, OD); =*Rollierites* JEANNET, 1951, p. 124 (type, *Stephanoceras renardi* NIKITIN, 1881b, p. 120, OD)]. Small to large size, including both microconchs and macroconch shells, narrow or medium-sized umbilicus, the whorl more or less depressed or not, coronate with tuberculate umbilical edge, strong ribbing, bi- or trifurcate. Evolute forms with more or less tuberculate inner whorls, whorl section more compressed and less thick than *Erymnoceras,* coarsely ribbed until the aperture, the secondaries branching from the tuberculate primary ribs are microconchs (*Rollierites*). *Middle Jurassic (middle Callovian,* Coronatum *Zone):* England, France, Germany, Switzerland, Portugal, central Russia, northern Africa, Crimean Peninsula, Caucasia, Syria, Iran, Israel, central Saudi Arabia, India (Kutch), Mexico.

E. (Erymnoceras). Large forms resembling inner whorls of *Teloceras* or *Tulites,* the outer whorl of which may become smooth and contracted. *Middle Jurassic (middle Callovian,* Coronatum *Zone):* England, France, Germany, Switzerland, Portugal, central Russia, northern Africa, Crimea, Caucasia, Syria, Iran, Israel, central Saudi Arabia, India (Kutch), Mexico.——FIG. 55,*1a–c. *E. coronatum* (BRUGUIÈRE); *a–b,* neotype (selected by THIERRY & others in FISCHER & others, 1994, p. 150), Pizieux, Sarthe, France, ×0.5 (new; Muséum National d'Histoire Naturelle, Paris, R04133; also figured by Thierry & others in Fischer & others, 1994, pl. 62,*3a–c*); *c,* better-preserved specimen, Herznach, Aargau, Switzerland, ×0.33 (Jeannet, 1951, pl. 36,*1*).——FIG. 55,*1d–e. E. renardi* (NIKITIN), holotype, Elatma Oolite, Rjasan, Volga basin, Russia, ×0.3 (Nikitin, 1881b, pl. 4,*24*).——FIG. 55,*1f–g. E. (R.) minuandum* JEANNET, holotype, Eisenoolite, Herznach, Switzerland, ×0.5 (Jeannet, 1951, pl. 46,*1a–b*).

E. (Erymnocerites) JEANNET, 1951, p. 121 [**E. argoviensis;* OD]. Differs from *Erymnoceras* in its coarse primary ribs and more numerous and distinctly prorsiradiate secondaries, more-depressed and more-rounded whorl, and narrower umbilicus. But there are shells intermediate between the extreme morphologies of both *Erymnoceras* and *Erymnocerites. Middle Jurassic (middle Callovian,* Coronatum *Zone):* France, Switzerland, Germany.——FIG. 55,*2 *E. (E.) argoviensis* (JEANNET), holotype, Einsenoolite, Herznach, Switzerland, ×0.3 (Jeannet, 1951, pl. 44,*1*).

Pachyerymnoceras BREISTROFFER, 1947, p. 101 [**Pachyceras jarryi* DOUVILLÉ, 1912a, p. 37; OD]. Medium to large size, including both microconch and macroconch shells; involute cadicone, inner whorls depressed and coronate, *Erymnoceras*-like, with tuberculate umbilical edge, vertical and smooth umbilical wall, strong ribs branching from tubercles into 3 or 4 secondaries; last adult whorl more compressed, with non-tuberculate and longer, strong, swollen ribs; intercalatories and ventrally inflated gerontic ribs on the last half of the body chamber. Type specimens in Eudes-Deslongchamps collection (Caen University), destroyed during the Second World War. *Middle Jurassic (middle–upper Callovian,* Coronatum *Zone,* Baylei *Subzone–*Athleta *Zone,* Trezeense *Subzone):* ?England, France, Algeria, Tunisia, Egypt, Israel, Saudi Arabia, Ethiopia, India (Kutch).——FIG. 56,*1a–d. *Pachyceras jarryi* (DOUVILLÉ), Marnes de Dives (Beds H.1-3), Villers-sur-Mer, Calvados, France; *a–b,* syntype, ×0.7 (DOUVILLÉ, 1912a, pl. 1,*10*); *c–d,* neotype (selected by CHARPY & THIERRY, 1977, p. 206), ×1 (Charpy & Thierry, 1977, pl. 5,*2;* Lyon University Collection, FSL 11632).

Kurnubiella GILL, THIERRY, & TINTANT, 1985, p. 726 [**K. ogivalis;* OD]. Dimorphic. Microconch small with moderately involute coiling, rounded inner whorls, then more compressed and ogive-shaped body chamber with acute venter and ventral rostrum; thick prorsiradiate ribs, raised on the umbilical edge, bifurcate on the third part of the side and cross the venter area; aperture with long lappets. Suture line of *Erymnoceras* type with wide and deep E lobe and shorter, bifid L lobe. Macroconch is the *levantinense* Lewy group, with *Pachyerymnoceras*-like inner whorls and compressed *Pachyceras*-like body chamber. *Middle Jurassic (middle Callovian,* Coronatum *Zone):* Israel, Saudi Arabia.——FIG. 57,*2a–b. *K. ogivalis,* holotype, Zohar Formation, Kurnub anticline, Hamakhtesh Hagadol, Israel, ×1 (Gill, Thierry, & Tintant, 1985, pl. 5,*4*).——FIG. 57,*2c–d. K. hatirae* (LEWY), holotype, complete specimen with the aperture, Zohar Formation, Kurnub anticline, Hamakhtesh Hagadol, Israel, ×0.5 (Lewy, 1983, pl. 6,*7–9*).——FIG. 57,*2e–f. K. levantinensis* (LEWY), holotype, nearly complete adult specimen, upper Zohar Formation, middle Tsiah Member, Makhtesh Hatira, Israel, ×0.66 (Lewy, 1983, pl. 3,*1,3*).

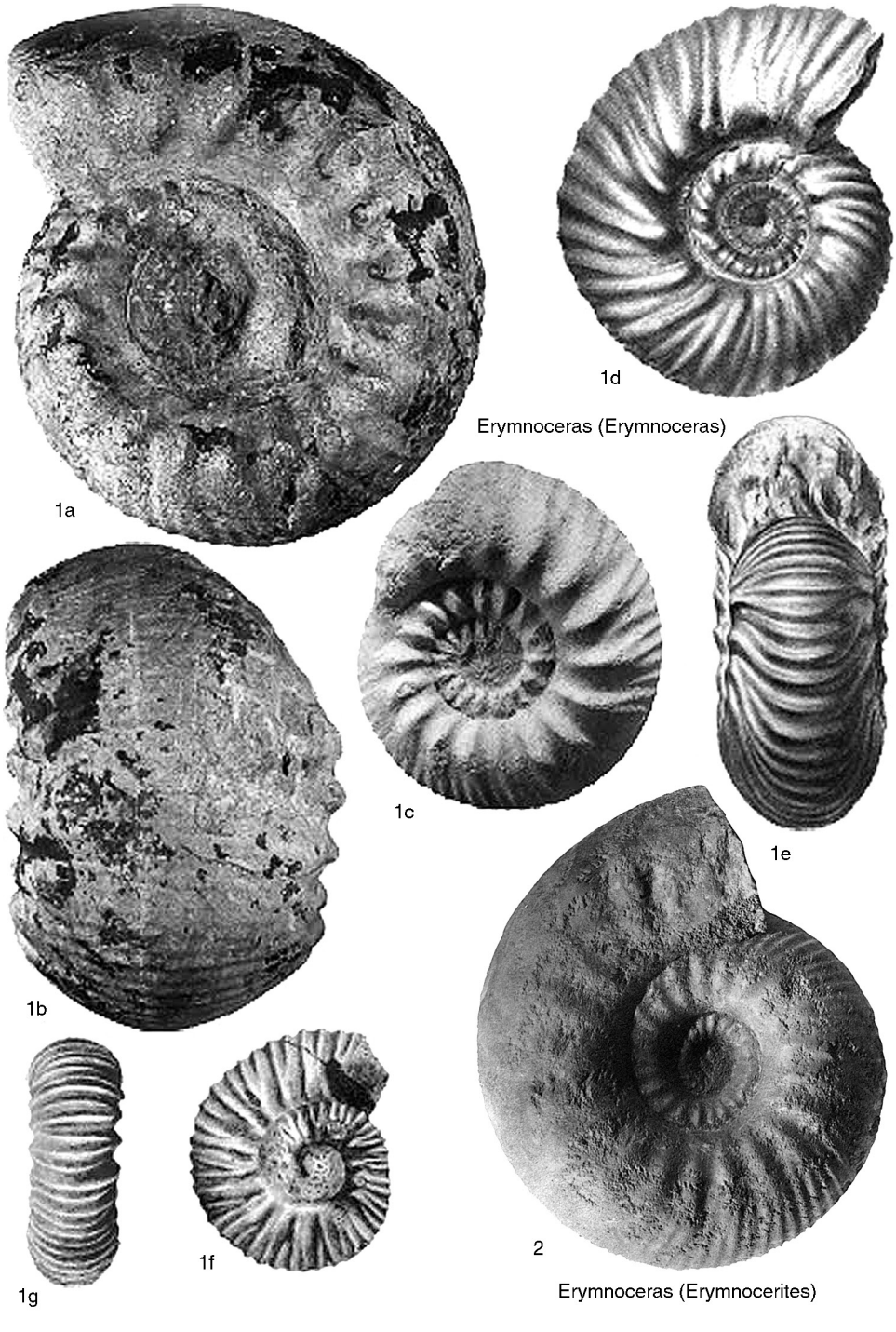

FIG. 55. Pachyceratidae (p. 73).

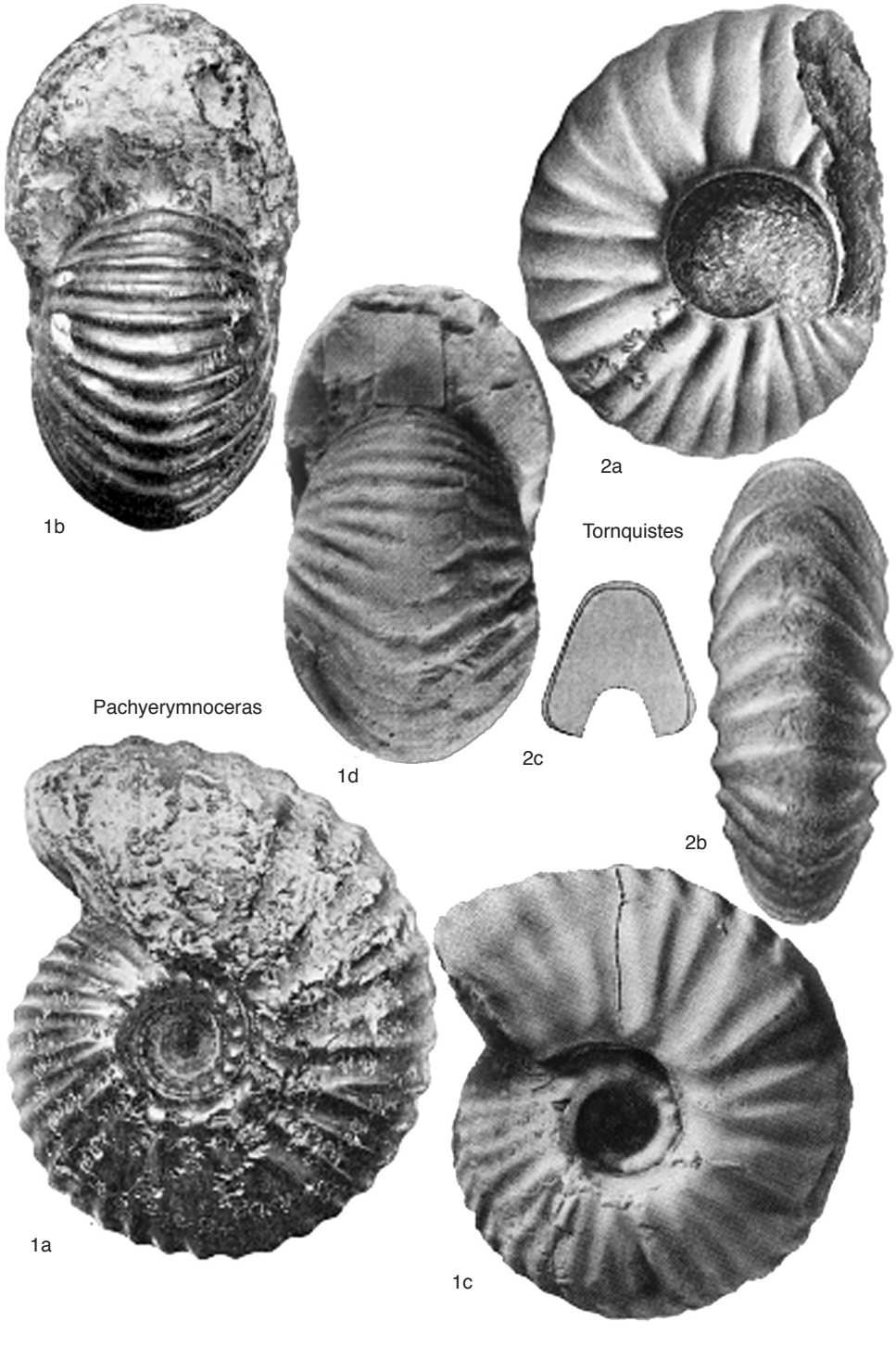

FIG. 56. Pachyceratidae (p. 73–76).

Pachyceras BAYLE, 1878, pl. 43 (legend), *non* RATZEBURG, 1844, p. 217 (Hymenoptera), ICZN Opinion 437, 1957a, p. 27 [**Ammonites lalandeanus* D'ORBIGNY, 1848 in 1842–1851, p. 477; OD] [=*Lalandeites* BREISTROFFER, 1947, p. 101, obj.]. Involute, whorl high, more or less thick, with rounded, and non-tuberculate umbilical edge; large macroconch displays lanceolate-acute venter becoming rounded just before the aperture; ribbing resembling *Morrisiceras,* first faint and fading on inner half of the whorl side; the last whorl with ventral folds (microconchs) or smooth (macroconchs). *Middle Jurassic (upper Callovian)–Upper Jurassic (lower Oxfordian):* France, northern Africa, Egypt, Saudi Arabia, Iran, India (Kutch).——FIG. 57,*1a–c.* **P. lalandeanum* (D'ORBIGNY), Villers-sur-Mer, Calvados, France; *a,* original figure, Marnes de Dives (Beds H.1-3), ×0.5 (d'Orbigny, 1848 in 1842–1851, p. 477, pl. 175,*1*); *b–c,* lectotype (selected by THIERRY in FISCHER & others, 1994, p. 155–156), ×0.5 (new; Muséum National d'Histoire Naturelle, Paris, MNHN R02367; figured by Fischer & others, 1994, pl. 67,*3*, 68,*1,* Institut de Paléontologie du Muséum, Paris, R.2367, d'Orbigny collection, 3180-1).

Tornquistes LEMOINE, 1910 in 1910–1911, p. 22 [**Macrocephalites helvetiae* TORNQUIST, 1894, p. 8; OD] [=*Herznachites* JEANNET, 1951, p. 34 (type, *H. helveticus,* OD); =*Pachytornquistes* THIERRY & CHARPY, 1982, p. 628, 638 (type, *T. (P.) oxfordiensis* TORNQUIST, 1894, p. 20, OD)]. Medium-sized shell with globular inner whorls, slightly eccentric coiling, and coarsening ribs on the last adult whorl; ribbing bifurcate, the branching on the ventral half of the whorl in the earliest forms and moving to the tuberculate umbilical edge in the highest. Probably dimorphic (BERT, 2009). Holotype lost (THIERRY & CHARPY 1982, p. 633); none of the specimens studied by the same authors and BERT agree with TORNQUIST's figure. *Upper Jurassic (lower Oxfordian,* Mariae *Zone,* Praecordatum *Subzone–middle Oxfordian,* Plicatilis *Zone):* England, France, Switzerland, Portugal, Spain, Poland, Bosnia, Italy (northern region, Sicily), northern Africa.——FIG. 56,*2a–c.* **T. helvetiae* (TORNQUIST), holotype, Terrain à chailles, Fringeli, Switzerland, ×0.3 (Tornquist, 1894, pl. 1,*1a–d*).

Protophites EBRAY, 1858b, p. 63 [**P. oxfordianus;* OD] [=*Christolia* ROLLIER, 1909, p. 614, *non* BRULLÉ, 1846 (Hymenoptera) (type, *Ammonites christoli* BEAUDOUIN, 1851, p. 596, OD)]. Closely resembling but unrelated to *Oecoptychius,* as ARKELL (in ARKELL & others, 1957) suggested. Dwarf, involute with scaphitoid coiling; pronounced smooth constriction just before the aperture with reflected peristome and with rostrum but no lappets. Macroconch unknown (?*Tornquistes*). *Upper Jurassic (lower Oxfordian,* Cordatum *Zone and Subzone–middle Oxfordian,* Plicatilis *Zone):* France, Switzerland.——FIG. 57,*3. P. christoli* (BEAUDOIN), Minerai de fer, near Châtillon-sur-Seine, France, ×2 (Beaudouin, 1851, pl. 10,*1–2*).

Family ASPIDOCERATIDAE Zittel, 1895

[Aspidoceratidae ZITTEL, 1895, p. 425]

The family is used here to include four major branches—the Peltoceratinae, Euaspidoceratinae, Aspidoceratinae, and Hybonoticeratinae—that originated from the Pseudoperisphinctinae and followed one another during the Late Jurassic. Slowly changing Peltoceratinae, Euaspidoceratinae, and also (to a certain extent) Aspidoceratinae share macroconchs with more or less quadrate whorl section and one or two rows of tubercles at the edges. Hybonoticeratinae also display tubercles, but associated with new or original features. Microconchs of the Peltoceratinae were identified long ago, but only recently and still under discussion in the Euaspidoceratinae and Aspidoceratinae. *Middle Jurassic (Callovian)–Upper Jurassic:* worldwide, mainly Tethyan.

Subfamily PELTOCERATINAE Spath, 1924

[*nom. transl.* SCHINDEWOLF, 1925, p. 320, *ex* Peltoceratidae, SPATH, 1924, p. 18]

The oldest branch displaying perisphinctoid, sharply ribbed inner whorls; outer whorls bituberculate, spinous or with coarse simple ribs, tending to capricorn morphology. Large or giant macroconchs, usually bituberculate with simple peristome, occur side by side with small microconchs with non-tuberculate ribbing and lappeted peristome. ROLLIER (1909, 1911) suggested origination of the Peltoceratinae from Zigzagiceratinae or Reineckeidae, but derivation from various Pseudoperisphinctinae—as proposed by WAAGEN (1875), SPATH (1931), PRIESER (1937), and others—is certainly right; however, derivation from "some Boreal Pseudoperishinctinae in the Middle Callovian in the N. hemisphere" (CALLOMON in DONOVAN, CALLOMON, & HOWARTH (1981,

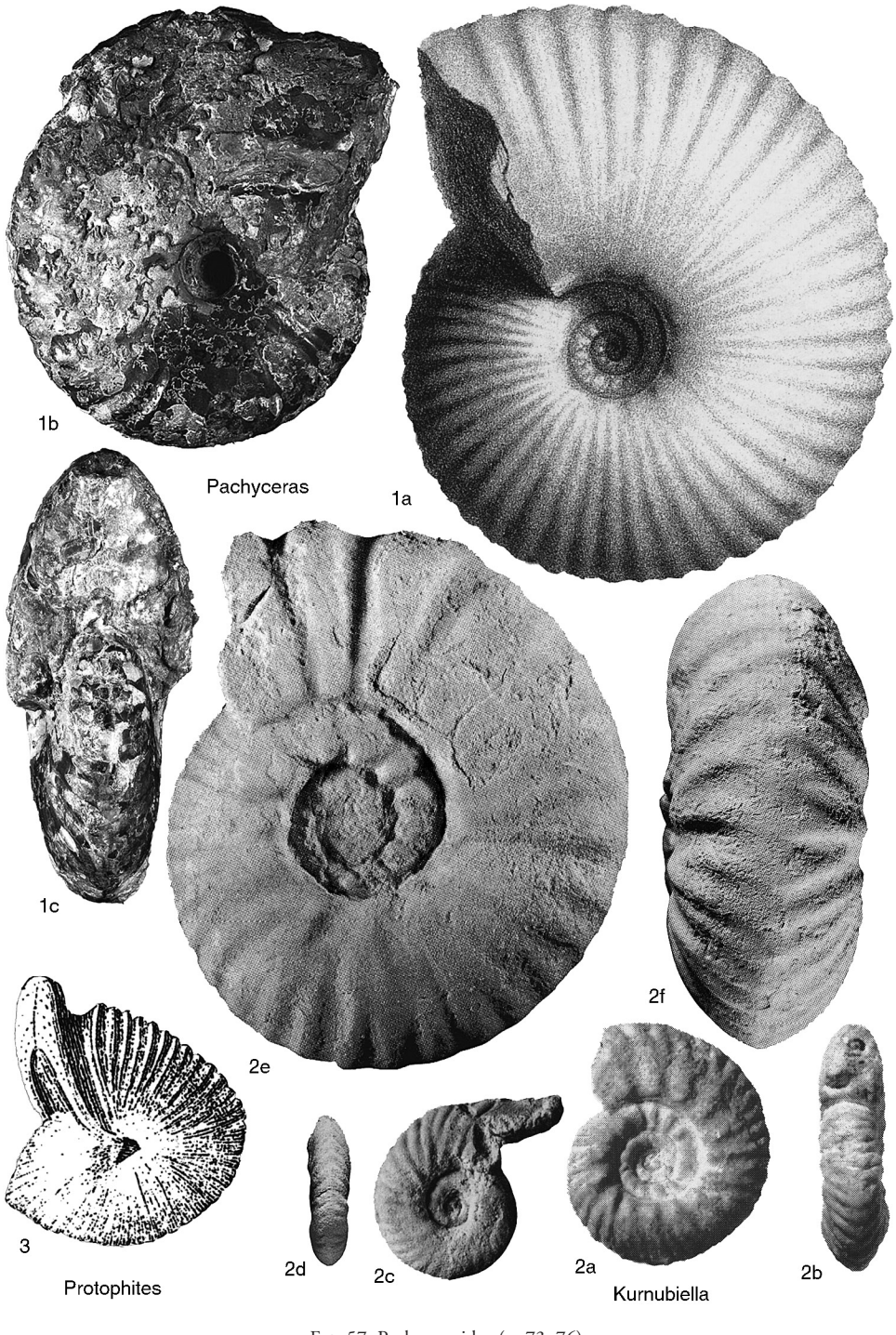

FIG. 57. Pachyceratidae (p. 73–76).

p. 152) is unlikely. A Tethyan origin and from the Tethyan southern margin is more probable. *Pseudopeltoceras* was ascribed to the subfamily by ARKELL in ARKELL and others (1957), but considered as a subgenus of *Hamulisphinctes* by MANGOLD (1970a) and BONNOT (1995). The polyphyletic origin assumed by ARKELL in ARKELL and others (1957) is still to be demonstrated. Aptychus still unknown (found in situ in *Epipeltoceras* [ÉNAY, 1962], a genus considered herein as a euaspidoceratid). *Middle Jurassic (upper Callovian,* Athleta *Zone,* Trezeense *Subzone)–Upper Jurassic (lowermost upper Oxfordian):* Europe, northern Africa, Egypt (Sinai), Ukraine (Donetsk, Crimea), Trans-Caspia, Turkey, Caucasia, Syria, Persia, Saudi Arabia, India (Kutch), ?Philippines, Indonesia, Papua New Guinea, Mexico, South America.

Peltoceras WAAGEN, 1871, p. 91 [**Ammonites athleta* PHILLIPS, 1829, p. 141; SD SCHINDEWOLF, 1925, p. 321] [=*Rursiceras* BUCKMAN, 1919, pl. 145 (type, *Ammonites reversus* LECKENBY, 1859, p. 9, also figured in BUCKMAN, 1919, pl. 145, OD)]. Evolute with hardly overlapping whorls and nearly flat venter; strong ribbing, the primaries bifurcate or trifurcate on the ventral margin; only one or two outer or two rows of tubercles. Small-sized microconch (*Rursiceras*), with biplicate ribbing, strongly rursiradiate and simple to the end, branching from the middle of whorl side; aperture with lappets. *Middle Jurassic (upper Callovian):* Europe, Madagascar, Turkey (Anatolia), Ukraine (Donetsk), Crimean Peninsula, Caucasia, India (Kutch), ?Philippines, Mexico, South America.

P. (Peltoceras) WAAGEN, 1871. Two rows of massive lateral tubercles, outer row developing first. *Middle Jurassic (Upper Callovian):* Europe, Madagascar, Turkey (Anatolia), Ukraine (Donetsk), Crimean Peninsula, Caucasia, India (Kutch), ?Philippines, Mexico, South America.——FIG. 58,*1a–b. *P. athleta* (PHILLIPS), neotype (designated by ARKELL, 1933, p. 610, pl. 37,*7,* caption), Hackness Rock, Scarborough, Yorkshire, England, ×1 (Spath, 1931, pl. 106,*3,* 107,*5;* figured by Arkell, 1933, pl. 37,*7*).——FIG. 58,*1c–d. P. reversum* (LECKENBY), holotype, Kelloway Rock, Scarborough, Yorkshire, England, ×1 (Buckman, 1919, pl. 145,*1–2*).

P. (Unipeltoceras) JEANNET, 1951, p. 164 [**Ammonites athleta unispinosus* QUENSTEDT, 1847 in 1845–1849, p. 190; OD]. Like *Peltoceras* (*sensu stricto*), but differing in developing only outer row of lateral tubercles. *Middle Jurassic (upper Callovian):* Europe.——FIG. 58,*2. *P. (U.) unispinosum* (QUENSTEDT), holotype, Braunen Jura ζ, Reichenbach, Germany, ×1 (Quenstedt, 1847 in 1845–1849, p. 190, pl. 16,*4*).

P. (Metapeltoceras) SPATH, 1931, p. 574 [**Ammonites armiger* J. de C. SOWERBY, 1840a, p. 329; OD]. Like *Peltoceras* (*sensu stricto*), but differing in developing inner lateral tubercles before outer tubercles. *Middle Jurassic (Upper Callovian):* Madagascar, India (Kutch).——FIG. 58,*3. *P. (M.) armiger* (J. de C. SOWERBY), holotype, Athleta Beds, Jikadi, India, ×0.4 (Spath, 1931, p. 574, pl. 114,*1*).

Peltoceratoides SPATH, 1924, p. 18 [**Peltoceras semirugosum* WAAGEN, 1875, p. 83, OD]. Evolute platycone with quadrate whorl section, ribbing first bifurcate, then outer whorl becoming bi- or trituberculate and spinous. *Upper Jurassic (lower–?upper Oxfordian):* worldwide.

P. (Peltoceratoides) [=*Wedekindia* SCHINDEWOLF, 1925, p. 321 (type, *Ammonites constantii* D'ORBIGNY, 1848 in 1842–1851, p. 502, OD); =*Parawedekindia* SCHINDEWOLF, 1925, p. 321 (type, *Ammonites arduennensis* D'ORBIGNY, 1848 in 1842–1851, p. 500, also as lectotype in FISCHER & others, 1994, p. 164, OD); =*Prieserites* JEANNET, 1951, p. 187 (type, *Peltoceras interscissum* UHLIG, 1881, p. 168, OD)]. Large macroconchs with quadratic whorl section; ribbing on inner whorls bifurcating near the umbilical edge and becoming gradually bituberculate on the outer whorls. Microconch (*Parawekindia*) with the inner whorls like those of *Peltoceratoides,* but ribs bifurcate at umbilical edge, simple and rursiradiate on the outer whorl and to the aperture, without tubercles and sometimes interrupted on the venter; peristome with lappets. *Upper Jurassic (lower–?upper Oxfordian):* Europe, central and southern Russia, Morocco, Ukraine (Donetsk), Turkey (Anatolia), Syria, Kenya, Tanzania, Madagascar, India (Kutch), Indonesia, New Guinea.——FIG. 59,*1a. *P. semirugosus* (WAAGEN), holotype, Dhosa Oolite, Lodai, India, ×0.5 (Waagen, 1875, p. 83, pl. 14,*1*).——FIG. 59,1*b–c. P. arduennensis* (D'ORBIGNY); *b,* incomplete lectotype (selected by MARCHAND & others in FISCHER & others, 1994, p. 164), Marnes et Calcaires de La Vacherie, Ecommoy, Sarthe, France, ×1 (new; Muséum National d'Histoire Naturelle, Paris, MNHN R03002; also figured by Fischer & others, 1994, pl. 69,*5*); *c,* complete specimen, Couches à Chailles, cement quarry, Pagny-sur-Meuse, Meuse, France, ×0.75 (Énay & Boullier, 1981, pl. 2,*1*).

P. (Peltomorphites) BUCKMAN, 1925a, pl. 564*A–B* [**P. hoplophorus*; OD] [=*Raspailites* JEANNET, 1951, p. 192 (type, *Ammonites eugenii* RASPAIL, 1842, p. 33, OD; see also MARCHAND & RIOULT in FISCHER & others, 1994, p. 164); =*Peltoraspailites* JEANNET, 1951, p. 197 (type, *P. argoviensis,* OD)]. Evolute and quadrate whorl section; inner whorls look like *Peltoceratoides; Euaspidoceras*-like middle and outer whorls, with thick

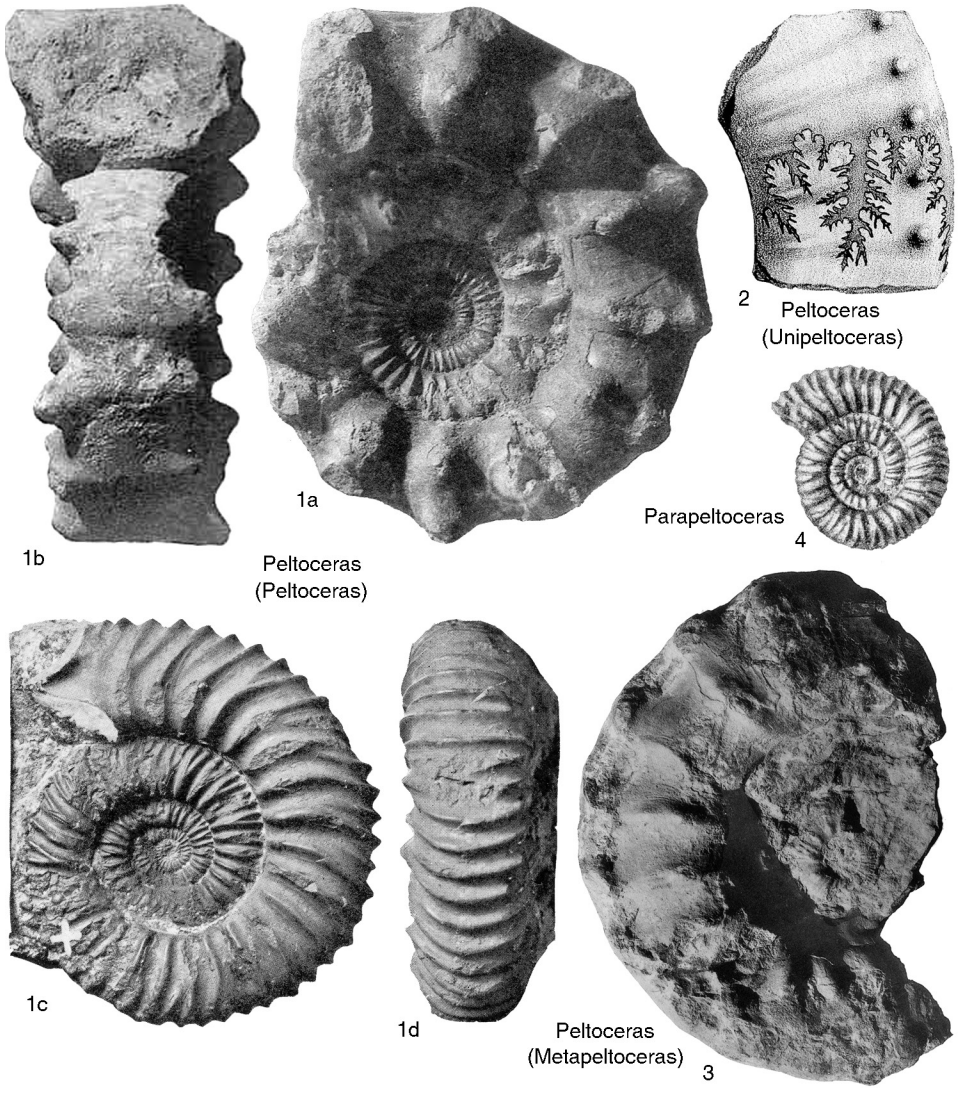

FIG. 58. Aspidoceratidae (p. 78–79).

whorl section and trituberculate ribs, the lateral tubercles strongly spinous. Includes "*eugenii*" group. *Upper Jurassic (lower Oxfordian):* Europe, Madagascar, northern Chile.——FIG. 59,*2.***P. (P.) hoplophorus* (BUCKMAN), lower Calcareous Grit, Yorkshire, England, ×0.33 (Arkell, 1945, p. 294, pl. 66,*1a–d*).

?Parapeltoceras SCHINDEWOLF, 1925, p. 321 [**Nautilus annulare* REINECKE, 1818, p. 79; OD]. Inner whorls of a larger incomplete specimen; evolute, whorl section rounded and depressed; ribs bifurcate above middle of whorl sides, the secondaries rursiradiate. Dubious as peltoceratid according to ARKELL (in ARKELL and others, 1957). *Middle Jurassic (middle Callovian, ?*Jason *Zone):* Europe, Madagascar, Turkey (Anatolia), Ukraine (Crimea, Donetsk).——FIG. 58,*4. R. annulare* (REINECKE), holotype, middle Callovian, Ützing/Langheim, Germany, ×1 (Dorn, 1931, p. 63(129), pl. 34(18),*4*).

Gregoryceras SPATH, 1924, p. 18 [**Ammonites transversarius* QUENSTEDT, 1847 in 1845–1849, p. 199] [=*Pseudogregoryceras* JEANNET, 1951, p. 200 (type, *P. iteni,* OD)]. Small or medium sized; whorl section subcircular at first, then more or less compressed, the whorl sides either convex, flat, or concave; strong rursiradiate ribs, some

simple, mostly bifurcate at or near the umbilical edge, with small tubercles at the branching; they bifurcate again at mid-side or a little above into well marked secondaries on the venter. A smooth stage is well developed in the earliest forms (e.g., *Pseudogregoryceras*), and progressively decreases and is lacking in the end forms, as well as the parabolae at the mid-side furcation point of the earliest forms. Probably dimorphic, but lappets are unknown and the peristome is splayed and slightly sinuous in both dimorphs. *Upper Jurassic (lower Oxfordian,* Cordatum *Zone,* Bukowskii *Subzone–upper Oxfordian,* Bifurcatus *Zone*, Grossouvrei *Subzone):* France, Germany, Switzerland, Italy, Spain, Bulgaria, Algeria, Tunisia, Turkey, Uzbekistan, Iran, India (Kutch), USA (Louisiana), Mexico, Chile.——Fig. 59,*3a–c. *G. transversarium* (Quenstedt), holotype, Birmensdorf Beds, Birmensdorf, Aargau, Switzerland, ×1 (Salfeld, 1906, pl. 11,*6a–c*).——Fig. 59,*3d–e. G. defayi* Bert & others, 2003, showing rounded whorl section and rursiradiate ribbing, with the peristome preserved, Bézaudun-les-Alpes, Hautes-Alpes, France, ×0.5 (Bert & others, 2003, pl. 3,*1a,d*).

Subfamily EUASPIDOCERATINAE Spath, 1931

[Euaspidoceratinae Spath, 1931, p. 588] [=Epipeltoceratinae Callomon in Donovan, Callomon, & Howarth, 1981, p. 149]

In the subadult or adult stages, the Euaspidoceratinae resemble the Peltoceratinae (evolute coiling, quadrate whorl section, two rows of tubercles), but the inner whorls are quite different. Fine ribbing with parabolae of the inner whorls of the euaspidoceratins contrast with the simple or bifurcate coarse ribs of the peltoceratins. Therefore, they are considered as an independent offshoot from Tethyan Pseudoperisphinctinae (Miller, 1968). Microconchs distinguished by the same features and constantly smaller than the macroconchs, contrary to the Peltoceratinae; Callomon (in Donovan, Callomon & Howarth, 1981) identified them as a side-branch and placed them in a new subfamily, the Epipeltoceratinae. *Middle Jurassic (upper Callovian,* Athleta *Zone,* Collotiformis *Subzone)–Upper Jurassic (lower Kimmeridgian,* Platynota *Zone):* worldwide, mainly Tethyan.

Euaspidoceras Spath, 1931, p. 326, 588 (footnote) [**Ammonites perarmatus* J. Sowerby, 1822, p. 72, pl. 352; OD]. Inner whorls finely ribbed, with parabolae later changing to tubercles; outer whorls evolute, whorl section quadratic, compressed, sometimes depressed, strongly ribbed, with two rows of tubercles. *Middle Jurassic (upper Callovian)–Upper Jurassic (? Lower Kimmeridgian):* worldwide.

E. (Euaspidoceras) [=*Neaspidoceras* Spath, 1931, p. 593 (type, *Aspidoceras tenuispinatum* Waagen, 1875, p. 93, OD); =*Arcaspidoceras* Jeannet, 1951, p. 224 (type, *A. frickense,* OD); =*Mirosphinctes* Schindewolf, 1926, p. 501 (type, *Perisphinctes mirus* Bukowski, 1887, p. 151, OD]. The more common and widely distributed form; macroconch of large size with the morphology typical of the genus. Small-sized microconch (*Mirosphinctes*) with biplicate and rursiradiate secondary ribs crossing the ventral area; inner whorls with numerous parabolic nodes; whorl section subcircular to oval; aperture constricted and flanged with long lappets. *Middle Jurassic (upper Callovian,* Athleta *Zone,* Collotiformis *Subzone)–Upper Jurassic (upper Oxfordian,* Bimammatum *Zone):* Europe, northern Africa, Syria, Egypt (Sinai Peninsula), Ukraine (Donetsk), Caucasia, Iran, Uzbekistan, Saudi Arabia, Kenya, Tanzania, Madagascar, India (Kutch), Nepal, Indonesia, Cuba, Mexico, Chile.——Fig. 60,*1a. *E. perarmatum* (J. Sowerby), holotype, Malton Oolite, Yorkshire, England, ×0.33 (Arkell, 1940, pl. 41,*1;* also figured by Arkell in Arkell & others, 1957, pl. 444,*1*).——Fig. 60,*1b, E. mirus* (Bukowski), lectotype (designated by Haas, 1955 p. 152), lower Oxfordian, Częstochowa, Poland, ×1 (Bukowski, 1887, pl. 28,*8*).——Fig. 60,*1c. E. frickense* (Moesch), holotype, complete adult specimen, middle Oxfordian, Wölfliswyl im Frickatal, Aargau, Switzerland, ×1 (Énay, 1966, fig. 160,*4*).

E. (Epaspidoceras) Spath, 1931, p. 594 [**Aspidoceras subdistractum* Waagen, 1875, p. 99; OD]. Tendency to develop a concave venter on the inner whorls and outer lateral spines. *Upper Jurassic (?lower Kimmeridgian):* France, Madagascar, India (Kutch).——Fig. 60,*2a–b. *E. (E.) subdistractum* (Waagen), holotype, Kantcote Sandstone, Gangta Bét, Kutch, India, ×0.66 (Waagen, 1875, pl. 21,*1a–b*).

Paraspidoceras Spath 1925a, p. 118 [**Ammonites meriani* Oppel, 1863 in Oppel 1862–1863, p. 230; OD] [=*Extranodites* Jeannet, 1951, p. 231 (type, *Ammonites edwardsianus* d'Orbigny, 1848 in 1842–1851, p. 504, OD); =*Struebinia* Zeiss, 1962, p. 17 (type, *P. (Struebinia) simplex, nom. nov. pro Aspidoceras edwardsianum* d'Orbigny in Neumayr, 1871, p. 373, OD); =*Simosphinctes* Barthel, 1957, p. 221 (type, *Perisphinctes tieringensis* Fischer, 1913, p. 50, OD)]. Early whorls depressed and coronate, with quadratic or trapezoidal whorl section and flat or rounded venter; outer adult whorl as in *Euaspidoceras;* smooth or sometimes ribbed (*Struebinia*), with outer row of tubercles spinous,

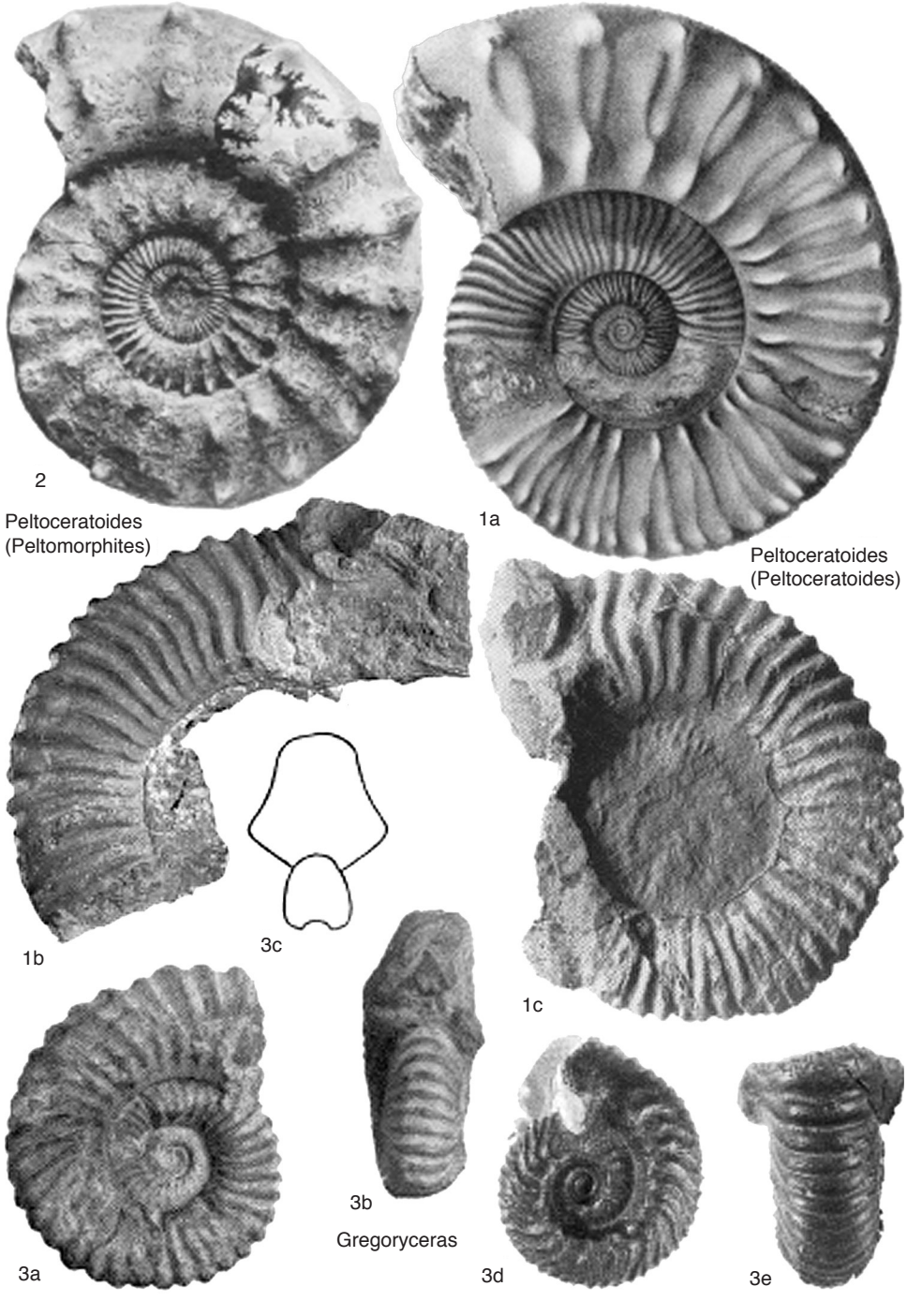

FIG. 59. Aspidoceratidae (p. 78–80).

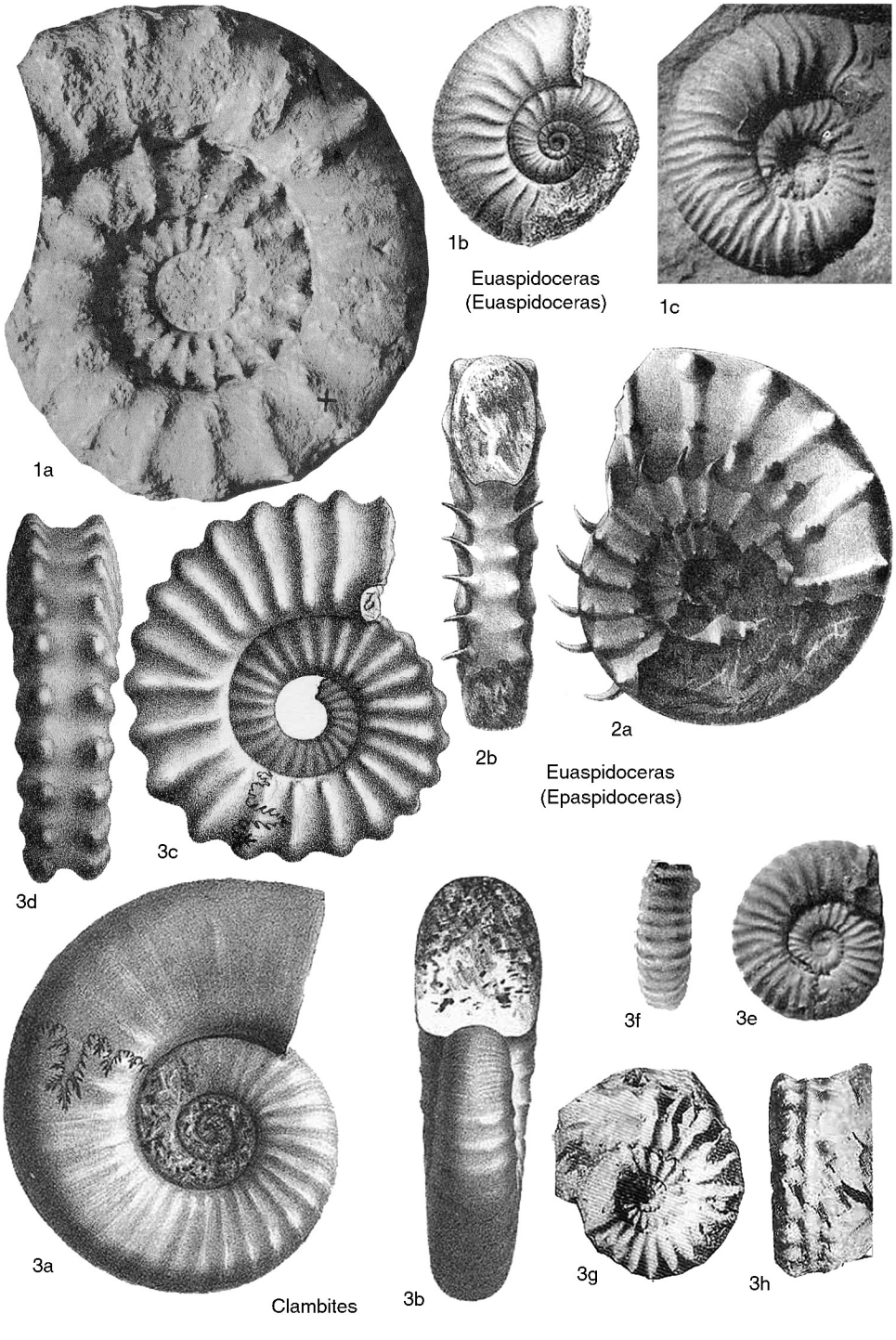

FIG. 60. Aspidoceratidae (p. 80–83).

more or less clavate, and inner row recessive or absent. Microconch (*Simosphinctes*) small, evolute with wide umbilicus; whorl section subquadratic on the inner whorls, the body chamber oval and compressed; ribs fine and prorsiradiate on the inner whorls, progressively more coarse and widely spaced; then ribs more or less strong, with marginal parabolae or knots; peristome with lappets. *Upper Jurassic (middle Oxfordian,* Plicatilis *Zone, Antecedens Subzone–lower Kimmeridgian,* Platynota *Zone):* France, Germany, Switzerland, Spain, Italy (Sicily), India (Kutch).——Fig. 61,*1a–b. *P. meriani* (Oppel), unter Effingerschichten, Oltingen, Aargau, Switzerland, ×0.88 (Strübin, 1908, pl. 1,*1,4*).——Fig. 61,*1c–d. P. submeriani* (Zeiss, 1962, p. 10), wholly septate, Birmenstorfer Schichen, Gansingen, Aargau, Switzerland, ×0.25 (Gygi, Sadati, & Zeiss, 1979, p. 924, fig. 11*a–b*).——Fig. 61,*1e. P. mamillanum* (Quenstedt), complete adult specimen, upper Oxfordian, *Planula* Zone, Obelshof near Heindenheim, Germany, ×0.1 (Schairer, 1968, pl. 12,*2*).——Fig. 61,*1f–h. P. tieringensis* (Fischer); *f–g,* holotype, Weiss-Jura γ, Felder von Tieringen, Germany; *f,* ×1; *g,* ×2 (Barthel, 1957, pl. 16,*2*); *h,* complete specimen with peristome, Malm γ, Henberg, Baden-Württemberg, Germany, ×1 (Geyer, 1961, pl. 6,*7*).

Clambites Rollier, 1922, p. 360 [**Ammonites clambus* Oppel, 1863 in 1862–1863, p. 225; SD Roman, 1938, p. 305] [=*Epipeltoceras* Spath, 1924, p. 18 (type, *Ammonites bimammatus* Quenstedt, 1887 in 1882–1888, p. 880, OD); =*Aulapeltoceras* Schindewolf, 1925, p. 322, obj.; =*Mariaceras* Turculet in Macarovici & Turculet, 1972, p. 91, pl. 29,*3* (type, *M. pontoeuxicum, nom. nov. pro Peltoceras berrense* Simionescu, 1907, p. 163, pl. 2,*4, non* Favre, 1876, OD); =*Amoebopeltoceras* Schweigert, 1995, p. 3 (type, *A. albertii,* OD)]. Small sized, whorl section compressed, with inner whorls resembling *Euaspidoceras* but feebly ribbed; outer row of tubercles recessive or absent on adult whorl. Microconch (*Epipeltoceras*) descended from *Mirosphinctes;* early forms have the same general shape but differ by the ventral smooth band; more recent forms have quadratic whorl section and strong, straight, distant ribs, mainly simple, ending at ventrolateral tubercles; venter smooth and concave, with a central furrow and a smooth keel in some species (e.g., *Amoebopeltoceras*); aperture with long lappets. *Upper Jurassic (upper Oxfordian,* Bimammatum *Zone):* southern Europe, northern Africa, northern Iran (Elburz), Uzbekistan.——Fig. 60,*3a–b. *C. clambus* (Oppel), holotype, Malm β, *Bimammatum* Zone, Gegend von Balingen, Baden-Württemberg, Germany, ×0.66 (Oppel, 1863 in Oppel 1862–1863, pl. 63,*1a–b*).——Fig. 60,*3c–d. C. bimammatum* (Quenstedt), holotype, Malm β, *Bimammatum* Zone, Laufen, Baden-Württemberg, Germany, ×1 (Quenstedt, 1887 in 1882–1888, pl. 95,*1*).——Fig. 60,*3e–f. C. semimammatum* (Quenstedt), Calcaires lités Formation, *Hypselum* Zone, Indrieux, Ain, France, ×1 (Énay, 1966, pl. 40,*14a–c*).——Fig. 60,*3g–h, C. albertii* (Schweigert), holotype and type species of *Amoebopeltoceras* Schweigert, Mülheim an der Donau, Baden-Württemberg, Germany, ×2 (Schweigert, 1995, p. 4, fig. *1c–d*).

?Intranodites Jeannet, 1951, p. 234 [**I. muehlbergi;* OD]. Whorls thick and massive, the umbilicus narrow; inner whorls with ribs simple or bifurcate, first from the umbilical edge, then from an inner row of tubercles, and crossing the venter; adult morphology unknown. *Upper Jurassic (lower Oxfordian,* Cordatus *Zone):* Switzerland.——Fig. 61,*2a–b. *I. muelhbergi,* holotype, nucleus, Cordatus Schichten (bed F), Herznach, Aargau, Switzerland, ×1 (Jeannet, 1951, pl. 32,*10*).

Cubaspidoceras Myczynski, 1976a, p. 277 [**C. kuteki;* OD]. Similar to *Euaspidoceras* in developing two rows of tubercles, but having involute coiling, more compressed and narrow whorl section with rounded venter; umbilical tubercles as long spines directed towards the umbilicus; disappearance of ribs and outer tubercles at large diameter and relative small size also resemble *Clambites. Upper Jurassic (middle Oxfordian,* Transversarium *Zone–upper Oxfordian,* Bimammatum *Zone):* Cuba.——Fig. 61,*3a–b. *C. kuteki,* holotype, nucleus, Francisco Formation, middle–late Oxfordian, Macagual, Pinar del Rio Province, Cuba, ×0.75 (Myczynski, 1976a, fig. *12a–b*).

Subfamily ASPIDOCERATINAE Zittel, 1895

[*nom. transl.* Salfeld, 1919, p. 21, *ex* Aspidoceratidae Zittel, 1895, p. 425] [=Physodoceratidae Schindewolf, 1925, p. 323; =Sutneriinae Zeiss, 1984, p. 575]

The subfamily joins together various morphologies from evolute, quadrate to involute, round-whorled forms, uni- or bituberculate, smooth or ribbed. Bivalved aptychus with unribbed, punctate outer surface (*Laevaptychus*). They are derived probably from euaspidoceratins in the upper Oxfordian to lower Kimmeridgian, with *Aspidoceras atavum, A. binodum,* and *Physodoceras circumspinosum.* Phyletic schemes have been proposed for a part only of the subfamily (e.g., Checa, 1985), but they are not convincing and Callomon (in Donovan, Callomon, & Howarth, 1981, p. 153) suggested that the morphologies noted above "occurred repeatedly without any major phylogenetic branching," and iterative evolution and heterochronic process were put forward

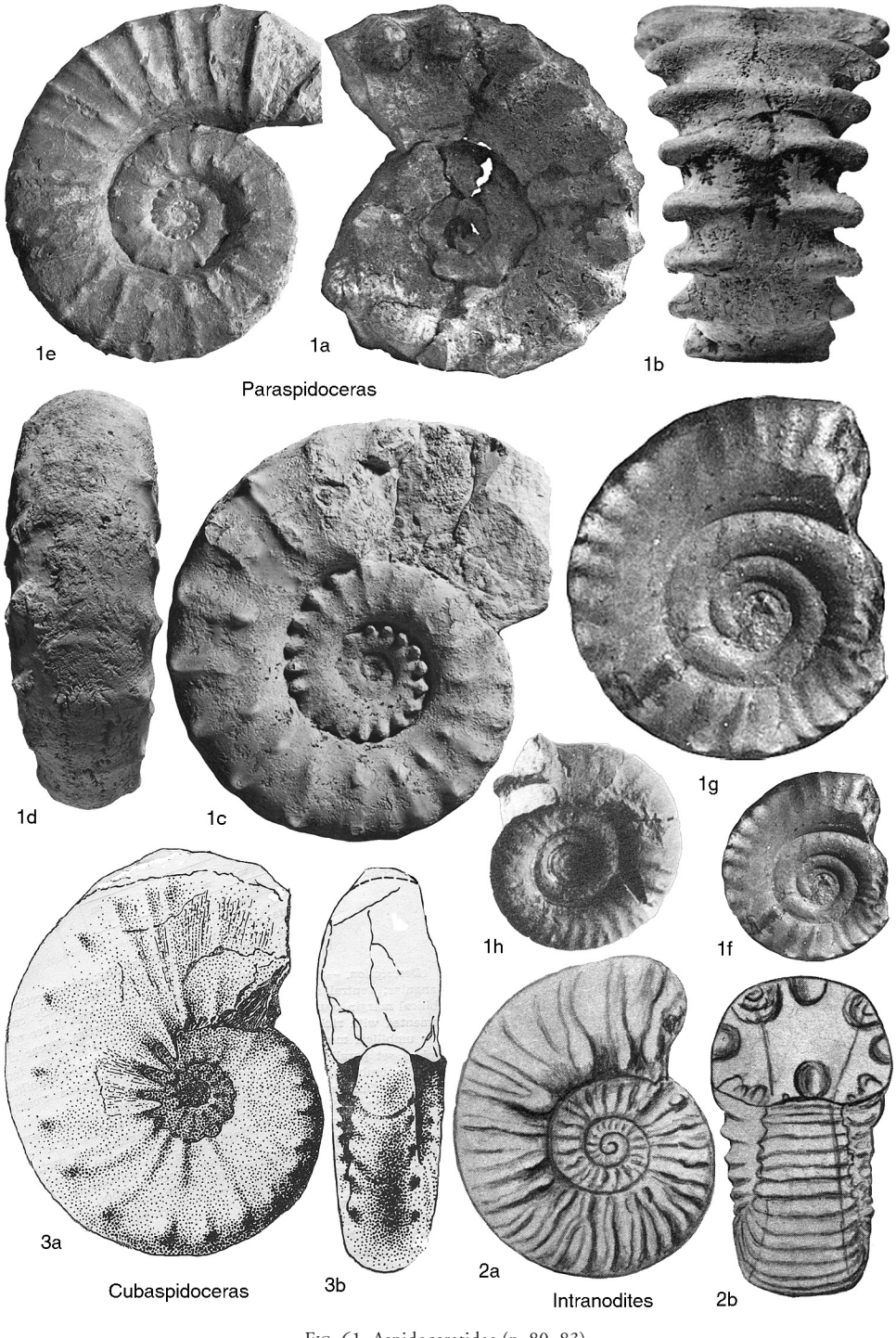

FIG. 61. Aspidoceratidae (p. 80–83).

by HANTZPERGUE (1989) for the successive occurrences of lower and upper Kimmeridgian unituberculate forms, which would be descendants of bituberculate *Aspidoceras.* On the contrary, SCHWEIGERT (1997) assumed that some of these are members of the same lineage known from the upper Oxfordian (*Bimammatum* Zone) to the lower Tithonian (*Semiforme* or *Verruciferum* Zone). Another much discussed question concerning the dimorphism has made progress over the past few years (GEYSSANT, 1994). HANTZPERGUE assumed only a size dimorphism within the genus *Orthaspidoceras,* but in southern England co-occurrences of *Sutneria* first with *Aspidoceras* supports SCHWEIGERT's (1997) opinion that *Sutneria* (microconch) is the dimorph counterpart of *Aspidoceras* (macroconch). *Upper Jurassic (upper Oxfordian)–Lower Cretaceous (Berriasian):* worldwide, but mainly Tethyan.

Aspidoceras ZITTEL, 1868, p. 58, 116 [**Ammonites rogoznicensis* ZEJSZNER, 1846, pl. 4,*4;* M] [=*Acanthosphaerites* ROLLIER, 1922, p. 360 (type, *Aspidoceras acanthicum* OPPEL, 1863 in OPPEL 1862–1863, p. 219, SD ARKELL, 1940, p. lxvii)] [=*Sutneria* ZITTEL, 1884, p. 474 (type, *Nautilus platynotus* REINECKE, 1818, p. 72, SD MUNIER-CHALMAS, 1892, p. CLXXI); =*Enosphinctes* SCHINDEWOLF, 1925, p. 324 (type, *Sutneria subeumela* SCHNEID, 1915a, p. 124, OD)]. Large or small-sized, rounded quadrate or depressed, bituberculate, the outer row soon fading or not, some species ribbed. *Upper Jurassic (upper Oxfordian)–lower Cretaceous (Berriasian):* worldwide.

A. (Aspidoceras). Evolute to fairly involute, small to large size, whorls rounded-quadrate or depressed, venter rounded, two rows of tubercles, the inner on the umbilical edge being present until the end, the outer near middle of whorl side and soon fading in many species. Microconch (*Sutneria*) dwarf planulate, compressed or coiled eccentrically, with involute depressed whorls; falcoid ribbing bifurcate or fasciculate, the secondaries more or less rursiradiate, changing on the body chamber to strong primaries that end in ventrolateral tubercles; the venter smooth or with a median groove in some species (e.g., *Enosphinctes*); small, pointed lappets. *Upper Jurassic (Oxfordian,* Bimammatum *or* Planula *Zone)–lower Cretaceous (Berriasian,* Jacobi *Zone):* Europe (including southern England), Russia, Ukraine (Crimea), northern Africa, Turkey, Ethiopia, Somali, Kenya, Tanzania, Iran, India, Nepal, New Zealand, Mexico, USA (Texas), Cuba, Argentina.——FIG. 62,*1a–b.* **A. rogoznicense* (ZEUSCHNER), lectotype, lower Tithonian, Rogoznik, Poland, ×1 (Zittel, 1868, pl. 24,*5a–b*).——FIG. 62,*1c–d. A. sesquinodosum* (DUMORTIER & FONTANNES), Kimmeridgian, Mount Crussol, Ardèche, France, ×1 (Dumortier & Fontannes, 1876, pl. 18,*6*).——FIG. 62,*1e. S. galar* (OPPEL), Basal Schwarzbach Formation, Oxfordian, *Planula* Zone, Summerhalde quarry, Schaffhausen, Switzerland, ×1.5 (Gygi, 2000, fig. 13,*3*).——FIG. 62,*1f–i. S. platynota* (REINECKE); *f–h,* Baden, Switzerland, ×1 (De Loriol, 1878 in 1876–1878, pl. 15,*2a–c*); *i,* lower Schwarzbach Formation, Kimmeridgian, *Platynota* Zone, Schaffhausen, Switzerland, ×1.5 (Gygi, 2000, pl. 13,*2*).——FIG. 62,*1j–k. S. subeumela* (SCHNEID), Weisser Malm ζ, Welheim, Bavaria, Germany, ×1 (Schneid, 1915a, pl. 6,*7a–b*).

A. (Pseudowaagenia) SPATH, 1931, p. 621 [**Ammonites haynaldi* NEUMAYR, 1873, p. 194; SD ARKELL, 1940, p. lxvii). Small to medium sized, evolute to fairly involute; whorl compressed, venter rounded, and abrupt umbilical edge with small, closely spaced inner tubercles directed towards the umbilicus; outer tubercles only occasionally present in some species. *Upper Jurassic (?Oxfordian,* Bimammatum *Zone–upper Kimmeridgian,* Beckeri *Zone):* southern Europe, Madagascar, India, Nepal.——FIG. 62,*2a–b.* **A. (P.) haynaldi* (NEUMAYR), holotype, Tithonian, Csofronka, Ardeal (=Siebenbürgen), Transylvania, Romania, ×1 (NEUMAYR, 1873, pl. 42,*3*).

Orthaspidoceras SPATH, 1925a, p. 118 [**Ammonites orthocera* D'ORBIGNY, 1850 in 1842–1851, p. 556; OD] [=*Benetticeras* CHECA & OLORIZ, 1984, p. 398 (*nom. nud.*); =*Benetticeras* CHECA, 1985, p. 141 (type, *B. benettii,* OD)]. Involute, large to medium sized, whorl section depressed; a single row of median tubercles directed towards the umbilicus, depending on the species, and fine radial lines sometimes accentuated or raised as folds; size dimorphism within the genus according to HANTZPERGUE (1989). *Upper Jurassic (Kimmeridgian):* Europe, Somali, Madagascar.——FIG. 64,*1a–d.* **O. orthocera* (D'ORBIGNY), lectotype, Gyé-sur-Seine, Aube, France; *a–b,* original drawing, ×0.33 (d'Orbigny, 1848 in 1842–1851, pl. 218,*1–2*); *c–d,* ×0.41 (new; Muséum National d'Histoire Naturelle, Paris, MNHN R03200; figured by Hantzpergue in Fischer & others, 1994, pl. 80,*3a–b*).

Physodoceras HYATT, 1900, p. 582 [**Ammonites circumspinosus* OPPEL, 1863 in OPPEL 1862–1863, p. 222; OD] [=*Anaspidoceras* VIGH, 1984, p. 72 (178) (type, *Ammonites neoburgensis* OPPEL, 1863 in 1862–1863, p. 223, OD); =*Schaireria* CHECA & OLORIZ, 1984, p. 398 (*nom. nud.*); =*Schaireria* CHECA, 1985, p. 184 (type, *Aspidoceras avellanum*

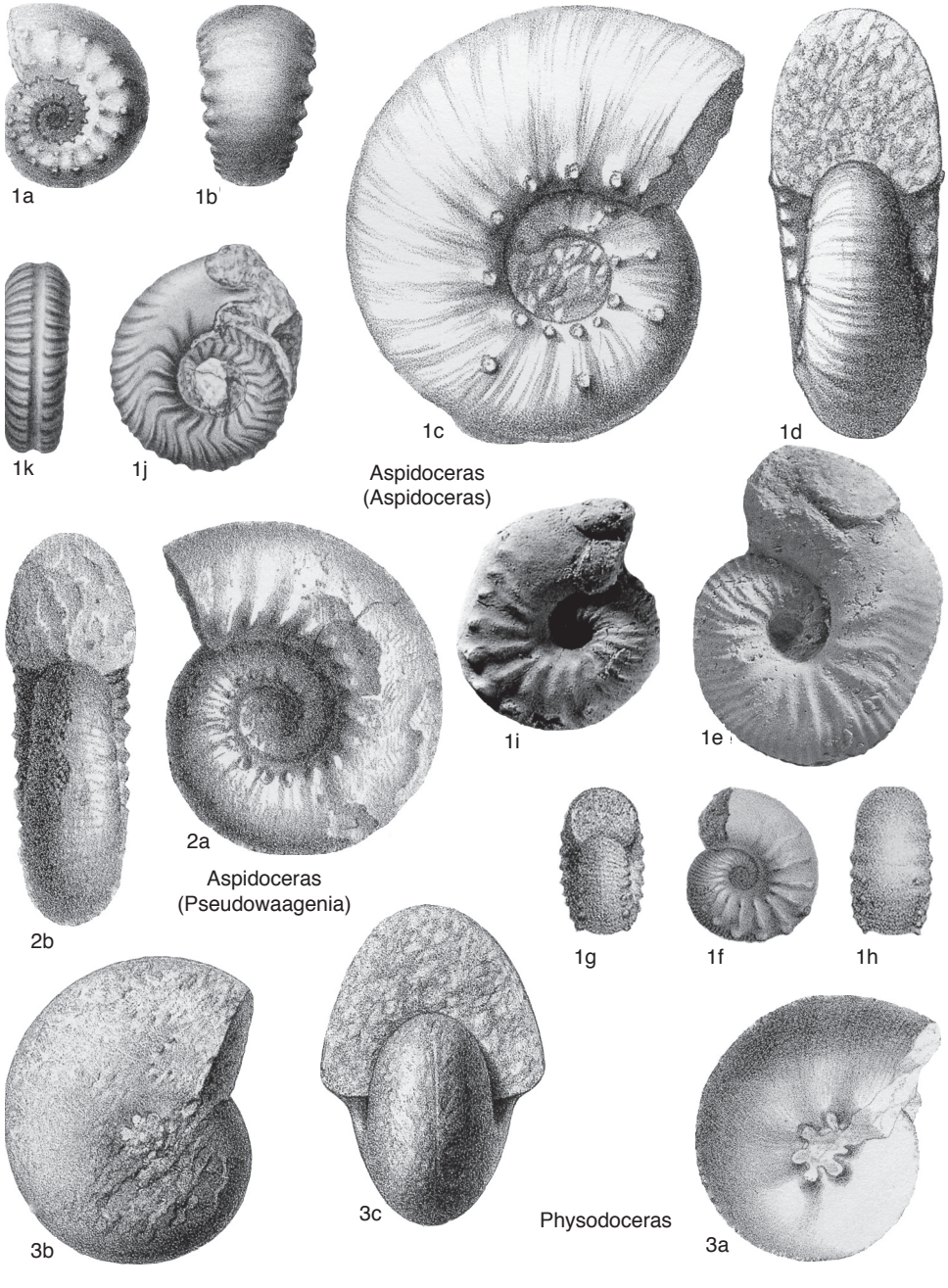

FIG. 62. Aspidoceratidae (p. 85–87).

ZITTEL, 1869, p. 149; ZITTEL, 1870, p. 86, OD); =*Chinamecaceras* CANTÚ CHAPA, 2006, p. 299 (type, *C. maldonai,* OD)]. Small to large, involute and globular, the whorl depressed and smooth with inner row of umbilical spines directed inward over the umbilicus; supposed size dimorphism. *Upper Jurassic (Kimmeridgian)–Lower Cretaceous (Berriasian,* Jacobi *Zone):* Europe, Russia, Ethiopia, Kenya, Madagascar, India, Nepal, Mexico, USA (Texas), Cuba.——FIG. 62,3*a–c. *P. circumspinosum*

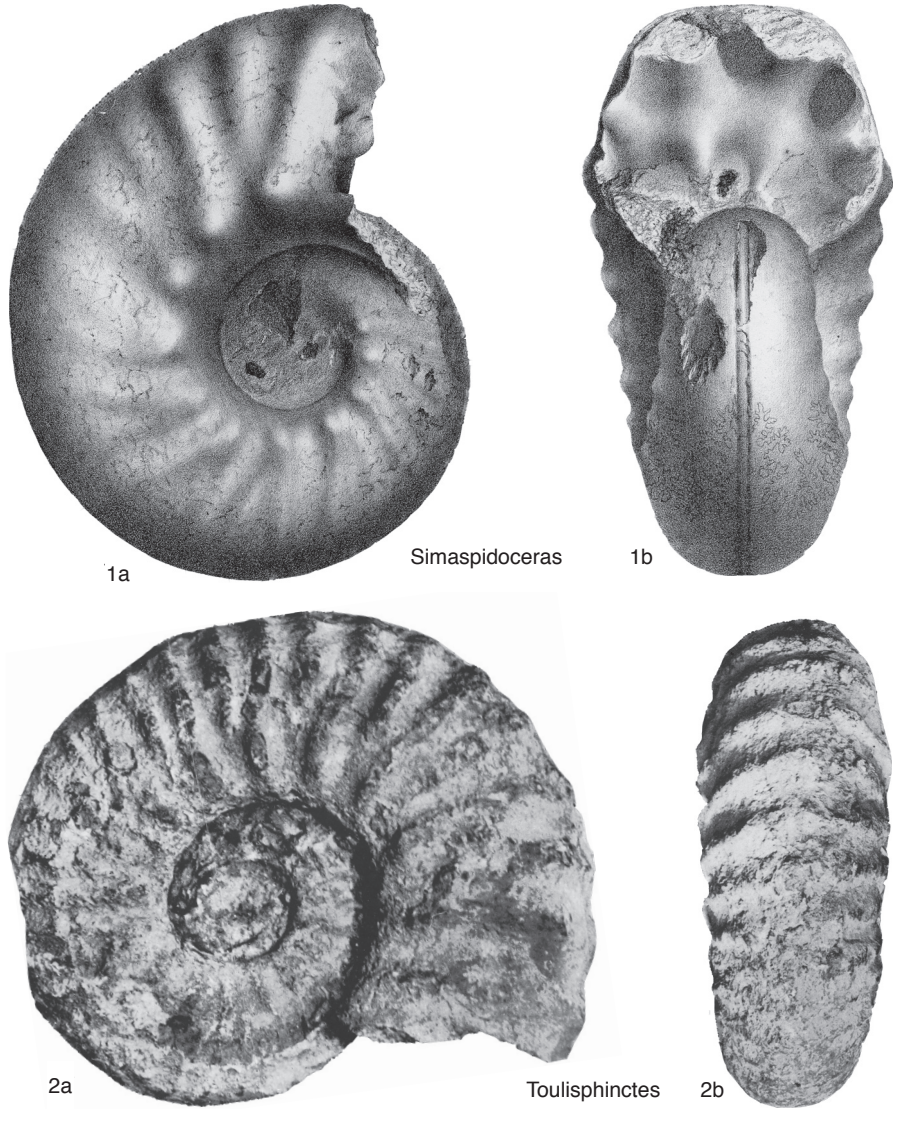

FIG. 63. Aspidoceratidae (p. 87–89).

(OPPEL); *a,* holotype, Weisse Jura γ, Donzdorfer Steige, Germany, ×1 (Quenstedt, 1858 in 1856–1858, pl. 75,*8*); *b–c,* Mount Crussol, Ardèche, France, ×1 (Fontannes, 1879b, pl. 13,*4–5*).

Simaspidoceras SPATH, 1925a, p. 118 [**Aspidoceras argobbae* DACQUÉ, 1905, p. 151; OD]. Shell large with quadrate or subquadrate whorl section; deep umbilicus and steep umbilical wall with blunt tubercles on the umbilical edge from which branch broad and rounded ribs ending on the ventrolateral region increasingly prominent with age. Suture complex. ?Subgenus of *Physodoceras. Upper Jurassic (lower Kimmeridgian):* Somalia, Ethiopia, Kenya, Yemen, Madagascar.——FIG. 63,*1a–b. *S. argobbae* (DACQUE), lectotype (designated by SPATH, 1925a, p. 118), Atschabo, Somalia, ×0.48 (Dacqué, 1905, pl. 18,*1a–c*).

Glabrophysodoceras SCOTT, 1943, p. 82 [**G. abyssinianum;* OD]. Involute and smooth physodoceratid, *Haploceras*-like, whorls ovate in cross section, the flanks and venter rounded; blunt, feeble tubercles around the umbilical border and broad, indistinct, distantly spaced ribs. ?Subgenus of *Physodoceras. Upper Jurassic (lower Kimmeridgian):* Ethiopia.——FIG. 64,*3a–b. *G. abyssinianum,* holotype, Dire Dawa, Harrar, Ethiopia, ×0.5 (Scott, 1943, pl. 21,*1,4*).

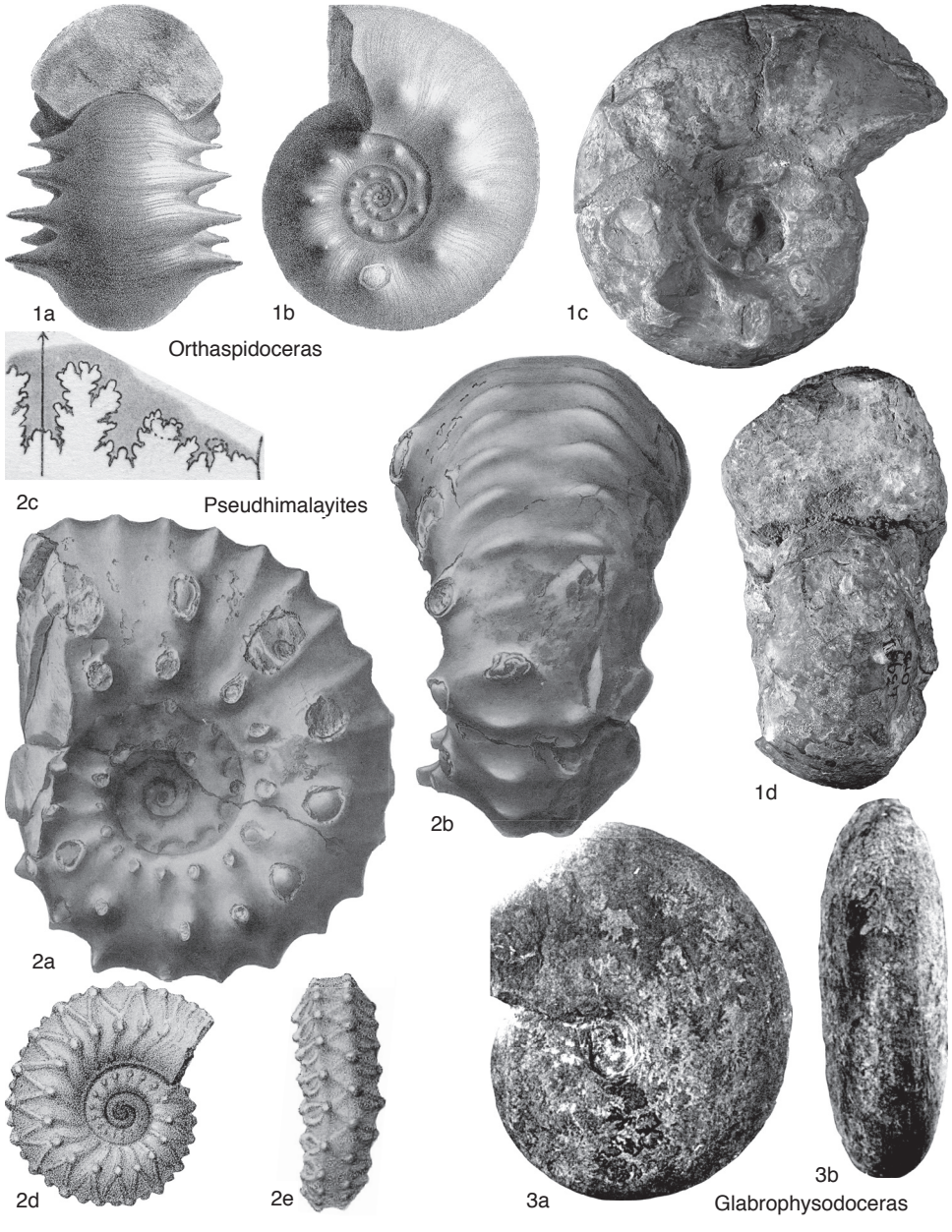

FIG. 64. Aspidoceratidae (p. 85–89).

Pseudhimalayites SPATH, 1925a, p. 118 [**Aspidoceras steinmanni* HAUPT, 1907, p. 189; OD; ?=*Cosmoceras subpretiosum* UHLIG, 1878, p. 657, *vide* SCHWEIGERT, 1997, p. 6)] [=*Simocosmoceras* SPATH, 1925a, p. 132 (type, *Ammonites adversus* OPPEL, 1865, p. 552; ZITTEL, 1870, p. 99, OD]. Inflated, involute, with thick, depressed whorls and deep umbilicus; two rows of tubercles, the inner umbilical smaller and developed later than the outer lateral; vague primary ribs and strong secondaries rising to transverse bullae on the venter on both sides of the median ventral groove. Microconch (*Simocosmoceras*) small, planulate-compressed, the inner whorls with bifurcate or fasciculate falcoid ribs; adult tuberculate with median lateral tubercles at

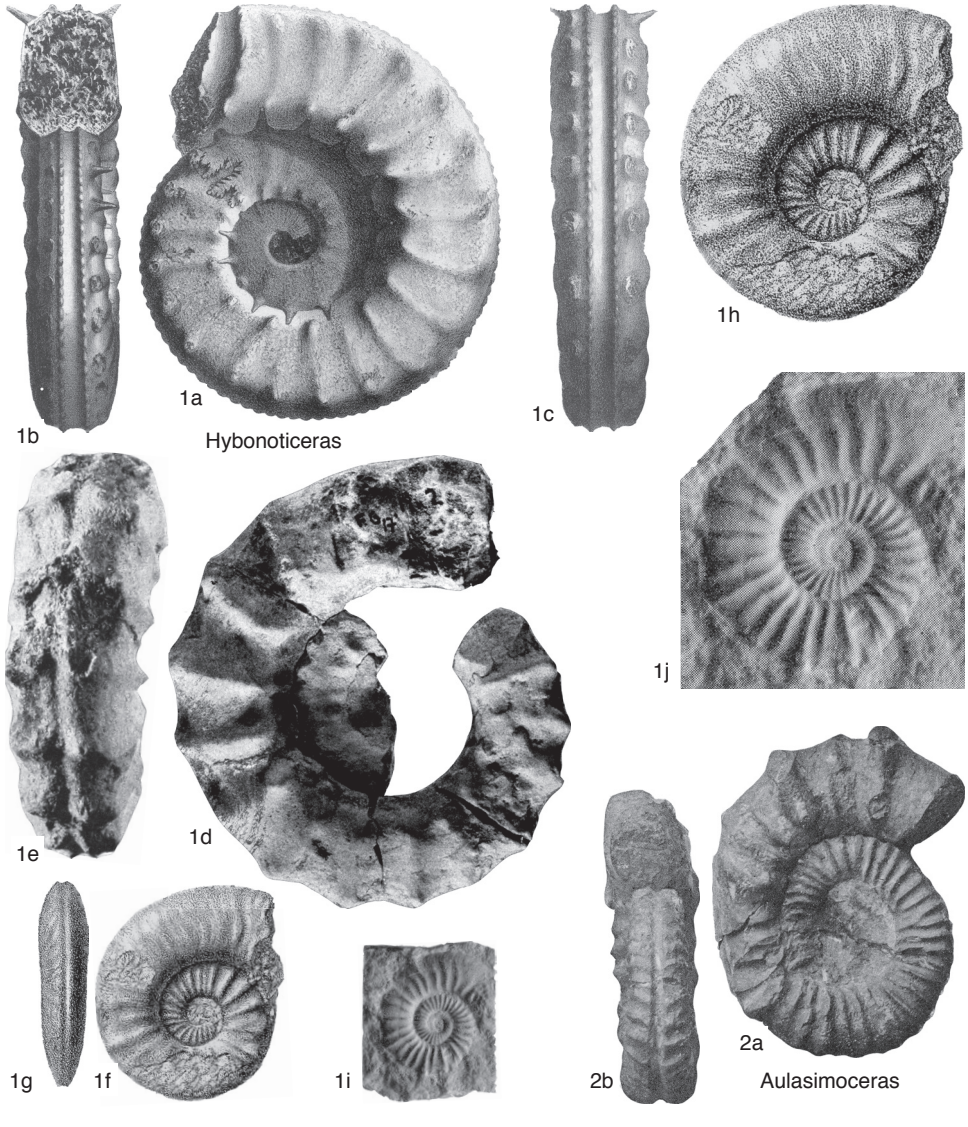

FIG. 65. Aspidoceratidae (p. 90).

the branching, the ventrolateral on both sides of the tabulate or concave venter, smooth or feebly ribbed. Secondaries looped and forming zigzag structure on the venter in the type species. Aperture with short lappets. *Upper Jurassic (lower Tithonian,* Semiforme/Verruciferum, Fallauxi *Zones*): Germany, southeastern France, Spain, Italy, Poland, Hungary, Cuba, Argentina.——FIG. 64,*2a–c. *P. steinmanni* (HAUPT), holotype, unknown locality, Argentina, ×0.5 (Haupt, 1907, pl. 7,*1a–c*).——FIG. 64,*2d–e. P. adversum* (OPPEL), holotype, Rogoznik, Poland, ×2 (Zittel, 1870, pl. 7(31),*10a–b*).

Toulisphinctes SAPUNOV, 1979, p. 106 [**T. ziegleri;* OD]. Very large form, whorl quadrate or depressed; coarse and strong ribbing, with two rows of tubercles, the outer lateral more numerous than the inner umbilical; secondaries crossing the venter without any change, but tendency to form bullae occurring in the type species on the ending part of the last whorl. *Upper Jurassic (lower Tithonian):* Bulgaria, Mexico, Argentina.——FIG. 63,*2a–b. *T. ziegleri,* holotype, Glożéné Formation, lower Tithonian, Glożéné, Bulgaria, ×0.15 (Sapunov, 1979, pl. 28,*1a–b*).

Subfamily HYBONOTICERATINAE Oloriz, 1978

[*nom. correct. pro* Hybonoceratinae Oloriz, 1978a, p. 332, original spelling corrected under the provisions of ICZN Code, 1999, Art. 32.5.3.2] [=Hybonoticeratinae Callomon, 1981 in Donovan, Callomon, & Howarth, p. 149, obj.]

The subfamily is derived from the Aspidoceratidae via *Pseudowaagenia* and the ventral groove is the only distinguishing feature of the earliest representative (*Hybonoticeras pressulum*) of the subfamily. Cecca (1997) suggested that the Hybonoticeratinae were possible ancestors of *Protancyloceras* and the Late Jurassic to Early Cretaceous uncoiled ammonites of the Subfamily Protancyloceratinae, because of a similar ventral groove and strong, raised ribs. But, according to Sarti (1999), a ventral groove is missing in the earliest *Protancyloceras* from the lower Tithonian, lower *Hybonotum* Zone, and a different origin from *Berckhemeria* (Passendorferiinae) was proposed by Schweigert and Zeiss (1998). *Upper Jurassic (Kimmeridgian–Tithonian):* Tethyan.

Hybonoticeras Breistroffer, 1947, p. 100, *nom. nov. pro Waagenia* Neumayr, 1878, p. 70, *non* Kriechbaumer, 1874 (Hymenoptera), *nec* Bayle, 1878 (=*Sonninia* Bayle in Douvillé, 1879) [**Waagenia hybonota* Oppel, 1863, in 1862–1863, p. 254, pl. 71,*1–4;* OD] [=*Hybopeltoceras* Oloriz, 1977, p. 2 (type, *H. linaresi,* OD); =*Hybonotella* Berchkhemer & Hölder, 1959, p. 34 (type, *Ammonites mundulus* Oppel, 1865, p. 547, SD Oloriz, 1978a, p. 365]. Small to medium sized, evolute, compressed; nearly smooth, but umbilical tubercles and growth lines or ribs, the ribs either simple and distant, bifurcate or trifurcate from umbilical tubercles, some ending at or looped to ventrolateral tubercles or spines; venter with a deep median groove, smooth, bicarinate, with keels either smooth or beaded; some species (e.g., *Hybopeltoceras*) strongly ribbed and with depressed *Peltoceras*-like whorl section. Suture with an asymmetrical ventral lobe. Microconch (*Hybonotella*) small, evolute, and compressed; ribs first radiate and simple, then geminate with spinous tubercles, the density and sinuosity variable; the body chamber smooth or ribbed; short, pointed lappets. *Upper Jurassic (upper Kimmeridgian,* Beckeri *Zone–lower Tithonian,* Hybonotum *Zone):* Germany, southeastern France, Spain, Morocco, northern Africa, Turkey, Somalia, Ethiopia, Kenya, Madagascar, Yemen, India (Kutch), Himalaya, Cuba, Mexico.——Fig. 65,*1a–c. *H. hybonotum* (Oppel), Volano, Italy, ×0.4 (Benecke, 1865, pl. 11,*1a–c*).——Fig. 65,*1d–e. H. linaresi,* holotype, lower Tithonian, Sierra Cabra, southern Spain, ×0.4 (Oloriz, 1977, fig. *2a–b*).——Fig. 65,*1f–h. H. (H.) mundulum mundulum* (Oppel), Calcaires du Château Formation, Crussol, Ardèche, France; *f–g,* ×1; *h,* ×2 (Fontannes, 1879b, pl. 12,*3a, b*).——Fig. 65,*1i–j. H. (H.) mundulum striatulum* (Berckhemer & Hölder), *Lithographicum* Zone, Calcaires du Château Formation, Crussol, Ardèche, France; *i,* ×1; *j,* ×2 (Hölder & Ziegler, 1959, pl. 20,*6*).

Aulasimoceras Spath, 1931, p. 643 [**Waagenia auberti* Pervinquière, 1907, p. 35; OD]. Evolute, broad umbilicus, whorl quadrate; inner whorls with strong ribs issued from umbilical tubercles, simple or geminate; the outer whorl more compressed, with coarse ventrolateral tubercles and deep ventral groove, without bordering keels, beaded or not. *Upper Jurassic (lower Tithonian,* Hybonotum/Lithographicum *and* Darwini *Zones):* Tunisia, Algeria, Italy (Sicily), Spain.——Fig. 65,*2 a–b. *A. auberti* (Pervinquière), holotype, Ammonitico Rosso, Tithonian, Jebel Zaghouan, Tunisia, ×1 (Pervinquière, 1907, pl. 2,*8a–b*).

Family AULACOSTEPHANIDAE Spath, 1924

[Aulacostephanidae Spath, 1924, p. 13] [=Pictonidae Spath, 1924, p. 13; =Raseniinae Schindewolf, 1925, p. 333; =Involuticeratidae Sasonov, 1960, p. 134; =Ilovaiskiceratidae Sasonov, 1960, p. 142]

This family is a well-defined branch of the main perisphinctid tree derived from middle Oxfordian ancestors (e.g., *Liosphinctes*). Several offshoots followed one another during late Oxfordian and Kimmeridgian times, some rather restricted to the Subboreal regions of northern Europe and Greenland, the others occurring mainly in the Submediterranean southern Europe. Phylogenetic relationships between them are still unclear. Although being closely delimited, the family covers a wide range of morphologies. It leads back to such perisphinctid forms as *Ringsteadia* or *Pictonia* with evolute or involute coiling, compressed or rounded whorl section and smooth, regular ribbing crossing the venter without interruption. Contrasting with these, end forms like *Aulacostephanus* show a quite different appearance, with compressed, angular whorl section; strong ribbing; and smooth, tabulate or grooved venter, and resemble the Cretaceous genus *Hoplites* (to which they were previously assigned). These are extreme forms displaying a wide range of variation in coiling and ornamentation style. Dimorphism is well expressed in the family; microconchs small sized and ribbed to the aperture with lappets;

macroconchs larger and the last outer whorl either smooth or nearly smooth or with strong and coarse ribbing. *Upper Jurassic (upper Oxfordian–Kimmeridgian):* Europe, Greenland, ?Mexico.

Decipia Arkell, 1937a, p. 68 [**Ammonites decipiens* J. Sowerby, 1821a, p. 169; OD]. The innermost whorls with sheaves of triplicate dischizotomous ribs, the secondaries not visible in the umbilicus, intercalatories being present or not. Later whorls have ribs, some bifurcated, the secondaries crossing the venter with a gentle forward sweep and regular intercalatories. Later ribbing modifies gradually to distant swollen primaries on the outer whorl. *Upper Jurassic (upper Oxfordian):* England.——Fig. 66,*1a–c. *D. decipiens* (J. Sowerby), upper Oxfordian, *Decipiens* Zone; *a–b,* holotype, Drift, Highgate Hill, London, England, ×0.5 (Arkell, 1937b, pl. F,*2a–b*); *c,* nuclei, Ampthill Clay, Lincolnshire, England, ×0.5 (Arkell, 1937b, pl. F,*4b*).

Ringsteadia Salfeld, 1913, p. 427 [**Ammonites pseudocordatus* Blake & Huddleston, 1877, p. 392; OD] [=*Microbiplices* Arkell, 1936, p. xli (type, *Ammonites microbiplex* Quenstedt, 1887 in 1882–1888, p. 876, OD); =*Vielunia* Wierzbowski & Głowniak in Wierzbowski, Głowniak, & Pietras, 2010, p. 70 (type, *V. dzalosinensis,* OD)]. Small or large, the maximum diameter up to 400 mm, very involute and discoidal to fairly evolute, planulate; whorl section first rounded, then changing to flattened oval or rounded-triangular. Inner whorls with rounded primary ribs, the secondaries arising often in sheaves of three or more. Ribbing preserved up to the aperture in some small-sized species, but in large species fading gradually before the end of the phragmocone. Outer whorl and body chamber smooth or covered with coarse, swollen ribs. Large forms with a stronger development of the secondary ribs, appearing lower on the whorl side and persisting up to larger diameter have been distinguished as a new genus (e.g., *Vielunia*); small-sized microconchs, first with the same morphology as the macroconch, but aperture bearing lappets, then (*Microbiplices*) evolute, whorl section circular to depressed and few, coarse, biplicate, rounded ribs and strong, straight secondaries crossing the venter, often in zigzag arrangement, the body chamber one whorl long, the ribbing unchanged until the aperture with lappets. *Upper Jurassic (upper Oxfordian,* Pseudocordata *Zone):* Subboreal Province; *Upper Jurassic (upper Oxfordian,* Bimammatum *and* Planula *Zones):* Submediterranean Province, Scotland, England, France (Normandy, southeastern region), Switzerland, Germany, Poland, southern Russia.——Fig. 66,*2a–b. *R. pseudocordata* (Blake & Huddleston), holotype, upper Oxfordian, *Pseudocordata* Zone and Subzone, Upper Calcareous Grit, Westbury, Wilts, England, ×0.25 (Buckman, 1925a, pl. 560*A–B*).——Fig. 66,*2c–d. R. caledonica* Sykes & Callomon, upper Oxfordian, *Pseudocordata* Zone, *Caledonica* Subzone, Staffin, Scotland; *c,* holotype, macroconch, test preserved, ×0.5; *d,* complete microconch with lappet, ×1 (Sykes & Callomon, 1963, pl. 121,*8–9*).——Fig. 66,*2e. R. dzalosinensis,* holotype, upper Oxfordian, *Planula* Zone, Raciszyn, Wielun Upland, Poland, ×1 (Wierzbowski, Głowniak, & Pietras, 2010, pl. 9,*1*).——Fig. 66,2*f–h. R. microbiplex* (Quenstedt), holotype, upper Oxfordian, *Bimammatum* Zone, Lochengrundle, Swabia, Germany, ×1 (Quenstedt, 1887 in 1887–1882, p. 876, pl. 94,*36*).——Fig. 66,*2i. R. anglica* (Arkell, 1947, p. 378), complete microconch, Sandfoot Grit, upper Oxfordian, *Pseudocordata* Zone and Subzone, Black Head, Dorset, England, ×1 (Wright, 2010, pl. 1,*8*).

Vineta Dohm, 1925, p. 33 [**V. jaekeli;* OD] [=*Balticeras* Dohm, 1925, p. 34 (type, *B. pommerania* Dohm, 1925, p. 34, SD Arkell in Arkell & others, 1957, p. 324), *nom. nov. pro Baltia* Dohm, 1925, p. 25 (*nom. nud.*), *non Baltia* Moore, 1878, p. 228 (Lepidoptera)]. Large form, involute to fairly involute, the whorl section compressed; inner whorl with dense ribbing and prorsiradiate primary ribs, the secondaries first rectiradiate, then stronger and prorsiradiate; whereas the primaries fade and the outer whorls are smooth. Constrictions on the inner whorls. *Upper Jurassic (upper Oxfordian,* Bimammatum *Zone–lower Kimmeridgian,* Hypselocyclum *Zone):* Poland, Switzerland, Germany, southeastern France.——Fig. 67,*4a. *V. jaekeli,* holotype, Czarnoglowy (formerly Zarnglaff), northwestern Poland, ×0.25 (Dohm, 1925, pl. 4,*4*).——Fig. 67,*4b. V. pommerania* (Dohm), holotype, Czarnoglowy (formerly Zarnglaff), northwestern Poland, ×0.25 (Dohm, 1925, pl. 5,*2*).——Fig. 67,*4c. V. weinlandi* Fischer, holotype, Weiss Jura γ, lower Kimmeridgian, *Platynota* Zone, Tieringen, Swabian Alb, Germany, ×0.5 (Fischer, 1913, pl. 5,*15*).

Pictonia Bayle, 1878, pl. 66 [**Pictonia baylei* Salfeld, 1913, p. 423; SD Salfeld, 1917, p. 73, ICZN Opinion 426, 1956, p. 259; see Arkell, 1951b, p. 178–180, for explanation of this complicated designation of the type species][=*Triozites* Buckman, 1923a, pl. 394 (type, *T. seminudatus,* OD); ?=*Colladites* Cantú-Chapa, 1967a, p. 5–6 (type, *Pictonia (C.) granadillense*, OD); =*Pictonites* Mesezhnikov, 1969, p. 105 (type, *Rasenia perisphinctoides* Wegele, 1929, p. 81, OD)]. Medium sized macroconchs, with ribbing fading rapidly on outer whorls. *Upper Jurassic (lower Kimmeridgian):* Europe, Asia, mainly Boreal regions.

P. (**Pictonia**)**.** Fairly evolute to evolute, whorl section high, oval to quadrate. Ribbing restricted to the innermost and middle whorls, at first perisphinctid-like, then strong bifurcate or trifurcate primaries, fading rapidly before the end of the phragmocone, the body chamber covered by fine growth lines; collared and flared constrictions on the middle whorls; aperture simple. Simplified suture line with retracted suspensive lobe. It is not necessary to distinguish

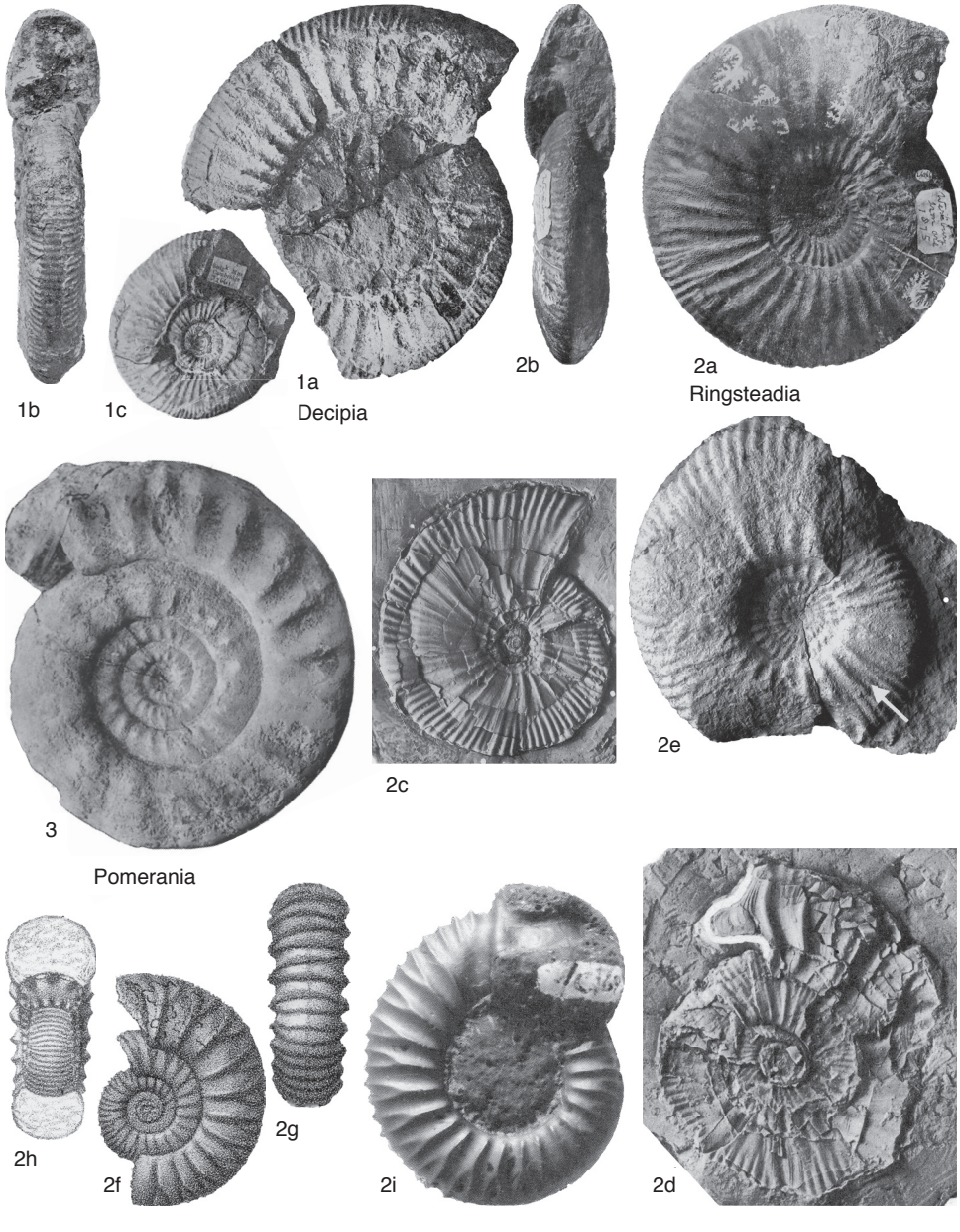

FIG. 66. Aulacostephanidae (p. 91–93).

the involute Submediterranean analogues of true *Pictonia* from the Subboreal and Boreal regions as a subgenus (*Pictonites*). *Upper Jurassic (lower Kimmeridgian):* England, France (Normandy), Germany, Poland, Russia, ?Mexico.——FIG. 67,*1a–b.* **P. baylei* (SALFELD); *a,* holotype, lower Kimmeridgian, *Baylei* Zone, Calcaires coquilliers, Cap la Hève, Le Havre, France, ×0.5 (Bayle, 1878, pl. 66,*1a*); *b,* topotype, same bed and locality, ×0.25 (Hantzpergue, 1987, 1989, pl. 20,*a;* Guyader Collection, Musée d'Histoire Naturelle, Le Havre, France).——FIG. 67,*1c. P. perisphinctoides* (WEGELE), *Bimammatum* Zone, Spielberg, Franconia, Germany, ×1 (Schneid, 1940 in 1939–1940, p. 88, pl. 7,*2*).

P. (Mesezhnikovia) WIERZBOWSKI & ROGOV 2013, p. 1100 [**Pictonia (Pictonia) involuta* MESEZHNIKOV, 1969, p. 104; OD]. Medium sized; as in

Pictonia, constrictions bordered by flared and collared ribs, but coiling more involute and ribbing fading first on inner side of the whorl, then on outer side, final part of last whorl smooth. Microconch unknown. *Upper Jurassic (lower Kimmeridgian,* Involuta *[more or less equivalent to the* Baylei*] Zone):* Russia (subpolar Urals, northern and central Siberia).——Fig. 67,*2a–b. *P. (M.) involuta* (Mesezhnikov), holotype, River Boyarka, approximately 70°36′N, 94°19′E, Krasnoyarsk Krai, Russia ×0.75 (Mesezhnikov, 1969, pl. 1,*1,1a*).

?Pomerania Arkell, 1937a, p. 69 [**P. dohmi, nom. nov. pro Pictonia baylei* Dohm, 1925, p. 32, *non* Salfeld, 1913, p. 423; OD]. Outer whorl with simple, large, swollen primaries similar to *Lithacosphinctes;* inner whorls assumed to be *Decipia*-like, but still unknown in the type and related species of the type area. Assignment to the Aulacostephanidae is disputable; possibly a senior synonym of *Lithacosphinctes. Upper Jurassic (upper Oxfordian,* Bimammatum–Planula *Zones):* Poland.——Fig. 66,*3. *P. dohmi,* holotype, Czarnoglowy (formerly Zarnglaff), Pomerania, northwestern Poland, ×0.75 (Dohm, 1925, pl. 5,*6*).

Pachypictonia Schneid, 1940 in 1939–1940, p. 89 [**Pictonia indicatoria;* OD]. Large and fairly evolute, whorl section oval-rounded; coarsely ribbed, the inner whorls with strong prorsiradiate primary ribs; the outer whorl with coarse, distant, wedge-shaped ribs. *Upper Jurassic (uppermost Oxfordian,* Galar *Zone–lower Kimmeridgian,* Hypselocyclum *Zone):* Poland, Russia, Germany, Switzerland, France.——Fig. 67,*3. *P. indicatoria,* holotype, Malm γ_2, *lower Kimmeridgian, Hypselocyclum* Zone, Zeegendorf, Franconian Alb, Germany, ×0.25 (Schneid, 1940 in 1939–1940, p. 90, pl. 4,*1*).

Rasenia Salfeld, 1913, p. 429 [**Rasenia involuta* Spath, 1935, p. 48, pl. 10,*5a–b;* SD ICZN Opinion 426, 1956, p. 259, see Arkell, 1951b] [=*Uralia* Sasonov, 1957, p. 72 (type, *Ammonites uralensis* d'Orbigny, 1845, p. 429, OD), *non* Mulsant & Verreaux, 1866 (Aves), *nec* Licharew, 1925 (Brachiopoda), *nec* Martynova, 1976 (Insecta), *nec* Kukalova-Peck & Sinichenkova, 1992 (Insecta); =*Zonovia* Sasonov, 1960, p. 148 (type, *Ammonites uralensis* d'Orbigny, 1845, p. 429, OD)]. Middle or small-sized, fasciculate ribbing with strong or fine and dense ribs, fading (macroconch) or not (microconch) on the outer whorl. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian).* Europe, Asia, mainly Boreal regions.

R. (Rasenia). Dimorphic; small (40–70 mm) or fairly large (up to 250 mm), evolute coarse-ribbed forms, overlapping and inflated inner whorls; sinuous primary ribs usually strong and bullate and giving rise to three to four, fasciculate secondaries passing over the venter without interruption; ribbing preserved unmodified up to the end of the body chamber and aperture constricted with lappets (microconch) or ornament fading at variable diameters, with primaries fading before the secondaries or secondaries fading first, or both reduced simultaneously; body chamber feebly ribbed with simple, blunt radial ribs, sometimes biplicate, aperture simple (macroconch; e.g., *Zonovia*). *Jurassic (lower Kimmeridgian,* Cymodoce *Zone):* England, Scotland, Norway, Greenland, Spitzberg, Russia (western region, northern Urals, western and northern Siberia).——Fig. 68,*1a–c. *R. involuta* (Spath), lower Kimmeridge Clay; *a–b,* lectotype, microconch, Market Rasen, Lincolnshire, England, ×1 (Spath, 1935, pl. 10,*5a–b*); *c,* complete adult macroconch, Westbury, Wilts, England, ×0.37 (Birkelund & others, 1983, fig. 4B).——Fig. 68,*1d–e. R. uralensis* (d'Orbigny), holotype, Russia, ×0.75 (d'Orbigny, 1845, p. 429, pl. 32,*6–7*).

R. (Rasenioides) Schindewolf, 1925, p. 335 [**Nautilus striolaris* Reinecke, 1818, p. 77, which Schindewolf interpreted from *Ammonites striolaris* Quenstedt, 1888 in 1882–1888, p. 967 (*partim*); OD] [=*Prorasenioides* Schindewolf, 1925, p. 338 (type, *P. transitorius, nom. nov. pro Ammonites striolaris* Quenstedt, 1888 in 1882–1888 (*partim*), p. 967, *non* Reinecke, see Schindewolf, 1926, p. 507, OD); ?=*Semirasenia* Geyer, 1961, p. 87 (type, *Ammonites moeschi* Oppel, 1863 in Oppel 1862–1863, p. 240, OD)]. Dimorphic; small sized or fairly large, involute to evolute, whorl section oval, nearly flat side and rounded venter, with dense and fine fasciculate ribbing, the primaries short, tuberculate, and prorsiradiate, splitting into two to eight, long, fine radial secondaries crossing the venter; microconch (e.g., type species) with lappets; macroconch with ribbing fading immediately after the end of the phragmocone (e.g., *Semirasenia*); some late specimens show a slight weakening in the middle of the venter, which points to a trend leading to *Aulacostephanus* (and subgenera). *Upper Jurassic (upper Oxfordian,* Planula *Zone–lower Kimmeridgian,* Hypselocyclum *Zone):* Scotland, England, France, Switzerland, Germany.——Fig. 68,*2a. *R. striolaris* (Reinecke), neotype, Weisse Jura, Mittel γ, Staffelberg, Franconia, Germany, ×1 (Geyer, 1961, pl. 21,*3*).——Fig. 68,*2b. R. moeschi* (Oppel), holotype, microconch, Baden, Aargau, Switzerland, ×1 (Geyer, 1961, pl. 8,*7*).——Fig. 68,*2c–d. R. lepidula* (Oppel), microconch, lower Kimmeridgian, *Uralensis* Zone, Eathie, Ross-Shire, Scotland, ×1 (Ziegler, 1963, pl. 111,*2–3*).

Prorasenia Schindewolf, 1925, p. 338 [**P. quenstedti, nom. nov. pro Ammonites bifurcatus* Quenstedt, 1887 in 1882–1888, p. 933; OD] [=*Desmosphinctes* Schindewolf, 1925, p. 325 (type, *Ammonites mniowniki* Nikitin, 1885, p. 42, OD); =*Ilovaiskiceras* Sasonov, 1960, p. 144, written erroneously as *Ilovaiskioceras* Sasonov, 1960, a typographic error corrected by Sasonov, 1961, p. 21 (type, *Ammonites anceps albus* Quenstedt, 1857 in 1856–1858, p. 617, OD, =*Ammonites stephanoides* Oppel, 1863 in Oppel 1862–1863, p. 237, *non Ammonites*

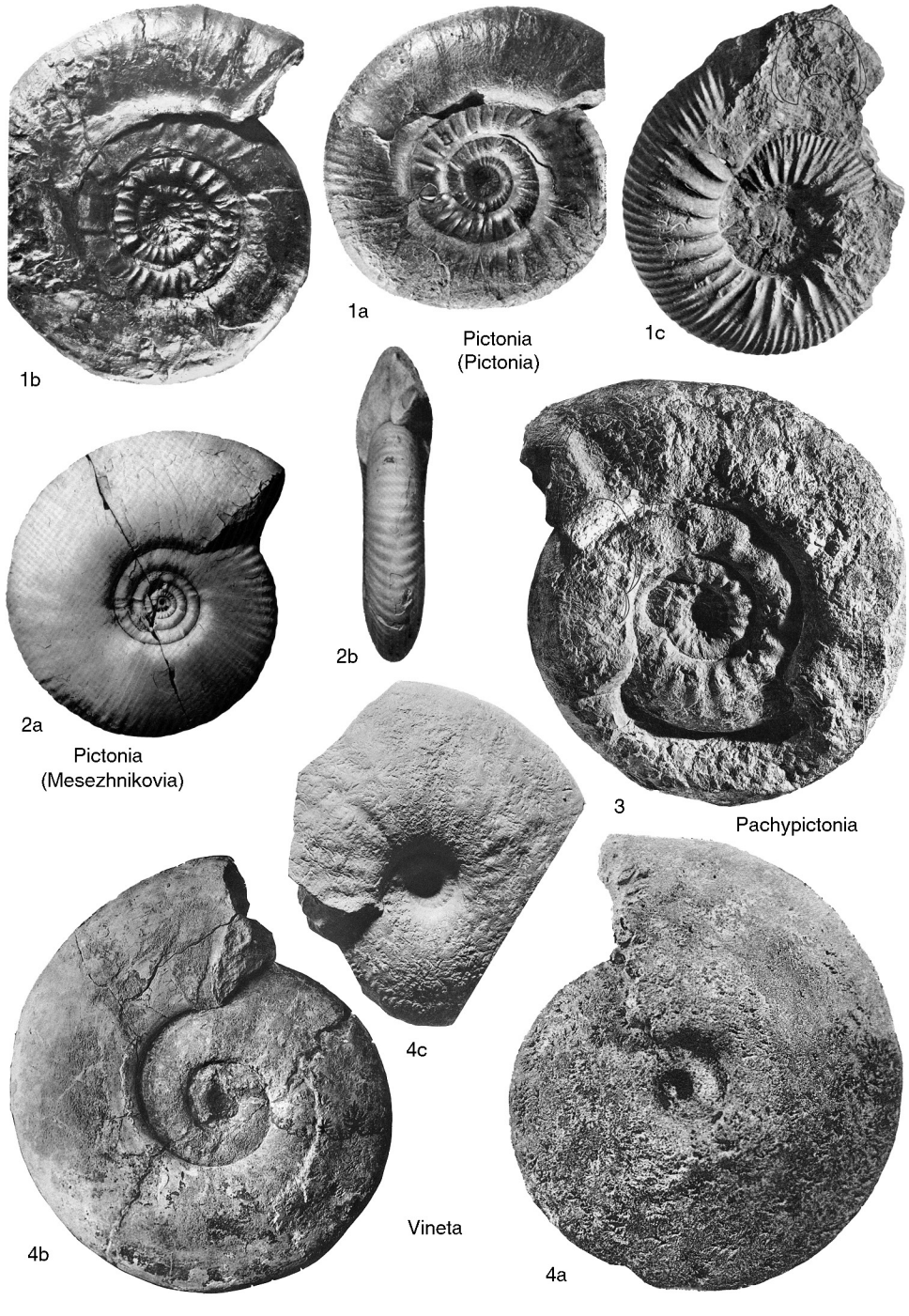

FIG. 67. Aulacostephanidae (p. 91–93).

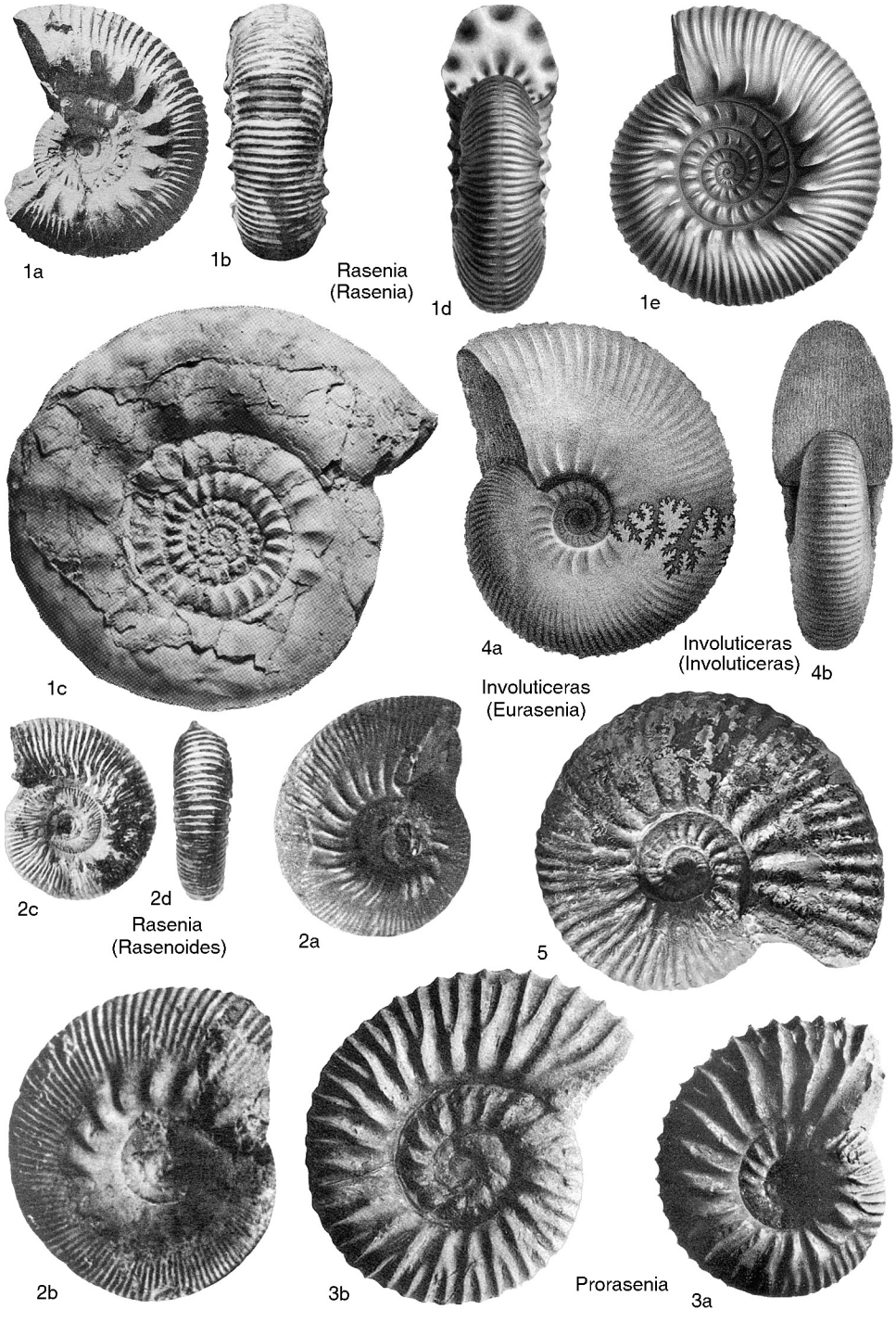

FIG. 68. Aulacostephanidae (p. 93–96).

triplicatus albus QUENSTEDT, 1846 in 1845–1849, p. 162)]. Small sized, whorl section rounded, strong ribbing, prorsiradiate and triplicate primaries on the inner whorls, the branching points below the mid-side, allowing the secondaries to be seen in the umbilicus; ribbing sharper and biplicate on the outer adult whorl; aperture with lappets. Microconch of latest *Ringsteadia, Pictonia,* and *Eurasenia. Upper Jurassic (upper Oxfordian,* Bimammatum *Zone–lower Kimmeridgian,* Divisum *Zone):* Germany, Switzerland, France, Poland, Russia.——FIG. 68,*3a. *P. quenstedti,* lectotype, Weisse Jura β, Beuren, Swabian Alb, Germany, ×1 (Schindewolf, 1926, pl. 19,*1*).——FIG. 68,*3b. P. witteana* (OPPEL), Badener Schichten, Mellikon Aargau, Switzerland ×1 (Geyer, 1961, pl. 18,*3*).

Involuticeras SALFELD, 1914a, p. 175 [**Ammonites involutus* QUENSTEDT, 1846 in 1845–1849, p. 165, pl. 12,*9;* SD SPATH, 1931, p. 469]. Medium sized, involute and compressed aulacostephanid, with more or less strong ribbing. *Upper Jurassic (lower Kimmeridgian):* Europe.

I. (**Involuticeras**). Involute, compressed; rounded venter; short primary ribs, thickened on the umbilical margin, and long, blunt secondary ribs cross the venter; ornament fades in middle of the whorl side in some species. *Upper Jurassic (lower Kimmeridgian,* Hypselocyclum *and* Divisum *Zones):* southern Germany, France, Switzerland, Poland.——FIG. 68,*4a–b. *I. involutum* (QUENSTEDT), Heuberg, Swabia, Germany, ×1 (Quenstedt, 1846 in 1845–1849, pl. 12,*9*).

I. (**Eurasenia**) GEYER, 1961, p. 87 [**Ammonites rolandi* OPPEL, 1863 in OPPEL 1862–1863, p. 239, pl. 67,*3a–b;* OD]. Similar to *Involuticeras.* Shell of medium size, involute to fairly evolute, whorl section first rounded, later high and oval; coarsely ribbed, with short, thickened primaries changing to bullae on the outer whorl; splitting into 3–5 secondary ribs at about one-third of whorl side, with ribs continuing across the venter. Supposed ancestral form of *Pararasenia. Upper Jurassic (lower Kimmeridgian,* Hypselocyclum–Divisum *Zones):* southern Germany, France, Switzerland, Poland.——FIG. 68,*5. *E. rolandi* (OPPEL), holotype, Malm γ_2 or γ_3, Peigniz, Franconia, Germany, ×0.5 (Schneid, 1939 in 1939–1940, pl. 6(10),*1,1a*).

Aulacostephanus TORNQUIST, 1896, p. 7 [**Ammonites pseudomutabilis* DE LORIOL, 1874, p. 28; SD ICZN Opinion 302, 1954b, p. 263, see ARKELL, 1935a, p. 252, and ARKELL, 1951c, p. 189] [=*Steueroceras* COSSMAN, 1899, p. 45, *nom. nov. pro Odontoceras* STEUER, 1897, p. 164, *non* SERVILLE, 1833 (Coelenterata), *nec* MACQART, 1835 (Diptera), *nec Odonthoceras* RONDI, 1861 (Diptera) (type, *O. anglicus* STEUER, 1897, p. 164 (38), OD); =*Sarygulia* KHUDYAEV, 1932, p. 647, fig. 2, *nom. nud.,* fully described by SASONOV, 1960, p. 157 (type, *A. pishmae* KHUDYAEV, 1932, p. 646, OD); =*Tobolia* SASONOV, 1960, p. 154, *non Tobolia* DAIN in BYKOVA & others, 1958 (Foraminifera) (type, *T. sosvaensis*, OD); =*Aulacostephanites* ZIEGLER, 1962, p. 44 (type, *Rasenia eulepida* SCHNEID, 1939 in 1939–1940, p. 146, OD)]. Dimorphic; small to large size, whorl section circular to compressed, biplicate to fasciculate ribbing, ventral smooth band or furrow. *Upper Jurassic (upper Kimmeridgian,* Mutabilis/Acanthicum–Autissiodorensis *Zones):* Greenland, northern Europe, northern Asia, Iraq.

A. (**Aulacostephanus**). Dimorphic, size small to very large; fairly involute to involute; whorl section circular to oval shaped and compressed; rectiradiate or prorsiradiate, sharp primary ribs tri- or quadrifurcate below mid-side, the secondaries fasciculate, ventral smooth band well pronounced or furrow. Except for increasing number of ribs, ornament of the microconch unchanged on the body chamber, aperture constricted with lappets; macroconch nearly smooth. *Upper Jurassic (upper Kimmeridgian,* Mutabilis/Acanthicus *Zone*–Autissiodorensis *Zone):* Greenland, Scotland, England, France, Switzerland, Germany, Poland, Russia.——FIG. 69,*1a–b. *A. pseudomutabilis,* lectotype (selected by DURAND, 1933, p. 306), Marnes et calcaires à Exogyres Formation, upper Kimmeridgian, *Eudoxus* Zone, Tonnerre, Yonne, France, ×1 (new; Muséum National d'Histoire Naturelle, Paris, MNHN R02908; also figured by Atrops in Fischer & others, 1994, p. 182, pl. 83,*2a–b*).

A. (**Aulacostephanoides**) SCHINDEWOLF, 1925, p. 339 [**Ammonites desmonotus* OPPEL, 1863 in OPPEL 1862–1863, p. 241, pl. 67,*1a–b;* OD]. Shell small (40–60 mm) or medium-sized (up to 150 mm); whorl section oval or nearly oval with sloping umbilical wall, rounded venter; well characterized by the high number of secondaries (up to 60 on half whorl), fine and weak ribbing, the primaries rectiradiate to prorsiradiate, fasciculate (up to 6) secondaries, prorsiradiates or flexuous, venter rounded with a smooth band on the median line. Microconch bears short lappets. Differs from *Aulacostephanus (sensu stricto)* in its steep umbilical wall; also differs from *Aulacostephanoceras* in its denser ribbing. *Upper Jurassic (upper Kimmeridgian,* Mutabilis/Acanthicum *Zone):* southern England, France, Switzerland, Germany, Poland.——FIG. 69,*2a–d. *A. desmonotus* (OPPEL); *a–b,* holotype (destroyed during the Second World War), near Boll, Swabian Alb, Germany, ×1 (Oppel, 1863 in 1862–1863, pl. 67,*1*); *c,* entirely septate specimen, lower Weissjura δ, *Acanthicum* Zone, Willmandingen, Swabian Alb, Germany, ×1 (Ziegler, 1962, pl. 2,*14*); *d,* specimen with the body chamber preserved on two-thirds or three-quarters of whorl, Weissjura δ, *Acanthicum* Zone, Swabian Alb, Germany, ×1 (Ziegler, 1962, pl. 2,*15*).

A. (**Aulacostephanoceras**) ZIEGLER, 1962, p. 68 [**Ammonites eudoxus* D'ORBIGNY, 1850 in 1842–1851, p. 552; OD]. Dimorphic, size small to very large, evolute to involute, whorl section circular or compressed, oval to angular-quadratic, umbilical wall high and steep, sides rounded, venter rounded

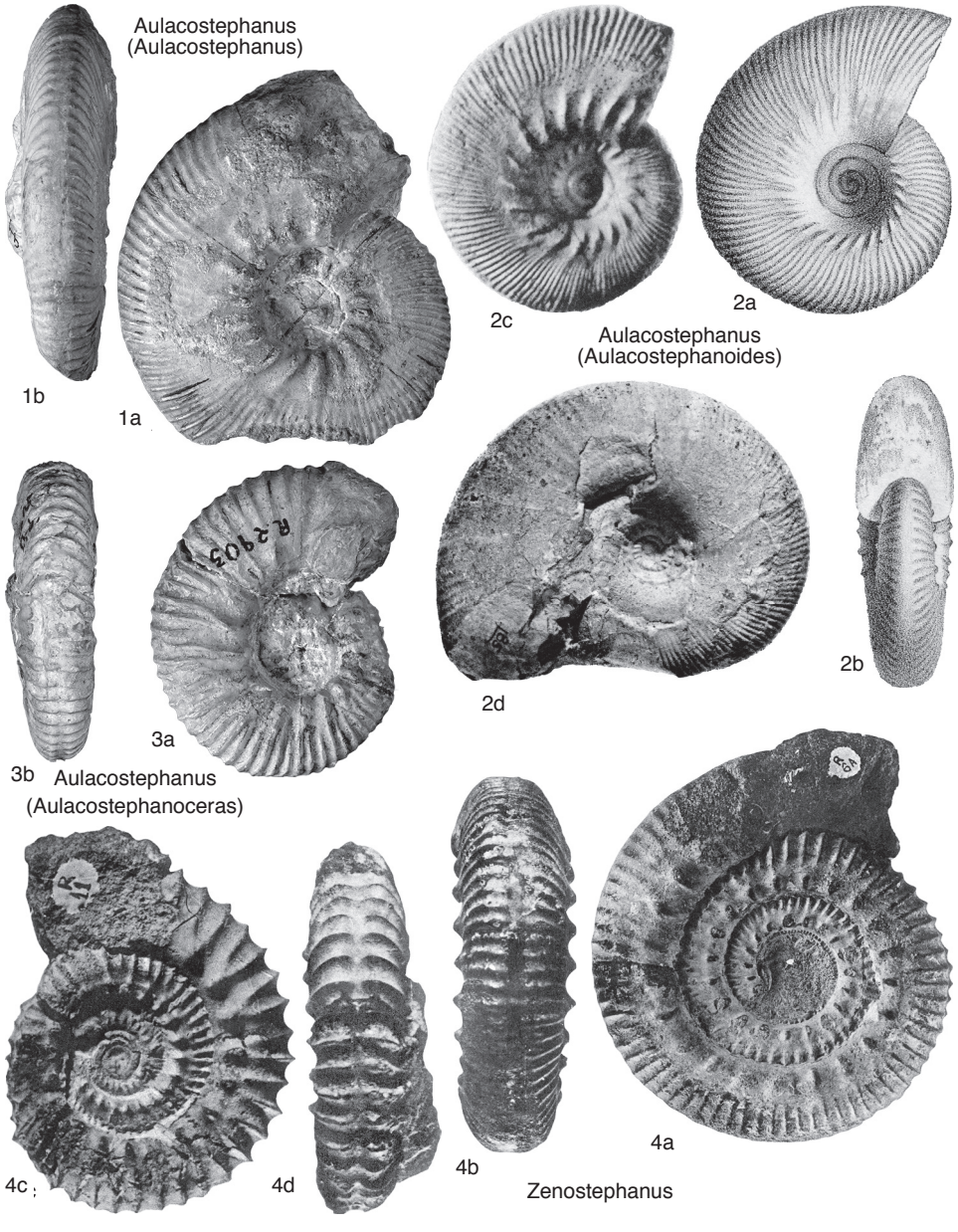

FIG. 69. Aulacostephanidae (p. 96–98).

or acute in the large specimens; coarse ribbing with radiate or prorsiradiate short primaries, biplicate or fasciculate between one-fourth to one-third of the side high, two to four long secondaries ending with tubercles along the ventral smooth band or furrow. Microconch ribbed to the end, aperture with lappets; macroconch ribbed or not and aperture simple. Differs from *Aulacostephanus* (*sensu stricto*) and *Aulacostephanoides* in the strong and prominent ribbing. *Upper Jurassic (upper Kimmeridgian,* Eudoxus *and* Autissiodorensis *Zones):* Greenland, Scotland, England, France, Switzerland, Germany, Poland, Russia (Siberia), northern Iraq.——FIG. 69,*3a–b. *A. eudoxus* (D'ORBIGNY), *Eudoxus* Zone, Saint-Jean-d'Angély, Charentes Maritimes, France, ×1 (new; Muséum National d'Histoire Naturelle, Paris, MNHN R022903; also figured by Hantzpergue in Fischer & others, 1994, pl. 82,*6a–b*).

Pararasenia Spath, 1925a, p. 152 [**Aulacostephanus zacatecanus* Burckhardt, 1906, p. 67, pl. 16,*1–4;* OD]. Probably dimorphic, but very few microconchs definitely identified; medium to large size; fairly evolute to involute; whorl section thick, rounded or ogival, umbilical wall high with rounded margin and broad venter; coarse and pronounced ribbing, with thickened primaries changing to bullae and thick, distant secondaries; ventral smooth band; body chamber of large specimen nearly smooth or smooth; the few known microconchs ribbed to the aperture with lappets. *Upper Jurassic (upper Kimmeridgian,* Acanthicum *and* Eudoxus *Zones):* France, Switzerland, Germany, Poland, Mexico.——Fig. 70,*1a–b. *P. zacatecana* (Burckhardt), holotype, *Idoceras* Beds, upper Kimmeridgian, *Acanthicum* Zone, Mazapil, Mexico, ×1 (Burckhardt, 1906, pl. 16,*1–4*).——Fig. 70,*1c. P. semieudoxus* (Schneid), microconch, Malm δ, upper Kimmeridgian, *Acanthicum* Zone, Kälberberg, Franconian Alb, Germany, ×0.75 (Schneid, 1939 in 1939–1940, pl. 13,*11*).——Fig. 70,*1d. P. calvescens* Ziegler, holotype, macroconch, Weissjura δ, upper Kimmeridgian, Geislingen Steige, Swabian Alb, Germany, ×0.5 (Ziegler, 1962, fig. 74).

Zenostephanus Callomon, Donovan, & van der Hoek, 2009, p. 671, *nom. nov. pro Xenostephanus* Arkell & Callomon, 1963, p. 232, *non Xenostephanus* Simpson, Minoprio, & Paterson, 1962 (Mammalia) [**Aulacostephanus (Xenostephanus) ranbyensis* Arkell & Callomon, 1963, p. 226; OD] [=*Xenostephanoides* Arkell & Callomon, 1963, p. 225 (type, *Aulacostephanus (Xenostephanoides) thurelli;* OD]. Dimorphic; small or medium sized; evolute coiling especially in the inner whorls; whorl section rounded-quadrate; strong ribbing with short primaries tending to form bullae or tubercles on the umbilical margin, bifurcate or triplicate with sheaves of secondaries and intercalatories; venter flat on the inner whorls with a smooth band or groove; on the body chamber ribbing of the microconch reverts to simple biplication, while on the macroconch it degenerates to biplicate primary ribs or simple, widely spaced ridges. *Upper Jurassic (upper Kimmeridgian,* Mutabilis *Zone):* England.——Fig. 69,*4a–b. *Z. ranbyensis* (Arkell & Callomon), holotype, macroconch, Drift, Ranby, Lincolnshire, England, ×0.5 (Arkell & Callomon, 1963, pl. 28,*1a,c*).——Fig. 69,*4c–d. Z. thurelli,* holotype, microconch, Drift, Ranby, Lincolnshire, England, ×1 (Arkell & Callomon, 1963, pl. 30,*1a–b*).

?Epicephalites Spath, 1928, p. 175 [**Macrocephalites epigonus* Burckhardt, 1906, p. 20; OD]. The systematic position of this so-called pseudo-rasenid (Hillebrandt & others (in Westermann, 1992, p. 241–272) is still disputable, but it resembles *Involuticeras.* Shell involute, inflated whorl section, no noticeable primaries and inner half smooth; ribs only on outer half of whorl side and continuous over the venter. *Upper Jurassic (upper Kimmeridgian,* Acanthicum *Zone):* Mexico.——Fig. 70,*2a–b. *E. epigonus* (Burckhardt), lectotype, *Idoceras* Beds, Sierra de Santa Rosa, Mexico, ×1 (Burckhardt, 1906, pl. 4,*8,10*).

?Subneumayria Spath, 1924, p. 17 [**Neumayria ordonezi* Burckhardt, 1906, p. 11; OD]. Another so-called pseudo-rasenid**,** endemic in Mexico, closely related to *Epicephalites,* but whorl more compressed, feeble ribs on the venter only and growth lines elsewhere. *Upper Jurassic (upper Kimmeridgian,* Acanthicum *Zone):* Mexico.——Fig. 70,*3a–b. *S. ordonezi* (Burckhardt), lectotype, *Idoceras* Beds, Sierra de Santa Rosa, Mexico, ×1 (Burckhardt, 1906, pl. 1,*2–3*).

Family SIMOCERATIDAE Spath, 1924

[Simoceratidae Spath, 1924, p. 19] [=Chignahuapitinae, *nom. correct.* herein *ex* Chignahuapinae Cantú Chapa, 2009, p. 215]

The family is heterogeneous and brings together various Tethyan forms, the exact origin of which is still uncertain. Previous authors agree that they are probably independently modified offshoots of various Perisphinctidae and even the lytoceratids (e.g., *Lytogyroceras*) (Spath, 1925a). Relationships with Passendorferiinae are suggested by close homoeomorphism between some of their late members (e.g., *Ceratosphinctes rachistrophus*) and the group of *Simoceras (Volanoceras) volanense.* Simoceratidae are probably the ancestral group of the Spiticeratidae. The family was more fully described by Spath (1925a, p. 131). *Upper Jurassic (lower Kimmeridgian–Lower Cretaceous (Berriasian):* Tethyan.

Simoceras Zittel, 1870, p. 89 [**Ammonites biruncinatus* Quenstedt, 1847 in 1845–1849, p. 260; SD Spath, 1925a, p. 131] [=*Verracruciceras* Cantú Chapa, 2006, p. 301 (type, *V. ruizi,* OD)]. Evolute, whorl section first depressed, then compressed with flat or concave whorl sides; inner whorls with numerous, simple ribs, feeble and distant on middle whorl; outer whorl tuberculate, irregular inner row of umbilical tubercles or bullae, outer row of heavy, distant clavi, bordering the concave venter, that are not opposite each other; suture line elaborate with deep, suspensive lobe. *Upper Jurassic (Tithonian):* Italy, Spain, Hungary.——Fig. 71,*1a–c. *S. biruncinatum* (Quenstedt); *a,* holotype, Rosso Ammonitico, Roveredo, Italy, ×1 (Quenstedt, 1847 in 1845–1849, pl. 19,*14*); *b–c,* topotype, ×0.5 (Zittel, 1870, pl. 8(32),*6b–c*).

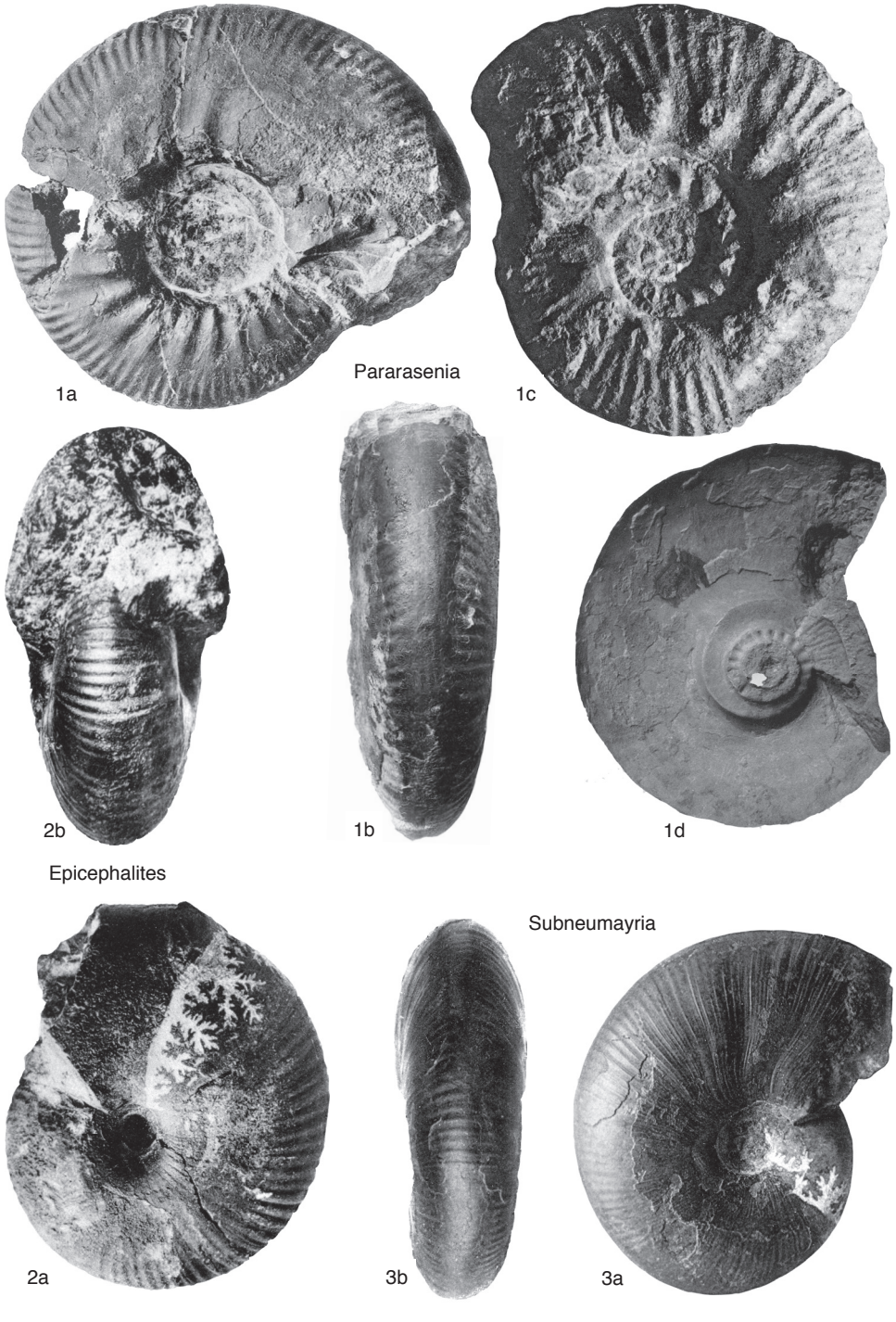

FIG. 70. Aulacostephanidae (p. 98).

Virgatosimoceras Spath, 1925a, p. 131 [**Simoceras rothpletzi* Schneid, 1915b, p. 88 (390); OD]. The most perisphinctid-like simoceratid. Large size, fairly evolute, whorl section compressed oval; innermost whorls with numerous simple or biplicate ribs, branching not visible in the umbilicus; later prominent, distant ribs, biplicate or triplicate, even quadriplicate, developing bullae on the umbilical edge; outer whorl with bifurcate or simple ribs; deep, complete constriction bordered adorally by simple rib; venter with median groove, becoming smooth on outer whorl. *Upper Jurassic (lower Tithonian,* Darwini *[*Mucronatum*]*–Fallauxi *[*Ciliata*] Zones):* southern Germany, southeastern France, Spain, southern Alps, Italy, Poland, Hungary.——Fig. 71,*2a–b. *V. rothpletzi* (Schneid), lectotype, Neuburg Formation, lower Tithonian, *Ciliata* Zone, Unterhausen near Neuburg an der Donau, Germany, ×1 (Schneid, 1915b, pl. 7(23),*3a–b;* a plaster cast of the external mold of a larger specimen is also figured pl. 7(23),*2*).——Fig. 71,*2c. V. albertinum* (Catullo), complete adult specimen with the aperture partly preserved, lower Tithonian, *Darwini [Albertinum]* Zone, Cabra, Cordoba, Spain, ×0.4 (Geyssant, 1997, pl. 25,*4*).

Volanoceras Geyssant, 1985, p. 679 [**Ammonites volanensis* Oppel, 1863 in Oppel 1862–1863, p. 231; OD] [=?*Simolytoceras* Oloriz, 1978a, p. 237 (type *Simoceras (Simolytoceras) andaluciense,* OD); =*Pseudovolanoceras* Cecca in Pavia & Cresta, 2002, p. 364 (type, *Simoceras* cf. *volanense* Oppel, var. *aesinense* Meneghini, 1885, p. 376, OD); =*Chignahuapites* Cantú Chapa, 2009, p. 17 (type, *Volanoceras chignahuapense* Cantú Chapa, 1990, p. 41, OD)]. Evolute, broad umbilicus, whorl section subquadrate or trapezoidal with sides flat or slightly convex; innermost whorls with numerous ribs simple or bifurcate; later strong ribs and two rows of tubercles, the outer developing first, acute or clavate, in ventrolateral position, not alternating, suture not elaborated then suspensive lobe short. *Upper Jurassic (Tithonian,* Semiforme–Microcanthum *Zones):* southern Spain, southern Germany, southeastern France, Italy (Trentino, Umbria-Marche, Sicily), Hungary, Greece, Algeria, Cuba, Mexico, Argentina.——Fig. 71,*3a–c. *V. volanense* (Oppel), Diphya Kalk, Tithonian, Volano, Italy; *a–b,* lectotype (destroyed during Second World War), ×1 (Oppel, 1863 in Oppel 1862–1863, pl. 58,*2a–b*); *c,* neotype (designated by Santantonio, 1986, p. 18), specimen in Oppel's type series, Bayerische Staatsammlung für Paläontologie und Historische Geologie, Munich, AS VIII 144, ×1 (Santantonio, 1986, pl. 5,*1*).

Cordubiceras Oloriz & Tavera, 1979a (October 19), p. 3 [**Simoceras (Cordubiceras) geminatum* Oloriz & Tavera, 1979a, p. 4; OD] [=*Baeticoceras* Geyssant, 1979 (October 26), p. 4 (type, *B. baeticum*, p. 14, OD]. Dimorphic, evolute, whorl section compressed quadrate to trapezoid, flat sides and narrow venter; inner whorls with dense and faint rectiradiate ribs and volanense-like ornament in the oldest species; then typical ornament of the genus, looped ribs and two rows of tubercles, the umbilical radially elongated, the outer changing to clavi; in the macroconchs only outer whorl with simple recti- or rursiradiate ribs, tubercles present or not. Suture slightly elaborated. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone):* Spain, Italy, Algeria, Tunisia.——Fig. 71,*4a. *C. geminatum* Oloriz & Tavera, holotype, incomplete macroconch, Carcabuey, Andalousia, Spain, ×0.33 (Oloriz & Tavera, 1979a, pl. 1,*1a–b*).——Fig. 71,*4b. C. baeticum* (Geyssant), holotype, adult, complete microconch with aperture, upper Tithonian, basal *Microcanthum* Zone, Cabra, Cordoba, Spain, ×0.33 (Geyssant, 1979, pl. 2,*3*).——Fig. 71,*4c. C. enayi* (Geyssant, 1979), holotype, macroconch with half a whorl living chamber, upper Tithonian, basal *Microcanthum* Zone, Cabra, Cordoba, Spain, ×0,33 (Geyssant, 1979, pl. 3,*1*).

Lytogyroceras Spath, 1925a, p. 131 [**Ammonites fasciatus* Quenstedt, 1848 in 1845–1849, p. 271, pl. 20,*11a–b;* OD]. Evolute, compressed, and many-whorled; *Lytoceras*-like and possibly a derivative of Lytoceratatoidea in spite of simple suture; ribs on the inner whorls, then smooth with deep constrictions fringed by flared ribs or collars on both sides. Dimorphic, only size difference. *Upper Jurassic (Tithonian,* Fallauxi *Zone,* Admirandum *Subzone*–Ponti *[*Volanense*] Zone):* southeastern France, southern Alps, Italy, Poland, Hungary.——Fig. 71,*5a. *L. fasciatum* (Quenstedt), holotype, Diphya Kalk, Tithonian, Roveredo, Italy, ×1 (Quenstedt, 1848 in 1845–1849, pl. 20,*11a–b*).——Fig. 71,*5b. L. subbeticum* (Oloriz), microconch, Hárskút, Hungary, ×1 (Főzy, 1988, pl. 13,*5*).——Fig. 71,*5c. L. volanensoides* (Vigh), macroconch, Lókút Hill, Hungary, ×0.5 (Főzy, 1988, pl. 13,*1*).

Simospiticeras Oloriz & Tavera, 1979b, p. 183 [**S. lojense;* OD]. Medium size, fairly evolute, whorl section rounded to oval, with deep, prorsiradiate constrictions throughout growth; *Spiticeras*-like inner whorls with primary ribs radially elongated or bullae, and 3–5 secondaries fading on the venter, interrupted on outer whorl by a single row of ventral nodes or tubercles, all of which support the placement in the Simoceratidae rather than the Spiticeratidae (e.g., Wright, Callomon & Howarth, 1996, p. 43), but the genus is surely a link with the latter. *Upper Jurassic (basal Upper Tithonian,* Microcanthum *Zone,* Simplisphinctes *Subzone–basal* Transitorius *Subzone):* Spain, Italy.——Fig. 72,*1a–f. *S. lojense; a–b,* holotype, Sierra Gorda, Granada, Spain, ×1 (Oloriz & Tavera, 1979b, pl. 1,*1a–b*); *c–f,* Monte Nerone, Italy, ×1 (Oloriz, Sari, & Tavera, 1993, pl. 1,*2a–b, 3a–b*).

Hemisimoceras Spath, 1925b, p. 159 [**H. semistriatum;* OD]. Poorly known from septate cast only; rounded, finely ribbed, inner whorls changing abruptly after a deep constriction with whorl thickness increasing, then smooth with distant

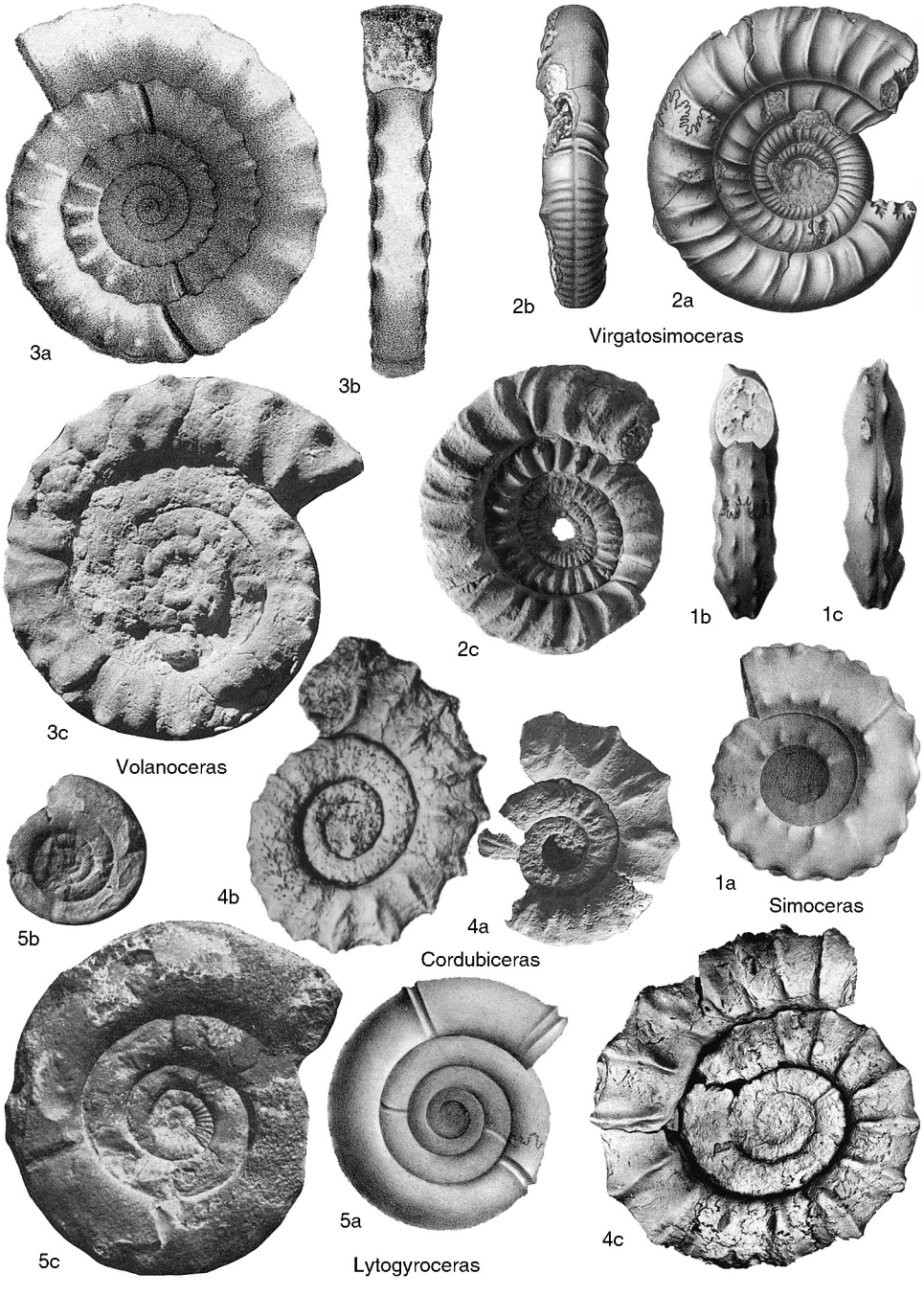

FIG. 71. Simoceratidae (p. 98–100).

primary ribs tending to develop ventrolateral tubercles. *Upper Jurassic (lower Tithonian):* Madagascar.——FIG. 72,*2a–b. *H. semistriatum,* holotype, Antsalova, Madagascar, ×1 (Spath, 1925b, pl. 1,*8*).

Pseudoclambites SPATH, 1925a, p. 149 [**P. aenigmaticus;* OD]. Only the body chamber known. Fairly evolute, whorl section rounded quadrate, venter tabulate to shallow-concave; densely ribbed at first, and then more distant and fading save on the dorsal part of the side.

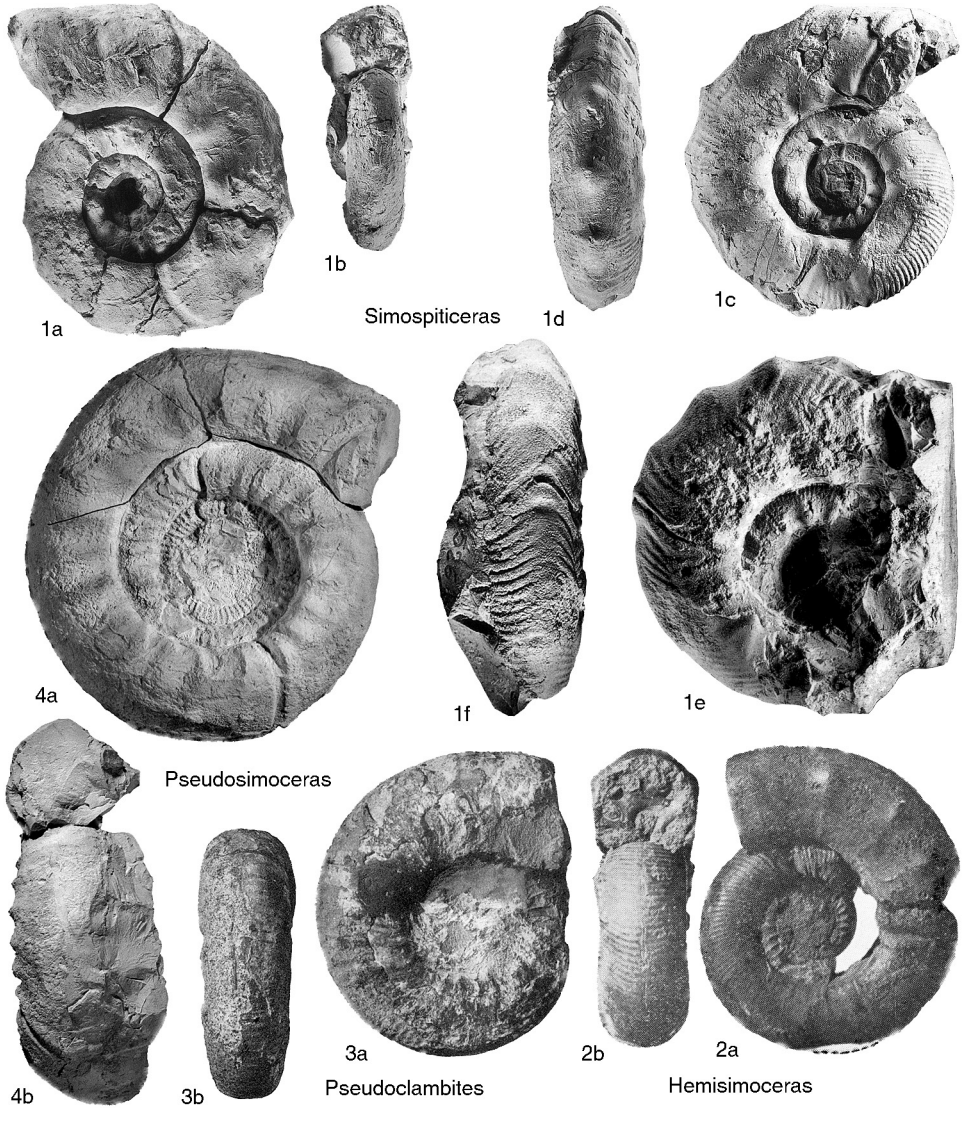

FIG. 72. Simoceratidae (p. 100–102).

Upper Jurassic (upper Tithonian): Somalia, Yemen.——FIG. 72,*3a–b*. **P. aenigmaticus,* holotype, Bihendula, Somalia, ×0.42 (Spath, 1925a, pl. 16,*9a–d*).

Pseudosimoceras SPATH, 1925a, p. 131 [**Olcostephanus stenonis* GEMMELLARO, 1876 p. 243; OD]. Medium size; evolute, wide umbilicus, depressed whorl section, gradually becoming more rounded on the body chamber; deep constrictions; blunt primary ribs change to distant ridges, simple, bifurcate or trifurcate; the secondaries polygyrate, fading on the venter, smooth on the outer whorl. *Upper Jurassic (lower Kimmeridgian,* Strombecki *Zone*–Herbichi *Zone,* Stenonis *Subzone):* Italy (northern region, Sicily), Spain, Madagascar.——FIG. 72,*4a–b*.

**P. stenonis* (GEMMELLARO), lectotype, nearly complete specimen with body chamber, Calatafimi, Sicily, ×0.5 (Pavia & Cresta, 2002, p. 373, fig. 240).

Family HIMALAYITIDAE Spath, 1925

[Himalayitidae, SPATH, 1925a, p. 144]

Following SPATH (1925a), the family is interpreted as an independent family; its resemblance to Berriasellidae (e.g., ventral furrow or smooth band, tendency to hoplitid-

like morphology) is only coincidental. The origin of the family is still uncertain and various plausible ancestors have been assumed in some members of the Ataxioceratidae, (e.g., *Torquatisphinctes, Biplisphinctes*). They display evolute coiling and biplicate ribbing, and some develop interruption of the ribbing on the venter as in the less-advanced himalayitids (e.g., *Aulacosphinctes*). Typical himalayitids develop rounded, inflated whorls and sharp ribbing with lateral tubercles or spines, usually but not invariably with ventral groove or smooth band. New forms described mainly from the Caribbean and East Pacific regions have enlarged the definition of the family, and two subfamilies, the Himalayitinae and Suaritinae are recognized. *Upper Jurassic (Tithonian)–lower Cretaceous (Berriasian):* southern (or Tethyan) Europe, northern and eastern Africa, Madagascar, Pakistan, India, Nepal, southern USA, Mexico, Cuba, South America.

Subfamily HIMALAYITINAE Spath, 1925

[*nom. corr.* Arkell, 1950, p. 364, *ex* Himalayitidae, Spath, 1925a, p. 144] [=Windhauseniceratinae Leanza & Zeiss, 1992, p. 1848 (*partim*)]

The subfamily brings together the genera that are thought to be the main stock originating from the Ataxioceratidae. Various morphologies are developed from evolute platycone with bifurcate and simple ribbing, ventral furrow or smooth band, to hoplitid-like forms with tabulate venter; sharp, bifurcate or simple ribbing; and lateral, ventral, and some umbilical tubercles. *Upper Jurassic (Tithonian)–lower Cretaceous (Berriasian):* southern (or Tethyan) Europe, northern Africa, Eastern Africa, Madagascar, Pakistan, India, Nepal, southern USA, Mexico, Cuba, South America.

Aulacosphinctes Uhlig, 1910b, p. 345 [**Ammonites morikeanus* Oppel, 1863 in Oppel 1863–1865, p. 281; SD Spath, 1924, p. 16]. Dimorphic. Evolute coiling, whorl section rounded to subquadrate, ribbing sharp and prominent, only bifurcate or simple primary ribs in the microconch and polygyrate ribs on the body chamber of the macroconch, no tubercles. Ventral furrow normally broad and clearly defined, shallower and rather narrow in some species, gradually decreasing in sharpness and often disappearing on the final body chamber. Microconch with lappets. *Upper Jurassic (upper Tithonian,* Ponti–Microcanthum *Zones):* Himalaya, Pakistan, India (Kutch), Somalia, Madagascar, Spain, Algeria, northern Morocco, Mexico, ?Argentina, ?California.——Fig. 73,*1a–c. *A. morikeanus* (Oppel); *a–b,* holotype, microconch, Spiti Shales, Ki, Spiti, India, ×1 (Oppel, 1863 in Oppel, 1863–1865, p. 281, pl. 80,*2a–b*); *c,* nearly complete specimen, Spiti Shales, pass from Chokkor to Damodarkund, Muktinath, Nepal, ×1 (Énay, 2009, pl. 49,*3a*).——Fig. 73,*1d–e. A. spitiensis* Uhlig, incomplete macroconch, lectotype, Spiti Shales, Jandu, Spiti, India, ×0.5 (Uhlig, 1910a, pl. 41,*1a–b*).

Corongoceras Spath, 1925a, p. 144 [**C. lotenoense* Spath, *nom. nov. pro Hoplites koellikeri* Haupt, 1907, p. 201, *non* Oppel, 1865, p. 555; OD]. Small to middle-sized, first fairly involute, then evolute, thick whorl section, first depressed, and then more rounded, the maximum thickness at midwhorl side; lateral tubercles; inner whorls with strong and prominent ribbing, simple or bifurcate primaries, with tubercles at mid side, the secondaries ending at ventral tubercles, looped in some species; ribs feebler on the venter; venter tabulate and depressed in the type species, but with central furrow or smooth band in many others; coarser and more distant bifurcate and simple ribs on outer whorls, with lateral and ventral tubercles. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone):* Himalaya, Madagascar, Mexico, Argentina.——Fig. 73,*2a–c. *C. lotenoense,* holotype, wholly septate, upper Tithonian, Cerro Lotena, Argentina, ×1 (Parent, 2001, p. 32,*9A–B*).

Ardesciella Bulot, Frau, & Wimbledon, 2014, p. 120 [**Himalayites (?Corongoceras) rhodanicus* Mazenot, 1939, p. 230; OD]. Proposed to accommodate the so-called "*Corongoceras*" of the Tethyan Realm. Small to medium size, slow coiling and wide umbilicus; whorl section first rounded, then subrectangulate to subquadrate; prominent ribbing with straight, simple or bifurcate primary ribs, the latter tuberculate at the branching point, and the secondary ribs ending with elongated bullae on both sides of the ventral furrow; adult ribbing slightly flexuose. *Upper Jurassic (upper Tithonian,* Microcanthum *and* Andreaei *Zones):* southern Spain, southeastern France, northern Morocco, Algeria.——Fig. 73,*3a–b. *A. rhodanica* (Mazenot), holotype, microconch or juvenile with body chamber nearly half a whorl long, upper Tithonian, Aizy, Isère, France, ×1 (Mazenot, 1939, p. 230, pl. 37,*7b–c*).

Micracanthoceras Spath, 1925a, p. 144 [**Ammonites microcanthus* Oppel in Zittel, 1868, p. 93; OD] [?=*Burckhardticeras* Oloriz, 1978a, p. 624, (type, *Himalayites (Micracanthoceras) peroni* Roman, 1936, p. 24, OD), *non Burckhardticeras* Flores Lopez, 1967, p. 28 (type, *Arnioceras fallaxoides* Erben, 1956, p. 240, OD) (ammonite, Arietitidae, Simemurian)]. Probably dimorphic. Macroconchs large, evolute; whorl section rounded quadrate, as thick as high, ribbing with bifurcate and more or less numerous simple ribs, lateral tubercles

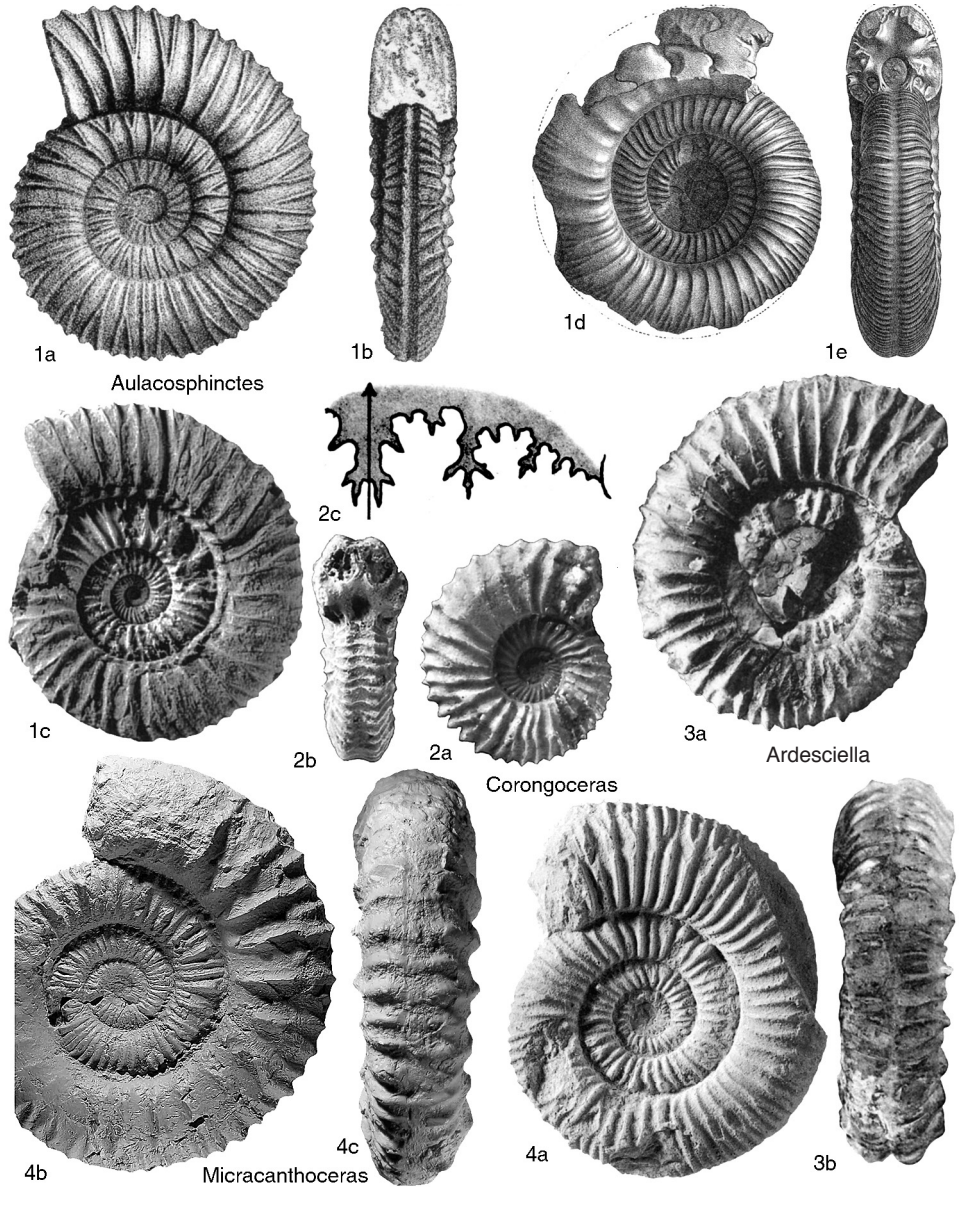

FIG. 73. Himalayitidae (p. 103–104).

at the branching point, secondaries ending in small ventral tubercle beside smooth band, ventral smooth band fading on the last whorl. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone):* southern Europe, Algeria, northern Morocco, eastern Africa, Madagascar, Texas, Mexico, Cuba, Peru, Argentina.——FIG. 73,*4a. *M. microcanthum* (OPPEL), lectotype (plaster cast), wholly septate, upper Tithonian, Stramberg, Mähren, Czech Republic, ×0.5 (Geyssant, 1997, pl. 26,*1*).——FIG. 73,*4b–c. M. koellikeri* (OPPEL), holotype (plaster cast), adult specimen, probably macroconch, with part of the body chamber, upper Tithonian, Stramberg, Mähren, Czech Republic, ×0.5 (Parent, Scherzinger, & Schweigert, 2011, p. 72, fig. 32).

Himalayites UHLIG in BOEHM, 1904, p. 38 [**H. treubi;* SD DOUVILLÉ, 1912b, p. 262]. Fairly involute coiling, whorl section depressed, bifurcate or polyfurcate and simple ribs, lateral tubercles only on the biplicate ribs, the secondaries ending beside the ventral smooth

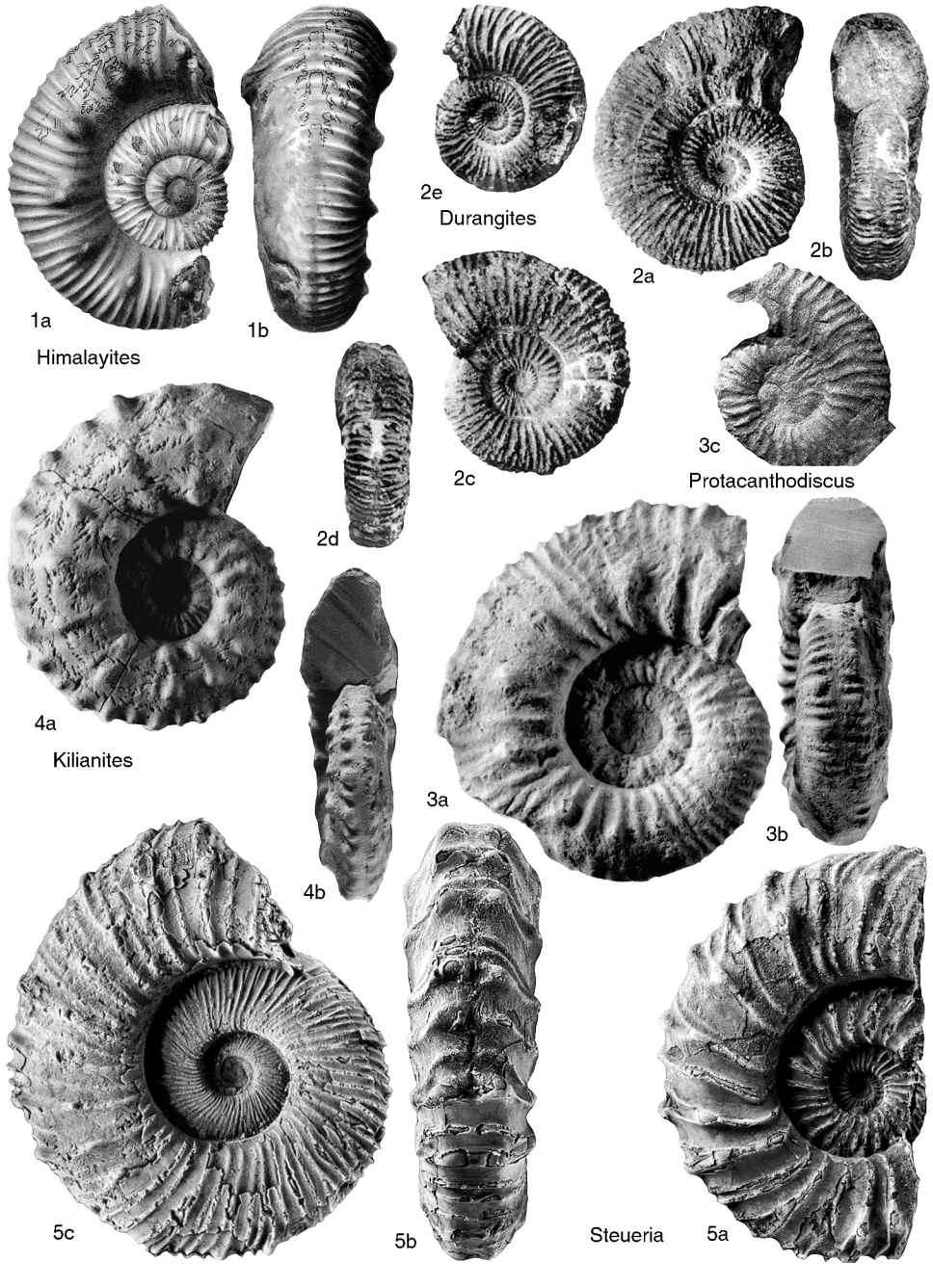

FIG. 74. Himalayitidae (p. 104–108).

band but no tubercles. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone,* Transitorius *Subzone)–Lower Cretaceous (?Berriasian):* southern Europe, Algeria, northern Morocco, eastern Africa, Madagascar, Pakistan (Salt Range), Himalaya, Indonesia, Mexico, Cuba, Peru, Argentina.——FIG. 74,*1a–b. *H. treubi,* holotype, wholly septate, Taliabu Island, Indonesia, ×0.66 (Boehm, 1904, pl. 7,*2a–b*).

Durangites BURCKHARDT, 1912, p. 143, 149 [**D. vulgaris;* SD CANTÚ CHAPA 1968, p. 22, the previous

designation by Roman (1938, p. 323) being invalid under ICZN Code, Art. 67.5] [=*Durangites* Burckhardt, 1910, p. 627, *nom. nud.; =Parasiella* Bulot, Frau, & Wimbledon, 2014, p. 121 (type, *Durangites astillerensis* Imlay, 1939, p. 46, OD)]. Small sized, whorl section rounded, quadrate and compressed; inner whorls with fine, rectiradiate, *Micracanthoceras*-like primary ribs, simple or biplicate, lateral tubercles at the branching points and ventral tubercles at end of secondaries, beside the ventral furrow or smooth band; on later whorls the ribs become rursiradiate, lateral tubercles quickly disappear, and ventral tubercles increase irregularly; on final whorls the ribs become flexuous and cross the venter without furrow or smooth band. Dimorphic. *Upper Jurassic (upper Tithonian,* Andraei *Zone–lower Berriasian,* Jacobi *Zone):* USA (California), Mexico, Cuba, Peru.——Fig. 74,*2a–e. *D. vulgaris*, upper Tithonian, San Pedro del Gallo, Mexico; *a–b,* lost lectotype (designated by Tavera Benitez, 1985, p. 158), complete adult macroconch, ×1 (Burckhardt, 1912, pl. 37,*1,2;* also figured in Frau, Bulot, & Wimbledon, 2015, p. 120, 3A); *c–d,* neotype (designated by Frau, Bulot, & Wimbledon, 2015, p. 119), complete macroconch, ×1 (Burckhardt, 1912, pl. 37,*3,9*); *e,* incomplete microconch, ×1 (Burckhardt, 1912, pl. 37,*7*).

Protacanthodiscus Spath, 1923a, p. 305 [**Hoplites andreaei* Kilian, 1889, p. 670; OD] [=*Boughdiriella* Wimbledon & others, 2013, p. 145, *nom. nud.; =Boughdiriella* Frau, Bulot, & Wimbledon, 2015, p. 123 (type, *B. chouetensis,* OD)]. Small to medium sized, fairly involute; dimorphic; whorl section first subcircular, then compressed, high quadrate to hexagonal in shape, venter tabulate; microconch and inner whorls of the macroconch with simple or biplicate ribs with small tubercle at the furcation point; middle and outer whorls of the macroconch with distant ribs that are simple, biplicate or trifurcate and intercalatories; two rows of tubercles, lateral and ventral, the former at the branching points, the latter ending the secondaries and bordering the ventral smooth band; macroconch aperture simple; microconch aperture with short lappets. *Upper Jurassic (upper Tithonian,* Andreaei *Zone):* southeastern France, southern Spain, Italy, Bulgaria, Algeria, Tunisia, Morocco.——Fig. 74,*3a–b. *P. andreaei* (Kilian), holotype, incomplete adult macroconch, *Andreaei* Zone and calpionellid *Crassicolaria* Zone, A2 Subzone, Cabra, Spain, ×0.66 (Énay, Boughdiri, & Le Hégarat, 1998a, p. 428, fig. 2,*16a–b*).——Fig. 74,*3c. P. chouetensis* (Frau, Bulot, & Wimbledon), complete microconch, *Andraei* Zone, Le Chouet, Drôme, France, ×1 (Frau, Bulot, & Wimbledon, 2015, p. 122, fig. *4A*).

Kilianites Énay, Boughdiri, & Le Hégarat , 1998c, p. 551 [**K. canavarii;* OD]. Like *Protacanthodiscus,* but with well-marked umbilical tubercles, simple intercalatories disappearing in the adult stage and well-developed ventral tubercles, hence the *Neocosmoceras*-like adult morphology. Inner whorl rounded, early compressed and octagon shaped, narrow ventral area with deep groove and fringing, strong tubercles; dense and fine ribbing with biplicate and simple ribs and lateral tubercles; later umbilical tubercles and bidichotomous ribs develop with lateral tubercle on the bifurcate ribs and strengthening of the ventral tubercles stronger on the secondaries than on the intercalatories; adult stage with only the biplicate primaries and strengthening of the ventral tubercles tending to clavi. *Lower Cretaceous (lower Berriasian,* Euxinus *Zone,* Jacobi *Subzone or* Jacobi *Zone):* southern Spain.——Fig. 74,*4a–b. *K. canavarii,* holotype, wholly septate, lower Berriasian, Cabra, Spain, ×0.5 (Énay, Boughdiri, & Le Hégarat, 1998c, p. 551, fig. 1,*1a–b*).

Hegaratites Boughdiri & others, 1999, p. 111 [**H. rheouisensis;* OD]. Dimorphic. Evolute, whorl section compressed; microconch with lappets, dense and fine simple ribs in the inner whorls resembling *Toucasiella; Protacanthodiscus*-like macroconch, but trituberculate with small umbilical, strong lateral, and sporadic ventral tubercles. Persistent ventral furrow. *Upper Jurassic (upper Tithonian,* Andreaei *Zone):* Tunisia.——Fig. 75,*2a–c. *H. rheouisensis,* Sidi Kralif Formation, upper Tithonian, *Andreaei* Zone, Jebel Rhéouis, North-South axis, Tunisia; *a,* holotype, incomplete microconch with lappet missing; *b,* small microconch with lappet; *c,* incomplete macroconch, ×1 (Boughdiri & others, 1999, pl. 1,*1,3–4*).

Toucasiella Énay, Boughdiri, & Le Hégarat, 1998b, p. 473 [**T. gerardi;* OD]. Small sized, fairly involute platycone; dimorphic; microconch with little change during growth except for the final part of the body chamber, when ventral smooth band disappears and the ribs cross the venter; prorsiradiate, simple, and more or less numerous bifurcate ribs, but only simple primaries in some extreme variants, both ending in some ventral tubercles beside smooth band; macroconch inner and middle whorls differ by lateral tubercles at the branching point that disappear together with the smooth band on last one-half of the body chamber. Extreme variants display looped ribs and strong ventral tubercles resembling some Suaritinae. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone,* Simplisphinctes *Subzone/* Chitinoidella boneti calpionellid *Zone):* southern Spain, Tunisia.——Fig. 75,*1a–c. *T. gerardi,* upper Tithonian, Cabra, Spain; *a–b,* holotype, complete adult microconch; *c,* paratype, complete adult macroconch, ×1 (Énay, Boughdiri, & Le Hégarat, 1998b, p. 474, fig. 4*a–b,* 9).

Tithopeltoceras Arkell, 1953, p. 39 [**Aspidoceras moriconii* Meneghini, 1885, p. 379; OD] Small to medium size; whorl section quadrate depressed; inner whorls with biplicate primary ribs and secondaries crossing the venter, the branching points high on the side, changing progressively to single row of tubercles, median or ventrolateral,

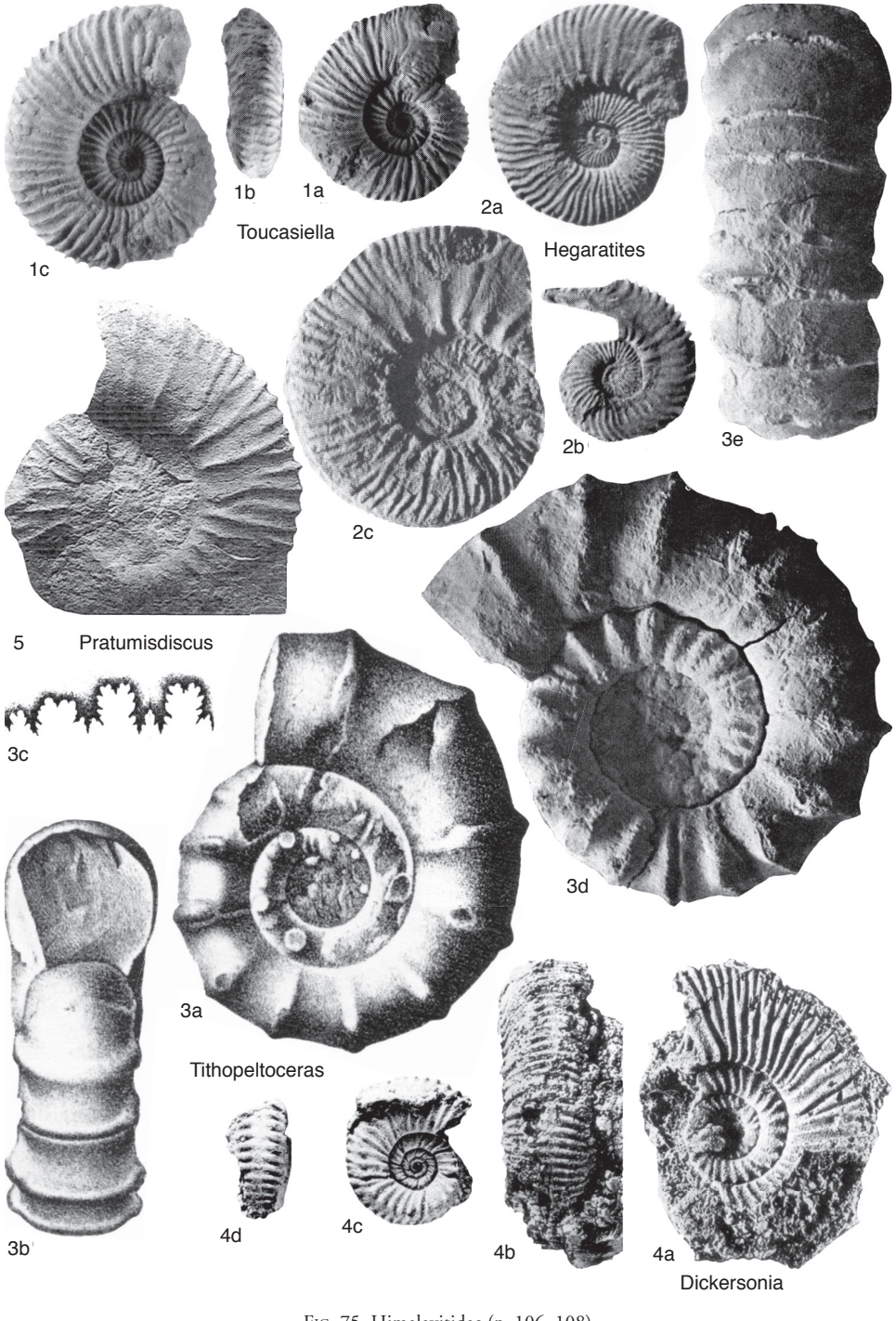

FIG. 75. Himalayitidae (p. 106–108).

weakening of the secondaries and venter more or less smooth; *Peltoceras*-like outer whorl with distant, swollen ribs and lateral bullae or not, passing strongly on the venter. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone):* southern Spain, Italy, Greece.——Fig. 75,*3a–c. *T. moriconii* (Meneghini), holotype, upper Tithonian, Ancona, Italy, ×0.75 (Meneghini, 1885, pl. 22,*2*).——Fig. 75,*3d–e. T. arkelli* Oloriz & Tavera, 1979c, holotype, nearly complete adult, upper Tithonian, *Microcanthum* Zone, Sierra Gorda, Granada, Spain, ×0.75 (Oloriz & Tavera, 1979c, pl. 2,*1a–b*).

?**Pratumisdiscus** Bulot, Frau, & Wimbledon, 2014, p. 121 [**P. elsae;* OD]. Small; evolute and compressed whorl section; inner whorls subquadrate, first with distant, prominent primaries; then simple, bifurcate ribs alternating irregularly with intercalatories, and strengthening of the umbilical part on the last whorl; venter tabulate with a ventral furrow delimited by outer row of tubercles. *Upper Tithonian (*Andreaei *Zone–calpionellid* Crassicolaria *Zone, A2 Subzone):* southeastern France.——Fig. 75,*5. *P. elsae,* holotype, incomplete specimen, Le Chouet, Drôme, France, ×1 (Bulot, Frau, & Wimbledon, 2014, p. 122, fig. 6).

Steueria Parent, Scherzinger, & Schweigert, 2011, p. 65 [**Berriasella alternans* Gerth, 1921, p. 117; OD]. Medium sized, dimorphic. Similar to *Micracanthoceras,* but differs by more involute coiling, densely ribbed inner whorls, and more compressed whorl section. Inner whorls thick and involute, middle and adult whorls platycone and more or less evolute, whorl section suboval to subtrapezoidal; two rows of tubercles, lateral and ventral, occurring on every other two (or four) primaries, appearing later when the ribbing is finer and denser; coarse primaries, simple or bifurcate on upper part of the side; uneven secondaries and ventral tubercles; persistent ventral smooth band or groove. Microconch smaller with lappets. *Upper Jurassic (upper Tithonian,* Alternans *[=*Microcanthum*] Zone,* Transitorius *Subzone):* Argentina.——Fig. 74,*5a–c. *S. alternans* (Gerth), upper Tithonian, *Alternans* Zone, Mendoza, Argentina; *a–b,* holotype, coarsely ribbed morphotype, ×0.5 (Parent, 2001, p. 32, fig. 9*D–E*); *c,* densely ribbed morphotype (="*Berriasella" inaequicostata* Gerth, holotype), ×0.5 (Parent, Scherzinger, & Schweigert, 2011, p. 67, fig. 29D).

Dickersonia Imlay, 1942, p. 1449 [**D. sabanillensis;* OD]. Form discoidal, compressed, fairly evolute; inner whorl section depressed with rounded sides and flattened venter; outer whorl compressed, subovate; strongly tuberculate inner whorl resembling *Corongoceras,* with simple and biplicate ribs, all bearing acute lateral tubercles, and stronger ventral tubercles bordering smooth, concave venter; tubercles less prominent with growth and outer whorl not tuberculate and ornamented by high, narrowly rounded ribs resembling those in *Berriasella,* but without ventral interruption. *Upper Jurassic (Tithonian):* Cuba.——Fig. 75,*4a–d *D. sabanillensis,* Viñales Limestones, upper Tithonian, Santa Clara province, Cuba; *a–b,* holotype; *c–d,* paratype, inner whorls, ×1 (Imlay, 1942, pl. 6,*11–12,14–15*).

Djurdjuriceras Roman, 1936, p. 16 [**D. djurdjurense;* OD). Fairly large, evolute; inner whorls with quadrate compressed whorl section, changing to slightly depressed on the outer whorl, venter rounded; dense, straight prorsiradiate ribs, simple or bifurcate, progressively more distant, crossing the venter without change; body chamber with coarse, very distant ribs, often simple, sometimes bifurcate or geminate. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone):* Algeria, southern Turkey, Argentina.——Fig. 76,*1a–b. *D. djurdjurense,* holotype, nearly complete, fully grown specimen, Red Nodular Limestone, upper Tithonian, Djurjura, Algeria, ×0.5 (Roman, 1936, pl. 2,*5d*).

Windhauseniceras Leanza, 1945, p. 22 [**Perisphinctes internispinosus* Krantz, 1926, p. 453; OD]. Dimorphic. Macroconch fairly large and evolute; inner whorls coronate with coarse, distant ribs biplicate and triplicate, a lateral row of tubercles at furcation points, the secondaries not interrupted on the venter, with median flattening but not tuberculate; perisphinctid-like outer whorl with rounded venter, biplicate ribs, and no tubercles. *Upper Jurassic (lower Tithonian,* Internispinosum *[=*Ponti*] Zone):* Argentina.——Fig. 76,*2a–f. *W. internispinosum*; *a–d*, Vaca Muerte Formation, Cerro Lotena, Neuquen-Mendoza, Argentina; *a–b*, lectotype, incomplete macroconch with beginning of body chamber, ×0.5 (Parent, 2003b, p. 355, fig. 1*A–B*); *c–d,* syntype, nucleus, ×1 (Krantz, 1928, p. 39, pl. 2,*4a–b*); *e–f,* microconch with lappets, Barda Negra, Neuquen-Mendoza, Argentina, ×1 (Parent & others, 2007, p. 21, fig. 9*A1–2*).

Hemispiticeras Spath, 1925a, p. 144 [**Reineckeia steinmanni* Steuer, 1897, p. 28(154); OD]. Large size; evolute, whorl section quadrate rounded; bituberculate ribs; strong, distant, bifurcate primary ribs with lateral row of tubercles and projected secondaries interrupted on the venter; row of ventral tubercles on inner whorls change later to median flattening or concavity. Adults unknown. *Upper Jurassic (lower Tithonian,* Internispinosum *Zone [=*Ponti*] Zone):* Argentina, Italy.——Fig. 76,*3a–d. *H. steinmanni* (Steuer), holotype, wholly septate macroconch, La Manga, Argentina, ×0.5 (Steuer, 1897, pl. 8(22),*1–4*).

INCERTAE SEDIS IN HIMALAYITINAE

Organoceras Myczynski, 1976b, p. 391 [**O. znoskoi;* OD)]. Unfortunately, Myczynski had no other ammonites from the same locality in western Cuba, and the single specimen is very close,

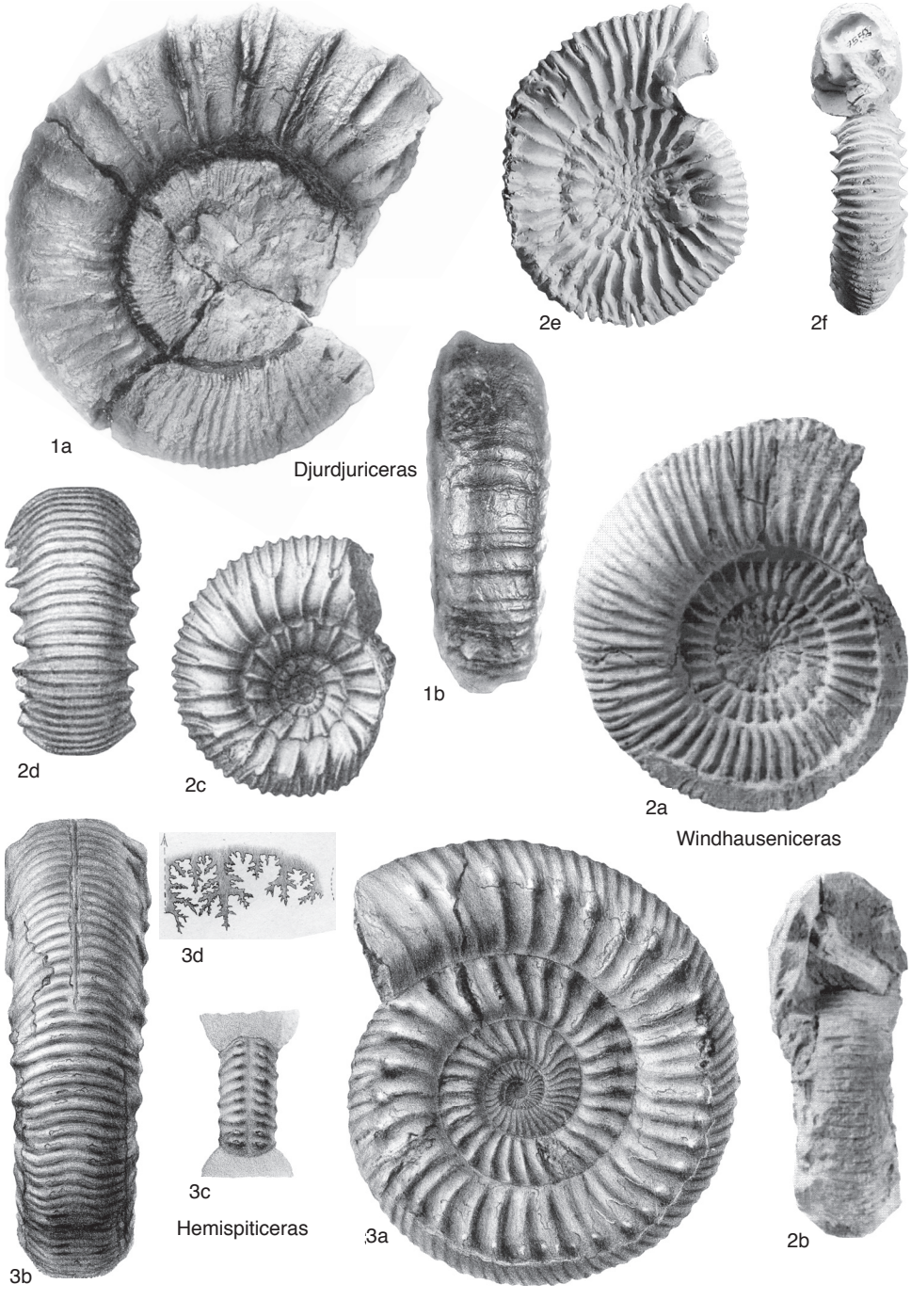

FIG. 76. Himalayitidae (p. 108).

perhaps identical, with *Durangites* of late Tithonian age. MYCZYNSKI probably misidentified the horizon of *Organoceras* as Oxfordian Jagua Formation instead of the Tithonian Vinales Formation. *Upper Jurassic (middle–upper Oxfordian):* western Cuba.

Subfamily SUARITINAE Cantú Chapa, 1998

[Suaritinae CANTÚ CHAPA, 1998, p. 22]

This subfamily was introduced for Tethyan Caribbean and South American genera that differ from Himalayitinae by having primary ribs looped to ventrolateral tubercles, or secondary ribs looped between ventrolateral and ventral tubercles, at some stage of growth. ZEISS and LEANZA (2008, p. 228) accepted with doubt the new subfamily, noting that most of the included genera have simple ribs on the inner whorls and questioning whether the subfamily should include genera "which present in the adult stage simple ribs instead of looped ribs." Looped structures of the specimens figured in CANTÚ CHAPA (1967b, p. 13, fig. 1, pl. 5,*5*) are located on secondaries issued from bifurcating points high on the side. Together with prevailing simple ribs, such looped secondary ribs occur in some specimens of the Tethyan genus *Simplisphinctes* TAVERA BENITEZ (1985, pl. 29,*2,7*) and were interpreted as a second row of tubercles very high on the side. Therefore, another possible opinion is that these genera show a common tendency for changing the well-defined bituberculate stage of the Himalayitinae to the mainly simple ribs and occasionally looped secondary ribs of the Suaritinae. *Toucasiella* is placed herein in the Himalayitinae because of its transitory bituberculate stage in the macroconch, but it is a transitional form towards the morphology of the Suaritinae. *Upper Jurassic (upper Tithonian):* southern Europe (or Tethys), northern Africa, Mexico, Cuba, South America.

Suarites CANTÚ CHAPA, 1967b, p. 12 [**Suarites bituberculatus;* OD] [=*Galeanites* CANTÚ CHAPA, 1998, p. 22 (type, *G. garcensis* CANTÚ CHAPA, 1967b, p. 22, OD)]. Poorly known; small size, moderately involute, whorls probably compressed; inner whorls with dense, coarse, simple or bifurcate ribs, with small, radially elongated tubercles high on the whorl side; secondary ribs looped to ventrolateral tubercles; ventral smooth band or groove is assumed from the supposed inner whorls described as *Galeanites,* but known only from the holotype. *Upper Jurassic (upper Tithonian):* Mexico.——FIG. 77,*1a. *S. bituberculatus,* holotype, Pimienta Formation, Mazatepec, Puebla, Mexico, ×0.5 (Cantú Chapa, 1967b, pl. 5,*5*).——FIG. 77,*1b–c. S. velardensis* CANTÚ CHAPA, Pimienta Formation, Mazatepec, Puebla, Mexico; *b,* holotype, ×0.5; *c,* paratype, inner whorls, ×1 (Cantú Chapa, 1967b, p. 13, fig. 1, pl. 2,*7*).

Housaites VILLASEÑOR & OLORIZ, 2009, p. 121, *nom. nov. pro Butticeras* HOUSA & DE LA NUEZ, 1975, p. 57, *non Butticeras* ANDERSON, 1958, p. 272 (Cretaceous Texanitinae) [**Parodontoceras butti* IMLAY, 1942, p. 1454; OD]. Moderately coiled, whorl section subovate; densely ribbed inner whorls, bifurcate primary below mid-side; during growth branching points rise to or a little above the middle of the side and frequency of simple ribs increases until all the ribs are simple, strong, inclined forward, and widely spaced; no ventral smooth band or groove. *Upper Jurassic (upper Tithonian):* Cuba, Mexico.——FIG. 77,*2. *H. butti* (IMLAY), holotype, Viñales Limestones, upper Tithonian, Pinar del Rio Province, Cuba, ×0.5 (Imlay, 1942, pl. 7,*11*).

Lotenia ZEISS & LEANZA, 2008, p. 229 [**Simplisphinctes (L.) neuquenensis;* OD]. Small, evolute, discoidal, whorl section quadrate, as high as thick, venter tabulate with median furrow well developed; inner whorls not densely ribbed; simple, sharp radial ribs ending with nodes or bullae on the external margin. *Upper Jurassic (upper Tithonian):* Argentina.——FIG. 77,*3a–b. *L. neuquenensis,* holotype, Vaca Muerte Formation, upper Tithonian, *Internispinosum* Zone, Cerro Loteno, Neuquén, Argentina, ×0.5 (Zeiss & Leanza, 2008, p. 230, fig. 2,*4;* p. 232, fig. 4).

Paralytohoplites MYCZYNSKI, 1996, p. 125 [**Lytohoplites carribeanus* IMLAY, 1942, p. 1453; OD]. Small, moderately evolute, whorl section subovate, first wider than high, later more compressed, venter regularly rounded; inner whorls with prorsiradiate simple ribs, more widely spaced during growth; very rare bifurcate ribs at the base of the side; constrictions not evident. *Upper Jurassic (upper Tithonian):* Cuba.——FIG. 77,*4a–b. *L. carribeanus* (IMLAY), holotype, Viñales Limestones, Pinar del Rio Province, Cuba, ×0.5 (Imlay, 1942, pl. 7,*1–2*).

Wichmanniceras LEANZA, 1945, p. 83 [**W. mirum;* OD]. Medium size, evolute planulate shell; whorl section subcircular, hardly wider than high, sides rounded, venter tabulate; regular, straight, simple ribs and frequent looped ribs, both ending at blunt ventrolateral tubercles; venter with diminishing furrow. *Upper Jurassic (upper Tithonian,* Internispinosum *Zone):* Argentina.——FIG. 77,*8a–b. *W. mirum,* holotype, Sierra Azul, Mendoza, Argentina, ×0.5 (Leanza, 1945, pl. 1,*4–5*).

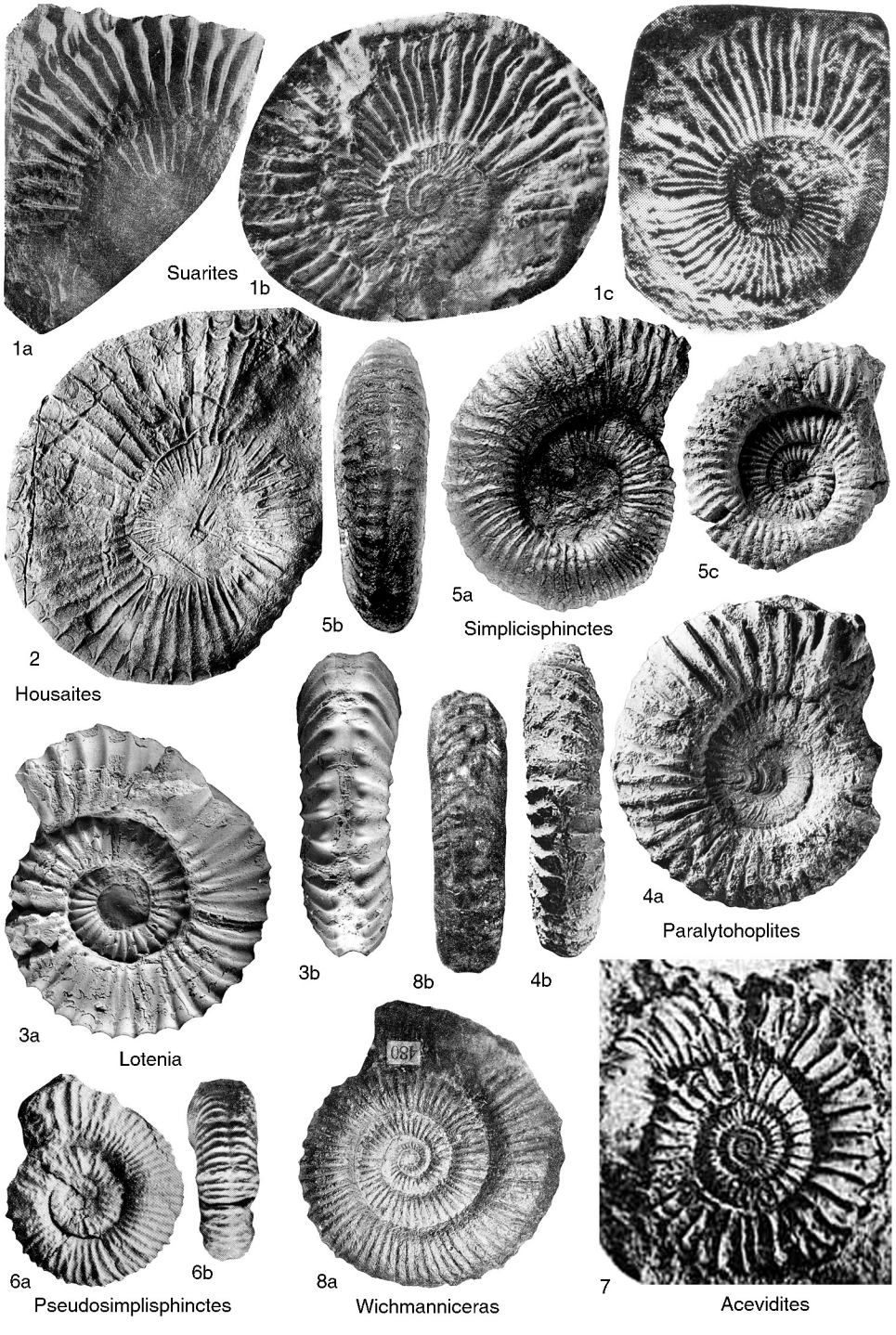

FIG. 77. Himalayitidae (p. 110–112).

Simplisphinctes Tavera Benitez, 1985, p. 208 [**Himalayites? abnormis* Roman, 1936, p. 31; OD]. Small size, evolute, whorl section rounded to oval, tabulate venter with smooth band; flexuous, rursiradiate, simple, but occasionally bifurcate and looped ribs on upper whorl side end at ventral tubercles. Dimorphic, microconch with lappets. *Upper Jurassic (upper Tithonian):* Spain, Algeria, Morocco.——Fig. 77,*5a–c.* **S. abnormis* (Roman), *a–b,* holotype, macroconch, Red Nodular Limestones, Djurjura, Algeria, ×0.5 (Roman, 1936, pl. 1,*6,6a*); *c,* nearly complete microconch, Rosso Ammonitico, *Microcanthum* Zone, *Simplisphinctes* Subzone, Castillo de Locubin, Jaen, Spain, ×0.5 (Geyssant, 1997, pl. 26,*2b*).

?Peudosimplisphinctes Tavera Benitez, 1985, p. 218 [**P. jimenezi;* OD]. Poorly known. Small size, fairly evolute; whorl section first depressed, later subcircular to oval; two successive ribbing stages, first a *Micracanthoceras*-like stage with simple and bifurcate ribs, branching high on the whorl side; followed by a *Simplisphinctes*-like stage, with a prominent ventral smooth band and mainly simple ribs ending at small tubercle-shaped thickenings. *Upper Jurassic (upper Tithonian,* Microcanthum *Zone,* Simplisphinctes *Subzone):* Spain.——Fig. 77,*6a–b.* **P. jimenezi,* holotype, complete adult microconch with lappets, Sierra Gorda, Granada, Spain, ×1 (Tavera Benitez, 1985, pl. 30,*9a–b*).

?Acevidites Cantú Chapa, 1967b, p. 13 [**A. acevedensis;* OD]. Small size, evolute; inner whorls with distant, radial, simple ribs; later, small tubercles occur at the external third of the rib, and weakened ribs end at small, radially elongated tubercles; on the final part of the last whorl widely spaced ribs are simple or looped. *Upper Jurassic (upper Tithonian):* Mexico.——Fig. 77,*7.* **A. acevedensis,* holotype, Pimienta Formation, Mazatepec, Puebla, Mexico, ×1 (Cantú Chapa, 1967b, pl. 4,*4b*).

Family ATAXIOCERATIDAE Buckman, 1921

[Ataxioceratinae Buckman, 1921, p. 31]

The family is still one of the most difficult to classify, though discoveries of the last 50 years provided new evidence, both stratigraphical and geographical, to join together previously disconnected groups of forms. The family evolved from the Perisphinctinae at the Oxfordian-Kimmeridgian boundary, with the development of a new morphological character—the polyschizotomous style of branching with its numerous variants, including bidichotome (or polyplocoid), polygyrate, fascipartite, and virgatipartite (or virgatotome). Quite distinct types of rib furcation have been distinguished and received various names, and several of these types may occur together in the same specimen or species. Additionally, in some groups the style of ribbing does not conform to one of these well-defined types, and other morphological features such as the general shape and whorl section need to be used. The family, as described herein, brings together several groups of genera of somewhat different morphology that evolved independently over a long period of time. Most genera are included in two subfamilies: the Ataxioceratinae of Kimmeridgian age and restricted to the European part of the Tethys and the Lithacoceratinae that were geographically more widespread during the Tithonian. Minor offshoots are the more restricted subfamilies, the Paraboliceratinae, Torquatisphinctinae, and Virgatosphinctinae. According to Cecca, Énay, and Hégarat (1989), Parent (2003a), and Bulot, Frau, and Wimbledon (2014), the use of the subfamily Paraulacosphinctinae Tavera Benitez, 1985 (based on the occurrence of a ventral smooth band or furrow) is considered unnecessary because its relationship with Lithacoceratinae remains unclear. *Upper Jurassic (late Oxfordian–Tithonian):* Tethyan, mainly Submediterranean.

Subfamily ATAXIOCERATINAE Buckman, 1921

[*nom. transl.* Arkell, 1950, p. 363, *ex* Ataxioceratidae Buckman, 1921, p. 31] [=Idoceratinae Spath, 1924, p. 11; =Gravesiinae Fischer & Zeiss, 1987, p. 229]

As the initial burst of the Ataxioceratidae, this subfamily gave birth to all the subsequent Submediterranean and Sub-Austral (Indo-Malagasian) subfamilies as well as the Subboreal and Boreal major branches that colonized the northwestern Europe and Russian Platforms. An origin from *Passendorferia* and the Passendorferiinae (Mélendez, 1989; Atrops & Mélendez, 1993; Mélendez & others, 2009) is not accepted herein, nor the origin from Indian middle Oxfordian Perisphinctinae (Roy and others, 2012). Following Atrops (1982), the late Oxfordian to early Kimmeridgian genus *Orthosphinctes,* formerly placed in the Perisphinctinae, gave rise to short living

offshoots, some of them probably linearly related to the succeeding genera.

The subfamily is characterized by dense, fine, many-branched ribbing, some genera developing the bidichotome furcation of *Ataxioceras* but typically not truly virgatotome. The inclusion of *Idoceras* in the Ataxioceratinae is supported by shell morphology and the ataxioceratoid ribbing of well-preserved Mexican *Idoceras* (Villaseñor & Oloriz, 2006). Hence, the synonymy between Idoceratinae and Ataxioceratinae previously assumed by Arkell in Arkell and others (1957) and Callomon (in Donovan, Callomon, & Howarth 1981) is confirmed. Besides these, stout or inflated morphologies with depressed to coronate whorls and coarse ribbing were developed as offshoots, often living in shallow platform environments (e.g., *Gravesia*). Thus, the subfamily Gravesiinae Fischer & Zeiss, 1987, is here considered to be a junior synonym of Ataxioceratinae. *Upper Jurassic (upper Oxfordian–lower Tithonian):* southern Europe, northern Africa.

Orthosphinctes Schindewolf, 1925, p. 324 [**Ammonites tiziani* Oppel, 1863 in Oppel 1862–1863, p. 246; OD] [=*Biplices* Siemiradzki 1891, p. 63, obj., suppressed in ICZN Opinion 504, 1958, p. 143, because not published in the nominative singular; =*Praeataxioceras* Atrops, 1982, p. 50 (type, *Perisphinctes laufenensis* Siemiradzki, 1898 in 1898–1899, p. 188, OD); =*Pseudorthosphinces* Énay, 1966, p. 518 (type, *Orthosphinctes (Pseudorthosphinctes) alternans,* OD); =*Lithacosphinctes* Oloriz, 1978a, p. 410 (type, *Ammonites lictor evolutus* Quenstedt 1888 in 1882–1888, p. 957, OD; *non A. oxynotus evolutus* Quenstedt, 1884, p. 178, *nec A. jurensis evolutus* Quenstedt, 1885, p. 379, *nec A. macrocephalus evolutus* Quenstedt, 1886, p. 655; =*Perisphinctes tranchandi* Bigot & Brasil, 1904, p. 100; =*P. carsiensis* Simionescu, 1907, p. 167(53), lectotype designated by Énay, 1966, p. 527); =*Orthosphinctes (Lithacosphinctes) siemiradzkii* Kiessling & Zeiss, 1992, p. 193, *nom. nov. pro A. lictor evolutus* Quenstedt, 1888 in 1882–1888, p. 957); ?=*Pseudopomerania* Wright, 1996, p. 438 (type, *Decipia (Pomerania) dewari* Arkell, 1947, p. 375, OD); but *Pseudopomerania* is possibly a junior synonym of *Pomerania* Arkell, 1937, p. 69 (type, *P. dohmi* Arkell, 1937, p. 69, *nom. nov. pro Pictonia baylei* Dohm, *non* Salfeld, 1925, p. 32, OD), which differs only by its *Decipia*-like supposed inner whorls, which are still unknown in the type and related species in the type area]. Evolute platycone, dimorphic, small to very large size; rectiradiate and bifurcated primary ribs, with symmetric secondaries, rare intercalatories and simple ribs in a few species, up to the aperture or modified on the outer whorl. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian):* Europe, western Asia, northern Africa.

O. (Orthosphinctes). Microconch small to medium sized; planulate evolute, whorl compressed or rounded, biplicate ribbing with symmetric secondaries, rare intercalatories and simple ribs in a few species; aperture with well-defined lappets; macroconch (*Pseudorthosphinctes* and *Lithacosphinctes*) medium-sized to very large, evolute; whorl section oval to rounded subquadrate; dense ribbing decreasing on the last whorl; rectiradiate and bifurcate primary ribs and very few, free ending intercalatories, sometimes joined to the primary up to the end; well-marked constrictions (*Pseudorthosphinctes*), stronger dorsally and more distant on the middle whorls, with 4 to 6 secondary ribs; last whorl with solid, simple ribs, swollen or triangular-shaped in some species; parabolae and constrictions on the inner whorls (*Lithacosphinctes*); aperture simple and oblique with a short ventral rostrum or simple and concave; suture line complex with deep suspensive lobe. The ICZN (2005, Opinion 2123) declared that third names of Quenstedt's trinominal system of nomenclature were available species-group names. Therefore, the earliest use of the species name is *Ammonites evolutus* Quenstedt, 1884, and the three subsequent uses by Quenstedt (1885, 1886, 1888 in 1882–1888) are junior homonyms. Three replacement names were proposed for *A. evolutus*, and the earliest of these is *P. tranchandi* (see synonymy above); however, *A. evolutus* is considered here as the correct name for the type species of *Lithacosphinctes*, according to Oloriz (1978a). *Upper Jurassic (upper Oxfordian,* Planula *Zone–lower Kimmeridgian,* Platynota–Hypselocyclum *Zones):* Germany, Switzerland, France, northern Italy, Spain, Portugal, Poland, southern England, Romania, northern Africa, northern Turkey, Uzbekistan.——Fig. 78,*1a. *O. (O.) tiziani* (Oppel), lectotype, Malm β, upper Oxfordian, *Planula* Zone, Hundsrück, Germany, ×0.5 (Wegele, 1929, p. 44(138), pl. 1,*4*).——Fig. 78,*1b.*O. (O.) laufenensis* (Siemiradzki), holotype, *upper Oxfordian*, *Bimammatum* Zone, Laufen, Germany, ×0.5 (Siemiradzki, 1898 in 1898–1899, pl. 26,*46*).——Fig. 78,*1c. O. alternans* Énay, holotype, Calcaires lités Formation, upper Oxfordian, *Bimammatum* Zone, Bouvesse, Isère, France, ×0.4 (Énay, 1966, fig. 159,*1*).——Fig. 78,*1d. O. (L.) evolutus* (Quenstedt), holotype (original of Quenstedt, 1888 in 1882–1888, pl. 105,*2*), Weisser Jura β, upper Oxfordian, *Planula* Zone, Wasseralfingen, Germany, ×0.33 (Atrops, 1982, pl. 27,*1*).

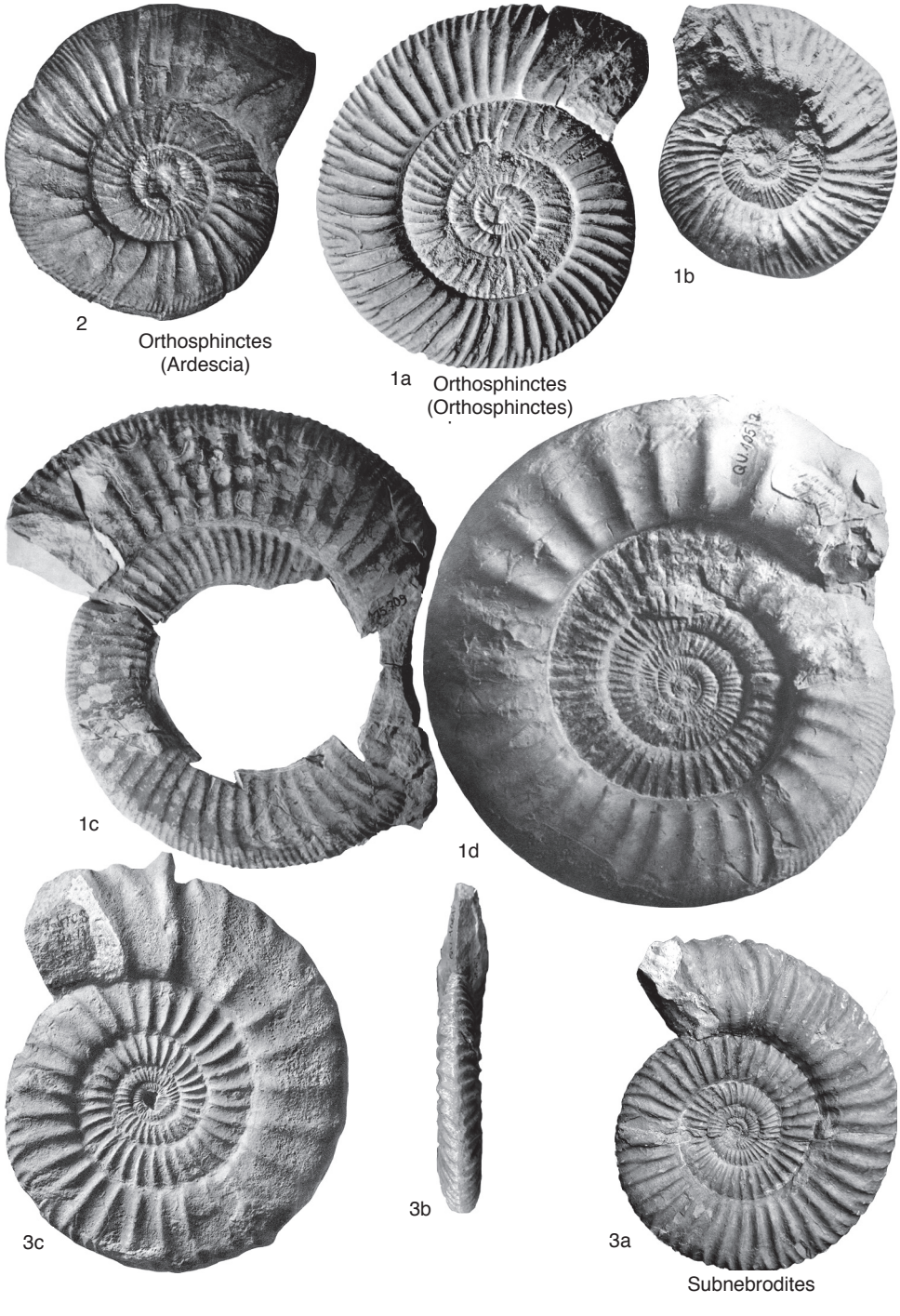

FIG. 78. Ataxioceratidae (p. 113–115).

O. (**Ardescia**) Atrops, 1982, p. 62 [**Ataxioceras desmoides* Wegele, 1929, p. 64; OD]. More distant primaries and increasing number of intercalatories, hence the rib curve shows clearly a decreasing of the rib number at the adult stage. Microconch. *Upper Jurassic (lower Kimmeridgian,* Platynota–Hypselocyclum *Zones):* Germany, Switzerland, France, Spain, Portugal, northern Africa.——Fig. 78,*2. *O. (A.) desmoides* (Wegele), holotype, lower Kimmeridgian, *Platynota* Zone, Pappenheim, Germany, ×0.5 (Wegele, 1929, pl. 6,*4*).

Subnebrodites Spath, 1925a, p. 129 [**S. planula* Spath, 1925a, p. 129, *nom. nov. pro Ammonites planula gigas* Quenstedt, 1888 in 1882–1888, p. 974, pl. 108,*2*, *non Ammonites planula* Hehl in Zeiten, 1830 in 1830–1833, p. 9 (see Énay & Howarth, 2017, and Article 67.13.1, ICZN Code, 1999); OD]. Offshoot of short duration, derived from *Orthosphinctes,* but differing in its more numerous, simple ribs with less well-defined branching and strong forward projection of the ribbing on the venter; ventral smooth band or furrow, except in the earliest species. Dimorphic. *Upper Jurassic (upper Oxfordian,* Planula *Zone):* France, Switzerland, Germany, Poland, Romania, Italy, Spain, Portugal, Morocco, Algeria, Tunisia.——Fig. 78,*3a–c. *S. planula,* Weisser Jura Middle β; *a–b,* lectotype, microconch, Wasseralfingen, Germany, ×0.5; *c,* macroconch, Spaichingen, Germany, ×0.4 (new; Geologische Institut, Universität Tübingen, Germany Ce5/108/2; also figured by Ziegler, 1959, pl. 1,*6*,*9*).

Ataxioceras Fontannes, 1879b, pl. 10, caption [**Perisphinctes (Ataxioceras) hypselocyclum;* OD] [=*Schneidia* Atrops, 1982, p. 155 (type, *Ataxioceras (S.) collignoni,* OD); =*Parataxioceras* Schindewolf, 1925, p. 328 (type, *Ammonites lothari* Oppel, 1863 in Oppel 1862–1863, p. 244, OD); =*Olorizia* Moliner in Moliner & Oloriz, 2009, p. 212 (type, *O. olorizi,* OD)]. Dimorphic; medium-sized to large macroconchs, fairly evolute to involute, constricted; dense ribbing decreasing early during growth; bidichotomous (or polyplocoid) more or less obvious primary ribs, occurring to a more or less advanced stage; secondary ribs fading on the outer whorl, the primaries only present on the inner part of the side; parabolae absent or very rare and only on the inner whorls. Aperture simple. Small to medium-sized microconchs, involute to very involute (*Schneidia*) or fairly evolute to involute and whorl section high-quadrate to oval (*Parataxioceras*); dense ribbing but decreasing early during growth; obvious subpolyplocoid primary ribs at the end of the phragmocone and the beginning of the body chamber; numerous well-marked constrictions (*Schneidia*); bidichotome (or polyplocoid) primary ribs obvious, occurring only at the end of growth in the oldest species, gradually reaching the inner whorls in the youngest; parabolae absent or well-marked, and generally lacking on the final half whorl (*Parataxioceras*); aperture with lappets. *Upper Jurassic (lower Kimmeridgian, upper* Platynota–Hypselocyclum *Zone):* Germany, Switzerland, Spain, Poland, Portugal, Bulgaria, northern Africa, northern Turkey, Mexico.——Fig. 79,*1a–b. *A. hypselocyclum,* Mount Crussol, Ardèche, France; *a,* lectotype (designated by Arkell, 1935a, p. 253), lower Kimmeridgian, ×0.5 (Fontannes, 1879b, pl. 10,*1*); *b,* topotype, lower Kimmeridgian, *Hypselocyclum* Zone, *Lothari* Subzone, ×0.4 (Atrops, 1982, pl. 40,*2*).——Fig. 79,*1c. A. collignoni* (Atrops), holotype, Mount Crussol, Ardèche, France, ×0.5 (Atrops, 1982, pl. 23,*2*).——Fig. 79,*1d–f. A. lothari* (Oppel), lower Kimmeridgian; *d–e,* holotype, Baden, Aargau, Switzerland, ×0.5 (Oppel, 1863 in Oppel 1862–1863, pl. 67,*6*); *f,* nearly complete adult specimen (but aperture missing), evolute variant, *Hypselocyclum* Zone, *Lothari* Subzone), Chauzon, Ardèche, France, ×0.5 (Atrops, 1982, pl. 41,*6*).

?Geyericeras Moliner & Oloriz, 2010, p. 102 [**G. aragoniense;* OD]. Small; moderately evolute; whorl section compressed quadrate; dimorphic; like *Ardescia,* but ribbing finer on the inner whorls and subpolyplocoid ribs close the aperture in the microconch and on the inner whorls of the macroconch but scarce and more or less frequent on the body chamber. *Upper Jurassic (lower Kimmeridgian,* Hypselocyclum *Zone,* Lothari *Subzone):* eastern Spain.——Fig. 79,*2a–c. *G. aragoniense,* Loriguilla Formation; *a–b,* holotype, complete adult microconch, reservoir of Calenda, Teruel Province, eastern Spain, ×1 (Moliner & Oloriz, 2010, p. 107, fig. 7,*A1–A2*); *c,* paratype, adult macroconch, Guadalope river section, Villarluengo area, Teruel Province, eastern Spain, ×0.5 (Moliner & Oloriz, 2010, p. 108, fig. 8A).

Idoceras Burckhardt, 1906, p. 38 [**Ammonites balderus* Oppel, 1863 in Oppel 1862–1863, p. 242; SD Spath, 1925a, p. 129] [=*Paraidoceras* Cantú Chapa, 1992, p. 27, obj.]. Platycone to discoid, involute to very involute; suboval to high oval whorl section; dense ribbing, primary ribs prorsiradiate, a few simple but mainly bifurcate and occasionally bidichotome; secondary ribs ventrally projected, venter with a median smooth band or furrow at some growth stage or in some species. Dimorphic: macroconch with smooth outer whorl, primary ribs preserved as radially elongated tubercles at the umbilical edge and a simple mouth border; microconch with lappets. *Upper Jurassic (lower Kimmeridgian,* Divisum *Zone):* Switzerland, Germany, France, Poland, Spain, Morocco, Mexico.——Fig. 80,*1a–c. *I. balderum* (Oppel); *a–b,* lectotype, wholly septate, Badener Schichten, Baden, Aargau, Switzerland, ×0.66 (Oppel, 1863 in Oppel 1862–1863, pl. 67,*2a–b*); *c,* involute form, ?macroconch, Weissejura, Ober γ, Oberdrackenstein, Germany, ×0.5 (Geyer, 1961, pl.

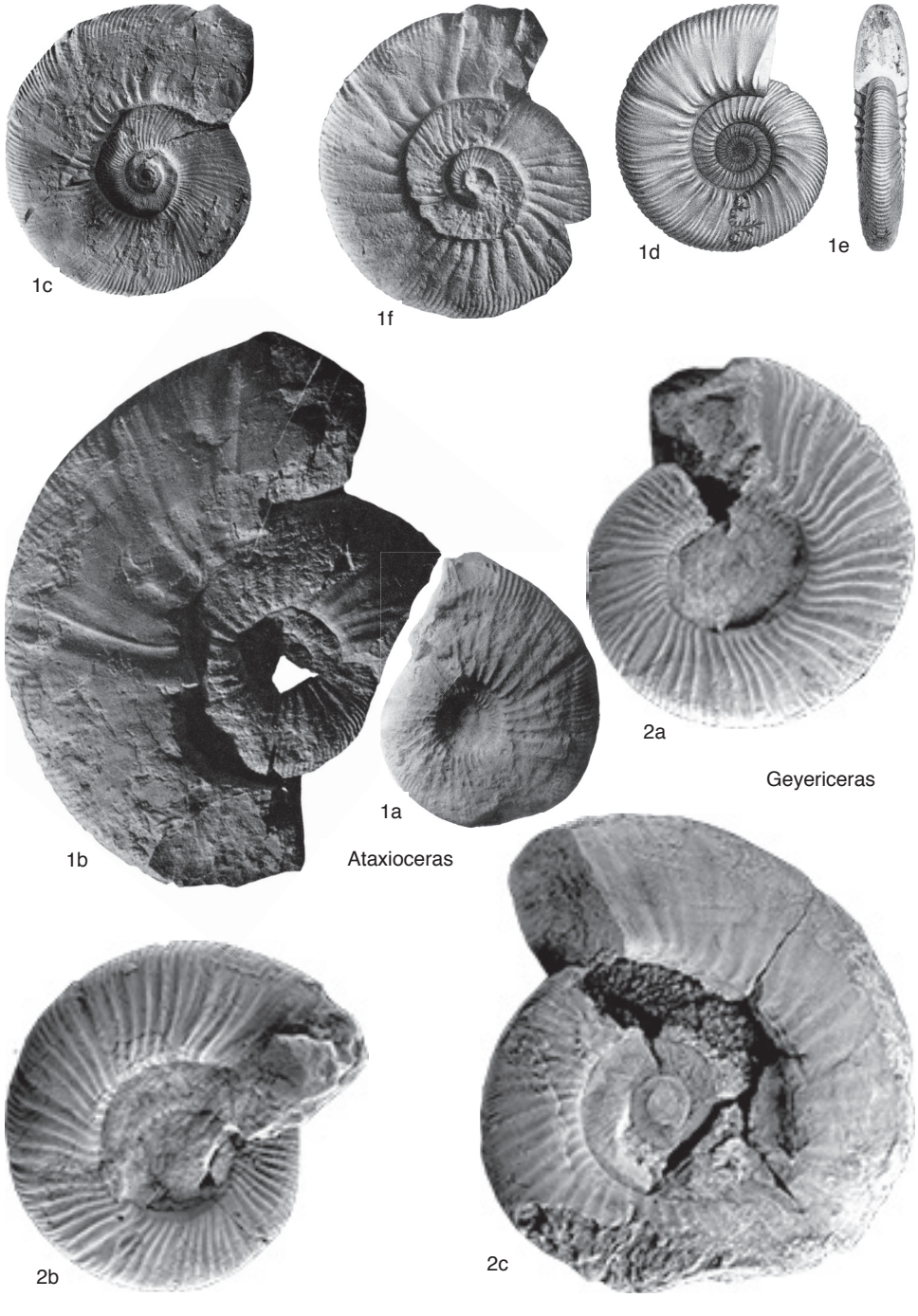

Fig. 79. Ataxioceratidae (p. 115).

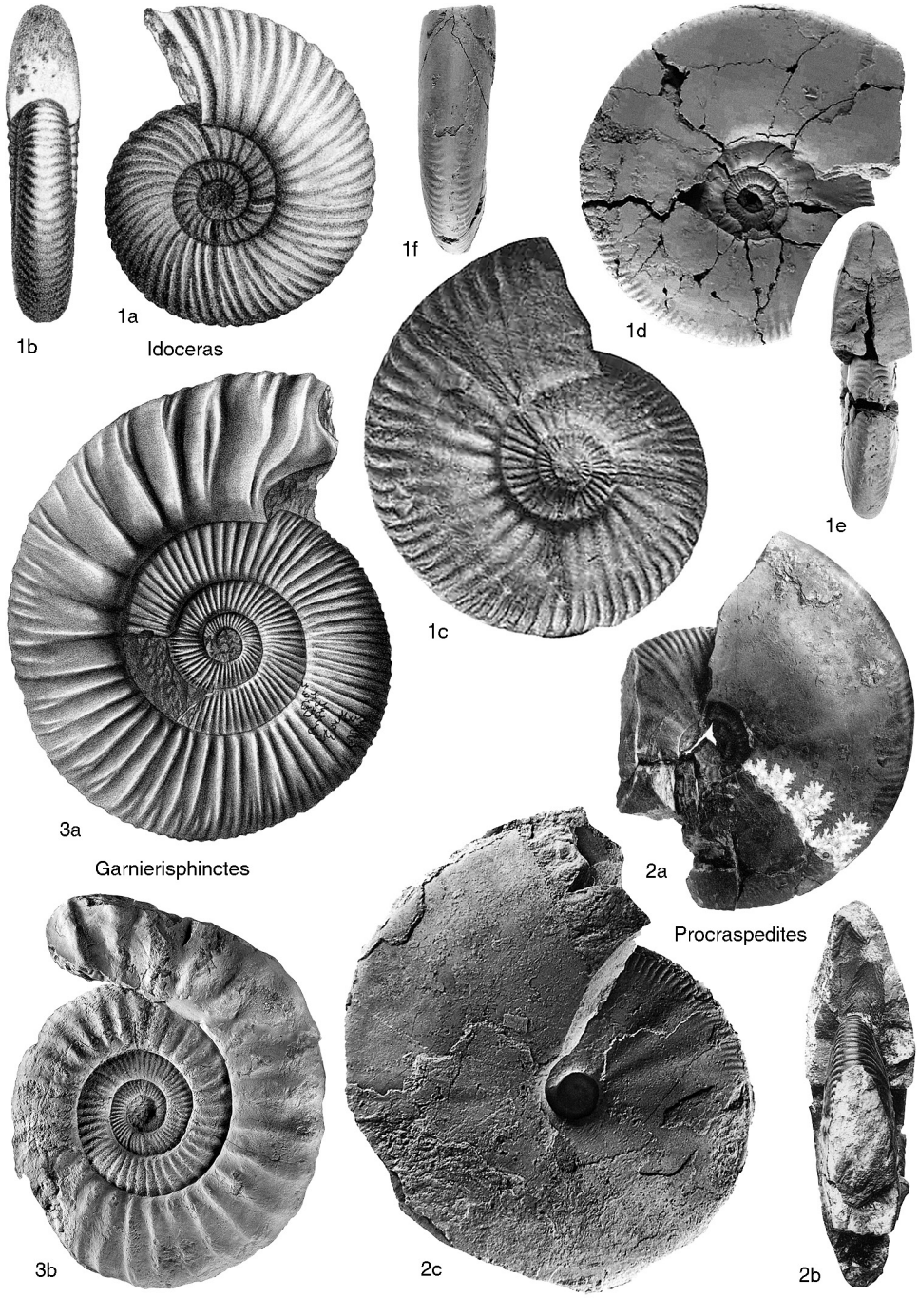

FIG. 80. Ataxioceratidae (p. 115–118).

2,*4*).——Fig. 80,*1d–f. I. durangense* Burckhardt, incomplete macroconch, upper lower Kimmeridgian, Mazapil, Mexico, ×0.25 (Villaseñor & Oloriz, 2006, fig. 1).

Procraspedites Spath, 1930, p. 56 [**Craspedites praecursor* Burckhardt, 1906, p. 98; OD]. Discoid evolute shell, compressed whorl section with narrow venter; well-ribbed inner whorls, the primary ribs soon fading at mid-side; some simple but most of them bifurcate first near the umbilical rim, then at two thirds side, and some intercalatories; secondary ribs not interrupted on the venter, fading on the outer whorl. Very similar to (and probably the descent of) Mexican *Idoceras.* Probably dimorphic. *Upper Jurassic (?lower and upper Kimmeridgian,* Eudoxus *Zone):* Mexico, USA (Texas).——Fig. 80,*2a–c. *P. praecursor* (Burckhardt); *a–b,* lectotype, Couches à Haploceras, upper Kimmeridgian, Veneda del Quemado, Sierra de la Caja, Mexico, ×0.5 (Burckhardt, 1906, pl. 18,*1–2*); *c,* nearly complete specimen, La Casita Formation, upper Kimmeridgian, *Eudoxus* Zone, Sierra de Palotes, Durango, Mexico, ×0.33 (Oloriz, Villaseñor, & Gonzales-Arreola, 1998, pl. 1,*13*).

Garnierisphinctes Énay, 1960b, p. 229 [**Ammonites garnieri* Fontannes in Dumortier & Fontannes, 1876, p. 81; OD]. Discoidal shaped; whorl height growing faster, the coiling more involute than in *Crussoliceras;* whorl section compressed, higher than thick, sides flat, and ventral area barely rounded; narrow, shallow constrictions at all growth stages; inner whorls display dense, prorsiradiate, sharp, regularly biplicate ribs that branch low on the upper part of the side; later, intercalatory ribs occur that give rise to pseudoschizotomous triplicate branches similar to polygyrate ribbing; last quarter to half whorl before the peristome of microconchs bears stronger, more distant ribs with schizotomous polyfurcate branchings of polygyrate type; macroconch dimorphs with ventral simple ribs unconnected or poorly connected to the biplicate branchings; on the body chamber primary ribs represented by more or less prominently swollen ribs that are enlarged on the venter. Aperture with lappets (microconch) or probably simple (macroconch). *Upper Jurassic (lower Kimmeridgian, uppermost* Hypselocyclum–Divisum *Zone [=acme of the genus]):* France, Germany, Switzerland, Spain, Bulgaria.——Fig. 80,*3a. *G. garnieri* (Fontannes), holotype, incomplete microconch, lower Kimmeridgian, *Divisum* Zone, Mount Crussol, Ardèche, France, ×0.33 (Dumortier & Fontannes, 1876, pl. 10,*2*).——Fig. 80,*3b. Garnierisphinctes* sp., macroconch, nearly complete adult, lower Baden Member, lower Kimmeridgian, *Divisum* Zone, Mellikon, Aargau, Switzerland, ×0.25 (Gygi, 2003, fig. 136).

Crussoliceras Énay, 1960b, p. 229 [**Ammonites crussoliensis* Fontannes in Dumortier & Fontannes, 1876, p. 97; OD [=*Badenia* Énay, 1960b, p. 229, *non* Finlay, 1930, p. 41 (gastropod) (type, *B. wegelei, nom. nov. pro Perisphinctes acerrimus* Wegele, 1929, p. 62, pl. 5,*4, non* Siemiradzki, 1891, p. 65, OD)]. Dimorphic. Medium sized, evolute shell with slow coiling; rounded quadratic whorl section, first depressed, then compressed oval on the outer whorl; sharp, rectiradiate primary ribs on the inner whorls, regularly bifurcated high on the side, stronger in the macroconch with simple intercalatory ribs that can result in a polygyrate structure; secondary ribs cross the venter without change; in the two dimorphs, rapid change in ribbing style following a constriction occurring before the end of the phragmocone, with strong, simple or bifurcate ribs, swelled or wedge-shaped, sometimes with traces of weakened secondaries on the venter. Aperture with lappets or simple. *Upper Jurassic (lower Kimmeridgian, uppermost* Hypselocyclum *and* Divisum *Zones [=acme of the genus]–upper Kimmeridgian,* Acanthicum–Eudoxus *Zones):* France, Germany, Switzerland, Spain, Morocco, Bulgaria, Russia.——Fig. 81,*1a–c. *C. crusoliense* (Fontannes), lower Kimmeridgian, *Divisum* Zone, Mount Crussol, Ardèche, France; *a,* holotype, incomplete microconch, ×0.4 (new; also figured by Énay, Gallois, & Etches, 2014, pl. 2,*1,* and Dumortier & Fontannes, 1876, pl. 14,*3*); *b–c,* topotype, complete well-preserved microconch; *b,* ×0.4; *c,* ×0.33 (Énay, Gallois, & Etches, 2014, pl. 2,*3*).

Progeronia Arkell, 1953, p. 38, *nom. nov. pro Ammonia* Ilovaĭsky & Florensky, 1941, p. 36, *non* Brünnich, 1772, p. 232, 246 (ammonite), *nec* Koch, 1842, p. 75 (Arachnida) [**Perisphinctes geron* von Ammon, 1875, p. 181; OD] [=*Hugueninsphinctes* Atrops, 1982, p. 63, 66, 122 (type, *Ammonites breviceps* Quenstedt, 1887 in 1882–1888, p. 880, OD)]. Dimorphic; large and evolute derivative of *Orthosphinctes;* whorl section compressed, venter rounded; bifurcate and trifurcate ribbing changing gradually as in *Orthosphinctes;* irregular on the outer whorl with distant primaries and long, fasciculate secondaries, fading on the ventral area. Microconch (*Hugueninsphinctes*) medium size, evolute, whorl section compressed, venter rounded; ribbing bifurcate and trifurcate with intercalatories; outer whorl with long, fasciculate secondaries, the terminal part with coarse primaries, strongly constricted; aperture with lappets, short and rounded. *Upper Jurassic (upper lower Kimmeridgian,* Divisum *Zone–upper Kimmeridgian,* Acanthicum *Zone):* Germany, France, Switzerland, Poland, Russia.——Fig. 82,*1a. *P. progeron* (von Ammon), holotype, Soldenauer Beds, Weissejura γ, lower Kimmeridgian, Söldenau near Ortenburg, Germany, ×0.35 (Geyer, 1961, pl. 7,*2*).——Fig. 82,*1b. P. ernesti* Schneid (*non* Quenstedt, *nec* de Loriol), upper Kimmeridgian, *Eudoxus* Zone, Weissenburg, Bavaria, Germany, ×0.4 (Schneid, 1915a, pl. 1,*5*).——Fig. 82,*1c–d. P. breviceps* (Quenstedt), holotype, complete

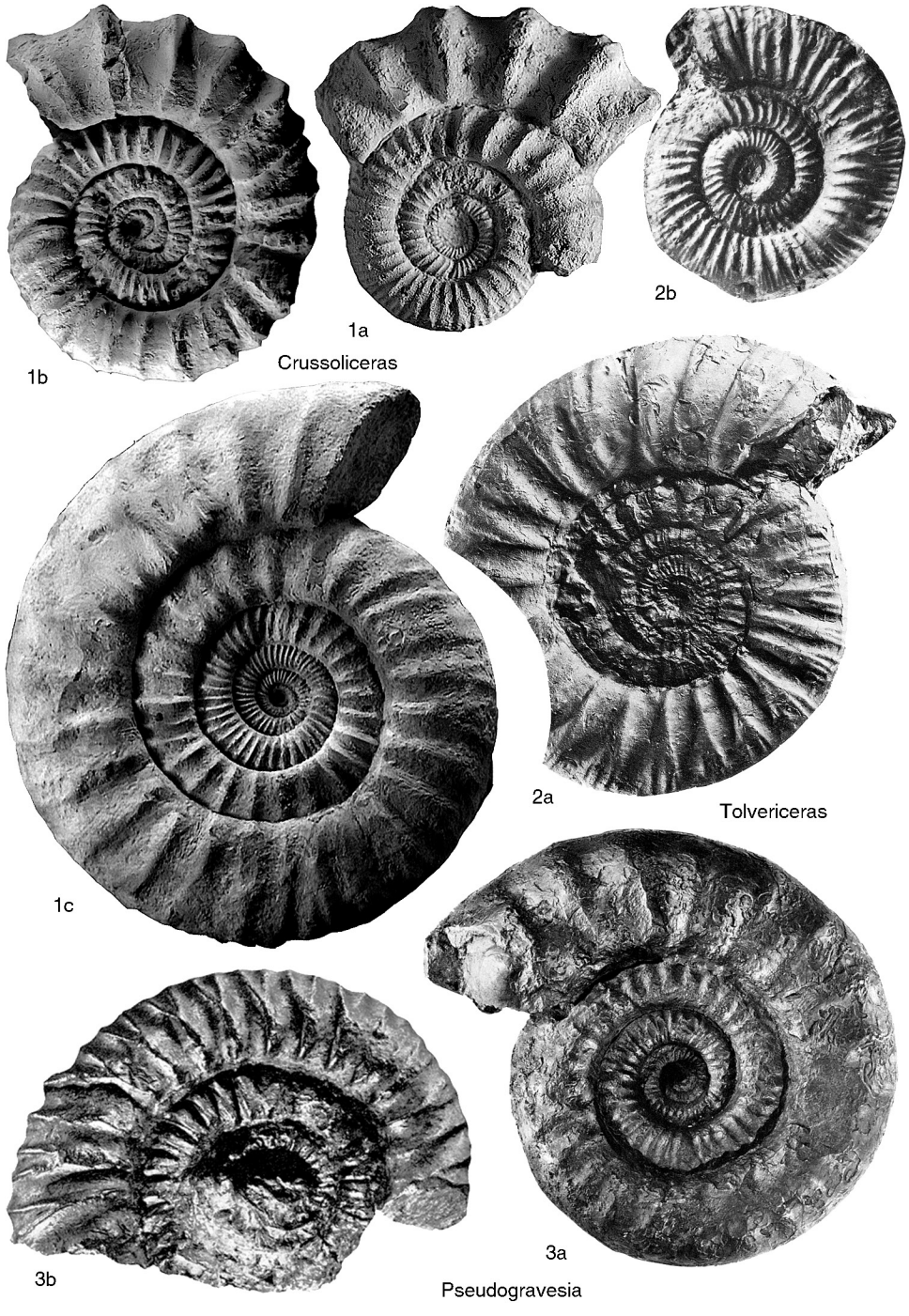

FIG. 81. Ataxioceratidae (p. 118–120).

microconch with the peristome, Weissejura γ, lower Kimmeridgian, Auendorf, Germany, ×0.33 (Atrops, 1982, pl. 44,*1–2*).

Tolvericeras Hantzpergue, 1987, p. 165 [**T. (T.) tolverense;* OD]. Small to medium size, evolute; oval-shaped whorl section; constrictions on the inner whorls, but no parabolae; strong and blunt, prorsiradiate primary ribs, the furcation point at mid-side shifting downward on the body chamber; first bifurcate and trifurcate, then fascipartite to polygyrate with up to four secondaries per primary, the secondaries crossing the venter uninterrupted. Dimorphic; macroconch with simple aperture, microconch with lappets. *Upper Jurassic (lower Kimmeridgian,* Divisum *Zone–upper Kimmeridgian,* Mutabilis *Zone):* France, Switzerland, ?southern Germany.——Fig. 81,*2a–b. *T. tolverense,* upper Kimmeridgian, *Mutabilis* Zone and Subzone), Touvre, Charente, France; *a,* holotype, macroconch, incomplete adult, ×0.3; *b,* microconch, ×0.5 (Hantzpergue, 1989, pl. 10,*b,e*).

Pseudogravesia Hantzpergue, 1987, p. 165 [**Tolvericeras (Pseudogravesia) hahni, nom. nov. pro Gravesia polypleura* Hahn, 1963, p. 101, pl. 11,*2–3, non Gravesia polypleura* Hahn, 1963, p. 101, pl. 11,*1; =G. gravesiana* (d'Orbigny, 1850 in 1842–1851, p. 559); OD] [?=*Hegovisphinctes* Zeiss, Schweigert, & Scherzinger, 1996, p. 129 (type, *H. rottgei,* OD)]. Dimorphic; small to large size, evolute, slow coiling and rapid thickening of the whorl section, quadratic rounded to subcircular and depressed; macroconch with perisphinctid ribbing on the inner whorls, primary ribs bifurcate with intercalatories first, then trifurcate and tending to polygyrate; secondary ribs fading on the outer whorl with strong or wedge-shaped primary ribs; aperture simple; microconch lacking the final stage with strong primaries, *Subdichotomoceras*-like in some species. *Upper Jurassic (upper Kimmeridgian,* Autissiodorensis *Zone and Subzone–lower Tithonian,* Gigas/Hybonotum *Zone):* France, Germany, southern England (Dorset).——Fig. 81,*3a. *P. hahni,* holotype, complete adult macroconch, Salviac Formation, lower Tithonian, *Gigas* Zone and Subzone, Saint-Chamarand, Lot, France, ×0.3 (Hantzpergue, 1989, pl. 13,*a*).——Fig. 81,*3b. P. morogensis* (Hantzpergue), *Subdichotomoceras*-like microconch, Calcaires de Saint-Martin d'Auxigny, upper Kimmeridgian, *Autissiodorensis* Zone, La Salle Saint-Martin, Cher, France, ×0.7 (Hantzpergue, 1989, pl. 12,*c*).

Gravesia Salfeld, 1913, p. 424 [**Ammonites gravesianus* d'Orbigny, 1850 in 1842–1851, p. 559; OD] [?=*Praegravesia* Fischer & Zeiss, 1987, p. 229 (type, *P. rolkei,* OD), but possibly a Middle Jurassic stephanoceratid (Schweigert, 1999, p. 28)]. Offshoot parallel to *Pseudogravesia,* the earliest forms preserving perisphinctoid ribbing on the inner whorls; probably derived from a common ancestor; small to large dimorphic pair, more or less involute, inflated, with depressed to coronate whorls; robust ribbing on the inner and middle whorls fading on the body chamber; short primary ribs tend to form periumbilical bullae and two to four secondaries cross the venter; suture line simplified with broad element; aperture simple in both dimorphs. *Upper Jurassic (upper Kimmeridgian,* Autissiodorensis *Zone and Subzone–lower Tithonian,* Gigas *Zone):* France, Germany, southern England (Dorset), Switzerland (Jura).——Fig. 82,*2a–c. *G. gravesiana* (d'Orbigny); *a–b,* holotype, wholly septate, lower Tithonian, *Gigas* Zone, *Gravesi* Subzone, Auxerre, Yonne, France, ×0.6 (Fischer & others, 1994, pl. 86,*2a–b*); *c,* microconch with the aperture, Hangende Bankkake Formation, lower Tithonian, *Hybonotum* Zone, Jura-Steinwerke Liptingen, Swabia, Germany, ×0.25 (Scherzinger, Schweigert, & Parent, 2006, p. 276, fig. 4).

?Afrogravesia Schweigert, Zeiss, & Westermann, 2012, p. 17 [**Gravesia loupekinei* Verma & Westermann, 1984, p. 59; OD]. East African homoeomorph of European *Gravesia* of unclear systematic position; placed here only for convenience. The single, well-known species, first described as *Gravesia,* shows inner whorls with coarse ribbing and coronate cross section, the primary ribs changing into distant, large, rounded bullae with three to five blunt secondaries; outer whorl smooth with incipient lateral swellings or blunt lateral nodes; suture line simple but different from European *Gravesia* with broad, bipartite external saddle. *Upper Jurassic* (*lower Tithonian,* Hybonotum *Zone):* Kenya, ?Madagascar.——Fig. 82,*3a–c. *A. loupekinei* (Verma & Westermann), holotype, New Mto Panga quarry, Mombasa, Kenya; *a,* complete specimen, slightly distorted, ×0.4; *b–c,* with outer whorl removed, ×1 (Verma & Westermann, 1984, pl. 12,*1a–c*).

Subfamily PARABOLICERATINAE Spath, 1928

[*nom. transl.* Arkell, 1950, p. 364, *ex* Paraboliceratidae Spath, 1928, p. 224] [?=Richterellinae Sapunov, 1977, p. 105]

The subfamily was proposed as a family (Spath, 1928, p. 224) ambiguously for genera formerly brought together with *Grayiceras* in the family Grayiceratidae (Spath, 1925a, p. 145), for which Mayaitidae (Spath, 1928) takes precedence (ICZN Opinion 471, 1957b, p. 205). Paraboliceratinae was considered by Arkell in Arkell and others

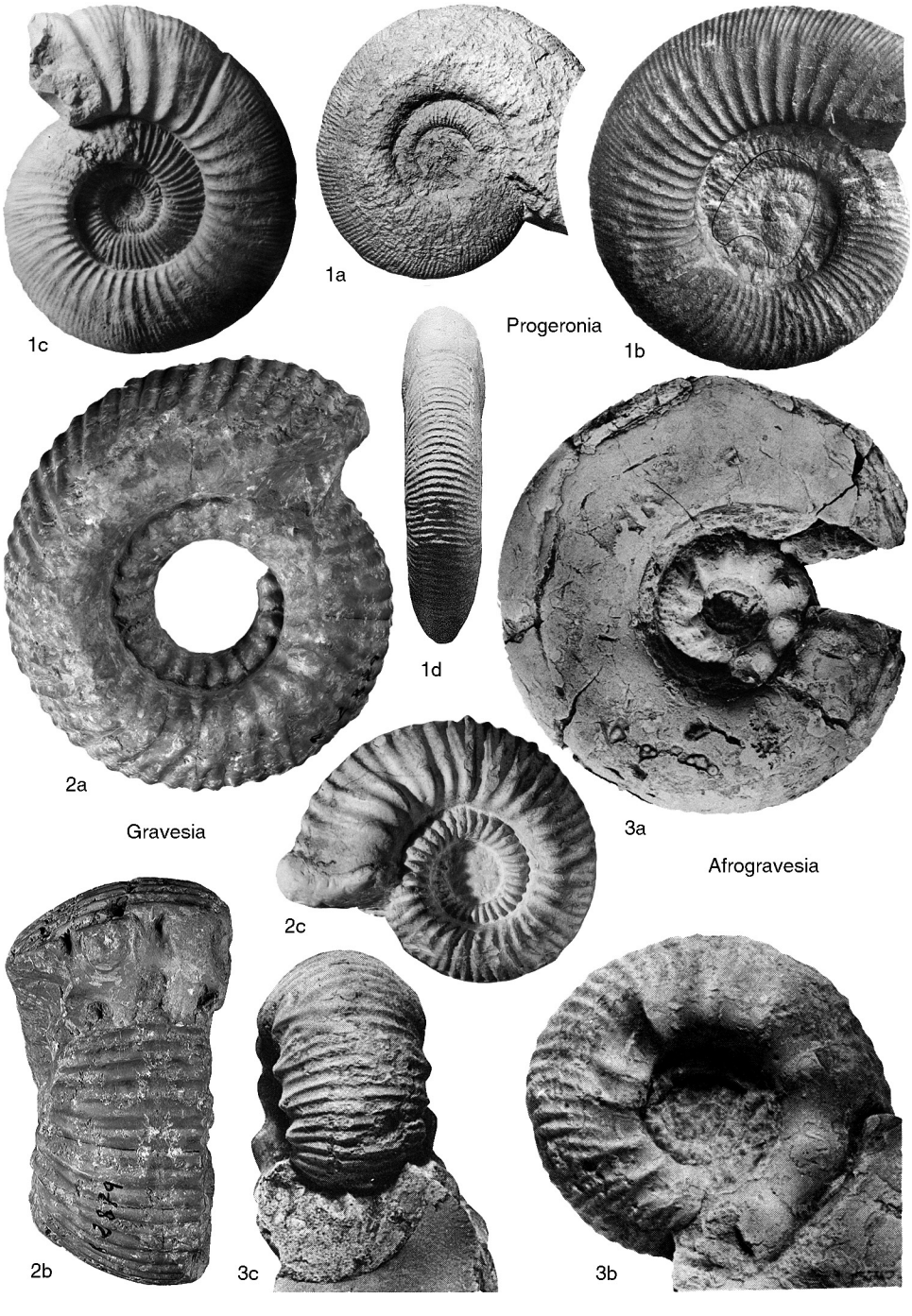

FIG. 82. Ataxioceratidae (p. 118–120).

(1957, p. 322) to be a junior synonym of Ataxioceratidae, by CALLOMON (in DONOVAN, CALLOMON, & HOWARTH, 1981, p. 150) to be a junior synonym of Berriasellinae, and their opinions also differed concerning the corresponding genera. The reason was probably the longstanding uncertainty about the exact age of such genera as *Paraboliceras, Paraboliceratoides,* and *Kossmatia* in the type area (ARKELL in ARKELL and others, 1957, p. 323, footnote 2). New and well-documented collections from Nepal (ÉNAY, 2009) provided additional evidence to reestablish Paraboliceratinae as a subfamily name. First, the number of potential genera to be included in the subfamily increased with the new genera *Nepalites* and *Stevensites,* which display several common features: (1) fine, dense, and flexuous ribbing, irregular in some; (2) many parabolic ribs or parabolic nodes; (3) secondary ribs projected at the periphery and V-shaped on the venter; and (4) simple aperture in both dimorphs, flexuous with a ventral rostrum. Except for the lack of lappets in the microconchs, all these features and especially the ribbing style, bidichotome ribs and parabolae suggest a direct link with the European Ataxioceratinae. Hence, the problem again arises of the European species, *Ammonites richteri* OPPEL, 1865, and its macroconch dimorph (*vide* CECCA, 1986) *"Lemencia" praerichteri* DONZE & ÉNAY, 1961, sometimes placed in *Kossmatia* (or *Berriasella*). *"L." richteri* is quite different from other Submediterranean associated species and could be accepted as a possible *Kossmatia*. *Upper Jurassic (Kimmeridgian):* Himalaya (India and Nepal), Indonesia (West Papua), Papua New Guinea, New Zealand.

Paraboliceras UHLIG, 1910a, p. 280 [**Ammonites jubar* BLANFORD in SALTER & BLANFORD, 1865, p. 82; SD ROMAN, 1938, p. 327 [=*Paraboliceratoides* SPATH, 1925a, p. 145 (type, *Ammonites mutilus* OPPEL in OPPEL, 1863–1865, p. 289, OD); =*Pseudoparaboliceras* GERTH, 1965, p. 212 (type, *P. aramarai,* OD)]. Dimorphic. Evolute to fairly involute; dense and flexuous ribbing, basically bifurcate with intercalatories, but made more or less irregular by bidichotome primary ribs and parabolic nodes on the shoulders, interrupted on the ventral by a smooth band. Aperture simple and flexuous with a ventral rostrum. As a whole ribbing stronger and coarser in the macroconch (*Paraboliceratoides*). *Upper Jurassic (Kimmeridgian):* India (Himalaya), Nepal, ?China (southern Tibet), Indonesia (West Papua), Papua New Guinea, New Zealand.——FIG. 83,*1a–b. *P. jubar* (BLANFORD), topotype, microconch, Spiti Shales, Kimmeridgian, ×0.5 (Uhlig, 1910a, pl. 44,*1a–b*).——FIG. 83,*1c–d. P. mutilum* (OPPEL), macroconch with part of the body chamber, Spiti Shales, Kimmeridgian, Chhokor, near Muktinath, Nepal, ×0.33 (Énay, 2009, pl. 22,*1a–b*).

Stevensites ÉNAY in ÉNAY & HOWARTH, 2018, p. 1, *nom. nov. pro Stevensia* ÉNAY, 2009, p. 144, preoccupied, *non* CAMERON, 1932, p. 309 (Coleoptera, staphylinids) [**Kossmatia desmidoptycha* UHLIG, 1910a, p. 277; OD]. More related to *Paraboliceras* than to *Kossmatia* in spite of the previous placement in the latter. Involute shell; whorl section compressed with tabulate venter; ribbing dense and flexuous; primary ribs fasciculate with intercalatory ribs and some bidichotome; secondary ribs projected on the venter; well-defined, smooth ventral band; probably dimorphic; aperture simple, flexuous, with ventral rostrum. *Upper Jurassic (Kimmeridgian):* Himalaya (India, Nepal), Indonesia (West Papua), Papua New Guinea, New Zealand.——FIG. 83,*2a–c. *S. desmidoptycha* (UHLIG)*; a–b,* lectotype, Spiti Shales, Lochambelkichak, Spiti, India, ×0.5 (Uhlig, 1910a, pl. 47,*2a,c*); *c,* Spiti Shales, *Paraboliceras* Beds, Chhokor, near Muktinath, Nepal, ×0.5 (Énay, 2009, pl. 23,*2a*).

Kossmatia UHLIG, 1907, p. 470 [**Ammonites tenuistriatus* GRAY, 1832 in 1830–1832, pl. 100,*4;* SD ROMAN, 1938, p. 326] [?=*Richterella* AVRAM, 1974, p. 17 (type, *Ammonites richteri* OPPEL, 1865, p. 556, OD), *non* HESSLER, 1965, p. 258 (Trilobita, Proetidae); ?=*Richteria* OLORIZ, 1978b, p. 1 (type, *Ammonites richteri* OPPEL, 1865, p. 556, obj.), *non* GIRAULT, 1920 (Insect, Hymenoptera), *nec* TODE, 1966, p. 305 (Insect, Hemiptera)]. Dimorphic. Evolute with the whorl section oval or quadratic-rounded to involute with the whorl section compressed; ribbing dense, rectiradiate, bow-shaped or flexuous, and projected toward the venter; primary ribs simple, bifurcate or polyfurcate (bidichotome); secondary ribs uninterrupted (only weakened on the internal mold) on the venter, without smooth band or furrow; aperture simple, with a short ventral rostrum. *Ammonites richteri* OPPEL, 1865, is included here as a possible species of *Kossmatia,* the only one known in southern Europe, together with the invalid junior synonyms *Richterella* and *Richteria. Upper Jurassic (lower Tithonian):* Himalaya (India, Nepal), ?China (southern Tibet), Indonesia (West Papua), Papua New Guinea, Antarctica.——FIG. 83,*3a–d. *K. tenuistriata* (GRAY); *a–b,* holotype, incomplete specimen, Spiti Shales,

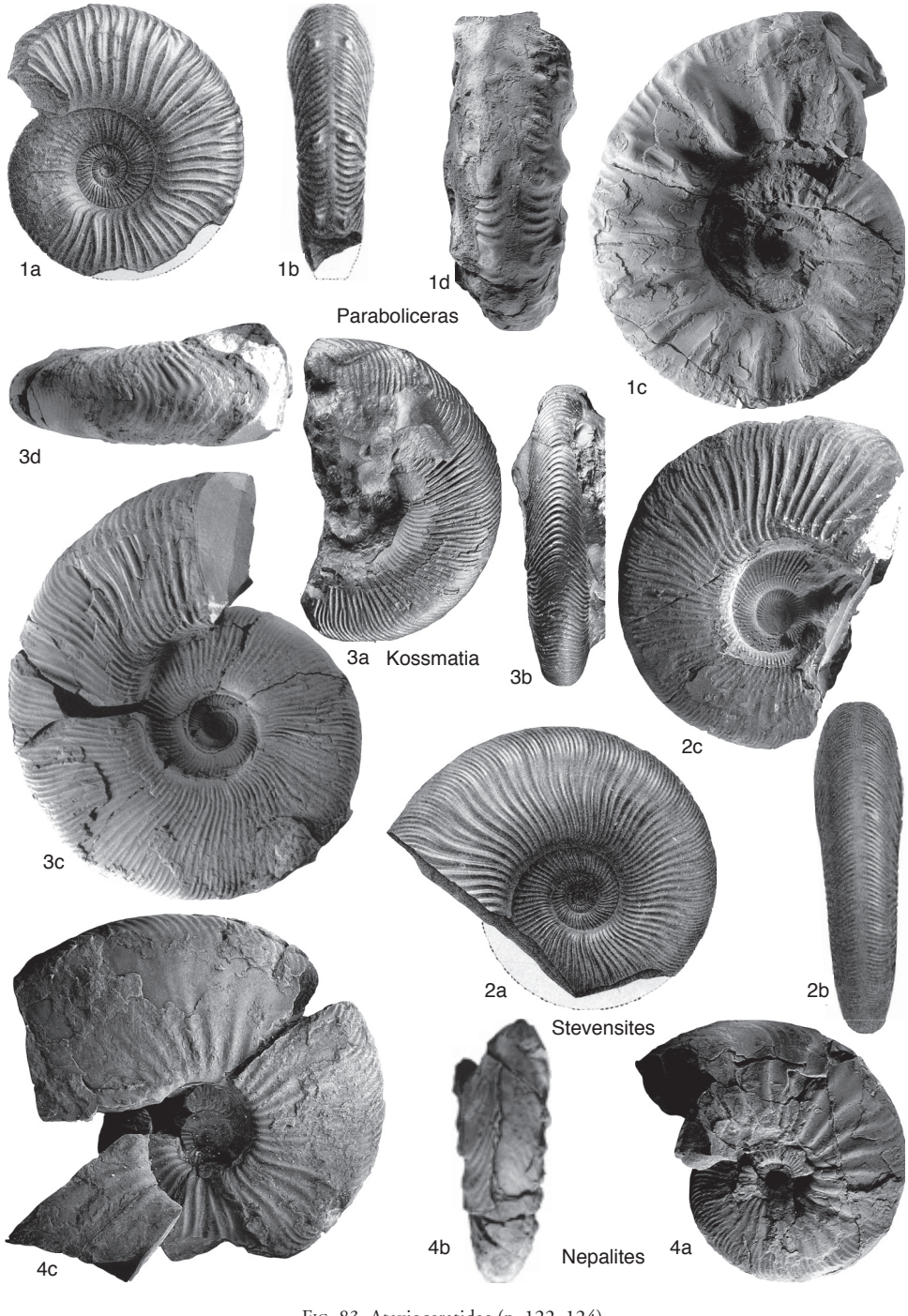

FIG. 83. Ataxioceratidae (p. 122–124).

"Sulgranees, Nepaul," probably Muktinath, 190 km northwest of Kathmandu, Nepal, ×0.5 (new; The Natural History Museum, London, NHMUK C.5051; also figured by Uhlig, 1910a, pl. 91,*3a–b*); *c–d,* complete adult microconch, Spiti Shales, Nupra near Muktinath, Nepal, ×0.5 (Énay, 2009, pl. 26,*1a–c*).

Nepalites Énay, 2009, p. 142 [**N. chhokorensis;* OD]. Dimorphic. Involute, whorl section compressed, venter rounded or slightly tabulate; dense primary ribs, first prorsiradiate, then flexuous, polyfurcate or fasciculate, parabolic ribs and nodes present or not; the secondary ribs projected and uninterrupted on the venter with a forward V-shaped bow; the ribbing more distant and stronger on the body chamber of the microconch; fading at mid-side in the macroconch. Aperture not preserved, probably simple with a ventral rostrum. *Upper Jurassic (?Kimmeridgian–lower Tithonian)*: Himalaya (Nepal).——Fig. 83,*4a–b. *N. chhokorensis,* holotype, microconch with half a whorl of body chamber, ?Kimmeridgian, Chhokor near Muktinath, Nepal, ×0.5 (Énay, 2009, pl. 22,*2a–b*).——Fig. 83,*4c. N. noduliferus* Énay, paratype, lower Tithonian, nearly complete macroconch, Dangardzong, near Jomosom, Nepal, ×0.5 (Énay, 2009, pl. 23,*1a*).

Subfamily LITHACOCERATINAE Zeiss, 1968

[Lithacoceratinae Zeiss, 1968, p. 49] [=Sublithacoceratinae Zeiss, 1968, p. 49; =Franconitinae Zeiss, 1968, p. 50; =Paraulacosphinctinae Tavera Benitez 1985, p. 78; =Windhauseniceratinae Leanza & Zeiss, 1992, p. 1848 (*partim*)]

The subfamily might be considered as one of the homeomorphic offshoots from the main evolving stock (e.g., Ataxioceratinae). The polyschizotomous style of branching with its numerous variants, bidichotome (or polyplocoid), polygyrate, fascipartite, virgatipartite, and virgatotome reached its highest degree. Since the publication of the original *Treatise* volume on Ammonoidea (Moore, 1957), the number of genera proposed for the European part of the north Submediterranean Province has greatly increased, and also in South America. The new genera recently proposed and described by Zeiss and Leanza (2010) probably developed from ataxioceratids that migrated into the Andean basins of Argentina and Chile. Leanza and Zeiss (1992) proposed the new subfamily Windhauseniceratinae for genera usually included in himalayitids and that evolved in South America as a development parallel to the European Paraulacosphinctinae Tavera Benitez (1985). However, the subfamily is not accepted herein and—except for *Windhauseniceras, Djurjuriceras,* and *Hemispiticeras* (already dealt with as Himalayitinae)—it is considered to be a junior synonym of Lithacoceratinae. Dimorphism within the subfamily is well established: dimorphic pairs that are convincingly associated are placed here in the same genus, but where the exact association is uncertain, the two dimorphs are placed in separate subgenera. *Upper Jurassic (Tithonian–?lowest Berriasian):* mainly Tethyan.

Lithacoceras Hyatt, 1900, p. 581 [**Ammonites ulmensis* Oppel, 1858 in 1856–1858, p. 771; OD] [=*Discosphinctes* Dacqué, 1914, p. 10 (type, *Perisphinctes arussiorum* Dacqué, 1905, p. 145; SD Spath, 1931, p. 445); =*Discosphinctoides* Oloriz, 1978a, p. 481 (type, *Perisphinctes roubyanus* Fontannes, 1879b, p. 56, OD); =*Pseudodiscosphinctes* Oloriz, 1978a, p. 482, 490 (type, *Perisphinctes ardescicus* Fontannes, 1879b, p. 54, OD); =*Virgalithacoceras* Oloriz, 1978a, p. 518 (type, *Virgatosphinctes (Perisphinctes) riedensis* Schneid, 1915a, p. 160, OD); =*Hofmanniceras* Vigh, 1984, p. 109(202) (type, *Sublithacoceras (H.) obliquestriatum,* OD); =*Silicisphinctes* Schweigert & Zeiss, 1999, p. 61 (type, *Subplanitoides hoelderi* Sapunov, 1979, p. 135, *nom. nov. pro Perisphinctes siliceus* (Quenstedt) in Berckhemer & Hölder, 1959, p. 42, OD)]. Large or very large size, first involute, then evolute, compressed; dense and sharp ribbing, bifurcate or simple on the inner whorls, polygyrates or virgatotome on the middle whorl, with up to 8 secondaries per primary, passing to coarse, simple or bifurcate ribs on the outer whorl. Microconch (*Silicisphinctes*): involute; fine and dense ribs, mainly biplicate with simple ribs, and possible polygyrate ribs before the aperture with lappet; resembles *Discosphinctoides,* but more densely ribbed and furcation points lower on the side. *Upper Jurassic (upper Kimmeridgian,* Beckeri *Zone–lower Tithonian,* Hybonotum *Zone):* Germany, southeastern France, Spain, Hungary, Somalia, ?India (Kutch), ?Japan, ?Argentina.——Fig. 84,*1a–b. *L. ulmense* (Oppel), upper Kimmeridgian, *Beckeri* Zone; *a,* holotype (original of Oppel, 1863 in 1862–1863, pl. 74,*1*), Weisser Jura ζ, vicinity of Ulm, Bavaria, Germany, ×0.5 (Hölder, 1961, pl. 5); *b,* complete adult, *Ulmense* Subzone, Nusplinger Plattenkalk, Egesheimer, Swabia, Germany, ×0.25 (Schweigert, 1998, fig. 3; also figured by Schweigert & Zeiss, 1999, fig. 3).——Fig. 84,*1c. L. hoelderi* (Sapunov), holotype, complete adult with lappets, Untere Hangende Bankkalke, vicinity of Bennenberg, Swabia, Germany, ×0.5 (Berckhemer & Hölder, 1959, pl. 14,*69*).——Fig. 84,*1d. L. roubyanus* (Fontannes), holotype, adult microconch with lappet, Calcaires du Château, upper Kimmeridgian–lower Tithonian, Mount Crussol, Ardèche, France, ×0.5 (new; Université Claude

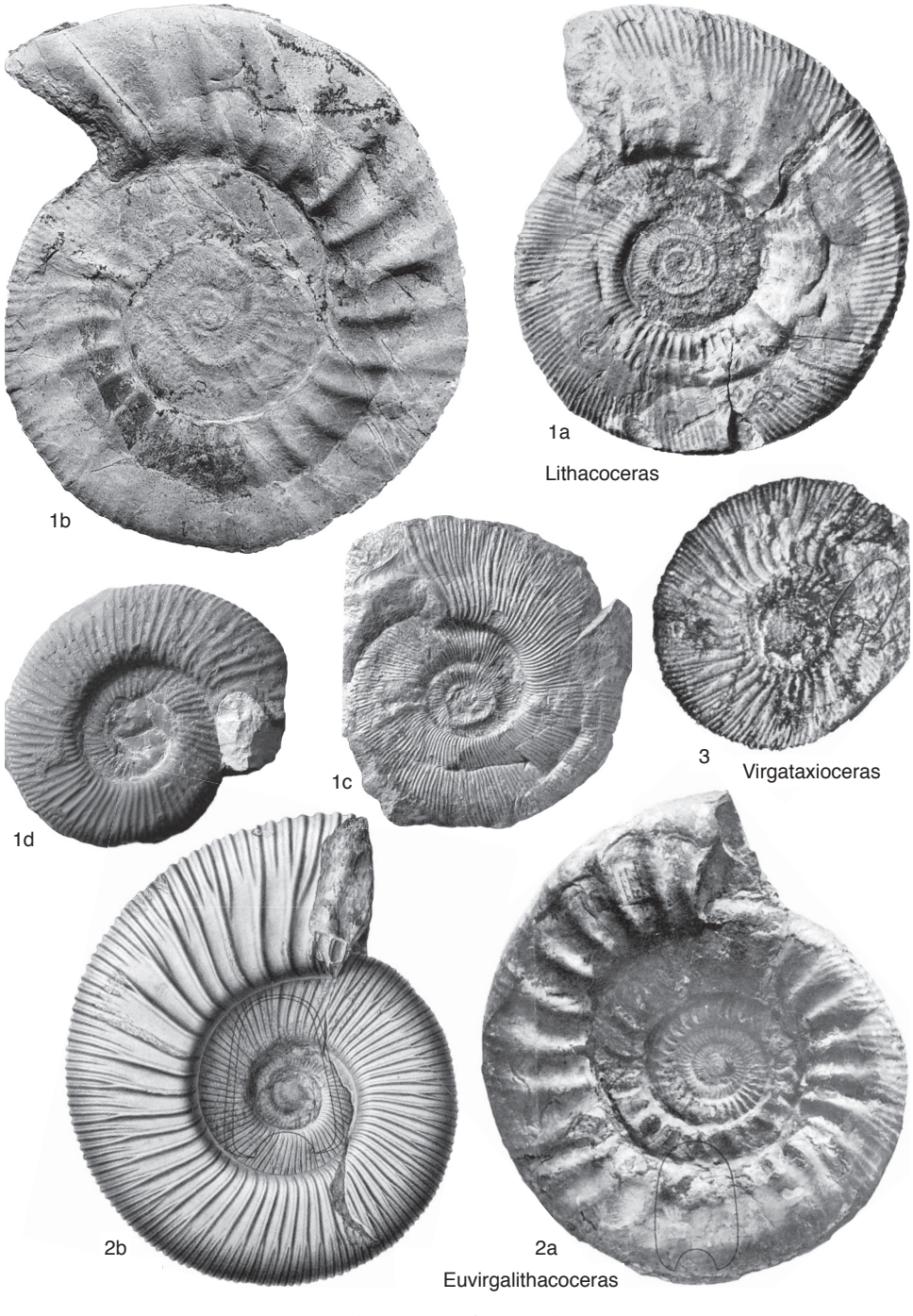

FIG. 84. Ataxioceratidae (p. 124–126).

Bernard, Lyon, UCBL-FSL 12558; also figured by Fontannes, 1879b, pl. 8,*6*).

Euvirgalithacoceras Zeiss, Schweigert, & Scherzinger, 1996, p. 137 [**Virgatosphinctes supremus* Schneid, 1915a, p. 152, 161; OD] [=*Herbichiceras* Fözy & Scherzinger, 2013, p. 182 (type, *Perisphinctes tantalus* Herbich, 1878, p. 131, OD); =*Subplanites* Spath, 1925a, p. 120 (type, *Virgatosphinctes (Perisphinctes) reisi* Schneid, 1915a, p. 162, OD)]. Dimorphic. Macroconchs of large size; like *Lithacoceras* but fascipartite ribs lacking, the bifurcate ribbing stage followed by polygyrate and virgatipartite bundles. Mainly distinguished on the basis of the supposed microconch dimorph, *Subplanites,* quite different from those of *Lithacoceras.* Small to medium size, involute to moderately evolute, rounded-subquadrate to high oval, compressed whorl section; inner whorls with biplicate ribbing, and outer whorl with true polygyrate ribs together with intercalatories, some of them more or less connected with the secondaries; aperture with short, rounded lappets. *Upper Jurassic (lower Tithonian,* Hybonotum *Zone):* Germany, southeastern France, Hungary.——Fig. 84,*2a. *E. supremum* (Schneid), lectotype, large, nearly complete specimen, lower Tithonian, *Hybonotum* Zone, Eichstätt, Bavaria, Germany, ×0.2 (Schneid, 1915a, pl. 4,*4*).——Fig. 84,*2b. E. reisi* (Schneid), holotype, nearly complete specimen, probable microconch, lower Tithonian, *Hybonotum* Zone, Unterhausen near Neuburg, Bavaria, Germany, ×0.33 (Schneid, 1915a, pl. 8,*1*).

Virgataxioceras Arkell, 1953, p. 39 [**Virgatosphinctes (? Perisphinctes) setatus* Schneid, 1915a, p. 165; OD]. Probably dimorphic. Like *Subplanites,* but with much denser and finer ribbing and polygyrate ribs well characterized and three or four secondaries per primary; inner whorls biplicate with some polygyrate ribs. *Upper Jurassic (upper Kimmeridgian,* Beckeri *Zone,* Subeumela–*early* Ulmense *Subzones):* Germany, Switzerland, France, Croatia, ?Bulgaria.——Fig. 84,*3. *V. setatum* (Schneid), lectotype, nearly complete microconch, upper Kimmeridgian, *Beckeri* Zone, Eichstätt, Bavaria, Germany, ×1 (Schneid, 1915a, pl. 5,*5*).

Franconites Zeiss, 1968, p. 75 [**Virgatosphinctes (Perisphinctes) vimineus* Schneid, 1915a, p. 164; OD] [=*Tithonosphinctes* Zeiss, 1968, p. 84 (type, *Franconites (Tithonosphinctes) stephanovi,* OD); =*Parakeratinites* Zeiss, 1968, p. 87 (type, *Parakeratinites communis,* OD); =*Heterokeratinites* Zeiss, 1968, p. 91 (type, *Franconites (H.) procurvus,* OD)]. Dimorphic. Macroconchs medium size with rounded quadrate whorl section; ribs fine, distant, prominent, and bifurcate on the inner whorls, changing to fascipartite and curved on the outer whorl, fading on the external part of the side, the inner part of the ribs strengthened; in some species ribbing is irregular (*Tithonosphinctes*); aperture simple and flexuous. Microconchs small sized; flexuous, simple, and bifurcate ribs up to the aperture; frequent irregularities in the ribbing (grouping or overlapping of ribs); strong forward projection of the ribs on the venter and ventral rostrum, and aperture with lappets; mimic of the Himalayan genus *Kossmatia;* unrelated, but morphologically close to the Subboreal genus *Keratinites. Upper Jurassic (lower Tithonian,* Vimineus *Zone):* southern Germany, southeastern France, Spain.——Fig. 85,*1a. *F. vimineus* (Schneid), holotype, complete adult, Middle Rennertshofener Beds, Unterstal, Bavaria, Germany, ×0.5 (Zeiss, 1968, pl. 14,*4*).——Fig. 85,*1b–d. F. communis* Zeiss, 1968, holotype, Middle Rennertshofener Beds, Ammerfeld, Bavaria, Germany, ×0.5 (Zeiss, 1968, pl. 10,*4–6*).

Usseliceras Zeiss, 1968, p. 52 [**U. franconicum;* OD] [=*Subplanitoides* Zeiss, 1968, p. 62 (type, *Usseliceras (S.) waltheri,* OD)]. Dimorphic. Macroconch medium to large size, high oval whorl section; ribbing mainly bifurcate or bidichotome, the outer whorl with the dorsal part of the ribs reduced to umbilical nodes, the ventral part with ribs decreasing to fascipartite bundles, dichotom or triplicate, or disappearing; venter flat or furrow may often occur on inner whorls. Microconchs small platycone shell; high oval or rounded-quadrate whorl section; bifurcate ribbing on the inner whorls, then outer whorl with bidichotome and polygyrate ribs; aperture with lappets. *Upper Jurassic (lower Tithonian,* Mucronatum *Zone):* southern Germany, southeastern France, northern Italy, Hungary.——Fig. 85,*2a. *U. franconicum,* holotype, complete adult, Tagmersheimer Bankalke, Tagmersheim, Bavaria, Germany, ×0.33 (Zeiss, 1968, pl. 1,5).——Fig. 85,*2b. U. waltheri,* holotype, nearly complete adult, Tagmersheimer Bankalke, Tagmersheim, Bavaria, Germany, ×0.5 (Zeiss, 1968, pl. 9,*2*).——Fig. 85,*2c. U. altegyratum* Zeiss, 1968, holotype, complete adult with lappet, Usssental Beds, Spindeltalshiefer, Kaziserschache, Bavaria, Germany, ×0.5 (Zeiss, 1968, pl. 5,*4*).

Dorsoplanitoides Zeiss, 1968, p. 93 [**D. bavaricus;* OD] [=?*Ammerfeldia* Zeiss, 1968, p. 96 (type, *D. ammerfeldensis;* OD)]. Medium-sized evolute shell, thick and depressed whorl section similar to *Dorsoplanites* (Dorsoplanitidae); strong and coarse ribbing with bifurcate, polygyrate, or bidichotome-fascipartite splitting mode; aperture simple and flexuous with ventral rostrum; supposed microconch of small size, evolute; prominent bifurcate ribs, the furcation point high on the side, the secondaries curved forward at the periphery. *Upper Jurassic (lower Tithonian,* Mucronatum–Vimineum *Zones):* southern Germany, southern Spain, ?northern Italy.——Fig. 85,*3a. *D. bavaricus,* holotype, nearly complete adult, Middle Rennertshofener Beds, *Vimineum* Zone, Finkestein, Bavaria, Germany, ×0.5 (Zeiss, 1968, pl.16,*1*).——Fig. 85,*3b. D. ammerfeldensis* (Zeiss), holotype, incomplete specimen, Middle Rennertshofener Beds, *Vimineum* Zone, Ammerfeld, Bavaria, Germany, ×1 (Zeiss, 1968, pl. 17,*6*).

Sublithacoceras Spath, 1925a, p. 134 [**Perisphinctes (Aulacosphinctes?) penicillatus* Schneid 1915b, p. 27(329); OD] [=*Pseudodiscosphinctes* Oloriz, 1978a, p. 482, 490 (type, *Perisphinctes ardescicus* Fontannes, 1879a, p. 13, OD)]. Small to medium sized, involute shell; high oval,

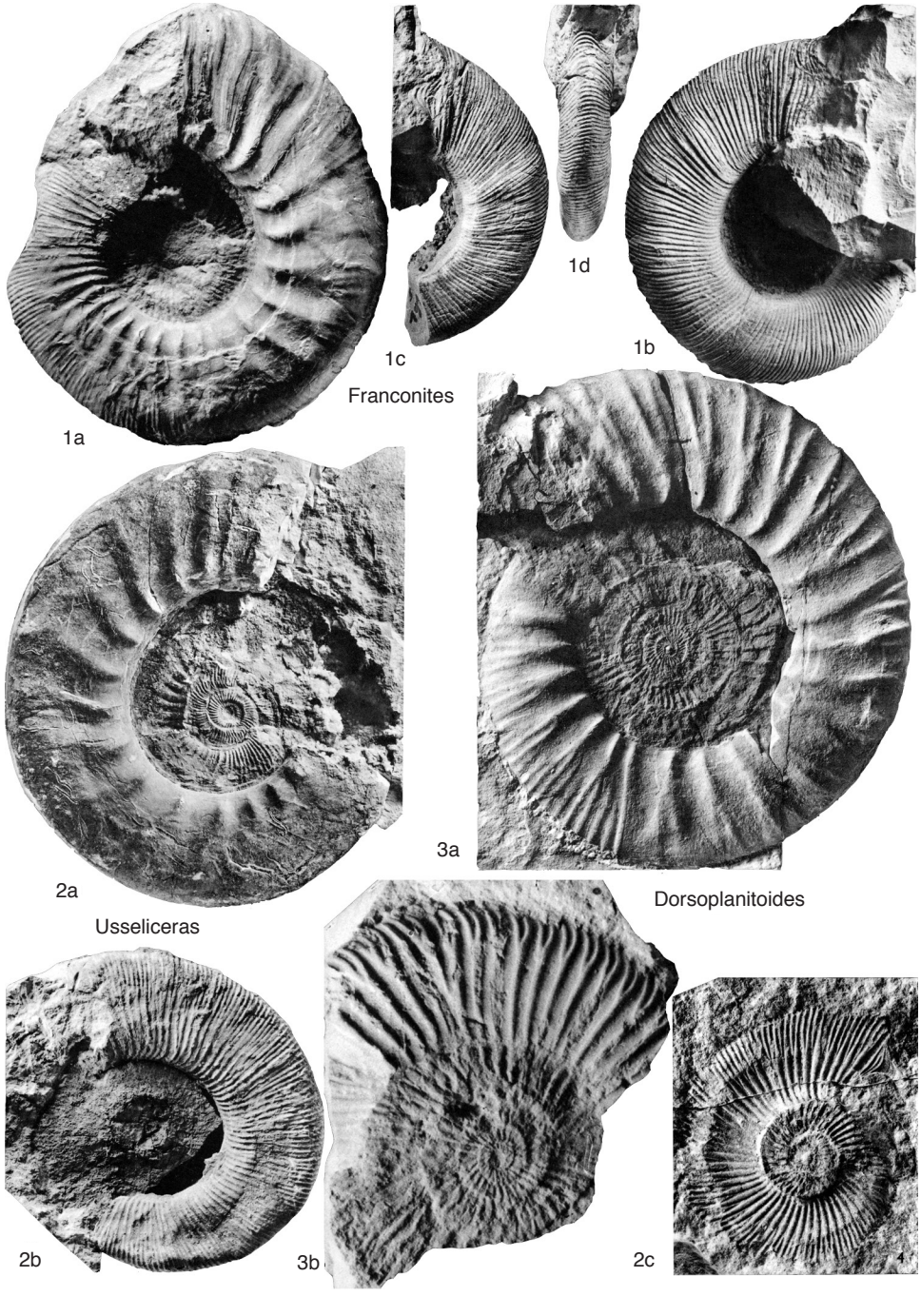

FIG. 85. Ataxioceratidae (p. 126).

compressed whorl section; dense, fine, bidichotomous or bifurcate ribbing, sometimes trifurcate. *Upper Jurassic (lower Tithonian, upper* Vimineus–Ciliata *Zones):* southern Germany, southeastern France.

S. (Sublithacoceras). Bidichotomous ribbing; short primary ribs bifurcate low on the whorl side, then long secondaries mostly split again at mid-whorl side or higher; secondaries continuous

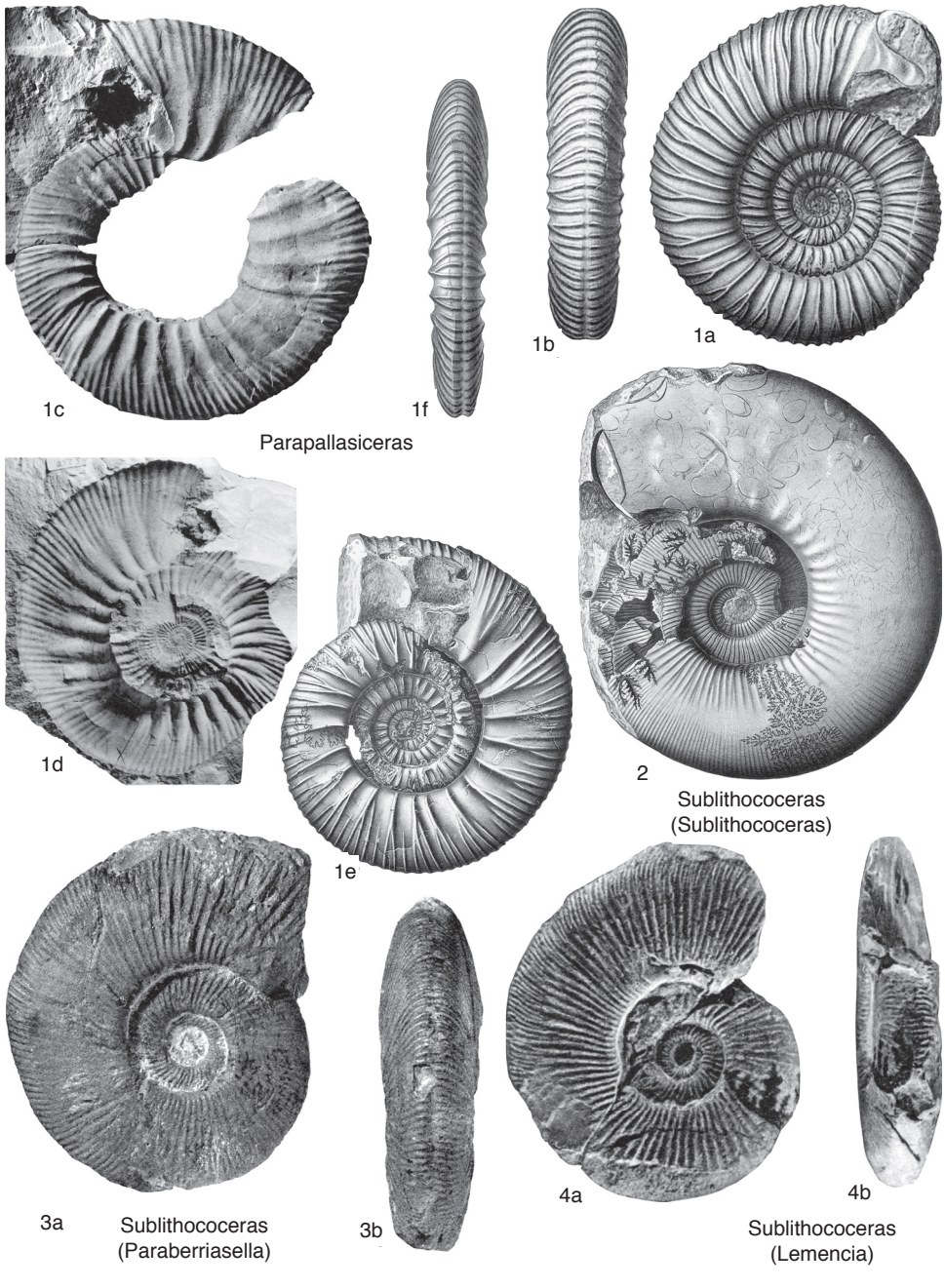

FIG. 86. Ataxioceratidae (p. 126–130).

across the venter; outer whorl with strengthening primary ribs and fading secondaries. Macroconch with simple aperture. *Upper Jurassic (lower Tithonian, upper* Vimineus–Ciliata *Zones):* southern Germany, southeastern France.—— FIG. 86,*2. *L. penicillatum* SCHNEID 1915b, lectotype, nearly complete specimen, Neuburg Formation, Unterhausen Member, *Ciliata* Zone, Neuburg a.d. Donau, Bavaria, Germany, ×0.4 (Schneid, 1915b, pl. 2,*3*).

S. (**Paraberriasella**) DONZE, 1948, p. 237 [**P. blondeti;* OD] [=?*Zeissiceras* VIGH, 1984, p.

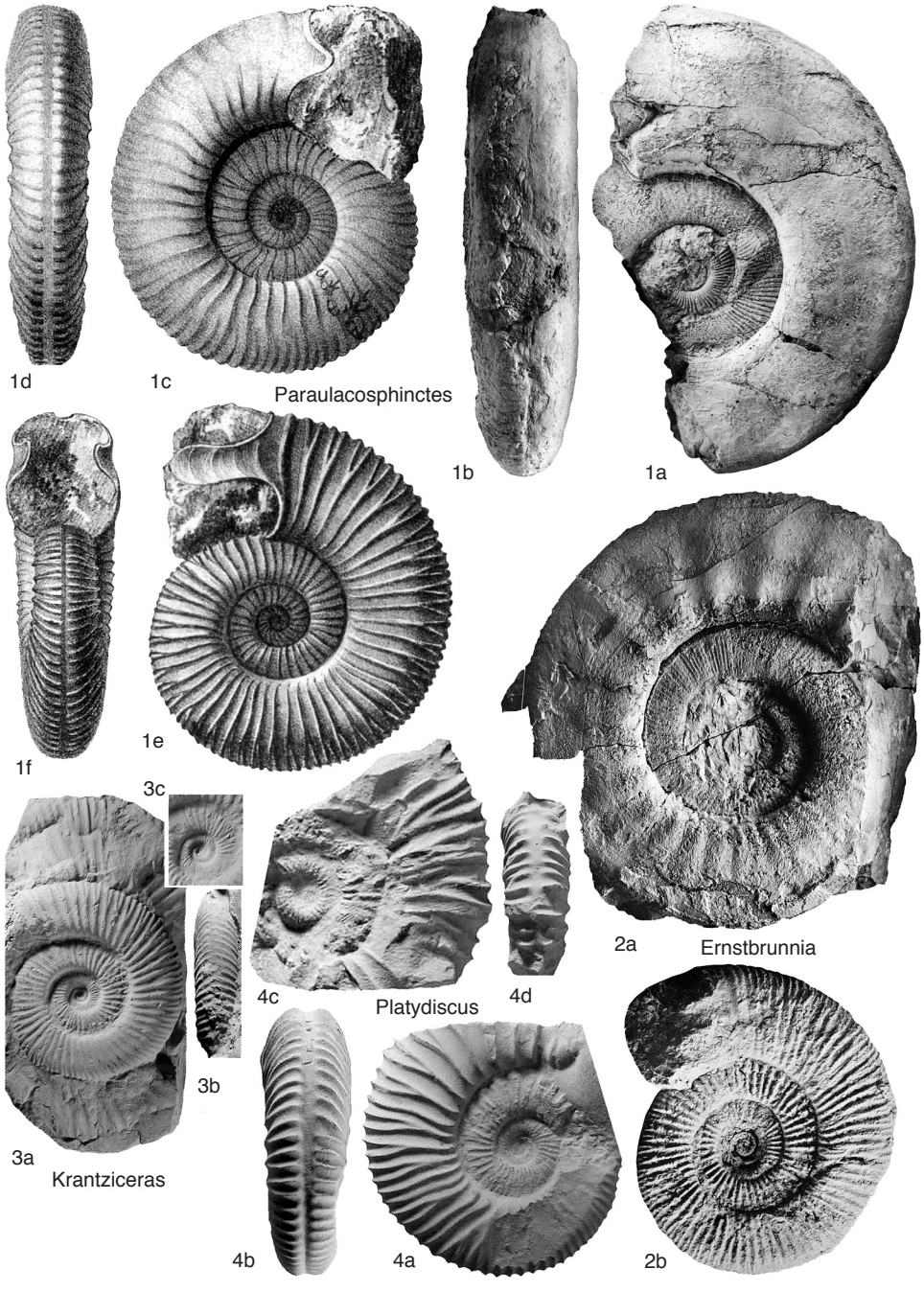

FIG. 87. Ataxioceratidae (p. 130–131).

111(203) (type, *Sublithacoceras (Z.) incertaeforme,* OD)]. Small size, fairly involute; dense and fine prorsiradiate ribbing, mainly bifurcate, a few trifurcate ribs occurring on the body chamber, the secondaries curved forward, ventral smooth band slightly on the inner whorls disappearing at the beginning of the body chamber; supposed microconch (*partim*) and subgenus of *Sublithacoceras. Upper Jurassic (lower Tithonian, upper* Vimineus–Ciliata *Zones):*

southern Germany, southeastern France.——Fig. 86,*3a–b. *S. (L.) blondeti,* holotype, incomplete adult, "pseudobreccia" of St. Concors, Lémenc near Chambéry, France, ×0.75 (Donze, 1948, fig. 9b,*1–2*).

S. (Lemencia) Donze & Énay, 1961, p. 158 [**L. pseudorichteri;* OD]. Small-sized, discoid-shaped, and compressed shell; dense and fine ribbing, mainly biplicate above mid-side, with a few trifurcate ribs on the outer whorl, especially on the adult shell; the secondaries interrupted on the venter by narrow groove disappearing at the beginning of the body chamber; aperture with lappets. Supposed microconch (*partim*) and subgenus of *Sublithacoceras.* The usual inclusion of the *ciliata* group in this subgenus has been questioned by Schweigert and Scherzinger (2004). *Upper Jurassic (lower Tithonian, upper* Vimineus–Ciliata *Zones):* southern Germany, southeastern France.——Fig. 86,*4a–b. *S. (L.) pseudorichteri,* holotype, incomplete adult, "pseudobreccia" of St Concors, Lémenc near Chambéry, France, ×0.75 (Donze & Énay, 1961, pl. 19*a–b*).

Parapallasiceras Spath, 1925a, p. 133 [**Berriasella (Aulacosphinctes?) praecox* Schneid, 1915b, p. 64 (366); OD] [=*Danubisphinctes* Zeiss, 1968, p. 109 (type, *Parapallasiceras (Danubisphinctes) palatinum,* OD); =*Neoburgites* Barthel, 1974, p. 71, *nom. nud.* (type, *Perisphinctes (Pseudovirgatites) palmatus* Schneid, 1915b, p. 78(380), OD); =*Isterites* Barthel, 1975, p. 426, *non Isterites* Barthel, 1969, p. 151, *nom.nud.* (type, *Perisphinctes (Pseudovirgatites) palmatus* Schneid, 1915b, p. 78(380), OD)]. Small size, evolute, rounded whorl section, Berriasella-like; straight, coarse, rectiradiate ribs, mainly bifurcate with a few polygyrate ribs; constrictions. Microconchs with lappets. Macroconchs (*Danubisphinctes*) medium sized, evolute, oval to trapezoid whorl section, inner whorl ribbing like *Parapallasiceras,* followed by polygyrate ribs, then fascipartite and virgatotome on the outer whorl. Aperture simple. *Upper Jurassic (upper lower Tithonian,* Vimineus–Palmatus *Zones):* southern Germany, southeastern France, northern Italy, central Poland.——Fig. 86,*1a–b. *P. praecox* (Schneid), lectotype, complete adult with aperture, lower Tithonian, Neuburg an der Donau, Bavaria, Germany, ×0.5 (Schneid, 1915b, pl. 3(19),*5*).——Fig. 86,*1c–d. P. palatinum* (Zeiss), holotype, complete adult, lower Tithonian, Ellenbrunn, Bavaria, Germany; c, complete outer whorl, ×0.33; d, inner whorls on the opposite side, ×0.5 (Zeiss, 1968, pl. 24,*2–3*).——Fig. 86,*1e–f. P. palmatum* (Schneid), lectotype (designated by Barthel, 1969, p. 151) of the type species of *Isterites* Barthel, with three-quarters whorl of body chamber, lower Tithonian, Neuburg an der Donau, Bavaria, Germany, ×0.27 (Schneid, 1915b, pl. 11(27),*3–3a*).

Paraulacosphinctes Schindewolf, 1925, p. 329 [**Ammonites senex* Oppel, 1865, p. 554; OD] [=*Moravisphinctes* Tavera Benitez, 1985, p. 103 (type, *Ammonites moravicus* Oppel in Zittel, 1868, p. 109, OD); =*Zittelites* Énay in Énay & Howarth, 2018, p. 1, *nom. nov. pro Zittelia* Tavera Benitez, 1985, p. 103, *non* Gemmellaro, 1869, p. 258 (Gastropoda) (type, *Ammonites eudichotomus* Zittel, 1868, p. 112, "normalform," OD); ?=*Andalusphinctes* Tavera Benitez, 1985, p. 123 (type, *A. lemenciformis,* OD)]. Macroconchs of medium size; whorl section quadrate to compressed high oval; dense, fine, and flexuous ribbing, bifurcate primary ribs, some simple and a few polygyrate; the secondaries interrupted on the venter with a midventral smooth band fading on the last whorl. Microconchs (*Moravisphinctes*) are small-sized platycones; whorl section compressed high oval or subquadrate; flexuous or rectiradiate ribbing mainly bifurcate with some simple or polygyrate ribs, interrupted on the venter with a median smooth band; lappeted aperture. *Upper Jurassic (upper Tithonian,* Transitorius *Zone):* Austria, Czech Republic, southeastern France, southern Spain, Italy, Bulgaria.——Fig. 87,*1a–b. *P. senex* (Oppel), lectotype (designated by Sapunov, 1979, p. 126), Stramberger Kalk, Stramberg, Czech Republic, ×0.36 (Zeiss, 2001, pl. 20,*2–3*).——Fig. 87,*1c–d. P. moravicus* (Oppel), lectotype (designated by Tavera Benitez, 1985, p. 104), complete adult, Stramberger Kalk, Stramberg, Czech Republic, ×1 (Zittel, 1868, pl. 21,*4a,c*).——Fig. 87,*1e–f. P. eudichotomus* (Zittel), holotype, complete adult, Stramberger Kalk, Stramberg, Czech Republic, ×1 (Zittel, 1868, pl. 21,*6a–b*).

Ernstbrunnia Zeiss, 2001, p. 49 [**E. bachmayeri;* OD] [=*Oloriziceras* Tavera Benitez, 1985, p. 63 (type, *O. salarensis,* OD)]. Macroconch: large-sized platycone, with slow coiling, large and shallow umbilicus; whorl section compressed; inner whorls with biplicate primaries and the furcation points high on the sides and just visible in the umbilicus; then changing gradually to the adult stage with fasciculate ribs, the umbilical part strengthened; no ventral furrow or smooth band. Microconch (*Oloriziceras*) small to medium size; whorl section subrectangular to high oval with flat sides and rounded venter; dense and prominent ribbing with bifurcate primary ribs and a few simple or polygyrate at the end of the shell; secondaries crossing the venter without any change and no ventral smooth band or furrow; aperture with lappets. *Upper Jurassic (lower upper Tithonian,* Simplisphinctes *Zone):* Austria, southeastern France, southern Spain.——Fig. 87,*2a. *E. bachmayeri,* holotype, Ernstbrunn, Austria, ×0.33 (Zeiss, 2001, pl. 11,*4*).——Fig. 87,*2b. O. salarensis,* holotype, Sierra Gorda, Granada, Spain, ×0.5 (Tavera Benitez, 1985, pl. 6,*1*).

Krantziceras Parent, Scherzinger, & Schweigert, 2011, p. 40 [**K. compressum;* OD]. Small-sized macroconch with *Paraulacosphinctes*-like morphology; evolute and compressed shell with flat sides and rounded venter; dense, rigid ribbing mainly bifurcate on the upper half of the side with a few simple ribs; isocostate or slightly variocostate

on the body chamber; narrow ventral groove on the septate whorls. *Upper Jurassic (upper Tithonian,* Alternans–Noduliferum *Zones):* Argentina.——Fig. 87,*3a–c*. **K. compressum,* holotype, adult macroconch with half a whorl of body chamber, *Noduliferum* Zone, Arroyo Cieneguita, Argentina; *a–b,* ×0.5; *c,* detail of innermost whorls, ×1 (Parent, Scherzinger, & Schweigert, 2011, p. 41, fig. 14,*E1–3*).

Platydiscus Parent, Scherzinger, & Schweigert, 2011, p. 42 [**P. beresii;* OD]. Small size; whorl section first rounded and fairly involute, then compressed with wide and shallow umbilicus; dimorphic; inner whorls of macroconch with strong, prorsiradiate ribs changing to dense and prominent, flexuous, bifurcated primaries, with a few simple, interrupted on the ventral groove fading near the aperture; microconch body chamber unevenly ribbed with short lappets. *Upper Jurassic (upper Tithonian,* Proximus *Zone):* Argentina.——Fig. 87,*4a–d*. **P. beresii,* Arroyo Cieneguita, Argentina; *a–b,* holotype, nearly complete adult macroconch, ×1 (Parent, Scherzinger, & Schweigert, 2011, p. 44, fig. 15,*A1–2*); *c–d,* paratype, nearly complete microconch, ×1 (Parent, Scherzinger, & Schweigert, 2011, p. 44, fig. 15,*G1–2*).

Zapalia Leanza & Zeiss, 1990, p. 176 [**Z. fascipartita;* OD] [=*Parazapalia* Zeiss & Leanza, 2010, p. 58 (type, *P. hillebrandti,* OD)]. Medium to large size, evolute macroconchs; dense to distant ribbing with bifurcate and simple ribs on the inner whorls, trifurcate or fascipartite on the next to last whorl with close or distant secondaries, up to five per primary rib; on outer whorl distant ribs biplicate, triplicate, polygyrate, or fascipartite. Medium size, evolute microconchs (*Parazapalia*), with biplicate or triplicate ribbing and occasionally trifurcate ribs occurring at constrictions; irregularities and intercalatories on the outer whorl and prominent, simple ribs before the aperture with large, lateral, spoonlike lappet. *Zapalia* is the type-genus of the subfamily Zapaliinae, recently proposed by Parent and others (2017); the new subfamily would include the following genera: *Indansites* Vennari, *Zapalia* Leanza & Zeiss, *Krantziceras* Parent & others, *Platydiscus* Parent & others (Lithacoceratinae), and *Choicensisphinctes* Leanza (Virgatosphinctinae). Because it was published after the end of 2016, it is not dealt with here. *Upper Jurassic (lower Tithonian, upper* Proximus *[=*Ponti*] Zone–upper Tithonian,* Internispinosum *[=*Microcanthum*] Zone):* Argentina.——Fig. 88,*1a*. **Z. fascipartita,* holotype, macroconch, Vaca Muerte Formation, Los Catutos Member, Zapala, Argentina, ×0.5 (Zeiss & Leanza, 2010, pl. 10,*1*).——Fig. 88,*1b*. *Z. hillebrandti,* holotype, complete microconch, Vaca Muerte Formation, Los Catutos Member, Zapala, Argentina, ×0.66 (Zeiss & Leanza, 2010, pl. 14,*3*).

Indansites Vennari, 2016, p. 94 [**Subplanites malarguensis* Spath, 1931, p. 468, *nom. nov. pro Perisphinctes* aff. *pseudolictor* Burckhardt, 1903, p. 36, pl. 24,*1–4, non* Choffat, 1893, p. 48, OD); =*Perisphinctes lictor* Burckhardt, 1900, p. 43, pl. 24,*4,10*, *non* Fontannes in Dumortier & Fontannes, 1876, obj.]. Dimorphic; large macroconch with subquadrangular to subrectangular whorl section, sides of varying convexity; successive ribbing stages determined by constrictions, with a different number of simple and bifurcated ribs on inner whorls, polygyrated, quadrifurcated to pseudofasciculate, and some intercalatory ribs on outer whorls; peristome simple or flexuous; small-sized microconch, usually without the quadrifurcate to pseudifasciculate ribbing stage; aperture with lappets; aptychi of *Praestriaptychus* type. *Upper Jurassic (lower Tithonian,* Picunleufuense *to* Proximus *Zones–lower upper Tithonian,* Internispinosum *Zone):* Argentina.——Fig. 89*a–f*. **I. malarguensis* (Spath), Vaca Muerta Formation; *a–b,* holotype (monotypy), presumably lost (Vennari, 2016) macroconch, complete adult? phragmocone, lower Tithonian, lower *Zitteli* (="*Mendozanus*") Zone, Casa Pincheira, Malargue, ×1 (Parent & others, 2017, p. 510, fig. 2D,*1–2*); *c–d,* incomplete macroconch, Vega de Escalone, Neuquén, ×0.5 (Vennari, 2016, pl. 2,*4–5*); *e–f,* adult microconch with lappet preserved, Picún Leufú, Neuquén, ×1 (Vennari, 2016, pl. 2,*1–2*).

?Neoperisphinctes Tavera Benitez, 1985, p. 131 [**Perisphinctes falloti* Kilian, 1889, p. 656; OD]. Dimorphic, small-sized platycone; whorl section compressed subrectangular, with convex sides and tabulate venter; two successive ornamental stages, first on the inner whorls of macroconch and the whole microconch alternation of bifurcate and simple ribs, then on the end of the septate whorls and the body chamber of the macroconch polygyrate ribs with strengthening of the umbilical part of the ribs; ventral smooth band. *Upper Jurassic (lower upper Tithonian,* Andreaei *Zone):* Spain.——Fig. 88,*2a–b*. **N. falloti* (Kilian), holotype by monotypy, Tithonian, Cabra, Cordoba, Spain, ×0.66 (Kilian, 1889, pl. 29,*4a–b*).

Subfamily TORQUATISPHINCTINAE Tavera Benitez, 1985

[Torquatisphinctinae Tavera Benitez, 1985, p. 52] [=Mazatepitinae Cantú Chapa, 2009, p. 7; =Cuetzalanitinae, *nom. correct.* herein *pro* Cuetzalaninae Cantú Chapa, 2009, p. 2, 10]

The type genus was not explicitly designated, and the subfamily brings together genera previously included in Virgatosphinctinae (Spath, 1931; Arkell in Arkell & others, 1957) or Perisphinctinae (Verma & Westermann, 1984; Howarth, 1998; Énay, 2009). It is a conservative offshoot with *Orthosphinctes*-like inner whorls, inferring a supposed origin from the same rootstock as the ataxioceratids, but with a relatively moderate

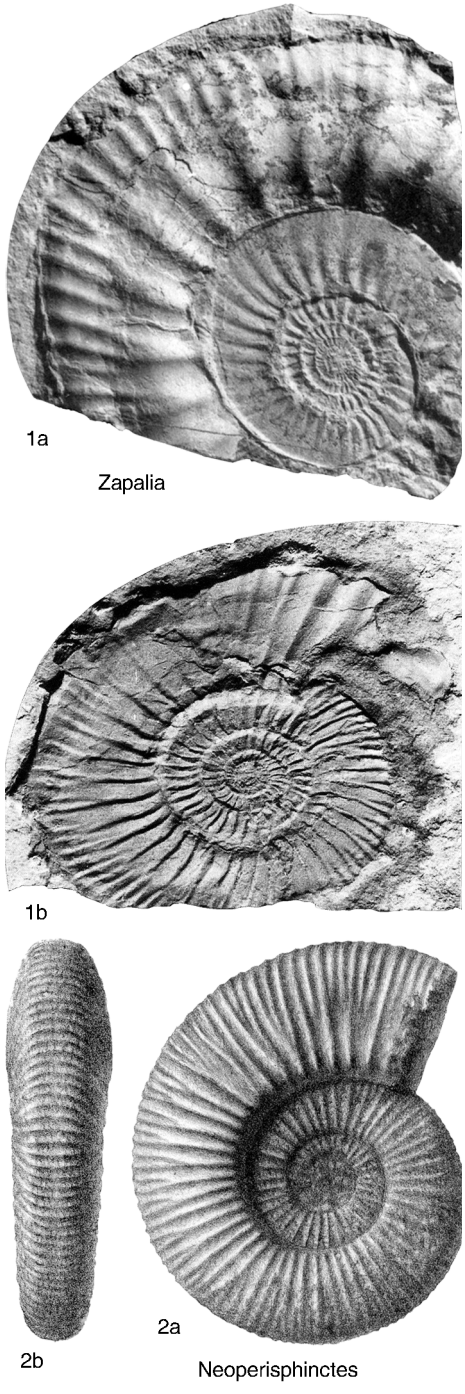

FIG. 88. Ataxioceratidae (p. 131).

development of polygyrate or virgatipartite ribbing. The most typical members of the subfamily—*Torquatisphinctes* and the related genera *Pachysphinctes* and *Katroliceras*—have a restricted distribution in the Sub-Austral Indo-Malgach Province. *Torquatisphinctes*-like morphologies with numerous simple ribs between the normal bifurcate ribs occur also in Submediterranean Europe, as well as Mexico and South America, but in the present state of knowledge it is difficult to decide between homoeomorphy or true relationship. *Upper Jurassic (upper Kimmeridgian–Tithonian):* Tethyan Province.

Torquatisphinctes SPATH, 1924, p. 15 [**Ammonites torquatus* J. de C. SOWERBY, 1840b, pl. 61,*12;* OD]. Small to medium size, fairly evolute, whorl section depressed, rounded-quadratic; isocostate ribbing unchanged on the body chamber with well-marked bifurcate and complete simple ribs; secondaries not modified on the venter. Lappets presumably present. *Upper Jurassic (upper Kimmeridgian):* Yemen, India (Kutch), Himalaya, Somalia, Kenya, Madagascar.——FIG. 90,*1. *T. torquatus* (J. de C. SOWERBY), holotype, wholly septate, locality unknown, Kutch, India, ×0.75 (Spath, 1931, pl. 76,*4a–b*).

Indodichotomoceras KRISHNA & PATHAK, 1993, p. 232 (PATHAK, 1989, p. 190, *nom. nud.*) [**Subdichotomoceras inversum* SPATH, 1931, p. 521; OD]. Small size, evolute to fairly involute; whorl section depressed, rounded-quadratic; sharp, biplicate ribbing, the secondaries not interrupted on the venter, with a few simple ribs at the end of the body chamber. Microconchs hardly distinguishable from Subboreal *Subdichotomoceras,* except by their denser ribbing on the inner whorls. *Upper Jurassic (Kimmeridgian):* India (Kutch), Yemen, Tanzania, Madagascar.——FIG. 90,*2a–b. *I. inversum* (SPATH), holotype, half a whorl of body chamber, Middle Katrol Beds, upper Kimmeridgian, east of Ler, India, ×0.5 (Spath, 1931, pl. 84,*7a–b,* 85,*4*).

Trapanesites OLORIZ in PAVIA & CRESTA, 2002, p. 373 [**Perisphinctes adelus* GEMMELLARO, 1872, p. 158; OD]. Microconchs; small size, fairly evolute; bifurcate ribbing, the secondaries unchanged on the venter; complete simple ribs and possible polygyrate ribs on end of the septate whorls and the body chamber. Adult aperture with lappets. Proposed for the so-called European and Mexican *Torquatisphinctes. Upper Jurassic (upper Kimmeridgian,* Beckeri *Zone–lower Tithonian):* Italy (Sicily), Germany, Mexico.——FIG. 90,*3a–b. *T. adelus*

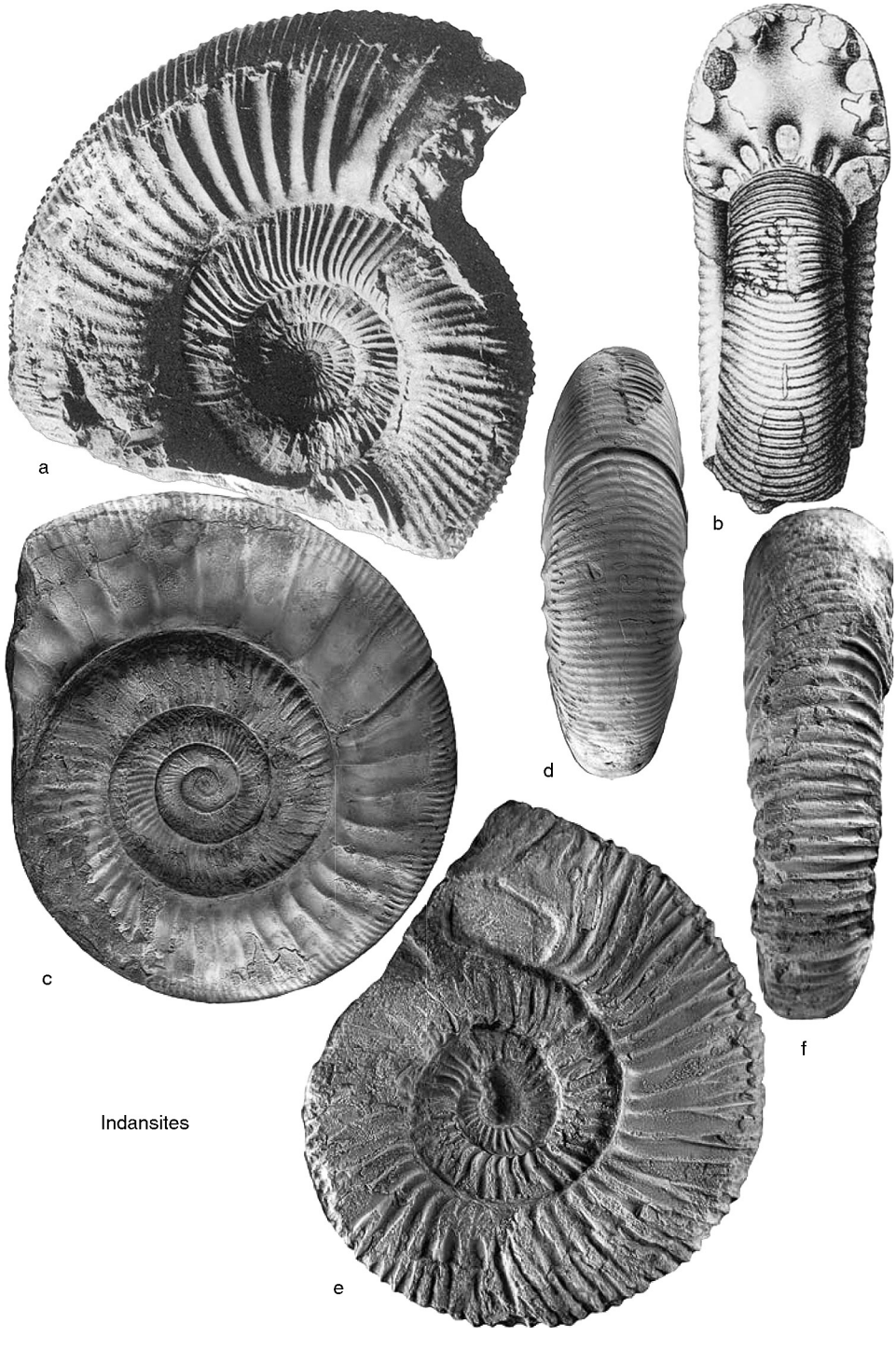

FIG. 89. Ataxioceratidae (p. 131).

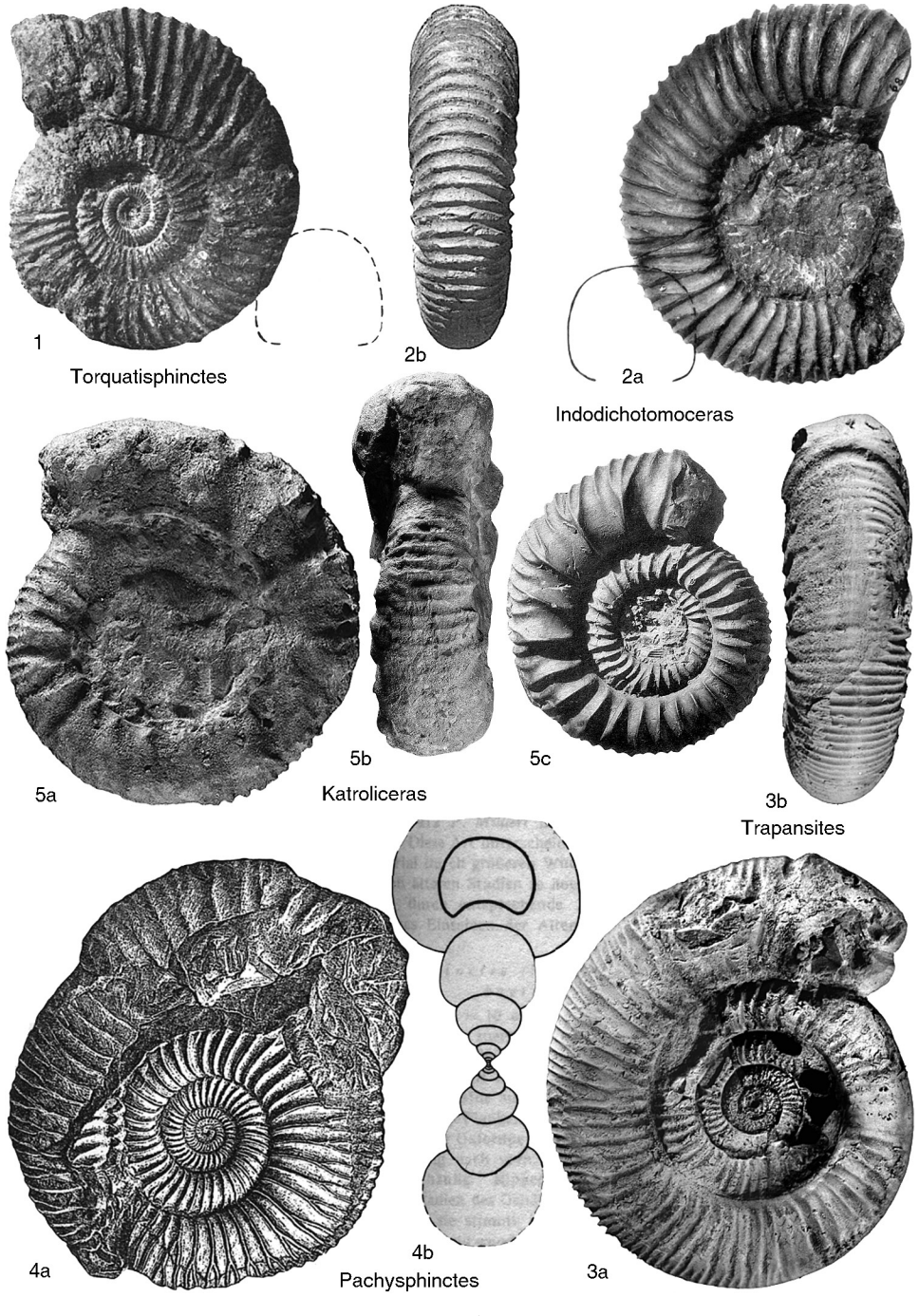

FIG. 90. Ataxioceratidae (p. 132–135).

(GEMMELLARO), lectotype (designated by OLORIZ in PAVIA & CRESTA, 2002, p. 374), complete adult microconch, Upper Jurassic White Limestones, olistoliths embedded in Neogene marls, near Favara, Sicily, ×0.5 (Pavia & Cresta, 2002, p. 375, fig. 241).

Pachysphinctes DIETRICH, 1925, p. 12 [**Perisphinctes (P.) africogermanus*; OD] [=*Balochistaniceras* FATMI

& Zeiss, 1999, p. 67 (type, *B. baragensis,* OD)]. Large to very large, dimorphic; stout, strong, depressed, and regularly biplicate inner whorls with complete simple ribs or not, changing to polygyrate triplicate on outer whorl of the microconch and massive, depressed outer whorl with large, coarse primary ribs in the macroconch; aperture with lappets or simple. *Upper Jurassic (upper Kimmeridgian):* Yemen, Somalia, Ethiopia, Tanzania, Kenya, Madagascar, India (Kutch), Himalaya.——Fig. 90,*4a–b. *P. africogermanus,* lectotype (designated by Verma & Westermann, 1984, p. 37), Mahokondo, Tanzania, ×0.36 (Dietrich, 1925, pl. 1,*2*).

Katroliceras Spath, 1924, p. 15 [**Ammonites pottingeri* J. de C. Sowerby, 1840b, p. 719; OD]. Small to medium size; dimorphic; evolute with depressed whorls and coarse, sharp, and distant ribbing; microconch mostly bifurcate with a few trifurcate ribs on the body chamber; ribbing denser and finer on inner whorls of the macroconch, changing rather abruptly to coarse, wedge-shaped trifurcate primaries with intercalatories. *Upper Jurassic (upper Kimmeridgian–lower Tithonian):* Yemen, Somalia, Ethiopia, Tanzania, Kenya, Madagascar, India (Kutch), Himalaya.——Fig. 90,*5a–c. *K. pottingeri* (J. de C. Sowerby); *a–b,* holotype, incomplete microconch, Kutch, India, ×0.5 (new; The Natural History Museum, London, NHMUK C.24956); *c,* complete adult microconch, lower Tithonian, Mombasa, Kenya, ×0.5 (Spath, 1931, pl. 102,*5*).

Biplisphinctes Oloriz, 1978a, p. 438 [**Perisphinctes cimbricus* Neumayr, 1873, p. 179; OD] [=*Kutekiceras* Zeiss, 2001, p. 45 (type, *Perisphinctes pseudocolubrinus* Kilian, 1895, p. 679, OD); =*Blaschkeiceras* Zeiss, 2001, p. 41 (type, *Perisphinctes (Aulacosphinctes) schoepflini* Blaschke, 1911, p. 217, OD)]. Dimorphic. Small size, evolute; whorl section depressed-rounded or quadratic-rounded; biplicate ribbing with rectiradiate primaries and projected secondaries; a few simple ribs. Microconch with lappeted aperture. Macroconchs (*Blaschkeiceras*) medium size with depressed-rounded whorl section; coarse and sharp ribbing, the inner whorls first biplicate, then with 3–4 secondaries and occasional simple ribs; outer whorl with virgatipartite ribbing. *Upper Jurassic (?upper Kimmeridgian–lower Tithonian):* Spain, Italy, Austria.——Fig. 91,*1a–b. *B. cimbricus* (Neumayr), holotype, Calcare incarnato, "Kimmeridgian," Campo Rovere, Sette Commune, Italy, ×0.75 (Schlögl & Zorn, 2012, pl. 9,*5,7*).——Fig. 91,*1c–d. B. pseudocolubrinus* (Kilian), lectotype (designated by Donze & Énay, 1961, p. 180), Diphya Kalk, Volano, Italy, ×0.66 (Zittel, 1870, pl. 9(33),*6a–b*).——Fig. 91,*1e–g. B. schoepflini* (Blaschke); *e,* holotype, Tithonian, Stramberg, Czech Republic, ×0.5 (Blaschke, 1911, pl. 4,*1*); *f–g,* inner whorls, Tithonian, Ernstbrunn, Austria, ×0.45 (Zeiss, 2001, pl. 9,*1–2*).

Catutosphinctes Leanza & Zeiss, 1992, p. 1847 [**C. rafaeli;* OD]. Dimorphic. Medium size and evolute. Macroconch ribbing with four, successive stages: inner whorls with simple and bifurcate ribs; then with trifurcate and simple ribs; then with distant primaries, biplicate or polygyrate, with irregular splitting; and final stage following a constriction with distant, biplicate and strong, irregular, simple ribs and intercalatories. Microconch with only the two first ribbing stages, and lappets in adult mouth border. *Upper Jurassic (lower Tithonian, upper* Proximus *Zone* (=Ponti *Zone)–upper Tithonian,* Internispinosum *Zone (*=Microcanthum *Zone):* Argentina.——Fig. 92,*1a–b. *C. rafaeli,* Vaca Muerte Formation, Los Catutos Member, Zapala, Argentina; *a,* holotype, nearly complete macroconch, ×0.4; *b,* paratype, microconch, ×1 (Zeiss & Leanza, 2010, pl. 3,*1,* 4,*8*).

Mapuchesphinctes Zeiss & Leanza, 2010, p. 48 [**P. garatei;* OD]. Dimorphic. Macroconch with giant evolute shell; thick, depressed whorl section; strong, well-spaced, bifurcate primaries; occasionally trifurcate secondaries projected across the venter without modification; and prominent, distant, simple ribs before the final aperture; microconch with ribbing style very similar to the macroconch, but small sized. *Upper Jurassic (lower Tithonian, upper* Proximus *[*=Ponti*] Zone)–upper Tithonian,* Internispinosum *Zone [*=Microcanthum*] Zone):* Argentina.——Fig. 92,*2a–b. *M. garatei,* holotype, macroconch, Vaca Muerte Formation, Cerro Lotena, Argentina, ×0.2 (Zeiss & Leanza, 2010, pl. 7,*1–2*).

?Mazatepites Cantú Chapa, 1967b, p. 6 [**M. arredondense;* OD] [=*Cuetzalanites* Cantú Chapa, 2009, p. 10 (type, *C. tonatiuhoides, nom. nov. pro Mazatepites arredondense* Cantú Chapa, 1967b, p. 7, pl. 1,*4, non* pl. 1,*1a–b,* OD)]. Probably dimorphic. Macroconch of medium size, fairly involute; *Lithacoceras*-like body chamber; inner whorls constricted with very distant simple ribs fading on the outer part of the side and the venter; microconch looks exactly like the macroconch inner whorls; resemblance to *Virgatosimoceras* was proved to be pure homeomorphy (Scherzinger, Fözy, & Parent, 2010). *Upper Jurassic (?lower Tithonian,* Zitteli–Proximus *Zones):* Mexico, Argentina.——Fig. 92,*3a–c. *M. arredondense,* Pimentia Formation, *Kossmatia* and *Pseudolissoceras* Beds, Tlatlauqui-Mazatepec, Puebla, Mexico; *a,* holotype, nearly complete specimen, ×0.33 (Cantú Chapa, 2009, fig. 3,*8*); *b–c,* paratype (holotype of *C. tonatiuhoides*), nearly complete specimen with living chamber one whorl long, possibly juvenile or microconch, ×0.33 (Cantú Chapa, 2009, fig. 3,*1,4*).

?Metagravesia Spath, 1931, p. 474, 504 [**M. decipiens;* OD]. Large to very large macroconch; involute, whorl section depressed to rounded-quadrate; regularly biplicate inner whorls with complete simple ribs or not; then blunt and distant primary ribs giving rise to spaced secondaries; microconch unknown. *Upper Jurassic (upper Kimmeridgian):* India (Kutch).——Fig. 91,*2. *M. decipiens,* holotype, wholly septate, incomplete specimen, Middle Katrol Formation, Fakirwadi, India, ×0.25 (Spath, 1931, pl. 94,*3a–b*).

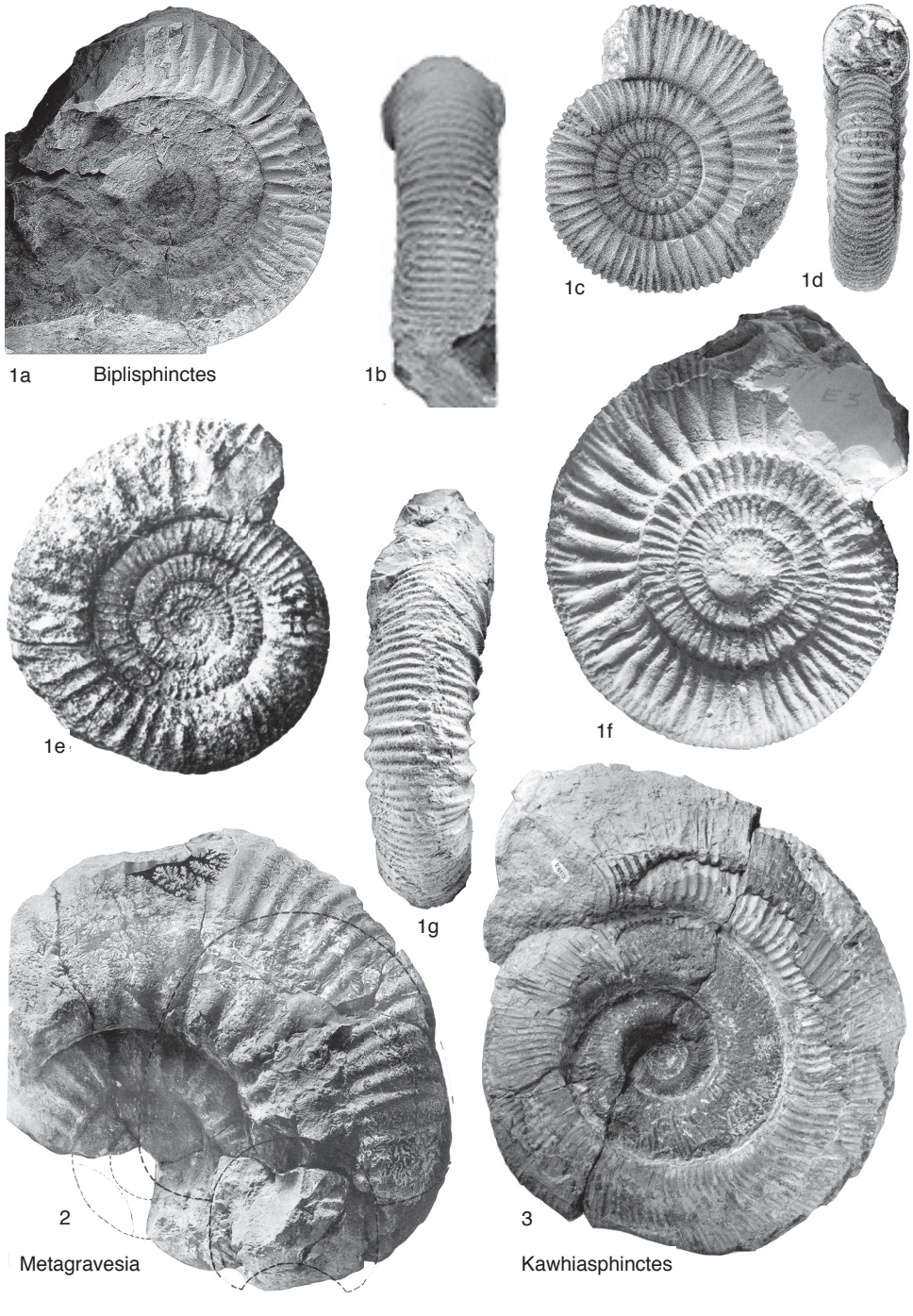

FIG. 91. Ataxioceratidae (p. 135–137).

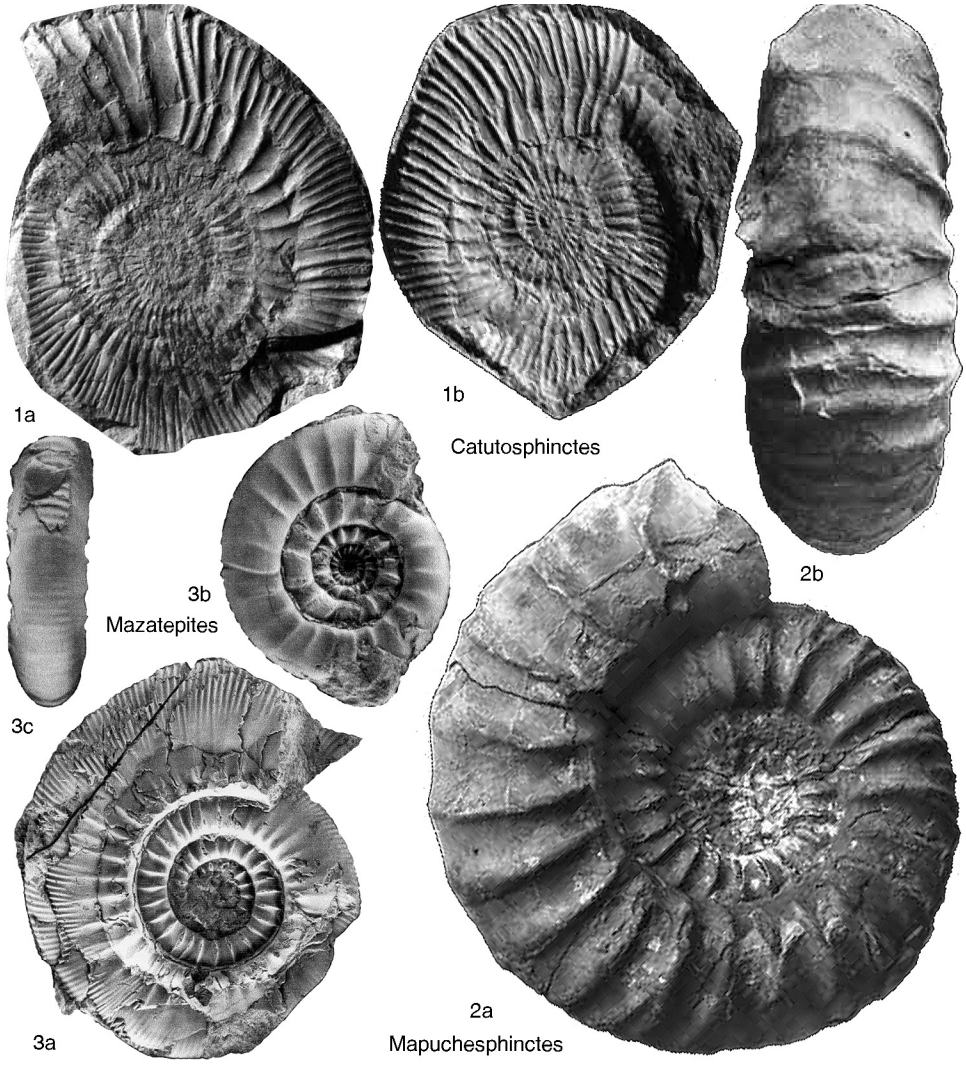

FIG. 92. Ataxioceratidae (p. 135).

?Kawhiasphinctes STEVENS, 1997, p. 78 [**K. antipodus;* OD]. Planulate shell with sharply defined, dense ribbing; simple and bifurcate ribs on the septate whorls; trifurcate ribs on the body chamber. Differs from *Torquatisphinctes* in its denser and finer ribbing, more abundant simple ribs, and the furcation points low on the whorl side. *Lower Tithonian:* New Zealand, Nepal.——FIG. 91,*3*. **K. antipodus,* holotype, Puoran stage, Mangaroan substage, Motutara Peninsula, Kawhia Harbour, New Zealand, ×0.22 (Stevens, 1997, pl. 30,*1*).

Subfamily VIRGATOSPHINCTINAE Spath, 1923

[*nom. transl.* ARKELL, 1950, p. 357, 363, *ex* Virgatosphinctidae SPATH, 1923a, p. 305] [=Pseudovirgatitinae SPATH, 1931, p. 468]

The subfamily was erected for the two Himalayan genera, *Virgatosphinctes* UHLIG, 1910b (which at the time included the group of *V. denseplicatus* WAAGEN, 1875, p. 201, later considered to be a new genus [=*Malagasites*

ÉNAY, 2009]) and *Aulacosphinctoides* SPATH, 1923a. According to UHLIG (1910b), the type genus is characterized by its virgatotome style of rib branching, a view that resulted in much subsequent discussion and differing opinions about the genera to be included in the subfamily. Additional complications are the occurrence of microconchs with bifurcate ribbing and incomplete knowledge of the relationships between the dimorphs. As used here, the subfamily includes genera displaying well-developed virgatotome style of ribbing (i.e., diversipartite, fascipartite, or virgatipartite), as well as genera with the same general shape, coiling, and whorl section, but with virgatotome ribs poorly developed, occasional, or modified. The occurrence of the subfamily in European Tethys is dubious, most of the so-called virgatosphinctids being regarded here as Lithacoceratinae. *Upper Jurassic (lower Tithonian):* Eastern Tethys, Indo-Southwest Pacific, South America (around Gondwanaland).

Virgatosphinctes UHLIG, 1910b, p. 307 [**Perisphinctes (V.) broilii;* SD R. DOUVILLÉ, 1910, p. 158]. Dimorphic; medium to large size, evolute to rather involute shell, slow-coiling, rounded and depressed whorl section; biplicate ribs in the inner whorls of both dimorphs, changing gradually to triplicate, polygyrate ribs on the adult whorl of some microconchs; others display fascipartite-diversipartite ribbing with 5–6 or up to 10 secondaries; outer whorl of the macroconch with nearly smooth venter and prominent, distant primaries; aperture with lappets or simple. *Upper Jurassic (lower Tithonian):* India (Himalaya), Nepal, Indonesia (Sula Islands), Antarctica, South America (Magellanes Basin).——FIG. 93,*1a–b. *V. broilii* (R. DOUVILLÉ), holotype, incomplete microconch, Spiti Shales, Shangra, India, ×0.5 (Uhlig, 1910a, pl. 91,1*a–b*).——FIG. 93,*1c–e. V. nupraensis* ÉNAY, incomplete adult macroconch, Spiti Shales, Nupra, Nepal; *c,* side view, ×0.33; *d–e,* inner whorls, side and ventral views, ×0.5 (Énay, 2009, pl. 34,*1a,c–d*).

Aulacosphinctoides SPATH, 1924, p. 16 [**Perisphinctes (Aulacosphinctes) infundibulum* UHLIG, 1910b, p. 371; OD]. Middle to large size, evolute with slow coiling and deep umbilicus; early whorls rounded, depressed; later whorls subrectangular. Dimorphic: inner whorls with fine to distant ribbing, typically biplicate with sigmoid secondaries in both dimorphs; microconchs have triplicate, polygyrate rib branching on the adult body chamber and lappets; macroconchs have more numerous biplicate ribs, tending to become bundled on adult whorl, and a simple aperture. *Upper Jurassic (lower Tithonian):* India, China (southern Tibet), Pakistan, India (Kutch), Madagascar, Indonesia (West Papua), Papua New Guinea, ?Japan, New Zealand, Antarctica, South America (Magellanes Basin).——FIG. 93,*2a–b. *A. infundibulum* (UHLIG), lectotype, incomplete microconch, Spiti Shales, Chidamu, India, ×0.5 (Uhlig, 1910b, pl. 72,*1a–b*).——FIG. 93,*2c. A. constrictus* ÉNAY, holotype, incomplete macroconch, Spiti Shales, Chhokor near Muktinath, Nepal, ×0.36 (Énay, 2009, pl. 43,*2b*).

Malagasites ÉNAY, 2009, p. 168 [**Perisphinctes (Virgatosphinctes) haydeni* UHLIG, 1910b, p. 334; OD]. Large to very large, planulate and involute shell, with inner whorls depressed, compressed and oval-shaped at the adult stage. Dimorphic: both dimorphs with biplicate primaries and a few simple ribs on the inner whorls; adult microconchs Subplanites-like, with polygyrate ribs and up to 4 or 5 secondaries and lappets; macroconchs have fascipartite ribs with intercalatories on later whorls, fading on the adult whorl, with smooth venter, distal, wedge-shaped dorsal ribs, and a simple aperture. *Upper Jurassic (lower Tithonian):* Madagascar, Tanzania, Kenya, India (Kutch), China (southern Tibet), Himalaya (India, Nepal), Papua New Guinea, Antarctica.——Fig. 94*a–b. *M. haydeni* (UHLIG), holotype, incomplete microconch, Spiti Shales, Jandu, Sherik River, Hundes, India, ×0.5 (Uhlig, 1910b, pl. 61,*2a–b*).——FIG. 94*c. M. cf. frequens* (OPPEL in UHLIG), macroconch, Chhokor, near Muktinath, Nepal, ×0.3 (Énay, 2009, pl. 41,*1a*).

Choicensisphinctes LEANZA, 1980, p. 32 [**Perisphinctes choicensis* BURCKHARDT, 1903, p. 50; OD]. Medium-sized to large, slightly inflated, and rather evolute shell with deep umbilicus and depressed trapezoidal whorl section; primary ribs strong and inflated with profuse (up to 13 or more) secondaries. Dimorphic: inner whorls with bifurcate ribs in both dimorphs. Microconch has polygyrate ribs on the end of the body chamber and lappets in the adult aperture. Macroconch has short, raised primary ribs on the end of the septate whorls and the body chamber, including isolated virgatotome with trifurcate or bifurcate and intercalary ribs, some polygyrate or polyschizostome; adult body chamber strongly variocostate to completely smooth, with simple aperture. *Upper Jurassic (lower Tithonian,* Picuculeufuense–Zitteli *Zones):* Argentina, Chile.——FIG. 95*a–d. *C. choicensis* (BURCKHARDT); *a–b,* holotype, incomplete macroconch, lower Tithonian (*Mendozanus* Zone), mountain pass near Choicathal, Argentina, ×1 (Burckhardt, 1903, pl. 6,*10–11*); *c,* neotype, microconch, adult shell with part of the aperture, Vaca Muerta Formation, upper lower Tithonian, Cordon del Burrero, Mendoza, Argentina, ×1 (Vennari, 2016, pl. 9,*6*); *d,* incomplete macroconch, Southern Mendoza, Argentina, ×0.5 (Vennari, 2016, pl. 10,*2*).——FIG. 95*e–f. C. mendozanus* (BURCKHARDT), lectotype, complete adult microconch, *Zitteli* Zone, Paso between Cajon del Buro and Rio Choica, Mendoza, Argentina, ×0.5 (Burckhardt, 1900, pl. 25,*7;* 1903, pl. 7,*5*).

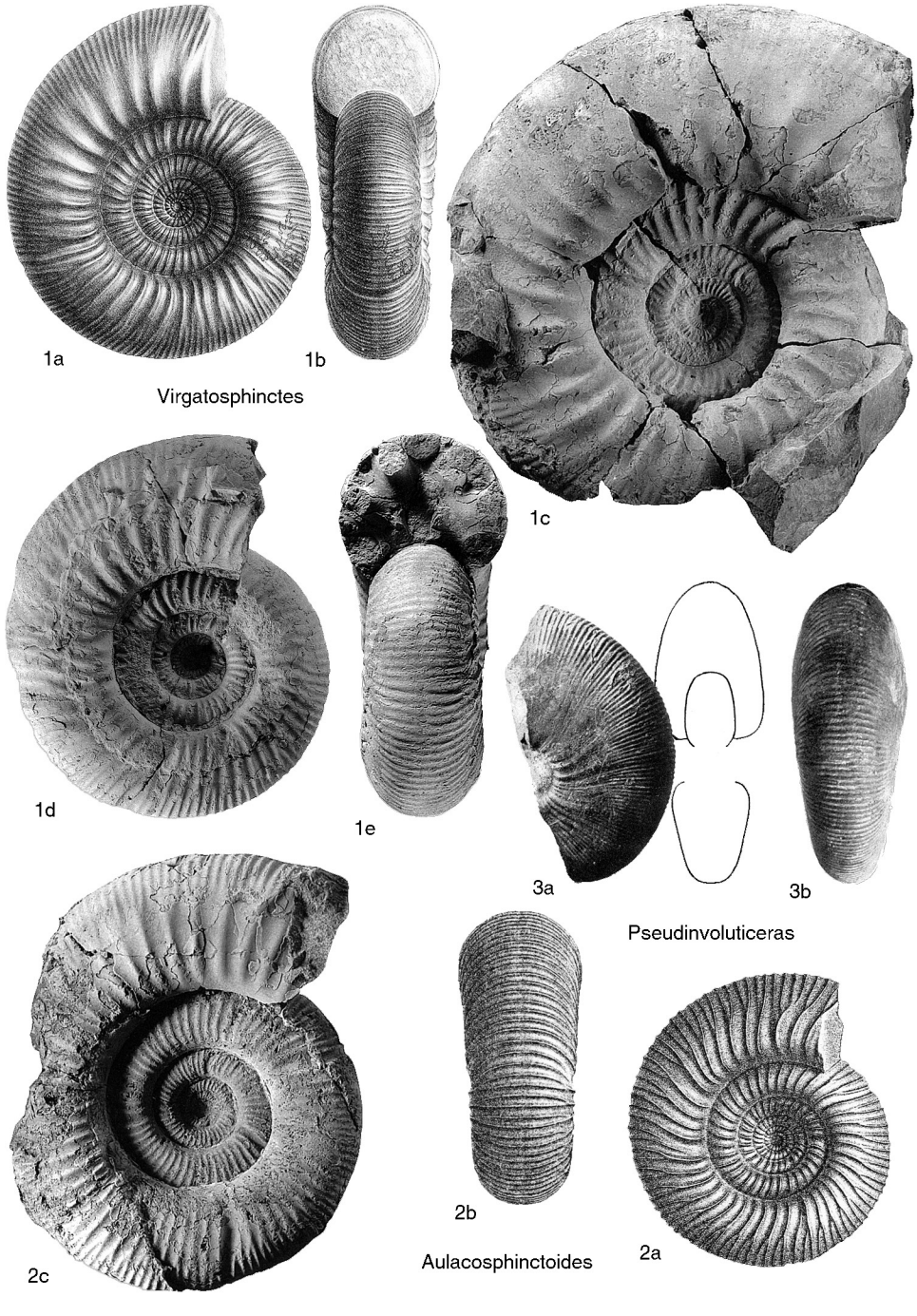

FIG. 93. Ataxioceratidae (p. 138–140).

Pseudinvoluticeras SPATH, 1925a, p. 133–134 [**P. somalicum;* OD]. Involute and compressed, high-oval whorl section; fine and dense ribbing; prorsiradiate primary ribs giving rise to bundles of 5–6 or even more ribs, crossing the venter without change. *Lower Jurassic (lower Tithonian):* Somalia, Madagascar, ?Argentina.—— FIG. 93,*3a–b. *P. somalicum,* holotype, wholly

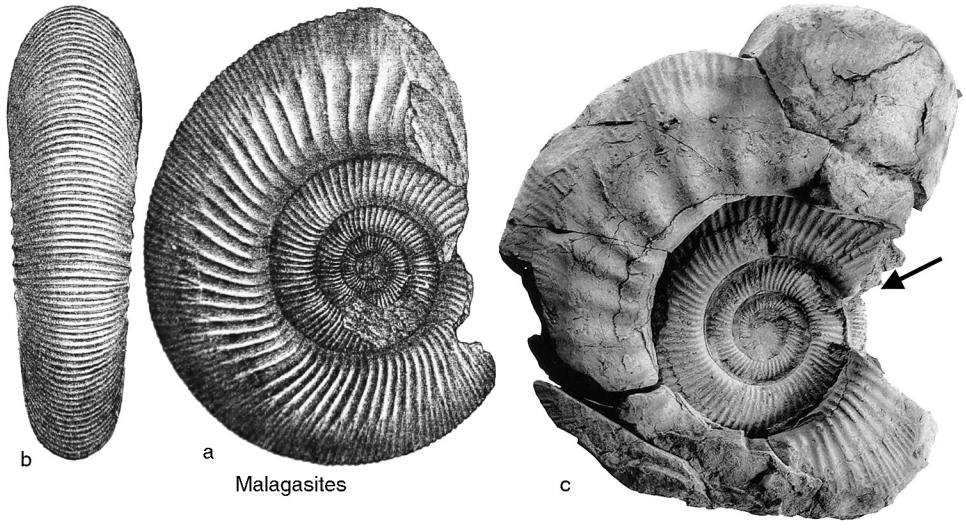

FIG. 94. Ataxioceratidae (p. 138).

septate, Bihendula, Somalia, ×0.61 (Spath, 1925a, pl. 15,*7a–b*).

Phanerostephanus SPATH, 1950, p. 104 [**P. subsenex;* OD]. More or less evolute macroconch with ovate whorl section and arched venter; inner whorls more depressed with bifurcating ribs, then triplicate polygyrate; branchings soon not clearly defined, then tending to disappear, and more distant primaries developing umbilical bullae; some constrictions; aperture simple with ventral rostrum. *Upper Jurassic (upper Kimmeridgian,* Beckeri *Zone–lower Tithonian):* Iraq (Kurdistan).——FIG. 96,*1a–b. *P. subsenex,* holotype, complete adult, Jebel (Chia) Gara, northern Iraq, ×0.5 (Howarth, 1992, pl. 1,*7–8*).

Nannostephanus SPATH, 1950, p. 114 [**N. subcornutus;* OD]. Probably dimorphic; endemic forms, currently known only in the Middle East. *Upper Jurassic (lower Tithonian):* Iraq.

N. (Nannostephanus). Small size; rather depressed inner whorls, finely and densely ribbed, the secondaries with a zigzag arrangement on the venter and tuberculate furcation points on the ventrolateral edge; aperture complete, but no lappets. Possible microconch dimorph of *Nothostephanus. Upper Jurassic (lower Tithonian):* Iraq (Kurdistan).——Fig. 96,*2a–b. *N. subcornutus,* holotype, complete adult, Jebel (Chia) Gara, northern Iraq, ×2 (Howarth, 1992, pl. 1,*3–4*).

N. (Nothostephanus) SPATH, 1950, p. 114 [**N. kurdistanensis;* OD]. Involute platycone; whorl section high with narrow, rounded venter; innermost whorls with distant, simple and bifurcate ribs; then more closely spaced trifurcate ribs with irregular or diversipartite branching; early weakening of the branchings, the secondaries tending to disappear and dorsal part of the primaries distinctly raised to form rounded umbilical tubercles. Possible macroconch dimorph of *Nannostephanus. Upper Jurassic (lower Tithonian):* Iraq (Kurdistan).——FIG. 96,*3a–b. *N. kurdistanensis,* holotype, adult with the beginning of the body chamber, Jebel (Chia) Gara, northern Iraq, ×0.5 (Howarth, 1992, pl. 1,*1–2*).

?Anavirgatites SPATH, 1925a, p. 133 [**A. divisiformis;* OD]. Discoid shaped, with fairly wide umbilicus; inner whorls show fairly close ribs, bifid and trifid; later ribs more distant and irregularly trifid; outer whorl with widely spaced simple ribs. *Upper Jurassic (Tithonian)*: Somalia, Eritrea, ?Chile.——FIG. 96,*4a. *A. divisiformis,* holotype, preserved as an impression (plaster cast), Bihendula, Somalia, ×0.5 (Spath, 1925a, p. 137, fig. 5).——FIG. 96,*4b. A. subambiguus* SPATH, 1925a, holotype, Bihendula, Somalia, ×0.5 (Spath, 1925a, p. 138, fig. 6).

Family VIRGATITIDAE Spath, 1923

[Virgatitidae SPATH, 1923a, p. 305] [=Pseudovirgatitinae SPATH, 1931, p. 468, footnote 2; =Ilowaiskyinae ZEISS, 1968, *nom. correct.* CALLOMON in DONOVAN, CALLOMON, & HOWARTH, 1981, p. 150, *pro* Ilowaiskyini ZEISS, 1968, p. 50 (tribe)]

Another branch derived from Submediterranean Ataxioceratidae, probably Lithacoceratinae, with furcation points of the secondary ribs very low on the whorl side, often at the umbilical edge. The family colonized mainly the Subbo-

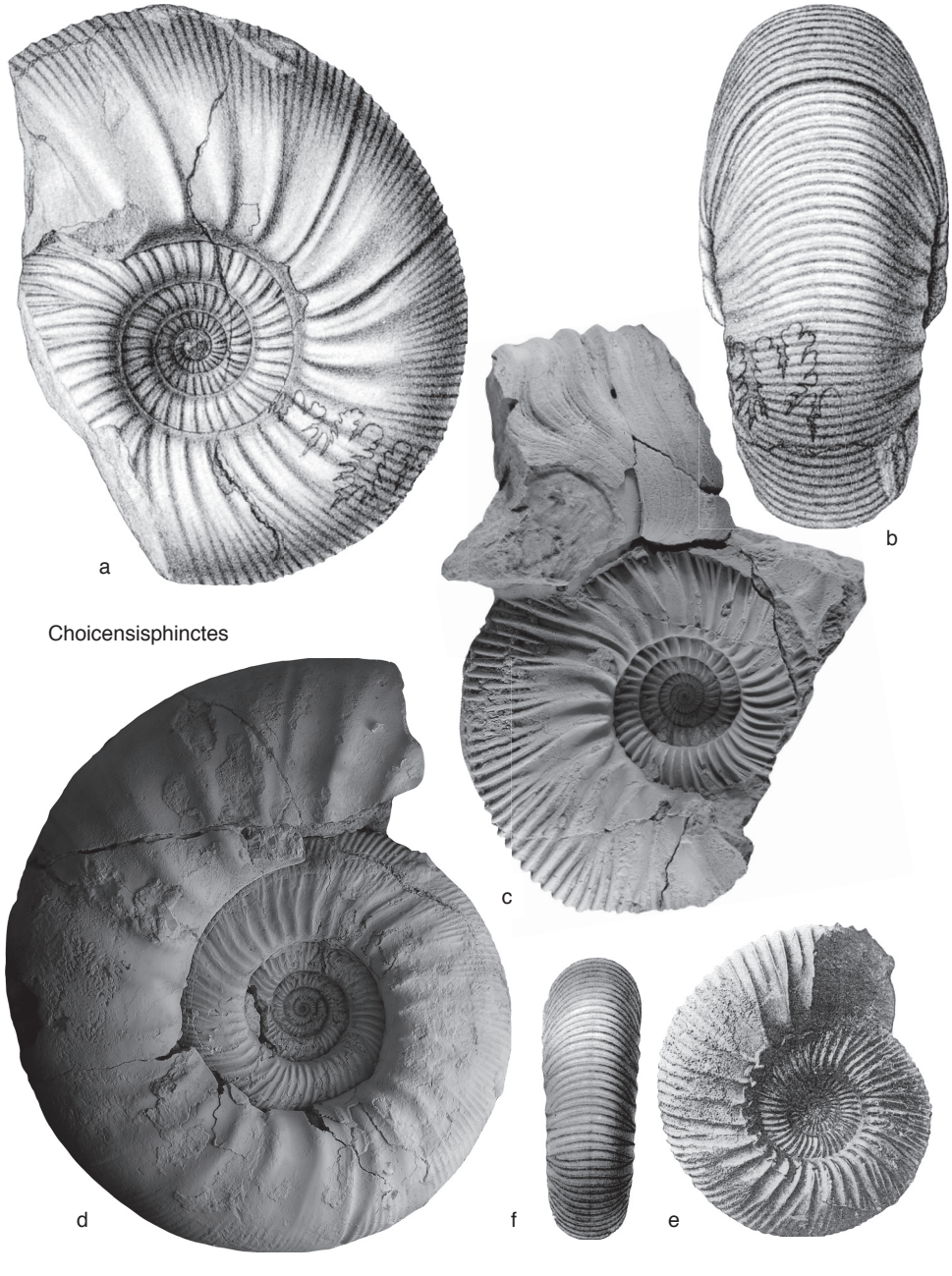

FIG. 95. Ataxioceratidae (p. 138).

real Polish Lowland and European Russia Platform (KUTEK & ZEISS, 1974, 1997; ZEISS, 1977; KUTEK, 1994), but a few representatives occur in the Subboreal northwest European Basin. CALLOMON (in DONOVAN, CALLOMON, & HOWARTH, 1981, p. 150) separated the subfamilies Ilowaiskyinae, Pseudovirgatitinae,

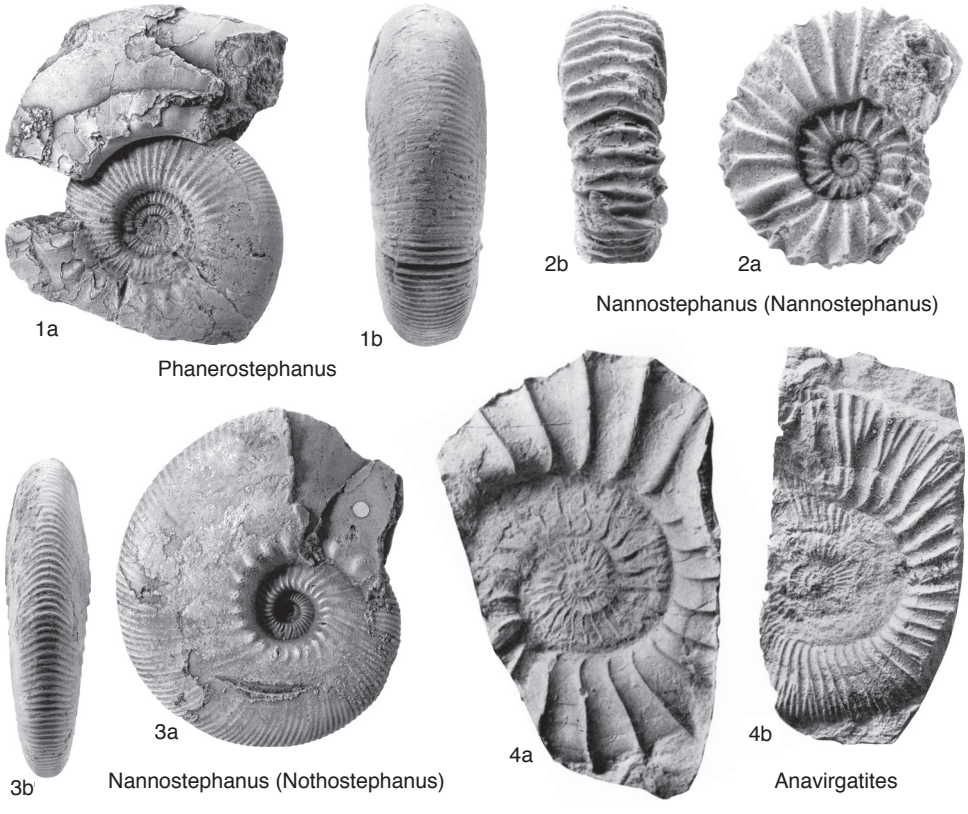

FIG. 96. Ataxioceratidae (p. 140).

and Virgatitinae, formerly distinguished (some of them as tribes) by ZEISS (1968). Each of them included only a few genera and, according to KUTEK and ZEISS (1974), they succeeded one another as a phyletic line. But the lower Volgian Subboreal so-called *Pseudovirgatites* should probably belong to a new homoeomorphic genus and lineage (ROGOV, June 2018, personal communication). Later, MITTA (1993) retained only two subfamilies, the Pseudovirgatitinae and the Virgatitinae, but these are not accepted herein and are included in the Virgatitidae. *Upper Jurassic (Volgian and Tithonian):* northern & eastern Europe, northern Asia.

Pseudovirgatites VETTERS, 1905, p. 227 [**Ammonites scruposus* OPPEL, 1865, p. 557; OD]. Medium size to large, dimorphic; inner whorls finely and densely ribbed, the ribs well outlined, the furcation points normally low on the side; following stages with polygyrate or bidichotome to fasciculate ribs, virgatipartite in some, but rare specimens stronger and more distant; adult whorl of the macroconch has dichotome to polygyrate ribbing and a simple aperture. *Upper Jurassic (upper Tithonian/lower Volgian,* Pushi *and* Tenuicostata *Zones):* Austria, Poland, Hungary.——FIG. 97,*1a–c.* **P. scruposus* (OPPEL); *a–b,* holotype (monotypy), macroconch, part of the body chamber, Stramberg Limestone, upper Tithonian, Ignaziberg, Czech Republic, ×0.33 (Zittel, 1868, pl. 24,*3a–b*); *c,* complete adult macroconch, Klentnice Beds, upper Tithonian, Niederfellabrunn, Austria, ×0.2 (Vetters, 1905, pl. 21,*1*).

Sarmatisphinctes KUTEK & ZEISS, 1997, p. 144 [**Divisosphinctes fallax* ILOVAÏSKY in ILOVAÏSKY & FLORENSKY, 1941, p. 45; OD] Small to medium size, dimorphic; inner whorls with biplicate ribbing, irregular and *Virgataxioceras*-like on larger whorls of the microconch, biplicate and triplicate in the macroconch; microconch aperture with lappets, macroconch aperture simple. *Upper Kimmeridgian (*Fallax *Zone):* Poland,

Russia.——Fig. 97,*2. *S. fallax* (Ilovaïsky), lectotype (designated by Énay, herein), incomplete specimen, ×0.45 (Ilovaïsky & Florensky, 1941, pl. 2,*5*).

Ilowaiskya Vialov, 1940 p. 78 [**Ilowaiskya sokolovi var. typica* Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 67; SD Mikhailov, 1964, p. 46, this being the taxonomic species actually involved in Vialov's (1940) misidentification of the type species as "Genotype: *Ilowaiskya Sokolovi* Ilov. (=*Virgatosphinctes contiguus* Sokolov, *non* Catt.)," referring probably to Sokolov's 1901 and 1903 papers, but both these papers lack description or figures suitable for being chosen as type. So the type species designation by Mikhailov is valid.] [=*Sokolovia* Ilovaïsky, 1934 (unpublished MS), *non* Böhm, 1933 (Paleogene Ostreiidae) (*nom. nud.*); =*Ilovaiskya* Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 67, obj. (Ilovaïsky's manuscript of 1934 was not published until its incorporation posthumously in Ilovaïsky and Florensky's paper of 1941, in which *Sokolovia* was replaced by *Ilovaiskya,* with reference to Vialov's paper)]. Small to medium size; dimorphic; first involute, then evolute at larger diameters; ribbing dense and biplicate on the inner whorls, more distant on middle whorls; some biplicate ribs joining at the umbilical edge and forming bidichotome ribs; occurrence of constrictions fringed by simple or polygyrate ribs; outer whorl shows strong variations in density of ribbing and place where changes occur; aperture simple in both dimorphs. Later *Ilowaiskya* are transitional to *Zaraiskites. Upper Jurassic (lower Volgian,* Klimovi/Pseudoscythica *Zones–lower Tithonian):* Poland, Russia.——Fig. 97,*3. *I. sokolovi* (Ilovaïsky), lectotype, incomplete specimen, Sukhaya Peschanka River, near Divnopolye, Orenburg Oblast, Russia, ×0.45 (Ilovaïsky & Florensky, 1941, pl. 8,*18*).

Zaraiskites Semenov, 1898 in 1897–1898, p. 114 [**Perisphinctes zaraiskensis* Michalski, 1890, p. 98; SD Basse, 1952, p. 639] [=*Provirgatites* Lewinski, 1923, p. 93, obj.]. Small to medium size, probably dimorphic; inner whorls with biplicate ribbing changing during growth to virgagtotome of variable duration, the secondaries more or less numerous and straight or sinuous; on the outer whorl ribbing becomes simple. *Upper Jurassic (middle Volgian,* Scythicus *to* Panderi *Zones–upper Tithonian):* Poland, Russia.——Fig. 97,*4a–b. *Z. zaraiskensis* (Michalski), lectotype (=Normaltype in Michalski, 1890), incomplete specimen with a large part of the body chamber, Phosphorite Bed, Moscow area, ×0.5 (Michalski, 1890, pl. 6,*1*).

Virgatites Pavlov in Pavlov & Lamplugh, 1891, p. 471 [**Ammonites virgatus* Buch, 1830, p. 3; SD Douvillé, 1911, p. 732, 738] [=*Euvirgatites* Lewinski, 1923, p. 27, obj.]. Small to medium size; involute to moderately evolute; whorl section rounded to compressed oval or high oval; early whorls with tubercle-like swellings, resembling those of *Acuticostites;* followed by a biplicate stage of short duration changing to virgatotome ribbing, the secondaries merging on the front side of the primary ribs, their number gradually increasing, sometimes reaching 7–8 and decreasing on the outer whorl. *Upper Jurassic (middle Volgian,* Virgatus *Zone–upper Tithonian):* Poland, Russia.——Fig. 97,*5a–b. *V. virgatus* (Buch), holotype (designated by Arkell, 1956a, p. 788), Black Shales, Karashovo on the river Moskva, 6 miles north of Moscow, Russia, ×0.5 (Buch, 1830, pl. 8,*1*).

Family DORSOPLANITIDAE Arkell, 1950 (Schindewolf, 1925)

[*nom. transl.* Callomon in Donovan, Callomon, & Howarth, 1981, p. 150, *ex* Dorsoplanitinae Arkell, 1950, p. 363] [=Polytosphinctidae, *nom. transl.* Callomon in Donovan, Callomon, & Howarth, 1981, p. 150, *ex* subfamily Polytosphinctinae Schindewolf, 1925, p. 326]

Near the Kimmeridgian-Tithonian boundary, Ataxioceratidae gave rise to a third major branch that is the root of almost all the subsequent faunas in the Boreal and Subboreal provinces during Tithonian and Volgian times. They are joined together in the family Dorsoplanitidae the name of which was fixed only recently. *Polytosphinctes* Schindewolf, 1925, p. 327, is an objective synonym of *Dorsoplanites* Semenov, 1897 in 1897–1898, so Arkell (1950, p. 363) replaced Polytosphinctinae Schindewolf, 1925, p. 326, with Dorsoplanitinae. Therefore, following the requirements of the ICZN *Code,* 1999 (Art. 40.2.1), Dorsoplanitidae (and Dorsoplanitinae) take priority from 1925. Genera included in the family by Arkell (in Arkell and others, 1957) are distributed among three different subfamilies: Pectinatitinae, Pavloviinae, and Dorsoplanitinae (Callomon in Donovan, Callomon, & Howarth, 1981, p. 150). Without considering the giant forms of the English Portland Beds, Mitta (1994, p. 32) did not accept Pavloviinae as a subfamily, and he merged it with the Dorsoplanitinae. But Wimbledon and Cope (1978, p. 183) maintained that these Portland Beds giants "are clearly closely related to *Pavlovia* of the beds beneath." Therefore, according to Donovan, Callomon, and Howarth (1981, p. 150), the family is

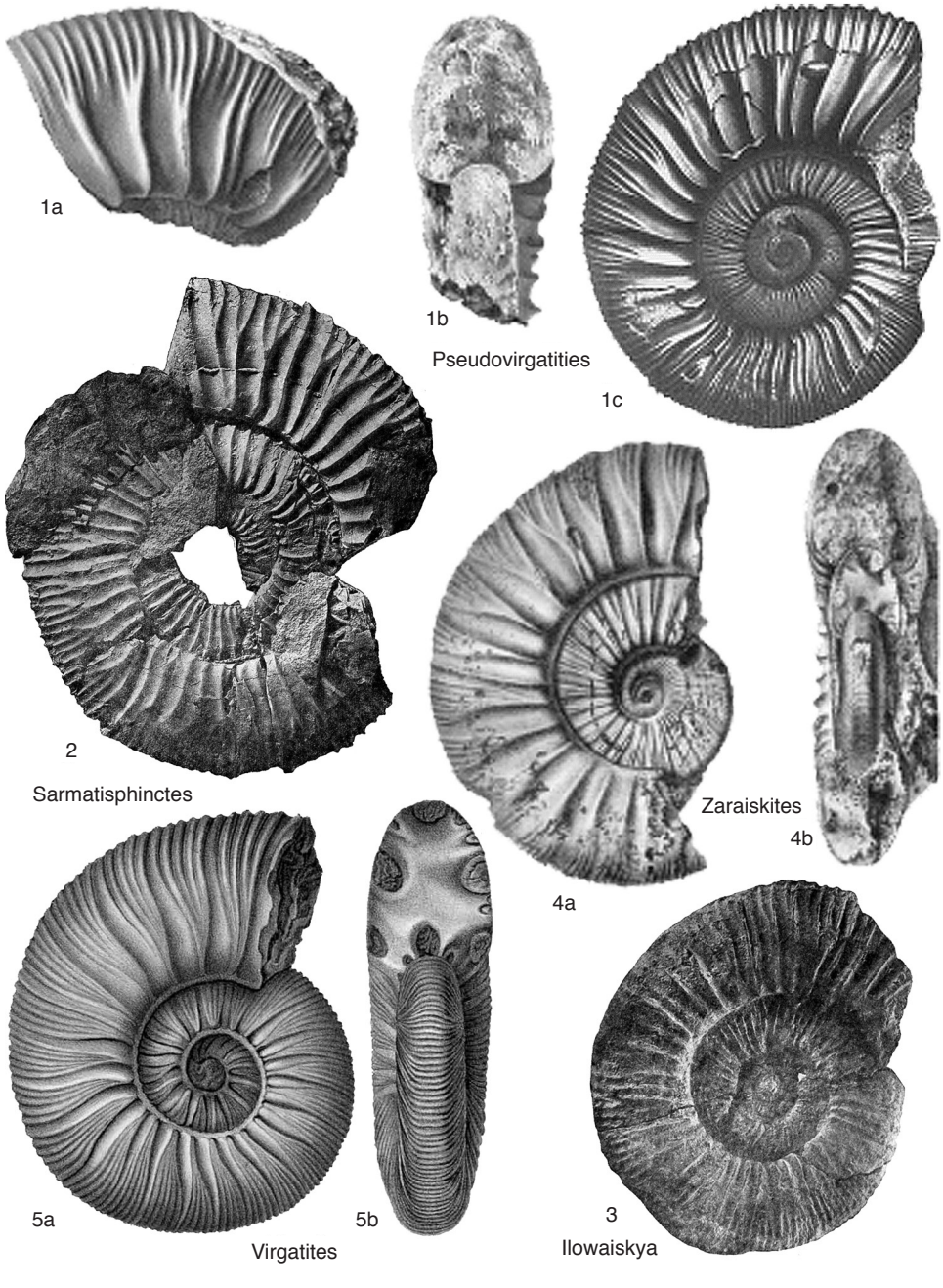

FIG. 97. Virgatitidae (p. 142–143).

here understood as consisting of three subfamilies (Pectinatitinae, Pavloviinae, and Dorsoplanitinae). Dorsoplanitids display some common features, such as fairly wide umbilicus, ribbing predominantly biplicate, sometimes triplicate and diversipartite, but never virgatipartite and so quite apart from the virgatitids; but, as

in the latter group, lappets are lost at the base of the Tithonian/Volgian and for a short time are replaced by ventral horns in the Pectinatitinae; mature peristomes with ventral protuberances (not horns) are also present in some pavlovids (Cope, 1978, pl. 51,*1*). *Upper Jurassic (Tithonian and lower–middle Volgian)–Lower Cretaceous (upper Volgian–Ryazanian):* northwestern and eastern Europe, Greenland, Russia (western and northern Siberia).

Subfamily PECTINATITINAE Zeiss, 1968

[Pectinatitinae Zeiss, 1968, p. 50, *nom. correct.* Callomon in Donovan, Callomon, & Howarth, 1981, p. 150, *pro* "tribe" Pectinatitini Zeiss, 1968, p. 50]

A subfamily characterized by the quick development of horned peristomes in the microconchs from ancestors with lappets, though these are sometimes short or reduced; ribs are biplicate in both dimorphs. Pectinatitinids are one of the earliest offshoots from Ataxioceratinae at the Kimmeridgian-Tithonian boundary, and they are considered to give rise to the pavlovids in the Upper Tithonian. *Upper Jurassic (lower Tithonian):* England, northern France, Greenland, Russia (subpolar Urals, Siberia).

Subdichotomoceras Spath, 1925a, p. 119 [**S. lamplughi;* OD; =*Perisphinctes lacertosus* Pavlow in Pavlow & Lamplugh, 1891, p. 468, *non* Dumortier & Fontannes, 1976, p. 100] [=*Sphinctoceras* Neaverson, 1925, p. 21 (type, *S. crassum* Neaverson, OD)] [=*Propectinatites* Cope, 1968, p. 16 (type, *P. websteri,* p. 17; OD)]. Medium-size, dimorphic genus; evolute, whorl section thicker than high and depressed; strong and prominent rectiradiate primary ribs uniformly bifurcate with symmetrical branching, the secondaries crossing the ventral area without any smooth band or furrow, the ribbing regularly disturbed by deep constrictions; aperture with short reduced (residual) or well-defined lappet (microconch) or simple (macroconch). *Propectinatites* was based on crushed specimens. *Upper Jurassic (upper Kimmeridgian, ?uppermost* Eudoxus–Autissiodorensis *Zones*): southern England, ?eastern France.——Fig. 98,*1a–d.* **S. lamplughi,* complete adults, preserved solid, Kimmeridge Clay, uppermost *Eudoxus* or *Autissiodorensis* Zone, Speeton, Yorkshire, England; *a–b,* holotype, microconch, ×0.66 (new; Town Museum, Geneva, Switzerland; also figured by Pavlow & Lamplugh, 1891, p. 468); *c–d,* macroconch, ×0.45 (new; Sedgwick Museum, Cambridge, England, J 35941; also figured by Énay, Gallois, & Etches, 2014, pl. 10,*2a–b*).

Pectinatites Buckman, 1922, pl. 354 [**Ammonites pectinatus* Phillips, 1871, p. 331; OD] [=*Wheatleyites* Buckman, 1922, p. 28 and 1923a, pl. 365 (type, *W. tricostulatus,* OD); =*Pectiniformites* Buckman, 1925a, pl. 568 (type, *P. bivius,* OD); =*Keratinites* Buckman, 1925b, pl. 601 (type, *K. keratophorus,* OD)]. Dimorphic; small to medium size; inner whorls with sharp biplicate ribbing, a little coarser on body chamber of the microconch with occasional simple and trifurcate ribs; ribbing very variable on the macroconch, usually with long primaries and two or five secondaries to each primary; constrictions in some species; aperture with ventral horn (microconch) or simple (macroconch). *Upper Jurassic (lower Tithonian,* Elegans–Pectinatus *Zones):* England, northern France, Greenland, Russia (subpolar Urals, western Siberia).

P. (Pectinatites). Dimorphic; small to medium size; finely ribbed on the inner whorls with tendency for ribs to bifurcate very low on whorl side; macroconch outer whorls with primary ribs typically strong with variable number of secondary ribs, never truly virgatotome; body chamber of microconch usually more coarsely ribbed, peristome with ventral horn often of great length; constrictions generally absent. *Upper Jurassic (lower Tithonian,* Pectinatus–Pallasioides *Zones):* England, northern France, Greenland, Russia (subpolar Urals, western Siberia).——Fig. 99,*1a–b.* **P. pectinatus* (Phillips); *a,* topotype, neotype (designated by Arkell, 1956a, p. 780), Shotover Grit Sands, Shotover Hill, Oxford, England, ×0.5 (Arkell, 1956a, pl. 41,*6*); *b,* complete microconch with aperture, Portland Sands, Cemetery Beds, Swindon, Wiltshire, England, ×0.45 (Buckman, 1922, pl. 354B).

P. (Arkellites) Cope, 1967, p. 24 [**P. (Arkellites) hudlestoni;* OD)]. Dimorphic, with little change in the ribbing during growth; microconch body chamber more coarsely ribbed than inner whorls and horn sometimes little more than an inflation of ventral part of the peristome; outer whorl of macroconch showing little change to the peristome, sometimes with strengthening of primary ribs and occurrence of intercalatory and unbranched primary ribs; peristome simple. *Upper Jurassic (lower Tithonian,* Elegans *to* Hudlestoni *Zones):* England, northern France, Greenland, Russia (subpolar Urals, western Siberia).——Fig. 99,*2a–b.* **P. (Arkellites) hudlestoni,* Upper Kimmeridge Clay, Kimmeridge, Dorset, England; *a,* holotype, macroconch, ×0.41; *b,* paratype, microconch, ×0.5 (Cope, 1967, pl. 7, pl. 8,*2*).

P. (Virgatosphinctoides) Neaverson, 1925, p. 11 [**V. wheatleyensis;* OD] [=*Allovirgatites* Neaverson, 1925, p. 29 (type, *A. woodwardi,* OD)]. Dimorphic, microconchs are sometimes undistinguishable from *Pectinatites (sensu stricto*); only the macroconch differs with modified body chamber often displaying polygyrate,

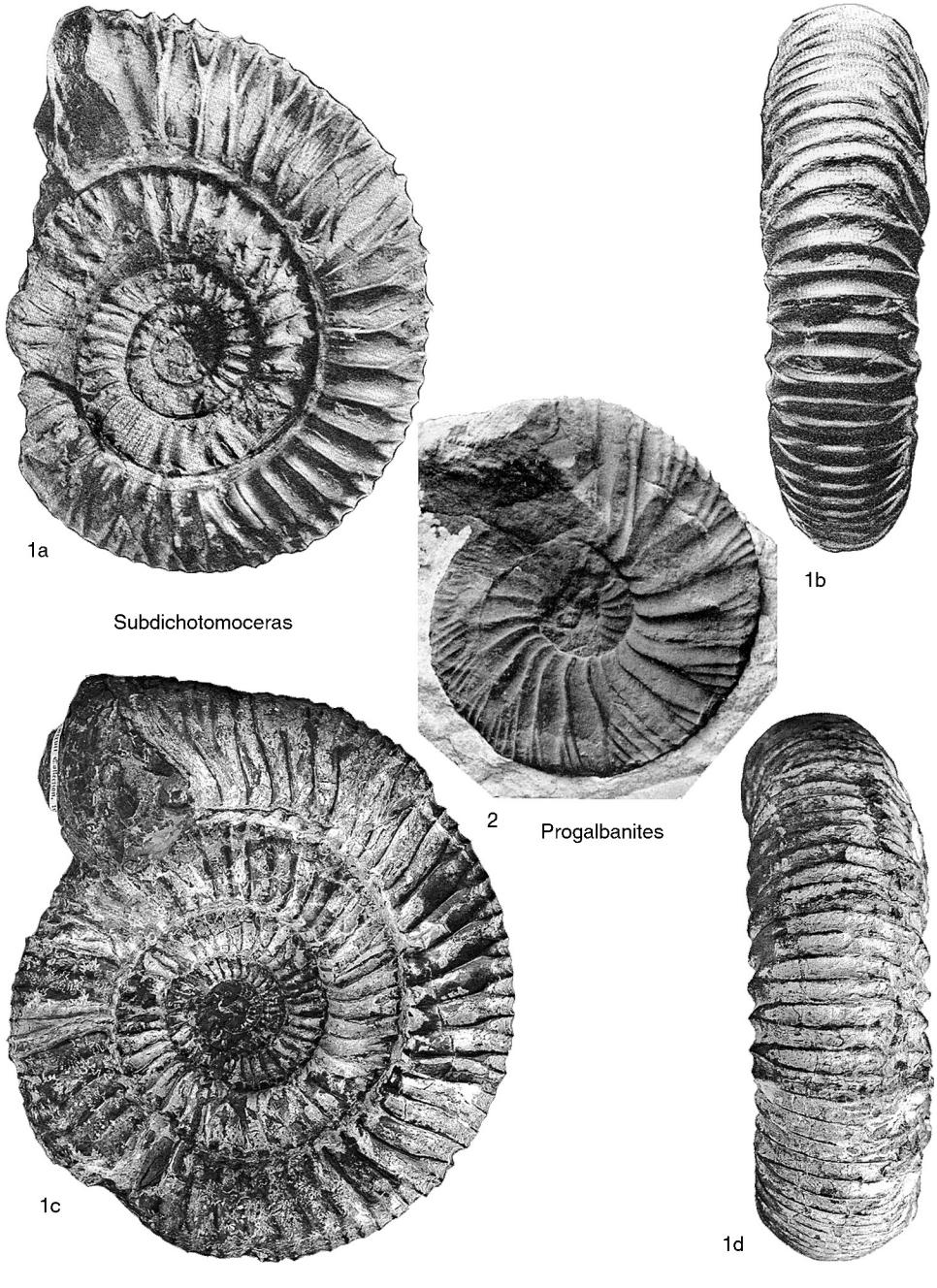

FIG. 98. Dorsoplanitidae (p. 145–147).

polyplok, or virgatotome ribbing; aperture simple. Often compared with Submediterranean *Subplanites,* but horned peristome of the microconch shows that *Virgatosphinctoides* is closely related to *Pectinatites. Upper Jurassic (lower Tithonian,* Elegans–Hudlestoni *Zones):* England, northern France, Greenland, Russia (subpolar Urals, western Siberia).——FIG. 99,*3a–b. *P. (V.) wheatleyensis* NEAVERSON; *a,* holotype, nearly complete specimen in solid

preservation, Nodule bed, *Wheatleyensis* Zone, Wheatley, Oxon, England, ×0.58 (Neaverson, 1925, pl. 1,*1*); *b,* complete adult microconch, Upper Kimmeridge Clay, Kimmeridge, Dorset, England, ×0.5 (Cope, 1967, pl. 21,*2*).

?Progalbanites Spath, 1936a, p. 30 [**Provirgatites albani* Arkell, 1935b, p. 339; OD)]. Small sized, fairly involute; compressed whorl section; inner whorls with bifurcate ribs; outer whorl ribbing *Zaraiskites*-like (but unrelated to the Russian genus); typically virgatotome furcation, with 3–5 secondaries and some simple ribs. *Upper Jurassic (upper Tithonian,* Fittoni *Zone):* England.——Fig. 98,*2.* **P. albani* (Arkell), holotype, incomplete specimen, lower Portland Sand, St. Alban's Head, Dorset, England, ×0.85 (Arkell, 1935b, pl. 26,*2*).

Subfamily PAVLOVIINAE Spath, 1936

[*nom. correct.* Callomon in Donovan, Callomon, & Howarth, 1981, p. 150, *pro* Pavlovinae Spath, 1936a, p. 26]

Proposed as a subfamily by Spath (1936a), Pavloviinae was included in the Dorsoplanitidae by Arkell (in Arkell & others, 1957), but it was considered to be a subfamily (Pavloviinae) by Callomon (in Donovan, Callomon, & Howarth, 1981, p. 150), and a member of the Dorsoplanitidae together with the Pectinatitinae and the Dorsoplanitinae. Later, Mitta (1994, p. 32) did not include the subfamily "until the ontogeny of the suture-line in all genera is known." However, pavlovids may be defined using some common features of the genera included in the subfamily: although some of the allied genera develop polygyrate ornament on the outer whorl, *Pavlovia* and allied genera show a biplicate ribbing style that is considered to be characteristic of the subfamily. These are a first offshoot of pavlovids, probably derived from the Pectinatitinae, whose oldest genus *Subdichotomoceras* (=*Propectinatites*) was for a long time assumed to be the forerunner of *Pavlovia* (Arkell in Arkell & others, 1957, p. 332), the difference in respective age being ignored. These pavlovids are one of the most characteristic components of the late Tithonian or Middle Volgian ammonites in the Boreal Province and probably the only one that all the subprovinces have in common (Cope, 1978). Beside these true pavlovids, the subfamily includes the well-known giant forms of the English Portland Beds and the northern France equivalents. Consisting of evolute round-whorled shells, with sharp rectiradiate biplicate ribs, frequent simple ribs and constrictions, they are clearly closely related to *Pavlovia* of the underlying beds (Wimbledon & Cope, 1978), but their distribution is restricted. *Upper Jurassic (upper Tithonian–middle Volgian):* England, northern France, ?Greenland.

Pavlovia Ilovaïsky, 1917a, p. 40 [**Pavlovia iatriensis var. primaria* Ilovaïsky, 1917a, p. 93; SD Spath, 1931, p. 470; Mikhailov's (1962, p. 6), later proposal of *Perisphinctes pavlowi* Michalski, 1890, p. 224, pl. 11,*6,* as type species is not valid] [=*Pavlovia* Ilovaïsky, 1915, p. 40, 43, *nom. nud.*; =*Lydistratites* Buckman, 1922, pl. 353A (type, *L. lyditicus,* OD); =*Pallasiceras* Spath, 1924, p. 16 (type, *Ammonites rotundus* J. Sowerby, 1821a, p. 169, OD); =*Aposphinctoceras* Neaverson, 1924, p. 149 (type, *A. decipiens* Neaverson, *nom. nov. pro Olcostephanus pallasianus var. nov.* Healey, 1904, p. 60, OD); =*Episphinctoceras* Neaverson, 1925, p. 24 (type, *E. inflatum,* OD); =*Holcosphinctes* Neaverson, 1924, p. 149 (type, *E. pallasioides,* OD); =*Pavlovella* Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 138 (type, *Pavlovia iatriensis* Ilovaïsky, 1917a, p. 40, obj.)]. Small size; whorl section thick, rounded or oval-shaped; regular, sharp, bifurcating radial ribs remain to the aperture, and occasional constrictions are associated with some type of compound rib and complete simple rib. Probably dimorphic: adult specimens fall in two size groups, but are without any distinctive features such as marked variocostation (macroconch) or apertural modification (microconch), except some specimens that show flaring of the peristome margin or ventral inflation of the peristome. *Upper Jurassic (upper Tithonian,* Pallasioides–Fittoni *Zones–middle Volgian*, Panderi *Zone*): England, northern France, Russia (western Siberia), Greenland.——Fig. 100,*1a–c.* **P. iatriensis*, Liapine region, Sverdlovsk, Russia; *a–b,* lectotype (designated by Mitta, 2015, p. 53), small, nearly complete with half a whorl of body chamber, possibly a microconch, ×1 (Ilovaïsky, 1917a, pl. 1,*1a–b;* also figured by Roman, 1938, pl. 28,*271–271a;* Arkell in Arkell & others, 1957, fig. 435,*4a–b;* both with erroneous magnification values); *c,* larger specimen, possibly a macroconch, ×0.75 (Ilovaïsky, 1917a, pl. 1,*2a*).

Paravirgatites Buckman, 1922, pl. 308 [**P. paravirgatus*; OD] [=*Shotoverites* Buckman, 1925a, pl. 562 (type, *S. pringlei*, OD)]. Inner and middle whorls like *Pavlovia,* changing gradually to coarse, ribbed outer whorl with simple to triplicate ribs; ribbing somewhat irregular. *Upper Jurassic (upper Tithonian,* Pectinatus *Zone):* England, northern France, ?Greenland.——Fig. 100,*2.* **P. (P.) paravirgatus,* holotype, nearly complete adult specimen, Shotover Grit Sand Dogger, Shotover, Oxford, England, ×0.5 (Buckman, 1922, pl. 308).

Epipallasiceras Spath, 1936a, p. 29 [**Pavlovia (E.) pseudaperta* Spath, 1936a, p. 56; OD]. Like

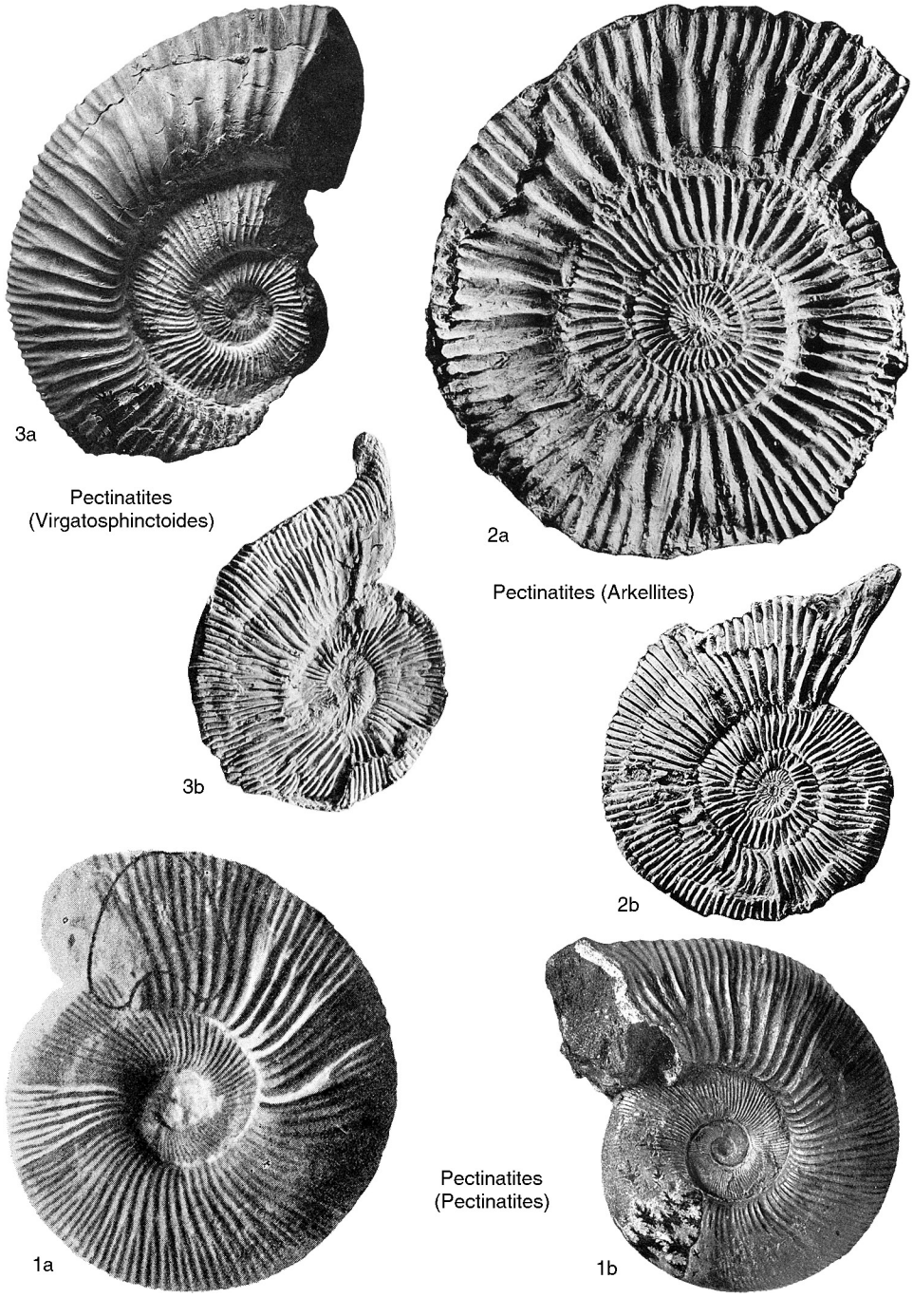

FIG. 99. Dorsoplanitidae (p. 145–147).

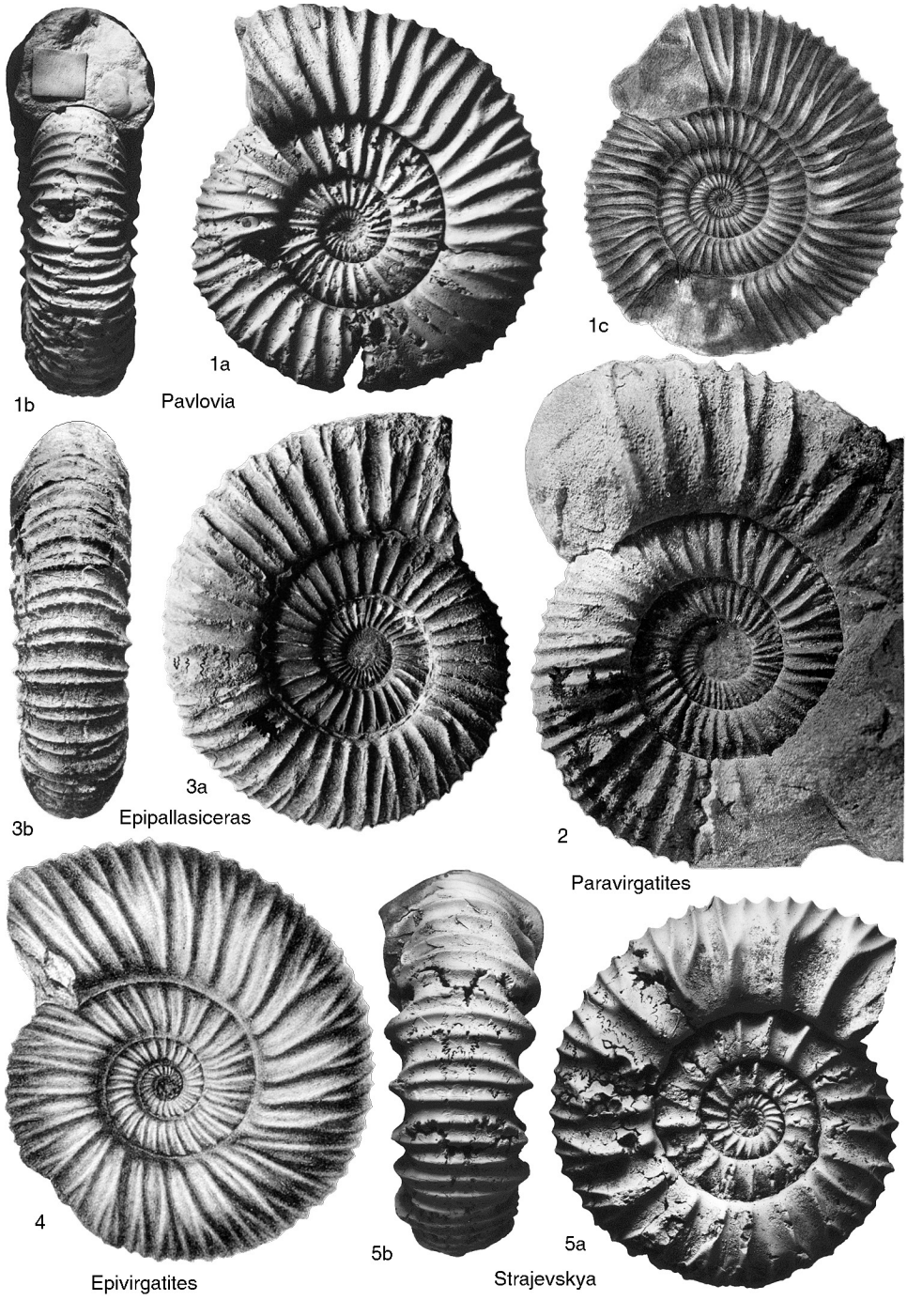

FIG. 100. Dorsoplanitidae (p. 147–150).

Pavlovia, but the dense and fine costation of the inner whorls is retained to a much longer stage and changing slowly; whorl sides flattened. *Upper Jurassic* (*upper Tithonian*): Greenland.——Fig. 100,3*a–b*. **E. pseudaperta* (Spath), holotype, nearly complete specimen, possibly a macroconch, Glauconitic Series, Crab Valley, Greenland, ×0.5 (Spath, 1936a, pl. 16,*1a–b*).

Strajevskya Mikhailov, 1962, p. 17 [**Pavlovia strajevskyi* Ilovaïsky, 1917a, p. 46, and 1924, p. 337; OD; Ilovaïsky's type specimens are not lost; lectotype for *P. strajevskyi* designated by Mitta (2015, p. 53); therefore, the neotype elected by Mikhailov (1962, p. 17) is not valid)]. Small size and evolute, with rounded-quadrate whorl section and coarse ribbing; inner whorl with biplicate ribs; middle and later whorls with tri- and quadripartite ribs, resulting in the dorsoplanitoid-like morphology. *Upper Jurassic (lower Volgian,* Scythicus *Zone):* Russia (eastern Urals, Siberia), ?England.——Fig. 100,5*a–b*. **S. strajevskyi,* lectotype, nucleus with small part of the body chamber, Severnaya Sos'va Basin, Russia, ×0.85 (Mitta, 2015, pl. 1,*1a–b*).

Epivirgatites Spath, 1924, p. 17 [**Perisphinctes nikitini* Michalski, 1890, p. 232(459); OD] [=*Nikitinella* Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 137, obj.; =*Biplicioceras* Ivanov in Ivanov & Muravin, 1986, p. 65 (type, *Perisphinctes bipliciformis* Nikitin, 1881a, p. 309, pl. 10,*52*, OD; lectotype designated by Ivanov, Baranov, & Muravin, 1987, p. 57)]. Fairly evolute, whorl high-rounded; irregular, prorsiradiate primary ribs, bifurcate to trifurcate, and constrictions; microconch (*Biplicioceras*) with biplicate ribs to the aperture. *Upper Jurassic (middle Volgian,* Nikitini *Zone–upper Tithonian,* Albani *Zone):* England, Poland, Russia.——Fig. 100,*4*. **E. nikitini* (Michalski), lectotype (designated by Arkell, 1956a, p. 790), nucleus with small part of the body chamber, Kachpur, Russia, ×1 (Michalski, 1890, pl. 12,*5*).

Virgatopavlovia Cope, 1978, p. 515 [**V. fittoni;* OD]. Dimorphic; inner whorls with sharp, fine, bifurcated ribs having furcation point high on the sides; closely paired, sharp secondary ribs; body chamber of macroconchs shows irregular ribbing, mainly virgatotome with polygyrate, bifurcate or simple, and intercalatory ribs; ribbing of body chamber in microconchs as in inner whorls, mainly bifurcate with occasional polygyrate and simple ribs; peristome simple in both dimorphs. Supposed ancestor of *Epipallasiceras. Upper Jurassic (upper Tithonian,* Fittoni *Zone):* England, Scotland.——Fig. 101,*1a*. **V. fittoni,* holotype, macroconch, nearly complete specimen, Hounstout Clay, Pier Bottom, Dorset, England, ×0.5 (Cope, 1978, pl. 54,*2*).——Fig. 101,*1b*. *V. hounstoutensis* Cope, 1978, paratype, complete microconch with peristome, Hounstout Clay, Hounstout Cliff, Dorset, England, ×0.8 (Cope, 1978, pl. 53,*3*).

Acuticostites Semenov, 1897 in 1897–1898, p. 110 [**Olcostephanus acuticostatus* Michalski, 1890, p. 71; OD] [=*Holcostephanoides* Spath, 1924, p. 17, obj.; =*Paravirgatites* Ilovaïsky, 1924, p. 353, *non* Buckman, 1922, pl. 308, obj.; =*Oxypleurites* Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 134, *non* Nalepa, 1891, p. 868 (Arachnida), obj.]. Small and evolute; whorl section rounded, slightly depressed at first, more compressed on the outer whorl; coarse ribbing, bifurcate with many simple ribs, the primary and secondary ribs very sharp and distant; simple ribs dominating on the outer whorl. *Upper Jurassic (middle Volgian,* Panderi *Zone):* Russia.——Fig. 101,3*a–b*. **A. acuticostatus* (Michalski), lectotype (designated by Énay, herein; no holotype or lectotype according to Mitta, 1993, p. 50), Volga area, Russia, ×0.75 (Michalski, 1890, pl. 5,*2a–b*).

Michalskia Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 140 [**Perisphinctes miatschkoviensis* Vischniakoff in Michalski, 1890, p. 159; OD]. Small, fairly involute; whorl section rounded slightly depressed, more high on the outer whorl; ribbing mainly biplicate and some biplicate ribs related to constrictions; the outer whorl with polygyrate ribs but never truly virgatotome. *Upper Jurassic* (*lower Volgian,* Panderi *Zone*): Russia.——Fig. 101,2*a–c*. **M. miatschkoviensis* (Vischniakoff), lectotype (designated by Ilovaïsky in Ilovaïsky & Florensky, 1941, p. 140; see Mitta, 1994, p. 34), Volga area, Russia; *a,* original figure, ×1 (Michalski, 1890, pl. 9,*9*); *b–c,* new figure, ×1 (Mitta & others, 1999, pl. 10,*3a–b*).

Titanites Buckman, 1921, pl. 231 [**T. titan*; OD] [=*Gigantites* Buckman, 1921, pl. 256A–B (type, *Ammonites giganteus* J. Sowerby, 1816, p. 55, OD); =*Briareites* Buckman, 1921, pl. 257A–B (type, *B. polymeles,* OD); =*Behemoth* Buckman, 1922, pl. 305A–B (type, *B. megasthenes,* OD); =*Hippostratites* Buckman, 1924, pl. 495A–B (type, *H. hippocephaliticus,* OD); =*Polymegalites* Buckman, 1925b, pl. 591 (type, *P. polypreon,* OD)]. These are gigantids proper; evolute, with compressed, high-oval whorl section; inner whorl biplicate; outer whorl with dense ribbing and long secondary ribs, the body chamber nearly smooth in the macroconch. Inner whorls (or perhaps microconch) described as *Paracraspedites. Upper Jurassic (upper Tithonian*, Okusensis–Anguiformis *Zones):* England, northern France, ?Greenland, ?Canada, ?Russia.——Fig. 102,1*a–b*. **T. titan* Buckman, holotype, nearly complete specimen, with the aperture preserved on the opposite side (*b*), Portland Stone Beds, upper Tithonian, *Anguiformis* Zone, Baggle Hill, Haddenham, Buckinghamshire, England, ×0.1 (Buckman, 1921, pl. 231A).

?Paracraspedites Swinnerton, 1935, p. 38 [**P. stenomphaloides;* OD] [=?*Neopavlovia* Casey & Mesezhnikov, 1986, p. 77 (type, *Crendonites* (*N.*) *felix* Casey & Mesezhnikov, OD)]. Status of the genus still uncertain, based on badly preserved specimens; large specimens, up to 650 mm in diameter (but not yet described), establish that the genus is a member of the so-called Portland giants and not related to *Subcraspedites* as had long been supposed.

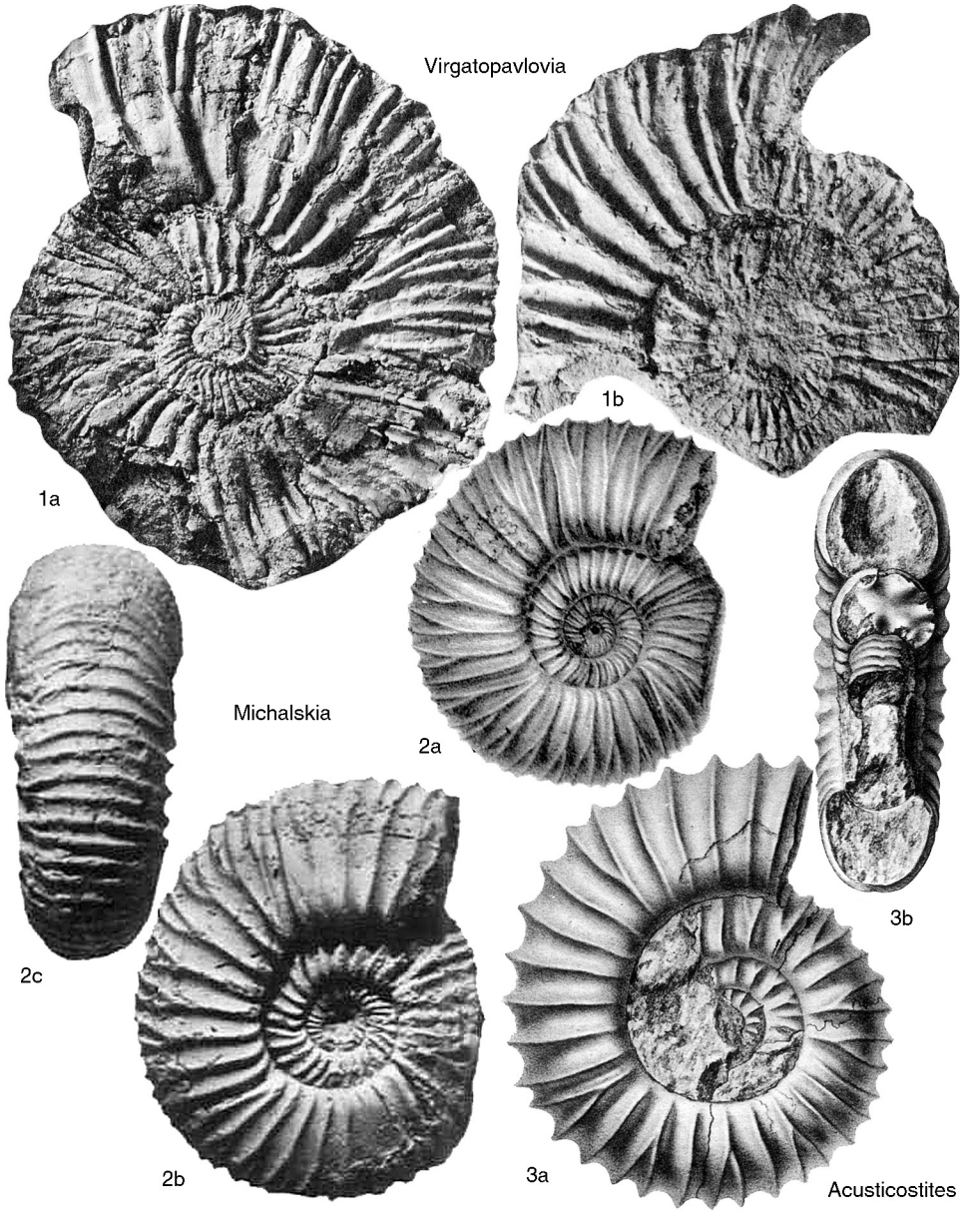

FIG. 101. Dorsoplanitidae (p. 150).

Possibly microconchs of *Titanites. Upper Jurassic (upper Tithonian,* Anguiformis *Zone):* England.——FIG. 103,*4. *P. stenomphaloides,* holotype, inner whorls (or perhaps microconch) altered by distortion, Lower Spilby Sandstone, Fordington boring, Lincolnshire, England, ×0.8 (Swinnerton, 1935, pl. 4,*1A*).

Glaucolithites BUCKMAN, 1922, pl. 306A–B [**G. glaucolithus;* OD] [=*Hydrostratites* BUCKMAN, 1926, pl. 676 (type, *H. bifurcus,* OD)]. Giant, serpenticone, whorl section rounded or compressed and biplicate ribbing; similar to *Titanites* but more involute. *Upper Jurassic (upper Tithonian,* Glaucolithus *Zone):* England, northern France.——FIG. 102,*2. *G. glaucolithus*, holotype, incomplete specimen, Portland Stone Beds, Long Crendon, Buckinghamshire, England, ×0.22 (Buckman, 1922, pl. 306A).

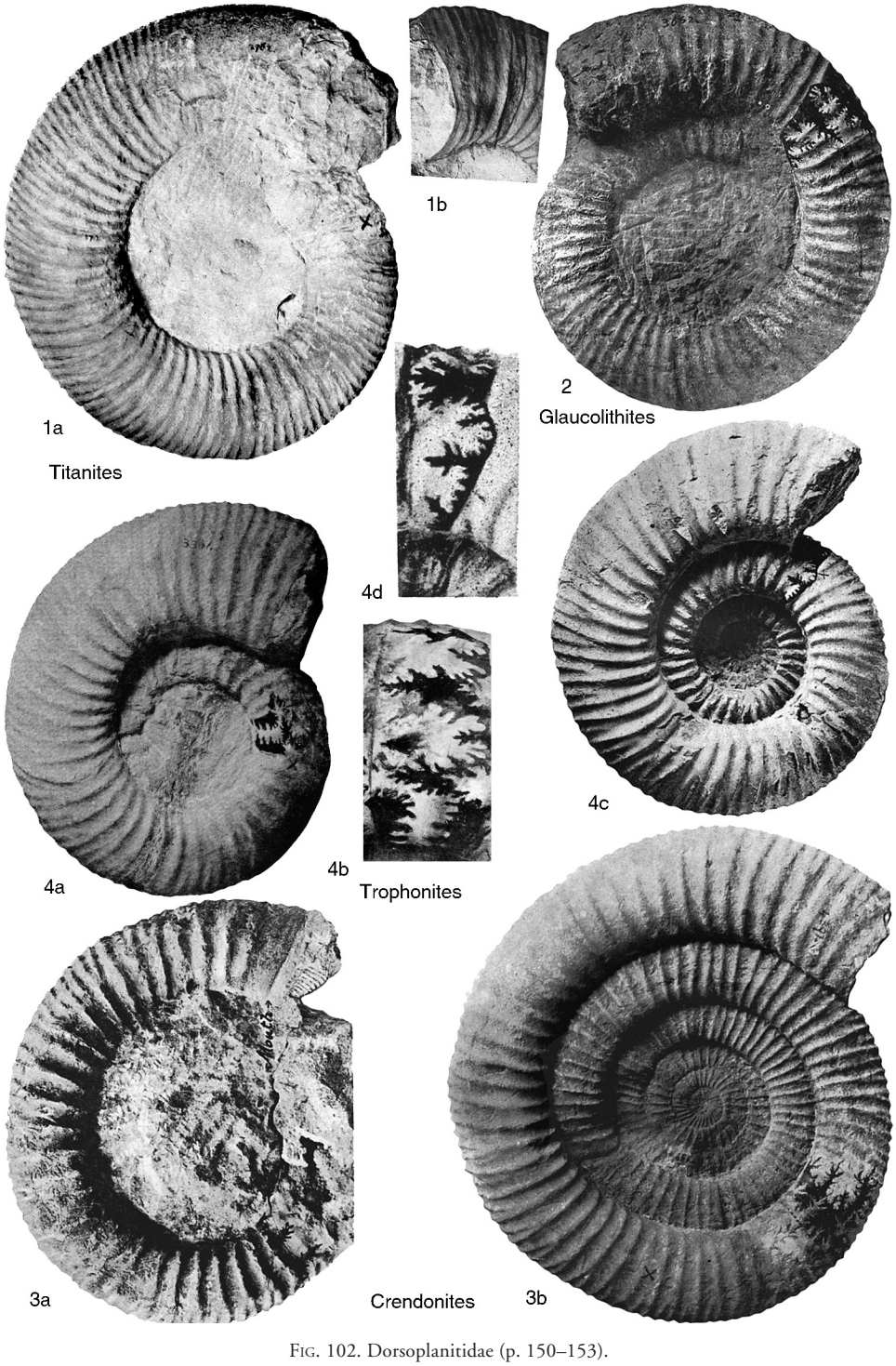

FIG. 102. Dorsoplanitidae (p. 150–153).

Crendonites BUCKMAN, 1923a, pl. 401 [**C. leptolobatus;* OD] [=*Aquistratites* BUCKMAN, 1924, pl. 534A–B (type, *A. aquator,* OD); =*Gyromegalites* BUCKMAN, 1925b, pl. 620A–B (type, *G. polygyralis,* OD)]. Small to large, evolute, serpenticone shell; dense ribbing regularly biplicate with constrictions; aperture simple in both dimorphs, with a collared border in the microconch. *Upper Jurassic (upper Tithonian,* Okusensis–Kerberus *Zones*): England, northern France, ?Greenland.——FIG. 102,*3a.* **C. leptolobatus,* holotype, complete microconch with the aperture preserved, Long Crendon, Buckinghamshire, England, ×0.5 (Buckman, 1923a, pl. 401).——FIG. 102,*3b. C. polygyralis* (BUCKMAN), subcomplete macroconch, Swindon, Wiltshire, England, ×0.2 (Buckman, 1925b, pl. 620A).

Trophonites BUCKMAN, 1922 (June), pl. 325A [**T. trophon;* OD] [=*Galbanites* BUCKMAN, 1922 (December), pl. 355A (type, *G. galbanus,* OD); =*Pleuromegalites* BUCKMAN, 1924, pl. 513 (type, *P. forticosta,* OD)]. Large, planulate shell; whorl height increasing fairly quickly; whorl section thick but not depressed, venter broadly rounded; ribbing bifurcate with intercalatories. *Upper Jurassic (upper Tithonian,* Okusensis–Kerberus *Zones):* England, northern France.——FIG. 102,*4a–b.* **T. trophon,* holotype, ?complete macroconch, Long Crendon, Buckinghamshire, England; *a,* ×0.12; *b,* ×0.3 (Buckman, 1922, pl. 325A).——FIG. 102,*4c–d. T. galbanus* (BUCKMAN), holotype, subcomplete specimen, Haddenham, Buckinghamshire, England; *c,* ×0.22; *d,* ×0.6 (Buckman, 1922, pl. 355A).

Kerberites BUCKMAN, 1924, pl. 520 [**K. kerberus;* OD] [=*Vaumegalites* BUCKMAN, 1924, pl. 536 (type, *V. vau,* OD)]. Gigantic, moderately involute; inner whorls with coarse, triplicate ribbing; outer whorl with ribs mainly biplicate with some peudoschizotomous intercalatories. *Upper Jurassic (upper Tithonian*, Kerberus *Zone):* England, northern France, Greenland.——FIG. 103,*1a–b.* **K. kerberus*, holotype, incomplete specimen, Portland Stone Beds, Chicksgrove, Tisbury, Wiltshire, England, ×0.75 (Buckman, 1924, pl. 520).

Glottoptychinites BUCKMAN, 1923a, pl. 403 [*G. *glottodes;* OD]. Small size (?microconch); thick and rounded-quadrate whorl section; sharp and strong ribbing, *Pavlovia*-like, with biplicate and many simple ribs that simplify and degenerate at end of the outer whorl corresponding to adult body chamber. *Upper Jurassic (upper Tithonian,* Kerberus *Zone):* England.——FIG. 103,*2.* **G. glottodes*, holotype, nearly complete specimen, Portland Stone Beds, Long Crendon, Buckinghamshire, England, ×0.37 (Buckman, 1923a, pl. 403).

Leucopetrites BUCKMAN, 1922, pl. 307A–C [**L. leucus;* OD] [=*Crendonina* BUCKMAN, 1925b, pl. 607 (type, *C. subrotundata,* OD)]. Medium size (but wholly septate), evolute, slowly coiling, thick, and quadrate whorl section, with mainly bifurcating ribs and only a few single ribs. *Upper Jurassic (upper Tithonian,* Okusensis–Kerberus *Zones):* England.——FIG. 103,*3.* **L. leucus,* paratype, wholly septate specimen, Portland Stone Beds, Long Crendon, Buckinghamshire, England, ×0.37 (Buckman, 1922, pl. 307C).

?Simotoichites BUCKMAN, 1923a, pl. 402A–B [**S. simus;* OD] Small size (?microconch); known from a single, badly preserved specimen; involute, flat-sided whorl section with tabulate venter; biplicate ribbing with short secondaries. *Upper Jurassic (upper Tithonian):* England.——FIG. 103,*5.* **S. simus,* holotype, Portland Stone Beds, Oakley, Buckinghamshire, England, ×0.5 (Buckman, 1923a, pl. 402A).

Subfamily DORSOPLANITINAE Arkell, 1950 (Schindewolf, 1925)

[ARKELL, 1950, p. 363 (see note under Dorsoplanitidae above for priority of Dorsoplanitinae)] [=Polytosphinctinae SCHINDEWOLF, 1925, p. 326; =Laugeitinae LOMINADZE & KVANTALIANI, 1985, p. 339]

Dorsoplanitinae, together with the Pectinatitinae and Pavloviinae, is one of the accepted subfamilies in the Dorsoplanitidae, according to CALLOMON (in DONOVAN, CALLOMON, & HOWARTH, 1981, p. 150). It is also an exclusively Boreal subfamily, and one of the two branches (with the Pavloviinae) derived from the Pectinatitinae at the beginning of the middle Volgian, with the type genus *Dorsoplanites.* The subfamily reached its peak, with the greatest number of genera, during the *Virgatus* Zone, middle Volgian, and was declining by the end of the middle Volgian (*Nikitini* Zone). The last representatives are in the upper Volgian, and gave rise to the first *Craspedites,* either from *Laugeites* (COPE, 1978; CALLOMON, 1981), or from *Serbarinovella* (MITTA, 1994). *Upper Jurassic* (*upper Tithonian–middle Volgian)–Lower Cretaceous (upper Volgian–Ryazanian):* northwestern and eastern Europe, Greenland, Russia (western & northern Siberia).

Dorsoplanites SEMENOV, 1897 in 1897–1898, p. 114 [**Perisphinctes dorsoplanus* VISCHNIAKOFF, 1882, pl. 1 *bis;* SD ROMAN, 1938, p. 285] [=*Polytosphinctes* SCHINDEWOLF, 1925, p. 327, obj.]. Middle to large size; whorl section depressed until the end or changing to high oval during growth; coarse blunt ribbing, bi or triplicate with diversipartite branching of the secondaries, fading on the venter on outer whorl. *Upper Jurassic (lower Volgian,* Magnum–Subcrassum *Zones–middle Volgian,* Panderi–Virgatus *Zones).*

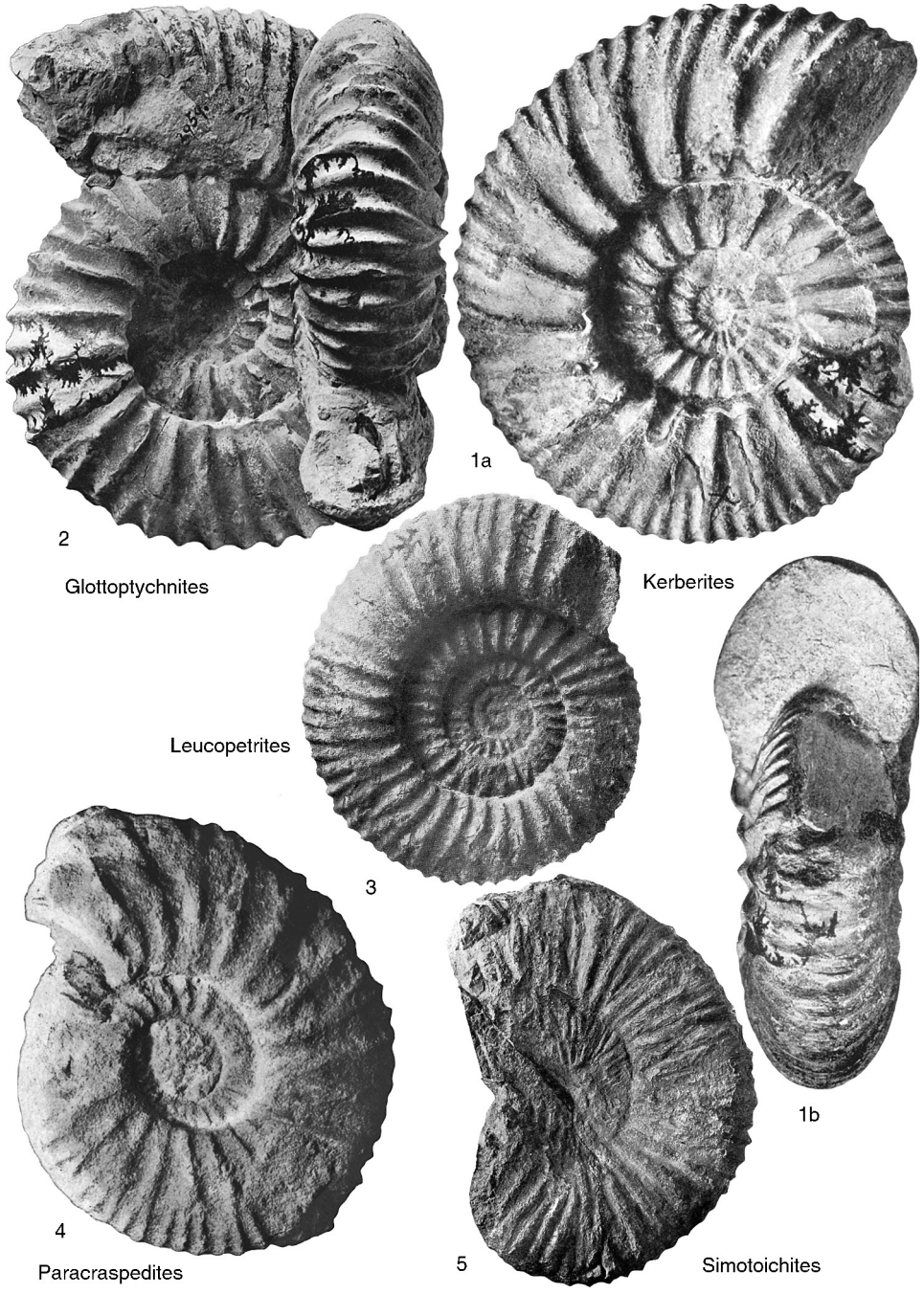

FIG. 103. Dorsoplanitidae (p. 150–153).

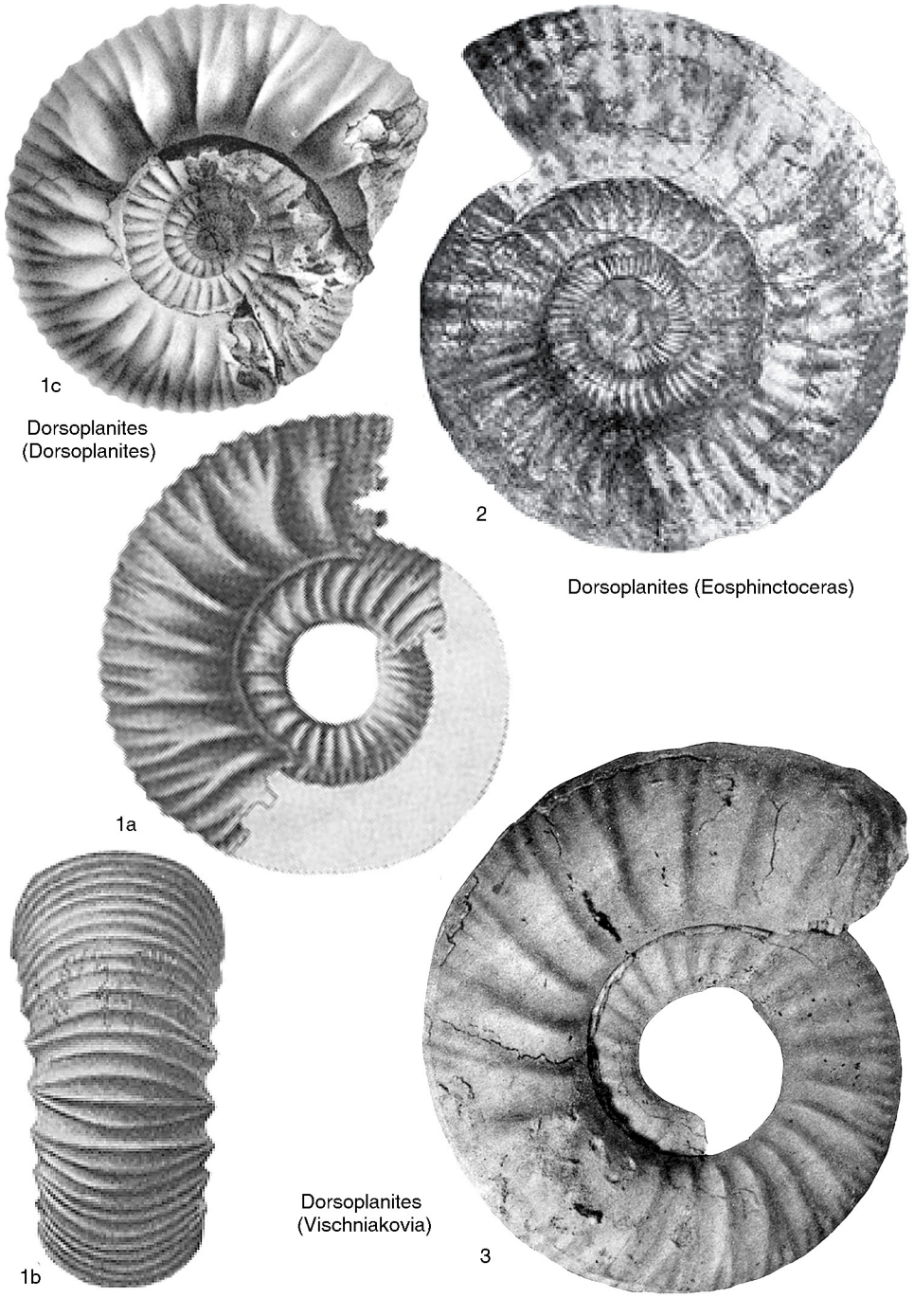

FIG. 104. Dorsoplanitidae (p. 153–156).

D. (Dorsoplanites). Dimorphic; inner whorls of the macroconch strongly and densely ribbed changing to distantly spaced ridges; the end of the phragmocone of microconch strongly ribbed; peristome constricted and ventrally collared. MIKHAILOV's (1966, p. 13) proposal of VISCHNIAKOFF's (1882, pl. 2,3) specimen as lectotype is not valid. But ARKELL's lectotype (1956a, pl. 45 caption) is not in the Vernasdskyi Museum and presumably lost, so the question of choosing a neotype is still open (MITTA, 1994, p. 35). *Upper Jurassic (middle Volgian,* Panderi–Virgatus *Zones):* Russia (western & Arctic regions, northern Urals, Siberia), Canada (Arctic Archipelago), Greenland.——FIG. 104,*1a–c. *D. dorsoplanus; a–b,* lectotype (designated by ARKELL, 1956a, p. 788), Mnevniki, Russia, ×0.9 (Vischniakoff, 1882, pl. 1 *bis,5*); *1c,* specimen with a large part of the body chamber preserved, Phosphorite Bed, Moscow area, Russia, ×0.58 (Michalski, 1890, pl. 11,*2a*).

D. (Eosphinctoceras) MESEZHNIKOV, 1974, p. 87 [**E. magnum;* OD] [=*Eosphinctoceras* MESEZHNIKOV, 1963, p. 121, *nom. nud.*]. Large to giant shell; coronate or low-oval middle whorls and more-compressed later whorls; ribs dense, bifurcate at first, then increasing number of trifurcate ribs, and all ribs becoming weaker. *Upper Jurassic (lower Volgian,* Magnum–Subcrassum *Zones):* Russia (western & Arctic regions, northern Urals).——FIG. 104,*2. *D. (E.) magnum,* holotype, Yatriya, northern Urals, Russia, ×0.25 (Mesezhnikov in Zakharov & Mesezhnikov, 1974, pl. 8,*1*).

D. (Vischniakovia) GERASIMOV, 1978, p. 110 [**Dorsoplanites* (*V.*) *serus;* OD]. Large size, differs from *Dorsoplanites* (*sensu stricto*) by its tighter coiling, inner and middle whorls more compressed and dense ribs slightly curved forwards at the ventrolateral margin. *Upper Jurassic (middle Volgian,* Virgatus *Zone):* central Russia.——FIG. 104,*3. *D. (V.) serus,* holotype, Lapatino quarry, Voskresenk district, Moscow region, Russia, ×0.4 (Gerasimov, 1978, pl. 1,*1*).

Lomonossovella ILOVAÏSKY in ILOVAÏSKY & FLORENSKY, 1941, p. 140 (ILOVAÏSKY MS in ZONOV, 1937, p. 39, footnote, *nom. nud.*)] [**Olcostephanus lomonossovi* VISCHNIAKOFF, 1882, pl. 2,*4;* SD CALLOMON & BIRKELUND, 1982, p. 366 (the lectotype designation by MITTA (1994, p. 35) and the neotype designations by MURAVIN (1979, p. 19) and IVANOV, BARANOV, and MURAVIN (1987, p. 64) are not valid)].] Medium to large size; fairly involute; inflated depressed whorl and rounded, trapezoidal whorl section; differing from *Dorsoplanites* in its strong, mainly bifurcate ribs, with intercalatories and rare, triplicate or simple ribs. Incorrect attribution of the type species to *Kerberites* (CALLOMON & BIRKELUND, 1982, p. 366) was due to homoeomorphy. ILOVAÏSKY's (1934) manuscript was not published until its incorporation posthumously in ILOVAÏSKY & FLORENSKY's paper of 1941. *Upper Jurassic (middle Volgian,* Virgatus *and* Nikitini *Zones):* central and southern Russia.——FIG. 105,1*a–c. *L. lomonossovi* (VISCHNIAKOFF), lectotype (designated by CALLOMON & BIRKELUND, 1982, p. 366), incomplete specimen, Mnevniki, Moscow, Russia, Vernadskyi Museum, ERHVI-64/10; *a–b,* ×1 (VISCHNIAKOFF, 1882, pl. 2,*4*); *c,* new figure of the same specimen, ×1 (Mitta & others, 1999, pl. 8,*3*).

Taimyrosphinctes MESEZHNIKOV, 1972, p. 120 [**T.* (*T.*) *excentricus;* OD] [=*Udschasphinctes* MESEZHNIKOV, 1972, p. 126 (type, *Laugeites* (?) *udschensis* SCHULGINA in SACHS & others, 1963, p. 59, OD)]. Small to very large planulate shell; moderately involute to evolute; subrectangular whorl section; ribbing similar to that of *Dorsoplanites,* but dorsal part of the ribs not raised on middle side; inner whorls with fine, dense, and sharp biplicate ribs; on middle whorls transitory triplicate ribs becoming quickly disrupted, resulting in appearance of intermediate ribs not achieving the branching point; secondary ribs sometimes curved slightly forwards near the ventral margin as in *Laugeites*, but without weakening and lacking ventral furrow or smooth band. Dimorphic, the supposed microconch (e.g., *Udschasphinctes*) with eccentric outer whorl and distant, pronounced sculpture. *Upper Jurassic (middle Volgian,* Maximus *and* Sachsi *Zones):* Russia (northern Siberia, Taymir, Khatanga, & Anabar river basins).——FIG. 105,*2a. *T. excentricus,* holotype, incomplete specimen, *Maximus* Zone, Debyaka-Tari River, central Taymir, Siberia, Russia, ×0.6 (Mesezhnikov, 1972, pl. 10,*1*).——FIG. 105,*2b. T. udschensis* (SHULGINA), holotype, incomplete specimen, *Maximus* Zone, Hadyga River, Udzha river basin, Siberia, Russia, ×1 (Mesezhnikov, 1972, pl. 12,*1a–b*).

Serbarinovella MITTA, 1988, p. 96 [**S. serbarinovi;* OD]. Medium size; coiling changing from strongly involute inner whorl to moderately involute outer whorl; whorl section first depressed, then more compressed, high, and rounded-trapezoidal; dense and fine ribbing in inner whorls, thicker and coarser with age; tripartite ribbing more rarely bipartite with some intercalatory ribs. *Upper Jurassic (middle Volgian,* Virgatus *Zone):* Russia (Moscow region).——FIG. 105,*3. *S. serbarinovi*, holotype, incomplete specimen, Voskresensk district, Moscow area, ×0.6 (Mitta, 1988, pl. 1,*1*).

Laugeites SPATH, 1936b, p. 334, *nom. nov. pro Kochina* SPATH, 1936a, p. 81, *non* RESSER, 1935, p. 40 (Trilobita) [**Kochina groenlandica* SPATH, 1936a, p. 82; OD] [=*Stschurovskya* ILOVAÏSKY MS in ILOVAÏSKY & FLORENSKY, 1941, p. 137 (type, *Perisphinctes stschurovskii* MICHALSKI, 1890, p. 250, OD); =*Prokachpurites* BREISTROFFER, 1947, p. 102, *nom. nov. pro Kochina* SPATH, 1936a, p. 81]. Finely ribbed dorsoplanitid with rounded whorl section and tendency for costation to fade and become entirely smooth, either the primary or the secondary ribs being lost first. *Upper Jurassic (middle Volgian,* Groenlandicus *Zone):* Greenland, Russia (western Siberia).——FIG. 105,*4. *L. groenlandica* (SPATH), holotype, wholly septate, Hartzfield Sandstone, Cape Leslie, Greenland, ×0.5 (Spath, 1936a, pl. 38,*1a–c*).

Epilaugeites MESEZHNIKOV, 1974, p. 130 [**Pavlovia vogulica* ILOVAÏSKY, 1917a, p. 67; OD]. Medium size shell; similar to *Laugeites* in general shape,

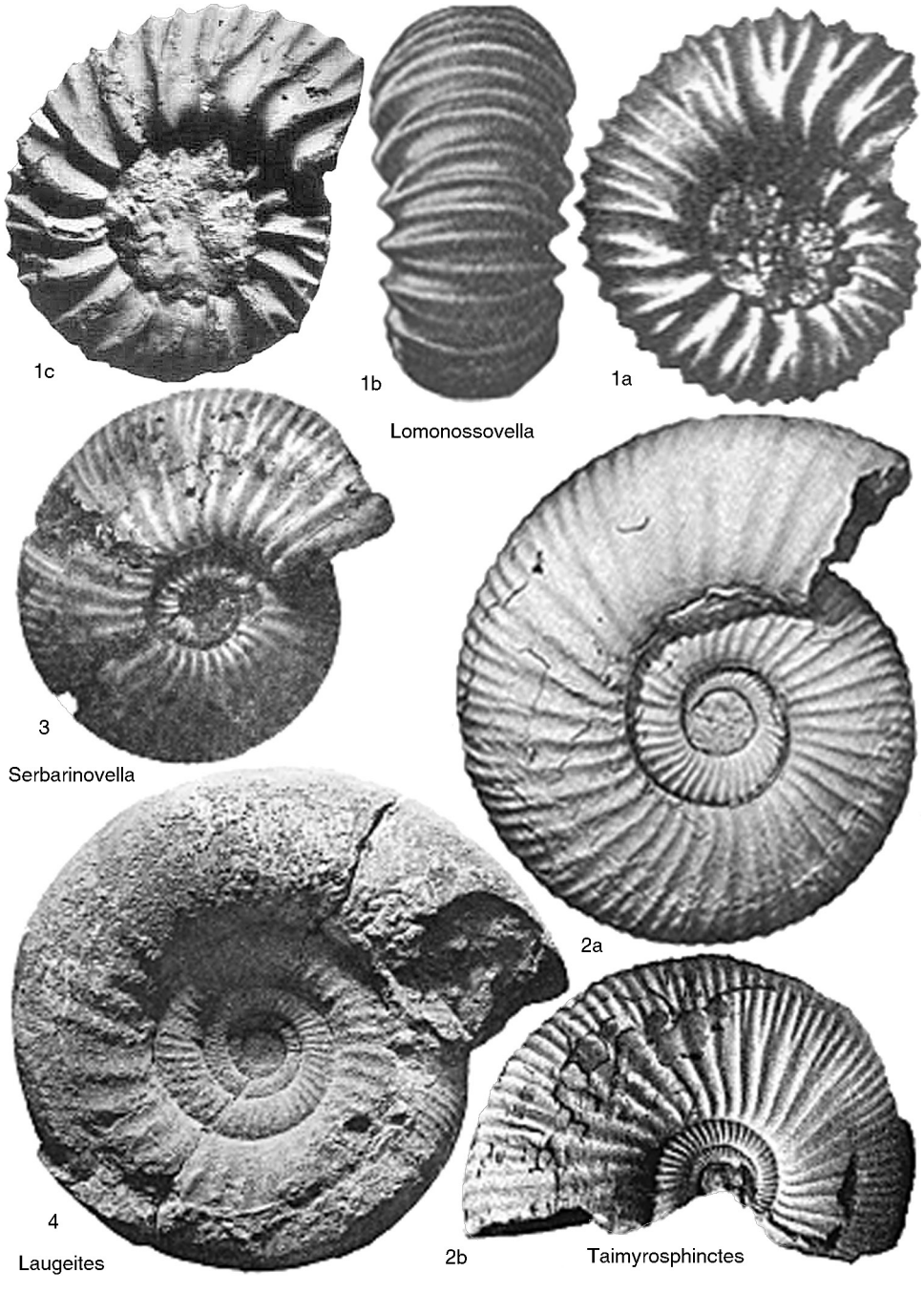

FIG. 105. Dorsoplanitidae (p. 156).

whorl section, and sculpture type, but differing in its suture line intermediate between Dorsoplanitinae and Craspeditidae and absence of changes of sculpture on the body chamber of mature specimens. *Upper Jurassic (uppermost middle Volgian,* Groenlandicus *Zone*, Vogulicus *Subzone):* Russia (western region, subpolar Urals).——FIG. 106,1*a–f.* **E. vogulicus* (ILOVAÏSKY); *a–b,* lectotype (designated

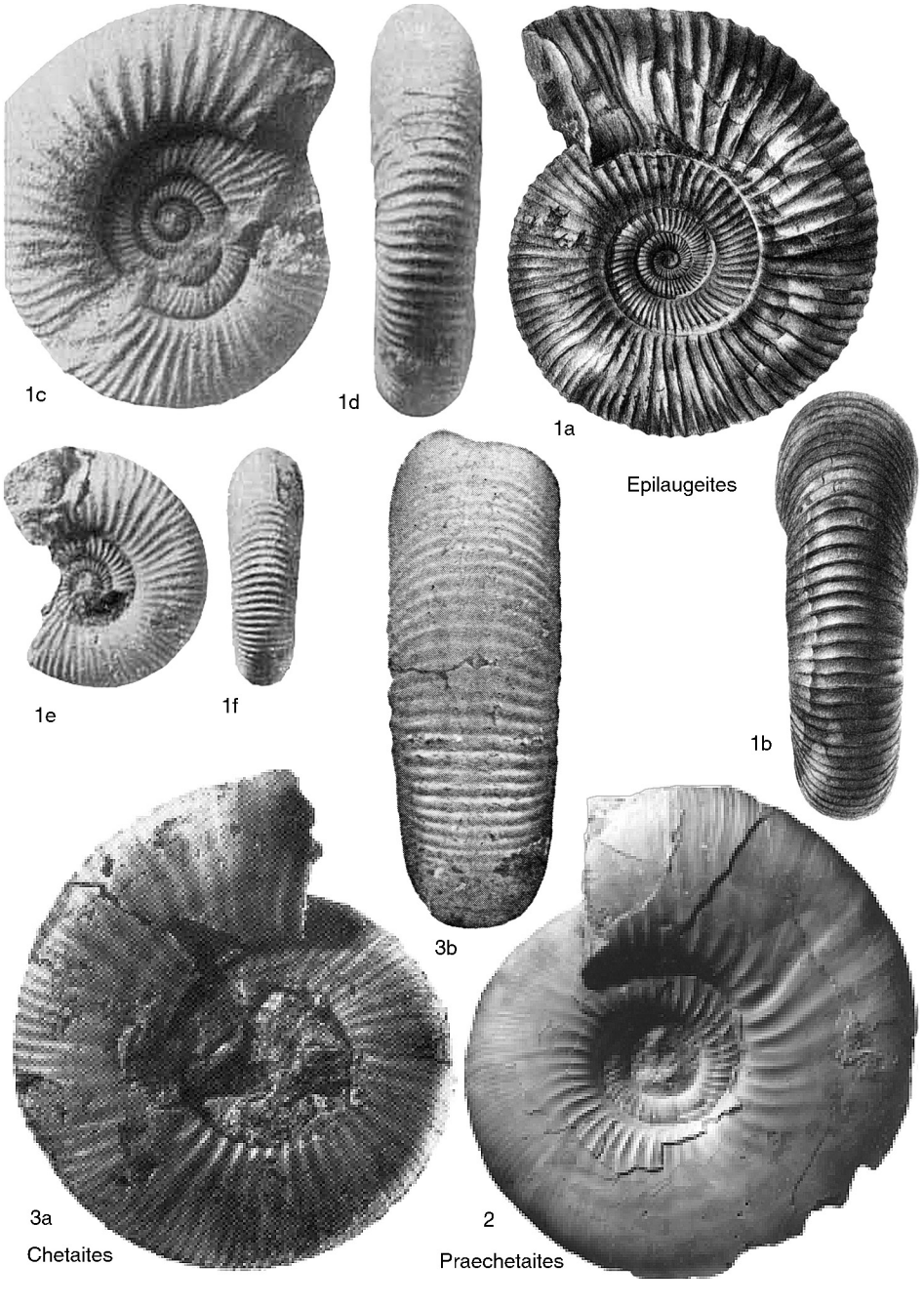

FIG. 106. Dorsoplanitidae (p. 156–159).

by MESEZHNIKOV, 1974, p. 131), complete adult, Liapine region, Sverdlovsk, Russia, ×1 (Ilovaïsky, 1917b, pl. 20,*1*); *c–d,* nearly complete macroconch, *e–f,* microconch, Yatria river, eastern slope of Polar Urals, northern Siberia, Russia, ×1 (Mesezhnikov, 1974, pl. 23,*1a–b, 3a–b*).

Praechetaites SASONOVA & SASONOV, 1979, p. 493 [**Virgatosphinctes exoticus* SHULGINA, 1967, p. 140; OD]. Moderately involute planulate shell; oval whorl section more compressed in the inner whorls; fine and dense ribbing fading early and gradually disappearing on the venter; ribs first

bifurcate, then trifurcate, polygyrate ribs together with intercalatories; umbilical part of primary ribs nearly smooth on outer whorl. *Upper Jurassic (upper middle Volgian,* Okensis, *and* Taimyrensis *Zones):* Russia (northern Siberia).——FIG. 106,*2. *P. exoticus* (SHULGINA), holotype, nearly complete adult, *Okensis* Zone, *Exoticus* beds, left bank of Boyarka river, northern Siberia, Russia, ×0.75 (Shulgina, 1967, pl. 4,*1*).

Chetaites SHULGINA, 1962, p. 198 [**C. chetae;* OD]. Moderately involute, laterally compressed planulate shell; whorl section oval to quadrate-rounded; inner whorl with fine, numerous ribs bifurcating at midside or a little below, similar to the inner whorl of *Dorsoplanites;* middle whorls similar to *Laugeites* with dense, mostly trifurcate ribs, becoming coarser on outer whorl. *Lower Cretaceous (upper Volgian,* Chetae *Zone):* Russia (northern Siberia).——FIG. 106,*3a–b. *C. chetae*, holotype, wholly septate, Kheta River, Taymir Peninsula, northern Siberia, Russia, ×1 (Shulgina, 1962, pl. 1,*1a–b*).

Family NEOCOMITIDAE Salfeld, 1921

[*nom. transl.* SPATH, 1923b, p. 31, *ex* Neocomitinae SALFELD, 1921, p. 347] [=Palaehoplitidae ROMAN, 1938, p. 319, *nom. nud.* (because not named after an included genus); =Berriasellidae SPATH, 1922, p. 111]

A varied family characterized by tendency to become compressed and flat-sided with tabulate or grooved venter. Primitive forms differing little from many earlier Perisphinctoidea, but different genera developing umbilical, lateral, or ventrolateral tubercles in different situations. Initially ribs simple at umbilical margin and bifurcating on outer part of side (Berriasellinae), but in Neocomitinae ribs branching both at umbilical margin and again on outer part of sides. Slight changes in suture at the umbilical seam mark a third subfamily (Endemoceratinae), which may well not be monophyletic. *Upper Jurassic (upper Tithonian)–Lower Cretaceous (upper Hauterivian, ?Lower Barremian):* southern & central Europe, northern Africa, Ukraine (Crimea) Turkey, Madagascar, Iraq, Iran, Pakistan, Himalayas, Indonesia (Papua), Papua New Guinea, New Caledonia, New Zealand, USA (California), Mexico, Cuba, Argentina, Peru, Paraguay.

Subfamily BERRIASELLINAE Spath, 1922

[*nom. transl.* ROMAN, 1938, p. 324, *ex* Berriasellidae SPATH, 1922, p. 111]

The primitive subfamily, more or less compressed, with ribs single at umbilical margin, branching halfway or higher up sides; venter tabulate or grooved at least at some stage of growth; tubercles sometimes absent or having some combination of umbilical, midlateral and ventrolateral tubercles. In the 1996 *Treatise* revision of the Cretaceous Ammonoidea by WRIGHT, CALLOMON, and HOWARTH, the subfamily Berriasellinae excluded the three genera included herein, but included *Simospiticeras* and *Protacanthodiscus,* referred herein to the Simoceratidae and Himalayitidae respectively (see description above). *Upper Jurassic (upper Tithonian)–Lower Cretaceous (upper Berriasian, ?lower Valanginian).* Same geographical distribution as the family.

Fierrites CANTÚ CHAPA, 1993, p. 53 [**Ammonites alamitosensis* AGUILERA in CASTILLO & AGUILERA, 1895, p. 30; OD]. Coarse, widely spaced ribbing and projected secondaries with oral anterior, angular, chevron and ventral furrow distinguish this genus and the genuine *Kossmatia,* with gentle, anterior, convex arching on the ventral area and without any furrow or smooth band. As used herein, the genus encompasses the so-called *"Kossmatia"* (not *Kossmatia* UHLIG, 1907) of North America (California, Texas, Mexico). *Upper Jurassic (upper Tithonian)–Lower Cretaceous (lower Berriasian):* USA (California, Texas), Mexico.——FIG. 107,*1a–c. *F. alamitosensis* (AGUILERA), La Caja Formation, El Verde Member, Sierra de Catorce, San Luis Potosi, Mexico; *a,* lectotype (designated by VERMA & WESTERMANN, 1973, p. 211), wholly septate macroconch, lateral view, ×0.9; *b–c,* another specimen with better-preserved ventral view, ×1 (Verma & Westermann, 1973, pl. 39,*4a, 7a–b*).

Pseudosubplanites LE HÉGARAT, 1971, p. 850 [**P. berriasensis;* OD]. Dimorphic; discoid shaped, moderately involute; flexuous, prorsiradiate ribbing, with primary ribs simple, bifurcate or polygyrate, more distant on the outer whorl; secondary ribs more or less widened and flattened, crossing the venter without change. Microconch small, with lappets. *Lower Cretaceous* (*lower Berriasian*, Jacobi and Grandis *Zones):* southeastern France, Bulgaria, Romania, Ukraine (Crimea), Caucasus, Tunisia.——FIG. 107,*2a. *P. berriasensis,* holotype, nearly complete macroconch, Les Combes, Drôme, France, ×0.66 (Le Hégarat, 1973, pl. 37,*2*).——FIG. 107,*2b–c. P. euxinus* (RETOWSKI), lectotype (designated by MAZENOT, 1939, p. 125), complete adult microconch, Theodosia, Crimea, Ukraine, ×1 (Retowski, 1893, pl. 10,*6–7*).

?Hegaratia PATRULIUS & AVRAM, 1976, p. 183 [**Corongoceras* (*Hegaratia*) *busnardoi;* OD]. Microconch, small size, whorl section compressed and wide umbilicus; differs from *Ardesciella* (Himalayitinae) in its more evolute coiling and spatulate distal part of the secondary and simple ribs; macroconch unknown. *Upper Jurassic (upper Tithonian)–*

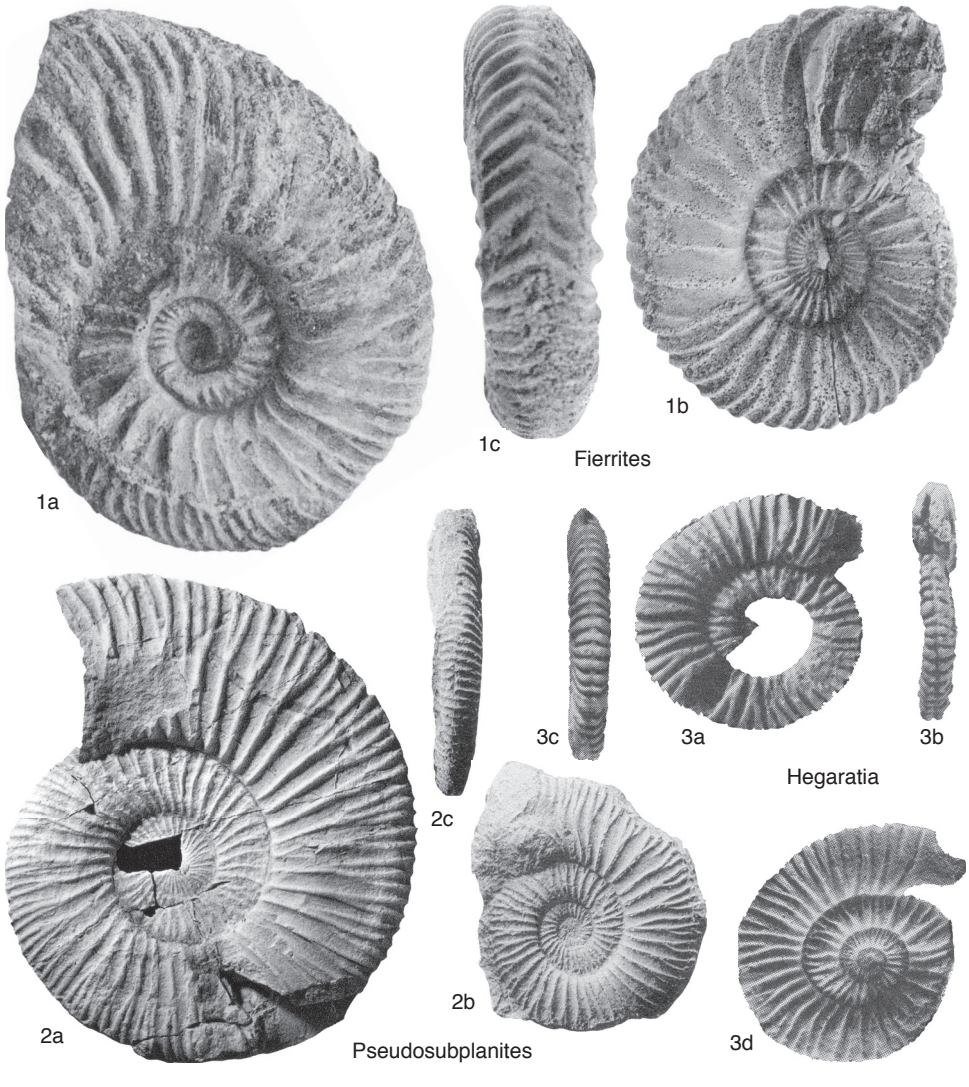

FIG. 107. Neocomitidae (p. 159).

Lower Cretaceous (Berriasian): Romania.——FIG. 107,*3a–d. *H. busnardoi,* holotype, Carhaga Beds, Mounts Persani, Romania; *a–c,* complete adult specimen, ×1; *d,* plaster cast from the external mold, ×1 (Patrulius & Avram, 1976, pl. 8,*2a–d*).

Malbosiceras GRIGORIEVA, 1938, p. 102 [**Ammonites malbosi* PICTET, 1867, p. 77; OD] [=*Lopeziceras* FRAU & others, 2016, p. 159 (type, *Ammonites chaperi* PICTET, 1868, p. 242, OD)]. *Lopeziceras* is not a Himalayitid, as assumed by the authors, but it is a Berriasellinid (Neocomitid); it is a synonym of *Malbosiceras* GRIGORIEVA, 1938, p. 102 (type, *Ammonites malbosi* PICTET, 1867, p. 77, OD), as described by WRIGHT, CALLOMON, and HOWARTH (1996, p. 50).

UNAVAILABLE NAMES IN PERISPHINCTOIDEA

Megapictonia SCHNEID, 1940 in 1939–1940, p. 89 (*nom. nud.*).

Subaulacosphinctoides PATHAK, 1989, p. 236 (*nom. nud.,* unpublished thesis).

Pseudokatroliceras Oloriz, 1978a, p. 651 (*nom. nud.,* no type designation).

?Vogulia Sasonov, 1950 in Mesezhnikov, 1959, p. 85 (*nom. nud.*).

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