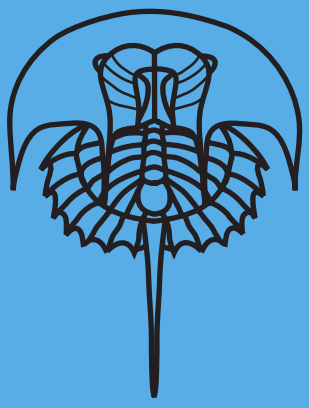

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Part L, Revised, Volume 3B, Chapter 6: Systematic Descriptions of the Stephanoceratoidea and Spiroceratoidea

Michael K. Howarth

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PART L, REVISED, VOLUME 3B, CHAPTER 6: SYSTEMATIC DESCRIPTIONS OF THE STEPHANOCERATOIDEA AND SPIROCERATOIDEA

MICHAEL K. HOWARTH

[Department of Earth Sciences, The Natural History Museum, Cromwell Road, London SW7 5BD, England; m.howarth@nhm.ac.uk]

Superfamily STEPHANOCERATOIDEA Neumayr, 1875

[*nom. transl.* J. P. SMITH, 1913, p. 661, *ex* Stephanoceratidae NEUMAYR, 1875, p. 905] [=Stepheoceratacеae BUCKMAN, 1919a, p. *xvi,* as Stepheoceratacea]

A morphologically highly varied group derived from similar planulate forms of upper Aalenian Erycitinae (Hammatoceratidae, Hildoceratoidea) mainly by the replacement of the ventral smooth band in that subfamily with ribs that are continuous across the venter in the earliest Stephanoceratinae. Subsequent rapid phylogenetic radiations, particularly in the lower Bajocian, gave rise to forms covering almost the whole range of ammonoid morphology, from extreme serpenticones (*Skirroceras*) to coronate cadicones (*Teloceras, Cadomites,* and *Cadoceras*), inflated sphaerocones (Sphaeroceratidae) and oxycones (Cardioceratinae), as well as sculptural features that include one or more rows of lateral tubercles. A ventral smooth band or groove interrupting the secondary ribbing reappears in some subfamilies (Garantianinae, Ermoceratinae), tabulate venters occur in Kosmoceratidae and keels in Cardioceratinae. Constrictions occur in a few Stephanoceratinae and Cardioceratidae but are rarely prominent. Dimorphism is usually strong and well developed, with highly developed lappets in the microconchs, but in one main branch (Sphaeroceratidae), lappets are lost and are never regained in any of its descendants, up to the last survivor, *Nannocardioceras,* at the top of the lower Kimmeridgian.

Sutures are typically highly complex, dense, and intricately incised, recalling their hammatoceratid ancestry, with long lateral lobes and retracted umbilical lobes supporting many auxiliaries. They became simpler in some families, notably those of more northerly boreal habitats (Kosmoceratidae and Cardioceratidae). A new character appearing simultaneously in both Stephanoceratinae and Otoitidae and persisting through most of their descendents is the lobe element U_n in the suture (SCHINDEWOLF, 1923, p. 344; 1965, p. 143 [413]). U_n first appears in early ontgeny as a division in the top of the internal lateral saddle and then increases to a full-sized lobe (Fig. 1.1–1.2). Conversely, in Perisphinctoidea (Fig. 1.3–1.4) the internal lateral saddle remains undivided by a lobe. The presence of U_n in stephanoceratids and its absence in perisphinctids has provided a strong indication of the path of evolutionary descent through the complex pattern of both superfamilies.

Aptychi are known, but rarely preserved, and are believed to be mainly *Granulaptychus, Praestriaptychi* (in Stephanoceratidae), and *Laevaptychus* (in Kosmoceratidae) (TRAUTH, 1927, 1930). Some aptychi have outlines resembling the cross section of the final body chamber, but they are in no way related to the outline of the highly modified aperture constricted by lappets in microconchs.

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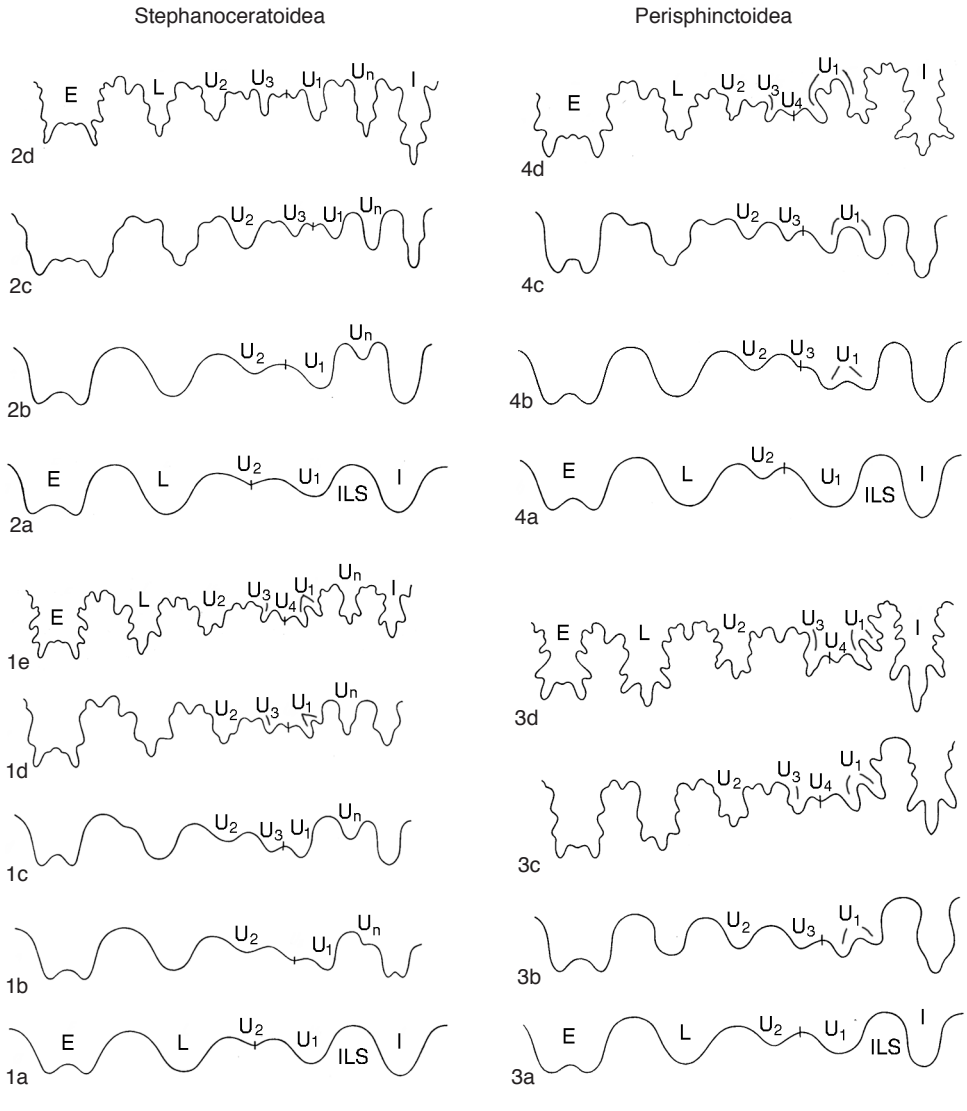

FIG. 1. Comparison of the suture development in Stephanoceratoidea and Perisphinctoidea; *1–2,* Stephanoceratoidea: *1a–e, Otoites,* lower Bajocian, England, *1e* at a whorl height (Wh) of 2.5 mm; *2a–d, Cardioceras,* lower Oxfordian, Scarborough, England, *2d* at Wh of approximately 2 mm; *3–4,* Perisphinctoidea: *3a–d, Bigotites,* Bajocian, Cap San Vigilio, Lake Garda, Italy, *3d* at Wh of 3.9 mm; *4a–d, Perisphinctes,* upper Oxfordian, Hildesheim, Germany, *4d* at Wh of approximately 3 mm; *E,* external lobe; *I,* internal lobe; *ILS,* internal lateral saddle; *L,* first lateral saddle; *U,* umbilical lobe; see text for further explanation (adapted from Schindewolf, 1965, fig. 246, 281; 1966, fig. 302, 315).

The earliest forms are prominently from western Tethys, and quickly become worldwide; later groups segregate bioprovincially, sometimes to mutual exclusion, as in Cardioceratidae (Boreal), Macrocephalitinae (Tethyan Province and peripheral Submediterranean Province) and Eurycephalitinae (Eastern Pacific Province).

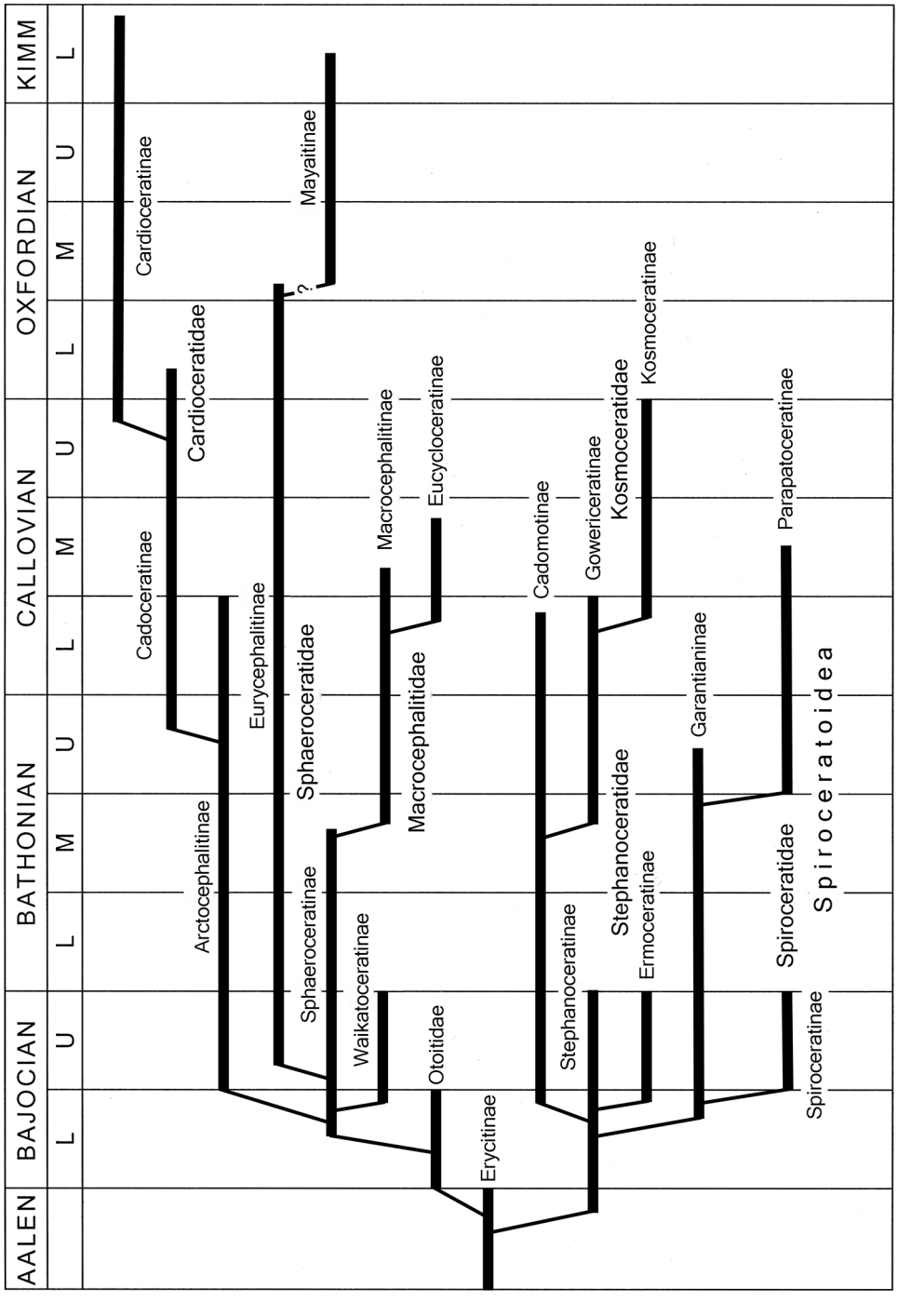

FIG. 2. Phylogeny of the superfamilies Stephanoceratoidea and Spiroceratoidea (new).

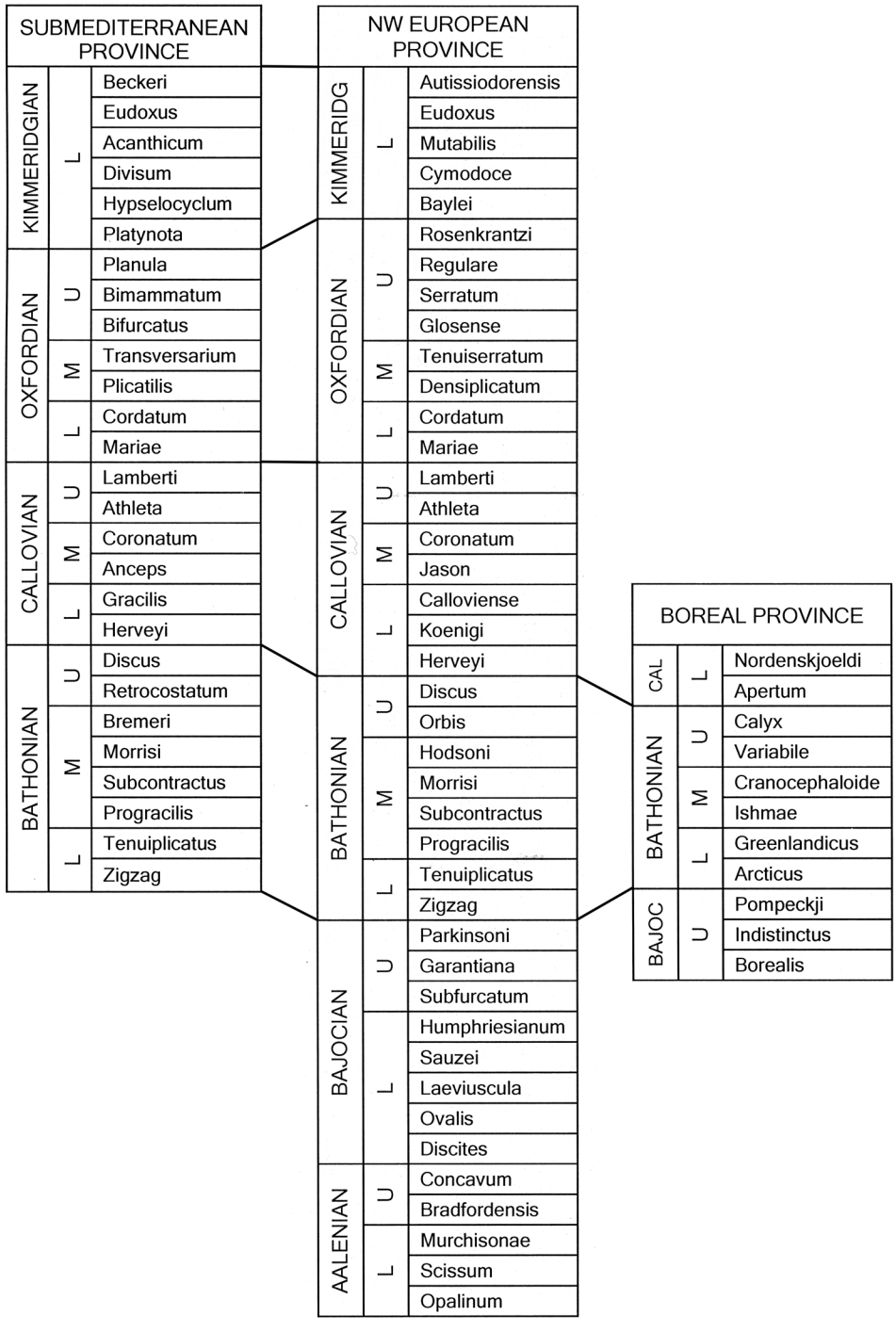

FIG. 3. Ammonite zones for the Aalenian to lower Kimmeridgian stages (new).

The phylogeny of the Stephanoceratoidea (Fig. 2) and the Bajocian to lower Kimmeridgian biostratigraphic ammonite zones used herein (Fig. 3) were derived from a variety of sources, including COPE and others (1980), CALLOMON (1981; 1984, p. 147; 1985, p. 54; 2003, p. 68) and CALLOMON, DIETL, and NIEDERHÖFER (1992, p. 15). *Middle Jurassic (upper Aalenian)–Upper Jurassic (lower Kimmeridgian):* worldwide.

Family STEPHANOCERATIDAE Neumayr, 1875

[*nom. correct.* FISCHER, 1882, p. 393, *pro* Stephanoceratinen NEUMAYR, 1875, p. 905, vernacular name, validated by ICZN Direction 14, 1955b, p. 466] [=Stepheoceratidae BUCKMAN, 1898, p. 450, table 2, obj.]

Evolute serpenticones to cadicones with whorl sections varying from rounded to strongly depressed; the adult body chamber varies in length from half a whorl (*Cadomites*) to 2⅛ whorls (some *Skirroceras*), the latter being one of the longest known in ammonites; strongly ribbed, often with tubercles at the point of furcation into bi- or polyplicate secondary ribs; ribs are continuous across the venter, except where a midventral smooth band or groove is developed in Garantianinae and Ermoceratinae. Strongly dimorphic, with size ratio typically 4:1 or greater: macroconchs evolute, round whorled to cadicone, usually strongly ribbed, though ribs may weaken on adult body chamber, which has a simple adult mouth border, sometimes with a strong terminal collar, reflected as a broad, shallow constriction on internal molds. Microconchs strongly ribbed to the end of the adult body chamber, and have simple (*Polyplectites*) to large spatulate lappets (*Normannites*) drooping over and severely constricting the adult aperture. Sutures of macroconchs very complex, with long, highly incised slender lobes and umbilical lobes strongly retracted. *Middle Jurassic (upper Aalenian–lower Callovian):* worldwide, except for the Boreal Province.

Subfamily STEPHANOCERATINAE Neumayr, 1875

[*nom. transl.* BUCKMAN, 1887, p. 14, *ex* Stephanoceratidae NEUMAYR, 1875, p. 905] [=Stemmatoceratidae MASCKE, 1907, p. 23; =Normannitinae WESTERMANN, 1954, p. 124; =Sturaniinae PARNES, 1985, p. 29]

Evolute serpenticone to depressed coronate shells, ribbed with short, strong primaries or bullae dividing at low to midlateral furcation points, marked by nodes or lateral tubercles, into sheaves of fine, sharp secondaries; occasionally a row of umbilical tubercles is developed. Strongly dimorphic: macroconchs usually strongly ribbed up to the simple adult peristome, which is often marked by a prominent flared collar that is reflected on the internal mold by a broad, shallow constriction; microconchs have large to enormous lappets, which are so large in some cases (*Normannites*) that the adult aperture is obstructed except for small residual openings to whose shapes the associated aptychi bear no relation (WESTERMANN 1954, p. 126, 131).

The morphology of this ornate group is highly variable, which has generated many nominal generic names. The generic classification adopted here places some dimorphs in separate genera where macroconch-microconch associations cannot, or have not yet been, determined. Taxa are listed in an order that reflects to some extent their phylogeny and biostratigraphical position.

The earliest stephanoceratids, the group of *Stephanoceras (Riccardiceras) longalvum* (VACEK), appear in the *Concavum* Zone of the upper Aalenian (Fig. 4,*1a–d*), and thereafter a line of successors can be followed into the upper Bajocian. Major phylogenetic branching in the Aalenian or lower Bajocian generated several new lineages. One of these was the main group leading to *Teloceras blagdeni,* which is derived from *Stephanoceras* in the lower *Humphriesianum* Zone, and then dominated the stephanoceratid faunas of the upper *Humphriesianum*–lower *Subfurcatum* Zones of Europe through an almost continuous range of intermediate forms, including *S. (Stemmatoceras).* This group terminated

abruptly in the lower *Subfurcatum* Zone, *Banksi* Subzone, but it is clearly distinct from the more conservative line of Stephanoceratinae that continued higher into the upper Bajocian, both in Europe as a minor element, and further afield as the main element. Other lineages derived from *S. (Stephanoceras)* include the Garantianinae and the Cadomitinae, the latter leading to the Kosmoceratidae. BUCKMAN, 1908a; BUCKMAN, 1909–1930; MCLEARN, 1929, 1932; WEISERT, 1932; SCHMIDTILL & KRUMBECK, 1938; ARKELL, 1952a; ARKELL & PLAYFORD, 1954; WESTERMANN, 1964a; SCHINDEWOLF, 1965; WESTERMANN & RICCARDI, 1979; PAVIA, 1983; WESTERMANN, 1995. *Middle Jurassic (upper Aalenian–upper Bajocian):* worldwide.

Stephanoceras WAAGEN, 1869, p. 248 [**Ammonites humphriesianus* J. DE C. SOWERBY, 1825, p. 161; SD BUCKMAN, 1898, p. 454, ICZN Opinion 324, 1955a, p. 231, see ARKELL, 1951, p. 226] [=*Stepheoceras* BUCKMAN, 1898, p. 454, obj.; =*Stephoceras* ROLLIER, 1909, p. 613, 616, obj., misspelling of *Stepheoceras*]. Large; evolute serpenticones to cadicones; whorl section rounded to highly depressed; short, strong primary ribs divide at low to midlateral tubercles or bullae into 2–4 secondaries that are continuous across the venter. Macroconchs; ribs are retained to the end of the adult whorl, which has a flared, collared mouth border; the corresponding microconchs are *Normannites*. *Middle Jurassic (upper Aalenian–lower Bajocian:* worldwide.

S. (Riccardiceras) WESTERMANN, 1995, p. 109 [**Coeloceras longalvum* VACEK, 1886, p. 99; OD] [=*Westermannites* DIETZE, & others, 2001, p. 10 (type, *Coeloceras limatum* POMPECKJ, 1897, p. 745, OD)]. The earliest forms; evolute serpenticones; ribs divide regularly into 2 or 3 secondaries low on the whorl side and there are a few intercalated secondary ribs; midlateral tubercles occur only on the innermost whorls; the septum has a distinct biaxial (bullate) structure, and the suture has a large 2nd lateral lobe U_2. *Middle Jurassic (upper Aalenian–lower Bajocian):* Europe (western Tethys), Iran.——FIG. 4,*1a–d.* **S. (Riccardiceras) longalvum* (VACEK); *a–b,* holotype, upper Aalenian, San Vigilio, Lake Garda, Verona, Italy, ×0.45 (Dietze & others, 2001, p. 9, fig. 6); *c–d,* the oldest known form of *Stephanoceras,* upper Aalenian, *Concavum* Zone, Horn Park, Dorset, England, ×0.7 (new; The Natural History Museum, London, NHMUK CA5595, J. H. Callomon Collection).

S. (Stephanoceras) [=*Grahamites* KILIAN & REBOUL, 1909, p. 7, 26 (type, *Ammonites skidegatensis* WHITEAVES, 1876, p. 34, OD); =*Kallistephanus* BUCKMAN, 1921, pl. 230 (type, *K. kalus,* OD); =*Skolekostephanus* BUCKMAN, 1921, pl. 249 (type, *S. skolex,* OD); =*Rhytostephanus* BUCKMAN, 1921, pl. 250 (type, *R. rhytus,* OD); =*Kreteostephanus* BUCKMAN, 1927b, pl. 755 (type, *K. kreter,* OD)]. Serpenticones, reaching large sizes with robust whorls; whorl section evenly rounded to moderately depressed; prominent midlateral tubercles on all whorls. *Middle Jurassic (lower Bajocian):* Europe, northern Africa, Anatolia, Kenya, Caucasus, Azerbaijan, Persia, Arabia, Japan, Indonesia, New Guinea, New Zealand, Western Canada, USA (Alaska, Oregon, Western Interior), Mexico, Argentina, Chile.——FIG. 4,*2a–b.* **S. (S. humphriesianum)* (J. DE SOWERBY), lectotype, *Humphriesianum* Zone and Subzone, Sherborne, Dorset, England, ×0.64 (*a,* new; The Natural History Museum, London, NHMUK 43908a; *b,* Buckman, 1908a, pl. 7,*1b*).

S. (Skirroceras) MASCKE, 1907, p. 23, 31 [**Ammonites humphriesianus macer* QUENSTEDT, 1886 in 1882–1888, p. 528; SD BUCKMAN, 1921, pl. 248, *nom. conserv.,* ICZN Opinion 2123, 2005, p. 159; *non Ammonites bucklandi macer* QUENSTEDT, 1883 in 1882–1888, p. 68] [=*Oecostephanus* BUCKMAN, 1921, pl. 265 (type, *O. dolichoecus,* OD); =*Dolichoecus* ROCHÉ, 1939, p. 175 (type, *Oecostephanus dolichoecus* BUCKMAN, 1921, pl. 265, M); =*Freboldites* TAYLOR, 1988, p.136 (type, *F. bifurcatus,* OD)]. Large, very evolute serpenticones with slowly expanding whorls and very long body chambers: 2⅛ whorls in *S. dolichoecus* (BUCKMAN); whorl section rounded; prominent midlateral tubercles, at least on the inner whorls. *Middle Jurassic (lower Bajocian,* Laeviuscula–*lower* Humphriesianum *Zones):* Europe, northern Africa, Caucasus, Iran, USA (Alaska, Oregon), Venezuela.——FIG. 5,*1.* **S. (Skirroceras) macrum* (QUENSTEDT), lectotype (designated by BUCKMAN, 1921, pl. 248), Bayeux, Calvados, France, ×0.25 (Schlegelmilch, 1985, pl. 23,*2;* original of QUENSTEDT, 1886 in 1882–1888, pl. 65,*11*).

S. (Stemmatoceras) MASCKE, 1907, p. 23, 30 [**Ammonites humphriesianus coronatus* QUENSTEDT, 1886 in 1882–1888, p. 539; OD; *non Ammonites coronatus* BRUGUIÈRE, 1789 in 1789–1792, p. 43 (*Erymnoceras,* Perisphinctoidea); =*Stephanoceras frechi* RENZ, 1913, p. 684, *nom. nov. pro Ammonites humphriesianus coronatus* QUENSTEDT, 1886 in 1882–1888, p. 539; =*Cadomites quenstedti* ROCHÉ, 1939, p. 205, obj.] [=*Gibbistephanus* BUCKMAN, 1928, pl. 780 (type, *G. gibbosus,* OD); =*Paviceras* GAUTHIER, RIOULT, & TRÉVISAN, 1996, p. 35 (type, *Stemmatoceras hoffmanni* SCHMIDTILL & KRUMBECK, 1938, p. 348, OD)]. Macroconchs; more involute, stouter, and whorls more depressed than *S. (Stephanoceras),* with coronate, cadicone inner whorls; transitional to *Teloceras.* Corresponding microconchs are possibly some early species of *Epalxites* (of which the type species is the microconch of *Teloceras). Middle*

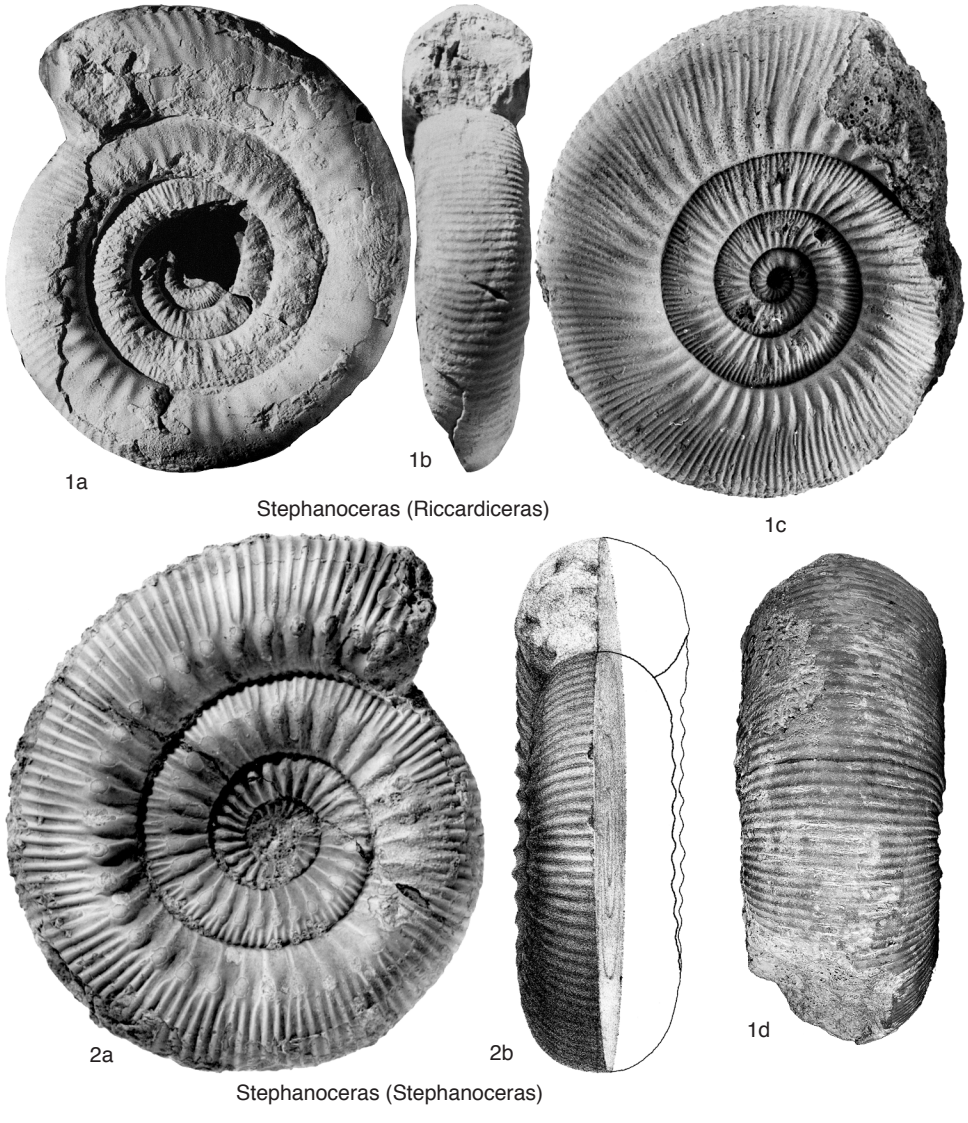

FIG. 4. Stephanoceratidae (p. 6).

Jurassic (lower Bajocian, Humphriesianum *Zone):* Europe, Caucasus, Iran, ?Western Australia, USA (Alaska, northwestern USA), Canada, Chile, ?Antarctica (Ellsworth Land).——FIG. 5,*2a–b. *S. (Stemmatoceras) frechi* RENZ, holotype, *Humphriesianum* Zone, Eningen, Germany, ×0.8 (*a,* Weisert, 1932, pl. 18,*4; b,* Schlegelmilch, 1985, pl. 27,*6*).

Masckeites BUCKMAN, 1920, pl. 152 [**M. densus;* OD] [=*Lokuticeras* GALÁCZ, 1994, p. 164 (type, *L. rossbrunnense,* OD)]. Inner whorls cadicone or coronate, with rounded to depressed whorl section; middle and outer whorls more evolute and serpenticone; primary ribs dense, dividing at small lateral tubercles into 2–4 dense secondary ribs, persisting to adult mouth border. Dimorphic: macroconchs (*Lokuticeras*) have a deep constriction followed by a flared collar at the adult mouth border; microconchs (*Masckeites*) with short body chamber and large spatulate lappets in the adult mouth border. Transitional to the Cadomitinae, having the spatulate lappets of Stephanoceratinae but the ribbing and shorter body chamber of Cadomitinae. *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone–upper Bajocian, lower* Subfurcatum *Zone):* Europe (Mediterranean Province of western Tethys,

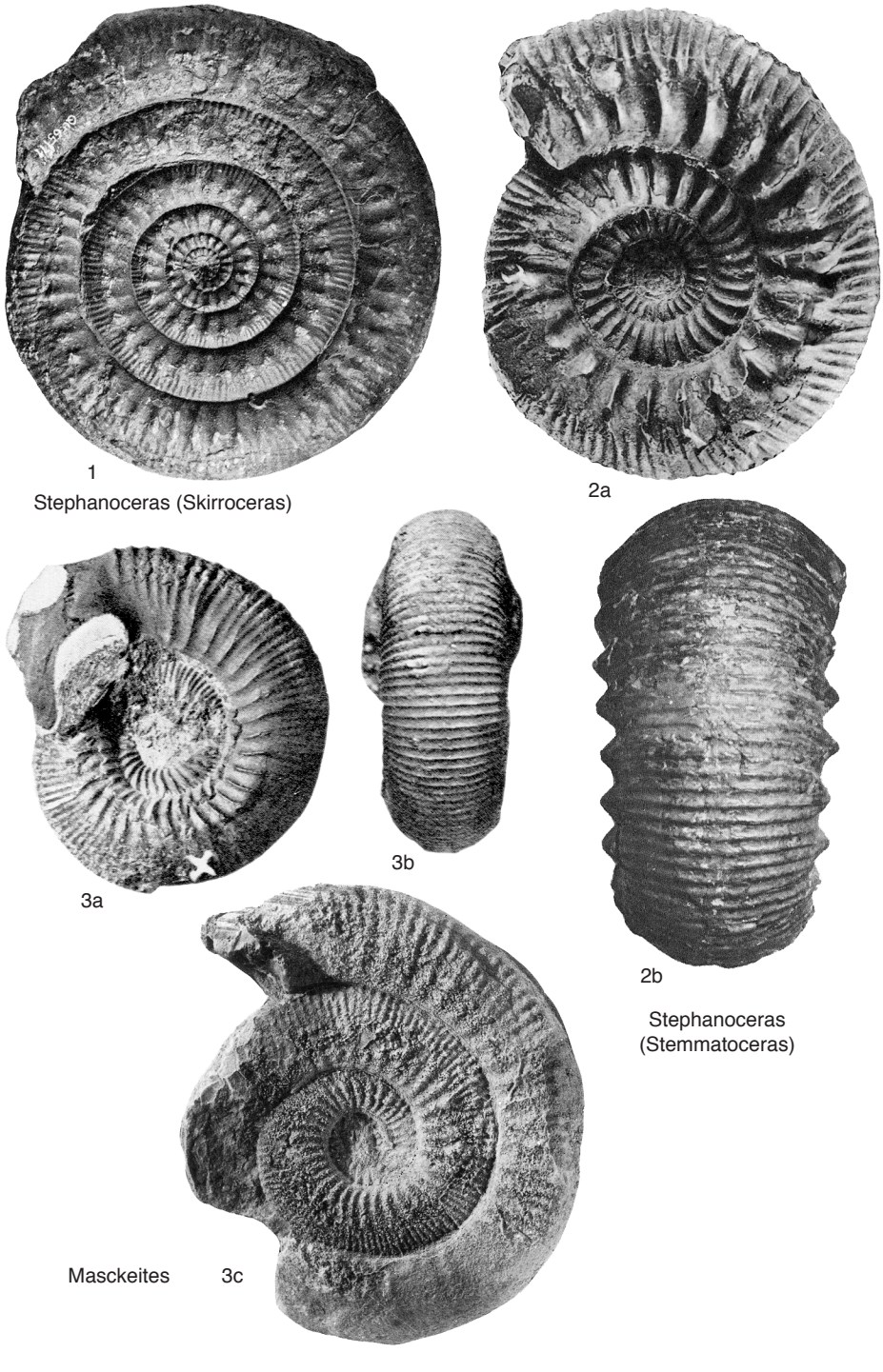

FIG. 5. Stephanoceratidae (p. 6–10).

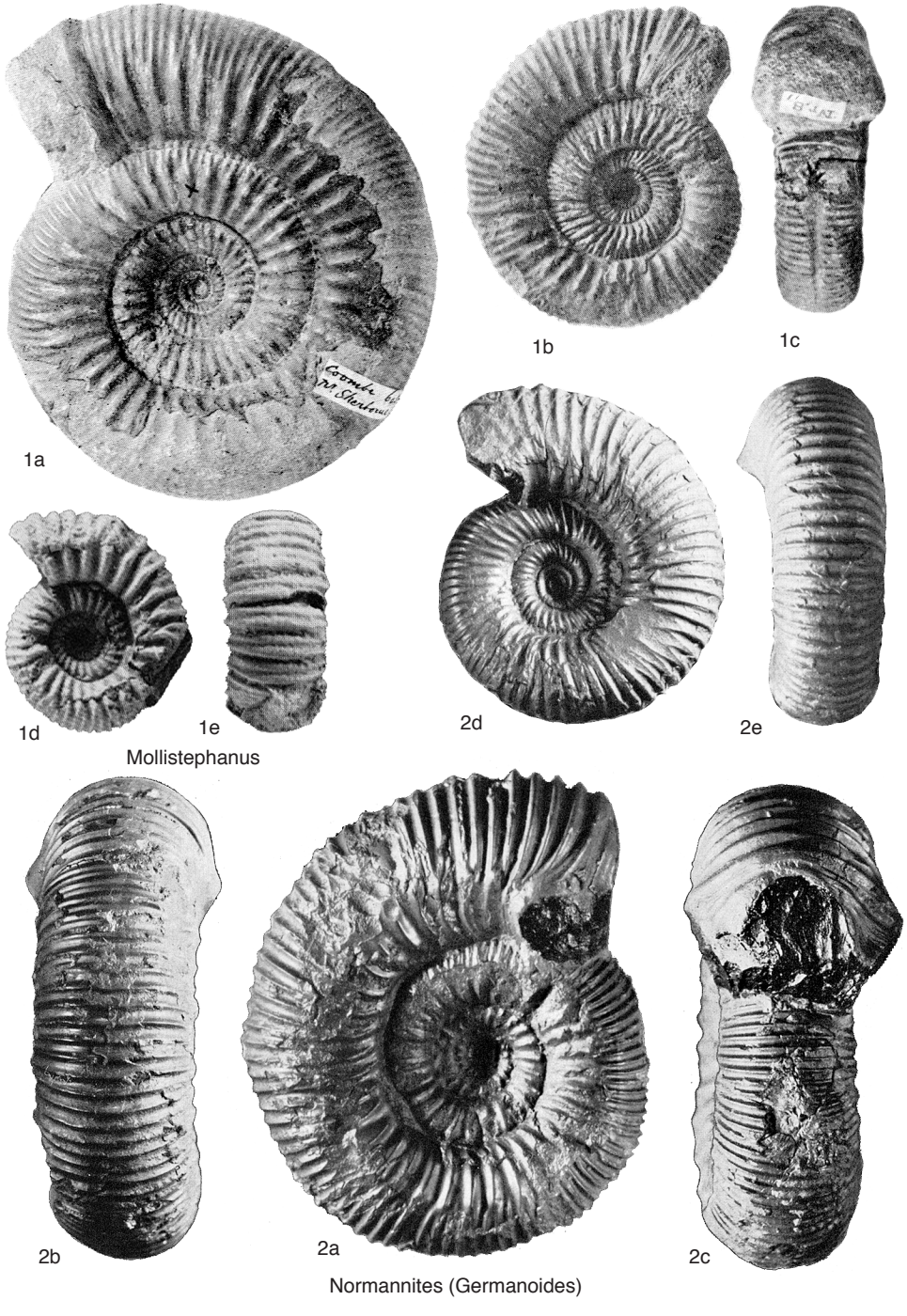

FIG. 6. Stephanoceratidae (p. 10).

Submediterranean Province), France (Calvados), Britain (rare).——Fig. 5,*3a–b. *M. densus,* holotype, microconch with large lappets, *Humphriesianum* Zone and Subzone, Sherborne, Dorset, England, ×1 (Buckman, 1920, pl. 152).——Fig. 5,*3c. M. rossbrunnense* (Galácz), holotype, macroconch, *Humphriesianum* Zone, *Blagdeni* Subzone, Lókút, Hungary, ×0.55 (Galácz, 1994, pl. 1,*1*).

Mollistephanus Buckman, 1922, pl. 344 [**M. mollis;* OD] [=*Phaulostephanus* Buckman, 1927b, pl. 754 (type, *P. paululus,* OD); =*Albarracinites* Fernandez-Lopez, 1985, p. 299 (type, *A. albarraciniensis,* OD)]. Small or dwarf forms, evolute, with dense, bifurcating ribs and small (or absent) midlateral tubercles; resembles early perisphinctids but macroconchs retain the characteristic prominent peristomal collar of *Stephanoceras.* Dimorphic: macroconchs with constriction and collar in the adult mouth border; microconchs (*Albarracinites*) have swollen secondary ribs, paired across the venter on the body chamber. Chandler & Dietze, 2004. *Middle Jurassic (lower Bajocian,* Discites–*lower* Sauzei *Zones):* England, France, Spain, Portugal, Hungary, Morocco, USA (Oregon), Mexico.——Fig. 6,*1a. *M. mollis,* holotype, macroconch, *Laeviuscula* Zone, Clatcombe, Sherborne, Dorset, England, ×1 (Buckman, 1922, pl. 344).——Fig. 6,*1b–c. M. paululum* (Buckman), holotype, Clatcombe, Sherborne, Dorset, England, ×1 (Buckman, 1927b, pl. 754).——Fig. 6,*1d–e. M. albarraciniensis* (Fernandez-Lopez), holotype, microconch, Iberian Cordillera, Spain, ×1.5 (Fernandez-Lopez, 1985, pl. 36,*1a–b*).

Normannites Munier-Chalmas, 1892, p. clxxii [**N. orbignyi* Buckman, 1908b, p. 146; SD, ICZN Opinion 309, 1954d, p. 347] [=*Itinsaites* McLearn, 1927, p. 73 (type, *I. itinsae,* OD); =?*Germanites* Schindewolf, 1929, p. 57 (type, *G. parvus,* M); =*Parallites* Westermann, 1954, p. 205 (type, *N. (P.) parallelus,* OD); =*Platystomites* Westermann, 1954, p. 218 (type, *N. (P.) platystomus,* OD); =*Dettermanites* Imlay, 1961, p. 471 (type, *D. vigorosus,* OD)]. Microconchs; evolute, with rounded to moderately depressed whorls; strong primary ribs bifurcate at midflank into secondaries that are continuous over the venter; small, subdued tubercles usually present at point of bifurcation; adult body chamber half to three-quarters of a whorl long, with large to enormous lappets in the mouth border that severely constrict the aperture in some. Although these are clearly microconchs associated with *Stephanoceras* and its subgenera, associations have not yet been identified with sufficient accuracy to merge the generic nomenclature of macroconch-microconch pairs. *Middle Jurassic (Bajocian,* Laeviuscula–*lower* Subfurcatum *Zones):* worldwide.

N. (Normannites). Strongly ribbed, moderately stout forms, secondaries bifurcating sharply at midflank, sometimes with subdued tubercles; adult body chamber one-half to three-quarters whorl long, with little-modified ribs, and peristome with enormous, elongated lappets severely constricting the aperture. Microconchs, probably associated with several subgenera of *Stephanoceras. Middle Jurassic (lower Bajocian,* Sauzei–Humphriesianum *Zones):* Europe, northern Africa, Saudi Arabia, Caucasus, Iran, New Guinea, USA (Alaska, northwestern USA, California), Canada, Honduras, Mexico, Chile, ?Antarctica (Ellsworth Land).——Fig. 7*a–g. *N. (N.) orbignyi* Buckman; *a–b,* holotype (now lost), Bayeux, Calvados, France, ×0.9 (d'Orbigny, 1846 in 1842–1851, pl. 135,*3–4*); *c–d,* neotype (designated by Westermann, 1954, p. 136), *Humphriesianum* Zone, Clatcombe, Sherborne, Dorset, England, ×1 (new; British Geological Survey, Keyworth, Nottinghamshire, England, GSM 49321; figured by Buckman, 1927b, pl. 734); *e–g,* complete adult microconch, Goslar, Germany, ×1 (new; Berlin University, Mascke Collection, MB-C.511).

N. (Germanoides) Westermann, 1956a, p. 251 [**Normannites (Gerzenites) nodosus* Westermann, 1954, p. 330; OD] [=*Alfeldites* Westermann, 1975, p. 229, *nom. nov. pro Germanites* Westermann, 1954, p. 316, *non* Schindewolf, 1929, p. 57, *nec* Mascke, 1907, p. 23, 28 (*nom. nud.*) (type, *Germanites bicostatus* Westermann, 1954, p. 321, OD)]. Ribs finer and more dense than in *N. (Normannites),* in some cases like perisphinctids. Microconchs. *Middle Jurassic (lower Bajocian,* Sauzei–*lower* Humphriesianum *Zones):* northwestern Europe.——Fig. 6,*2a–c. *N. (G.) nodosum* (Westermann), holotype, *Sauzei* Zone, Gerzen, near Alfeld, Lower Saxony, Germany, ×1 (Westermann, 1954, pl. 31,*2a–c*).——Fig. 6,*2d–e. N. (G.) bicostatum* (Westermann), holotype of type species of *Alfeldites,* lower *Humphriesianum* Zone, Gerzen, near Alfeld, Lower Saxony, Germany, ×1 (Westermann, 1954, pl. 30,*1a–b*).

Domeykoceras Hillebrandt, 1977, p. 54 [**D. dehmi;* OD]. Inner whorls involute, compressed, subquadrate; later whorls more evolute and rounded; umbilical wall vertical or overhanging; ribs dense, short, bifurcating low on the whorl side with some intercalatories. Dimorphic: microconchs are among the largest known in the subfamily, with short lappets in the adult mouth border; macroconchs have plain, sinuous mouth borders. *Middle Jurassic (Bajocian, ?upper* Humphriesianum–*lower* Subfurcatum *Zones).* Chile.——Fig. 8,*1a–d. *D. dehmi; a–c,* holotype, microconch with lappet in the aperture, Quebrada Juncal, 25°39′S, 69°15′W, Cordillera Domeyko, Antofagasta Province, northern Chile, ×0.5; *d,* paratype, fragmentary macroconch, Quebrada del Profeta, 25°00′S, 69°14′W, Cordillera Domeyko, Antofagasta Province, northern Chile, ×0.5 (Hillebrandt, 1977, pl. 4,*1;* p. 51, fig. 6e; p. 53, fig. 7a; pl. 5,*5*).

Kumatostephanus Buckman, 1922, pl. 345 [**K. kumaterus;* OD] [=*Cymatostephanus* Cossmann, 1924, p. 34, illegal emendation to original spelling;

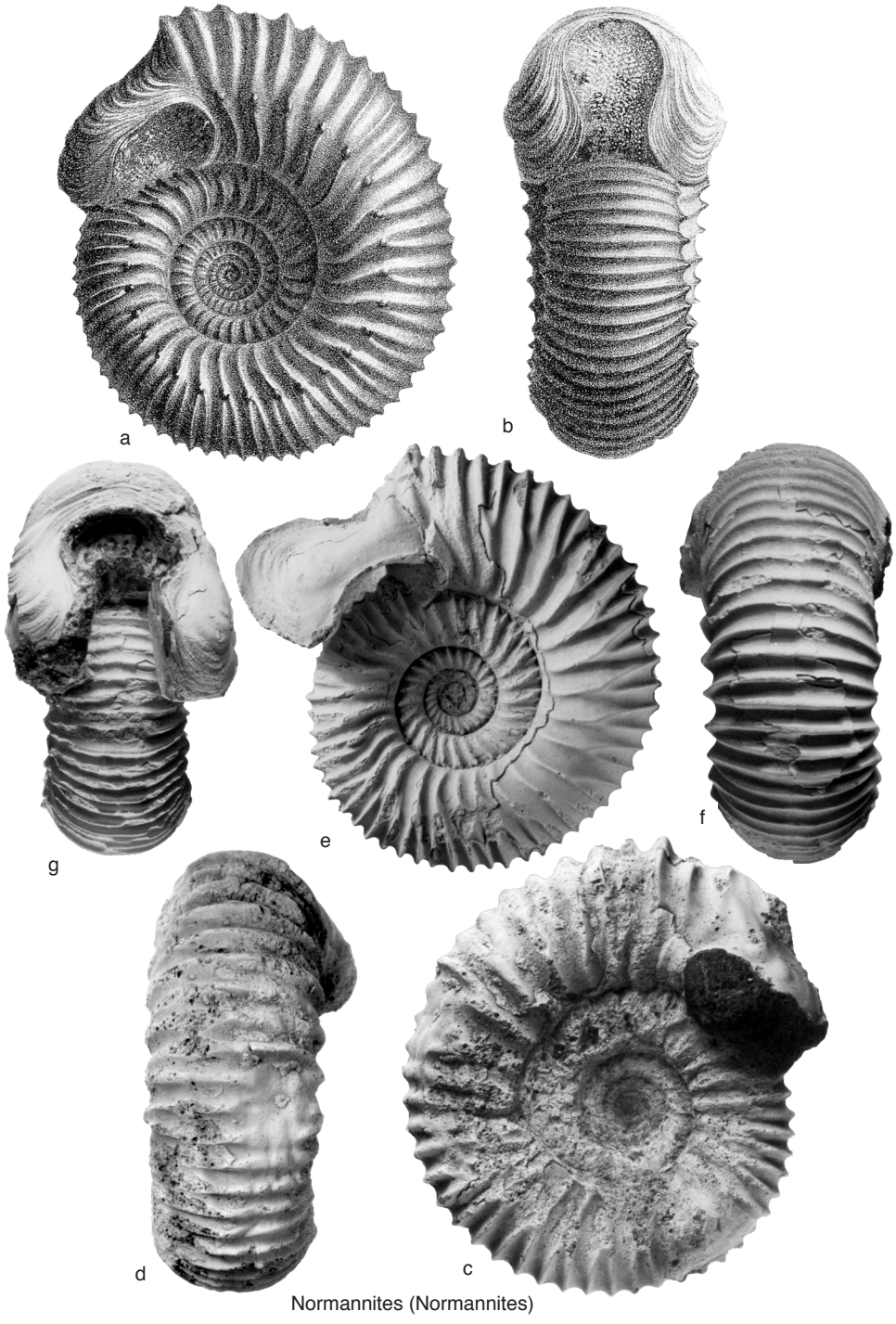

FIG. 7. Stephanoceratidae (p. 10).

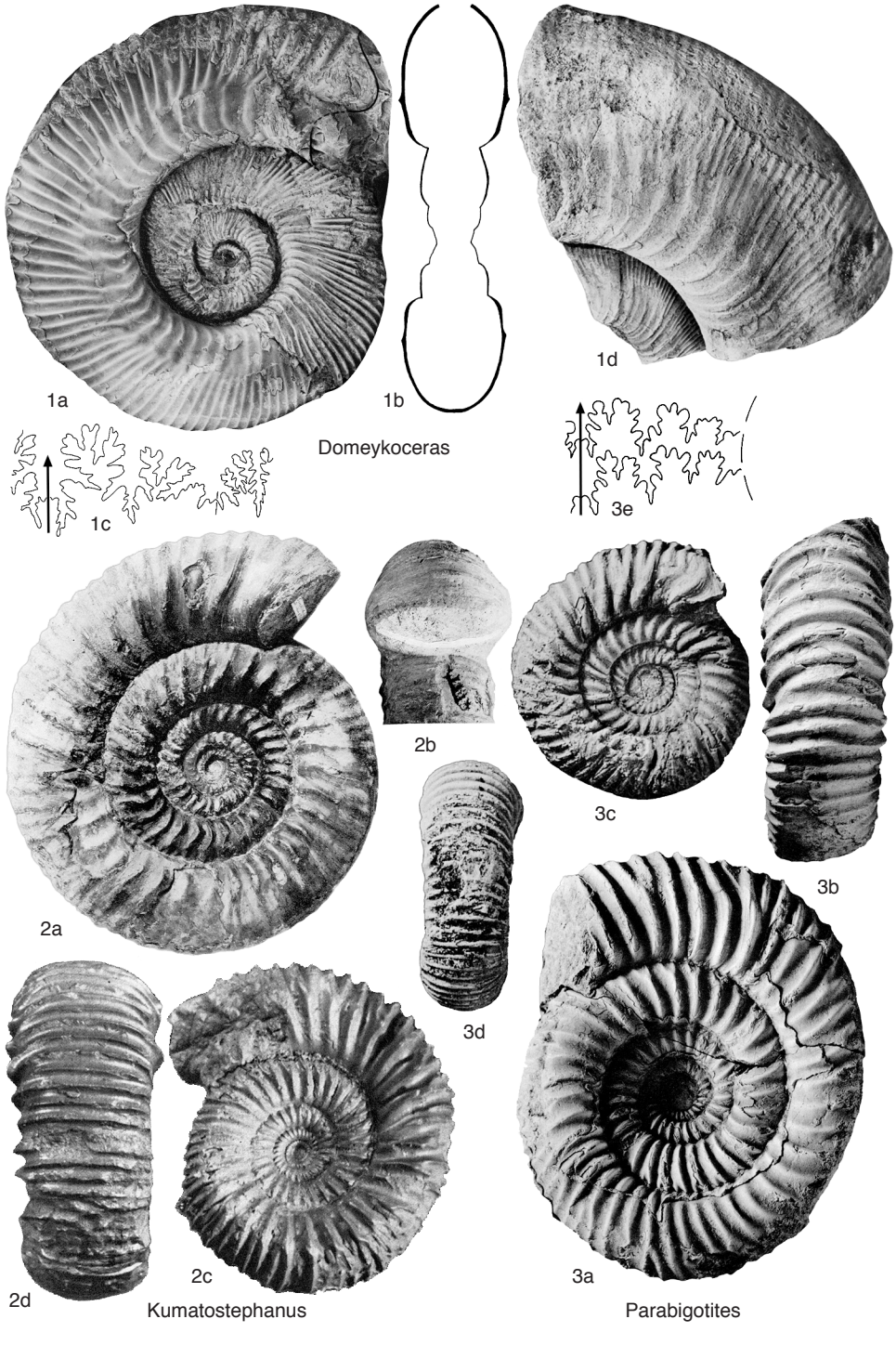

FIG. 8. Stephanoceratidae (p. 10–13).

?=*Gerzenites* Westermann, 1954, p. 230 (type, *Normannites (Gerzenites) rugosus,* OD)]. Evolute; moderately depressed whorls; strong, coarse ribs bifurcate just below midwhorl at strong tubercles or spines; secondary ribs are interrupted by a narrow, smooth band at midventer. Somewhat perisphinctid in appearance. Dimorphic: macroconchs are adult at 190–300 mm in diameter, with a raised collar and ventral rostrum on the sinuous adult mouth border; microconchs (*Gerzenites*) adult at 50–90 mm, with large spatulate lappets. Chandler & others, 2013. *Middle Jurassic (lower Bajocian, upper* Laeviuscula–Humphriesianum *Zones):* England, France, Germany, Spain, Hungary, Iran, USA (Alaska), ?Chile.——Fig. 8,*2a–b. *K. kumaterus,* holotype, macroconch, Sandford Lane, Sherborne, Dorset, England, ×0.33 (Buckman, 1922, pl. 345A–345B).——Fig. 8,*2c–d. K. rugosus* (Westermann), holotype, microconch, Gerzen, near Alfeld, Lower Saxony, Germany, ×1 (Westermann, 1954, pl. 19,*4a,4c*).

Parabigotites Imlay, 1961, p. 472 [**P. crassicostatus;* OD]. Evolute, with rounded whorl section and perisphinctid appearance; coarse primary ribs bifurcate high on the whorl side and curve gently forwards across the venter; periodic irregular constrictions are followed adorally by oblique simple ribs. Dimorphic: macroconchs ribbed to the end of adult body chamber, about one whorl long, and the simple, slightly flared final aperture is preceded by a broad, shallow constriction; microconchs with body chamber about half a whorl long, and short lappets. *Middle Jurassic (lower Bajocian,* Crassicostatus *Zone of Alaska [*=Sauzei *Zone, part]):* USA (Alaska, Oregon).——Fig. 8,*3a–e. *P. crassicostatus,* Wide Bay, Alaska Peninsula, Alaska, USA; *a–b,* holotype, macroconch, ×0.6 (Imlay, 1964, pl. 29,*14–15*); *c–e,* microconch with lappet, holotype of *Normannites kialagvikensis* Imlay; *c–d,* ×1 (Imlay, 1964, pl. 13,*7–8*); *e,* sutures, ×2 (Imlay, 1964, pl. 13,*10*).

Duashnoceras Westermann, 1983, p. 32 [**Stephanoceras floresi* Burckhardt, 1927, p. 25; OD]. Evolute; early whorls depressed with broad, arched venter, becoming more compressed with subcircular whorl section on middle and outer whorls; widely spaced primary ribs of low relief end at a large lateral tubercle, from which 3 or 4 secondary or intercalated ribs cross the venter without interruption. Dimorphic: macroconchs adult at 80–150 mm in diameter; microconchs adult at 35–70 mm and have small lateral lappets. *Middle Jurassic (upper lower–lower upper Bajocian):* Mexico, Chile.——Fig. 9,*1a–h. *D. floresi* (Burckhardt); *a–d,* holotype, probable microconch, two parts of the same specimen, Duashnú, 16°52′N, 18°04′W, 130 km west of Oaxaca, Mexico, ×1 (Westermann, 1983, pl. 10,*1a–d*); *e–h,* Los Rebajes, 5 km southeast of San Juan Mixtepec, Oaxaca, Mexico; *e,* an almost complete macroconch, ×0.6 (Sandoval & Westermann, 1986, fig. 19-1); *f,* venter of another almost complete macroconch, ×0.7 (Sandoval & Westermann, 1986, fig. 19-8); *g–h,* complete microconch with small lappet in mouth border, ×1 (Sandoval & Westermann, 1986, fig. 23-4, 23-5).

Zemistephanus McLearn, 1927, p. 72 [**Ammonites richardsoni* Whiteaves, 1876, p. 32; OD] [=*Kanastephanus* McLearn, 1927, p. 73 (type, *K. crickmayi,* OD)]. Moderately involute, inflated cadicones with coronate section but rounded flanks; well-spaced, short primary ribs or bullae on more evolute inner whorls divide low on the flank into sheaves of fine secondary ribs that curve forwards across the arched venter; ribs fade on outer whorls, leaving large, blunt nodes at the umbilical edge and fine, radial striations on venter. Dimorphic: macroconchs have slightly flared adult mouth border with collar; microconchs more evolute, like inner whorls of macroconchs, with short lappets in the adult mouth border. McLearn, 1949; Arkell & Playford, 1954; Imlay, 1964. *Middle Jurassic (lower Bajocian,* Richardsoni *Zone of North America [=?upper* Sauzei *Zone of Europe]):* USA (Alaska, Oregon, Montana, Utah), Canada (British Columbia, Alberta), Western Australia, ?Indonesia.——Fig. 10*a–e. *Z. richardsoni* (Whiteaves); *a–d,* Mackenzie Bay, 53°12.8′N, 132°05′W, north shore of Maude Island, Skidegate Inlet, Haida Gwaii (Queen Charlotte Islands), British Columbia, Canada; *a–b,* holotype, macroconch, ×0.6; *c–d,* complete microconch with lappet in mouth border, ×0.8 (Hall & Westermann, 1980, pl. 3,*2a–b,* pl. 2,*1a–b*); *e,* suture of a macroconch at diameter of 88 mm, Fossil Point, Tuxedni Bay, Alaska, USA, ×0.7 (Imlay, 1964, pl. 26,*5*).——Fig. 10*f–g. *Z. crickmayi* (McLearn), holotype, Mackenzie Bay, 53°12.8′N, 132°05′W, north side of Maude Island, Skidegate Inlet, Haida Gwaii (Queen Charlotte Islands), British Columbia, Canada, ×1 (McLearn, 1927, pl. 16,*7–8*).

Teloceras Mascke, 1907, p. 23 [**Ammonites blagdeni* J. Sowerby, 1818, p. 231, pl. 201; OD] [=*Epalxites* Mascke, 1907, p. 23 (type, *Ammonites contractus anceps* Quenstedt, 1886 in 1882–1888, p. 521, *nom. conserv.,* as *Ammonites anceps* Quenstedt, 1886, ICZN Opinion 2123, 2005, p. 158, OD; *non Ammonites anceps* Zieten, 1830 in 1830–1833, p. 1 (*ex Nautilus anceps* Reinecke, 1818, p. 82), *non Ammonites anceps carinatus* Quenstedt, 1856 in 1856–1858, p. 473)]. Very large, coronate, highly depressed cadicones; venter almost flat; strong, widely spaced primary ribs end at large ventrolateral tubercles from which two or more secondary ribs are continuous across the venter. Dimorphic: the adult body chamber of macroconchs contracts and becomes rounded, the ribs tend to fade, and the adult aperture is simple; microconchs (*Epalxites*) are strongly ribbed to the adult mouth border, which has large lappets. *Middle Jurassic (Bajocian, upper* Humphriesianum–*lower* Subfurcatum *Zones):* Europe, USA (Alaska, ?Montana), Canada (Alberta), Chile.——Fig. 11,*1a–c. *T. blagdeni* (Sowerby), holotype, macroconch, *Humphriesianum* Zone, Sherborne, Dorset, ×0.33 (new; The Natural History Museum, London, NHMUK 43908c).——Fig. 11,*1d–i. T. anceps* (Quenstedt);

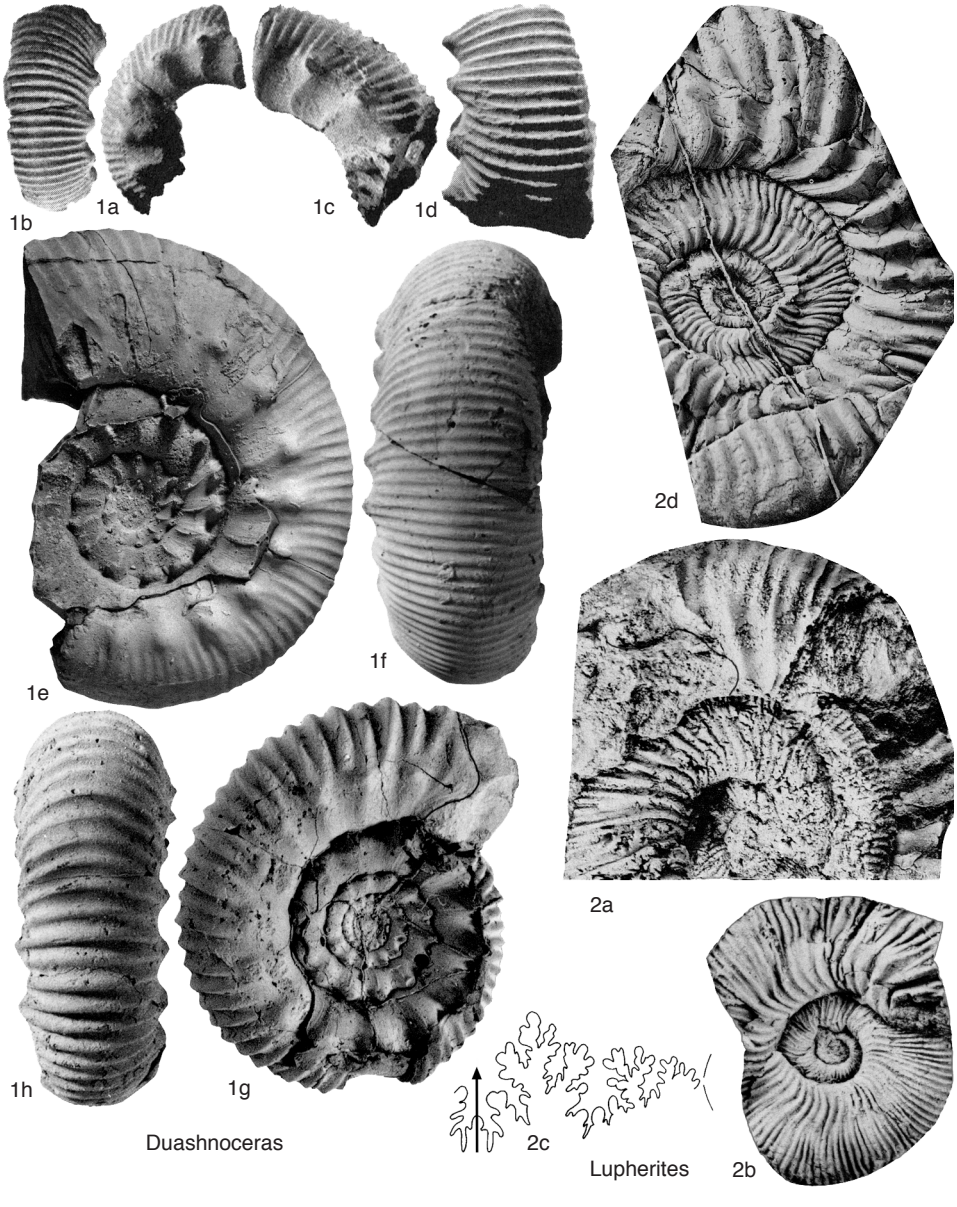

FIG. 9. Stephanoceratidae (p. 13–15).

d–e, crushed holotype, microconch, Lauffen am Neckar, Baden-Württemberg, Germany, ×1 (Westermann, 1954, pl. 28,*1a–b;* original of QUENSTEDT, 1886 in 1882–1888, pl. 64,*20*); *f–g,* paratype, Gerzen, Alfeld, Hannover, Germany; *f,* ×1; *g,* ×2 (Westermann, 1954, pl. 28,*2,* p. 299, fig. 127); *h–i,* microconch, *Humphriesianum* Zone, ?*Blagdeni* Subzone, Sherborne, Dorset, England, ×1 (Arkell, 1933, pl. 34,*5,5a*).

Arkelloceras FREBOLD, 1958, p. 9 [**A. tozeri;* OD]. Macroconchs, moderately involute with broad, rounded, depressed whorls; short, widely spaced ribs of low relief divide at midwhorl height into stronger secondary ribs that are interrupted by a midventral smooth band, which may be bounded by incipient tubercles; ribs fade on the body chamber; adult body chamber one whorl long, with broad, shallow constriction followed by a flare in

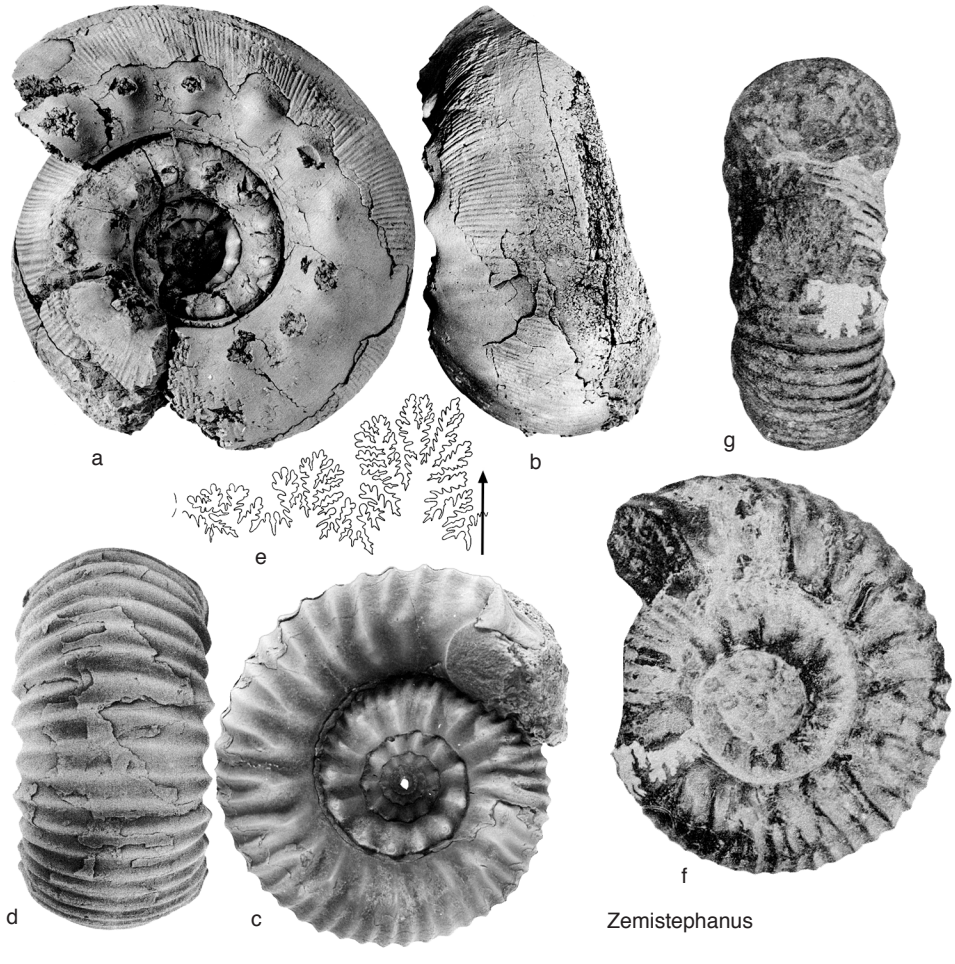

FIG. 10. Stephanoceratidae (p. 13).

final aperture. Microconchs more evolute and more strongly ribbed to the final aperture, but the peristome is unknown; microconchs resemble *Normannites* except for the ventral smooth band. FREBOLD, 1958; IMLAY, 1964; WESTERMANN, 1964a; EFIMOVA & others, 1968. *Middle Jurassic (lower Bajocian,* Sauzei *or lower* Humphriesianum *Zones):* Canada (Prince Patrick Island, Northwest Territories, Axel Heiberg Island, Nunavut [formerly Arctic Canada], Alberta), USA (southern Alaska), Russia (northeastern Siberia).——FIG. 12*a–e. *A. tozeri,* Wilkie Point Formation, 10 miles north of Cape Canning, east side of Intrepid Inlet, Prince Patrick Island, Canada; *a,* holotype, macroconch, ×0.5; *b–c,* paratype, ×0.5; *d–e,* inner whorls of another paratype, ×1 (Frebold, 1958, pl. 9,*1a,2a–b,* pl. 10,*1a,* pl. 11,*2b*).——FIG. 12*f–g. A. mclearni* FREBOLD, holotype, microconch, Wilkie Point Formation, 10 miles north of Cape canning, east side of Intrepid Inlet, Prince Patrick Island, Canada, ×1 (Frebold, 1958, pl. 12,*1a,c*).

Lupherites IMLAY, 1973, p. 90 [**L. senecaensis;* OD]. Involute, moderately compressed whorls; short, irregular, forwardly curving primary ribs divide low on whorl side into backwardly curving secondaries that cross the venter radially; lateral tubercles very small or absent. Dimorphic: microconchs with short body chamber and short lappets; probable macroconchs revert to normal stephanoceratid coiling and ribbing on the adult body chamber. *Middle Jurassic (lower Bajocian, ?*Humphriesianum *Zone):* USA (Oregon).——FIG. 9,*2a–d. *L. senecaense,* Snowshoe Formation, Seneca area, eastern Oregon, USA; *a,* holotype, microconch with part of lappet visible, ×1; *b,* paratype, microconch, ×1; *c,* suture of another paratype, ×1.5; *d,* probable macroconch, ×0.7 (Imlay, 1973, pl. 45,*9,* pl. 47,*9,14–15*).

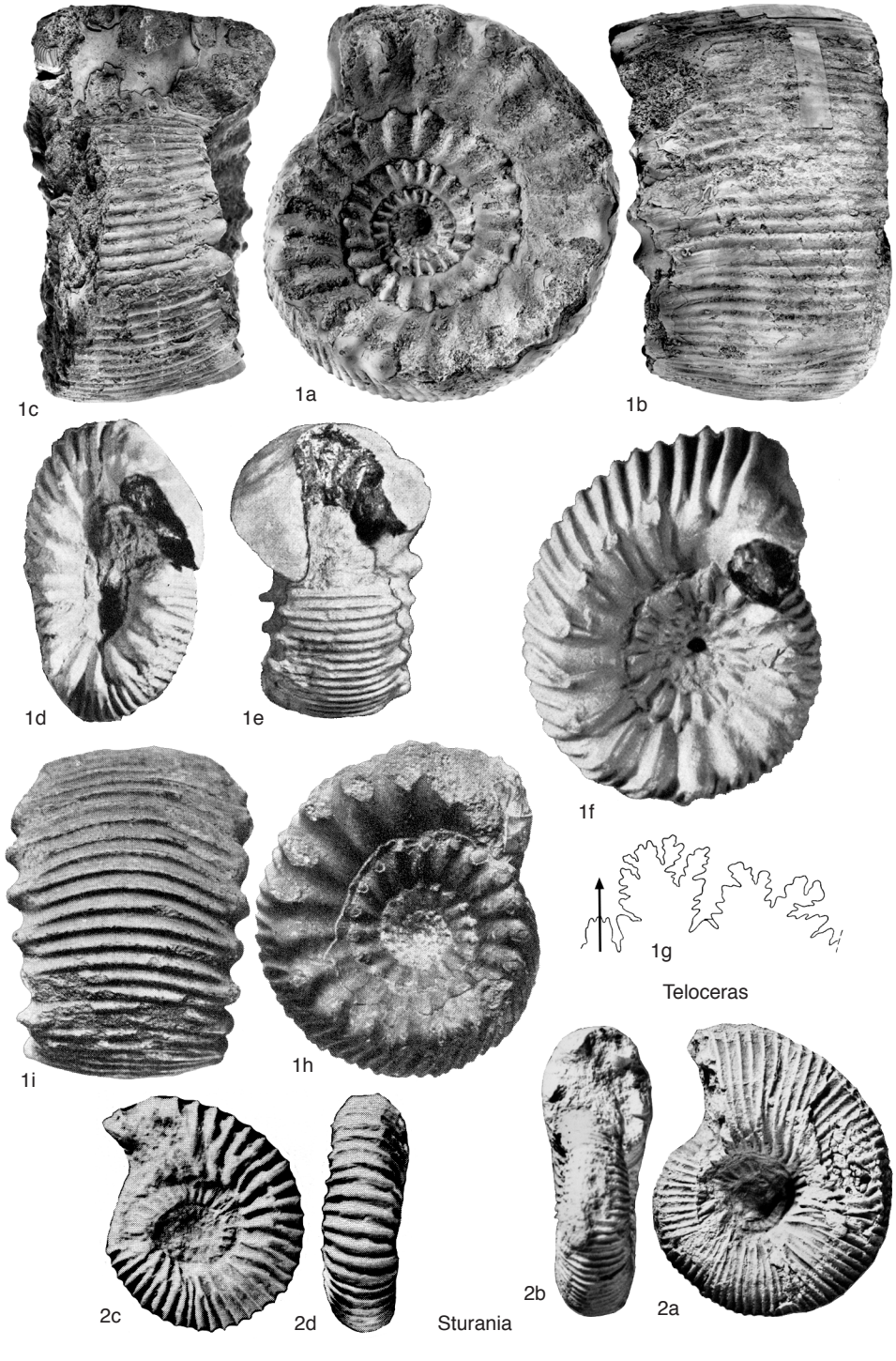

FIG. 11. Stephanoceratidae (p. 13–17).

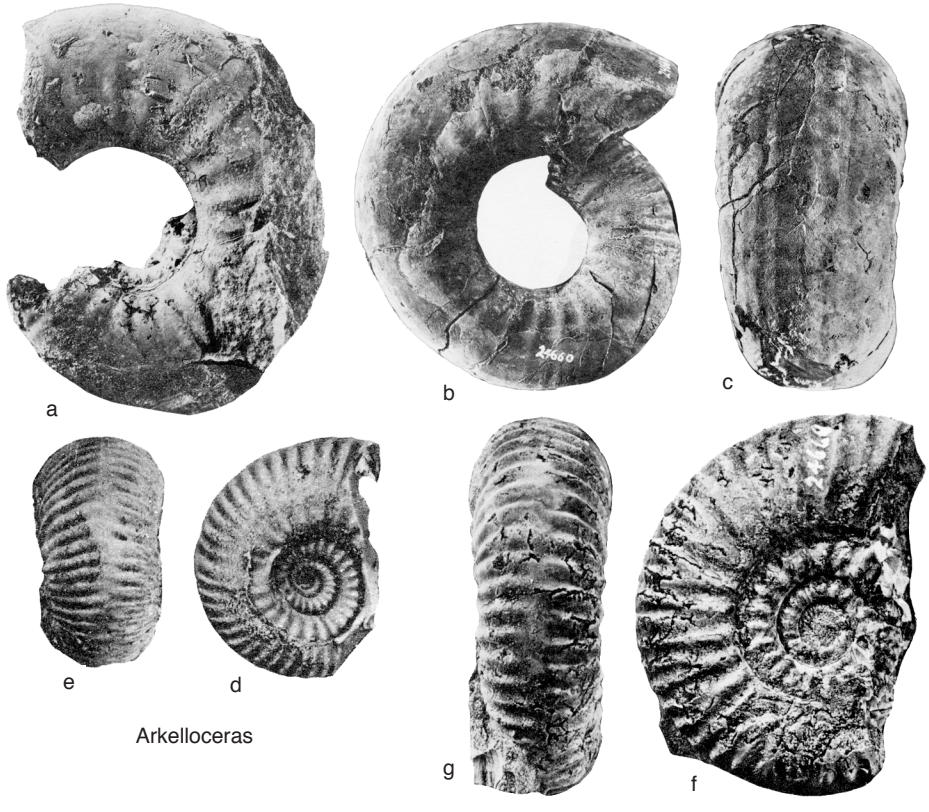

FIG. 12. Stephanoceratidae (p. 14–15).

Sturania PARNES, 1985, p. 29 [**S. sturanii;* OD]. Small, variable, ranging from planulate to compressed involute; ribs fine and dense to coarse, short primaries bifurcate or trifurcate irregularly low on the side of the whorl, with accentuated furcation point; 3–5 constrictions per whorl. Probably dimorphic, macroconchs more involute and compressed, microconchs more evolute. Poorly known from a few small specimens that show considerable variation. *Middle Jurassic (upper Bajocian):* Egypt (Sinai).——FIG. 11,*2a–b. *S. sturanii,* holotype, possible macroconch, wholly septate, Gebel Maghara (Jabal al Magharah), North Sinai, Egypt, ×1.5 (new; figured by Parnes, 1985, pl. 1,*2–3*).——FIG. 11,*2c–d. S. planula,* holotype, possible microconch, with body chamber, Gebel Maghara (Jabal al Magharah), North Sinai, Egypt, ×1.5 (Parnes, 1985, pl. 1,*21–22*).

Parareineckeia IMLAY, 1962, p. 25 [**P. hickersonensis;* OD]. Evolute, depressed subquadrate planulates; strong primary ribs bifurcate at irregular ventrolateral tubercles; the secondary ribs are looped across the arched or flat venter, and weaken at an incipient midventral spiral groove; 3–4 inconspicuous constrictions per whorl. Dimorphic: macroconchs become more involute on the body chamber; microconchs are strongly ribbed to the end of the adult body chamber, which has lateral lappets. Microconchs bear some resemblance to *Parastrenoceras* (Garantianinae). *Middle Jurassic (upper Bajocian):* USA (Alaska, Oregon), Canada (British Columbia).——FIG. 13*a–e. *P. hickersonensis; a–e,* holotype, microconch, 1.5 miles northeast of the head of Hickerson Lake, north of Chinitna Bay, Alaska, USA; *a–b,* ×1; *c,* suture, ×1.5 (Imlay, 1962, pl. 7,*1–2,4*); *d–e,* microconch with complete adult body chamber and lappet, Boulder Creek, 25 km northeast of Chickaloon, Talkeetna Mountains, Alaska, USA, ×0.7 (Imlay, 1980, pl. 10,*1,4*).——FIG. 13*f. P. shelikofana* IMLAY, holotype, macroconch, wholly septate, Wide Bay, Alaska Peninsula, Alaska, USA, ×0.5 (Imlay 1953b, pl. 55,*8*).

Irianites WESTERMANN & GETTY, 1970, p. 271 [**Coeloceras moermanni* KRUIZINGA, 1926, p. 44; OD]. Evolute; whorls subquadrate to depressed; short primary ribs bifurcate or trifurcate at midwhorl side at a sharp tubercle, forming sharp secondaries that weaken in midventer to an incipient sulcus; smaller tubercles

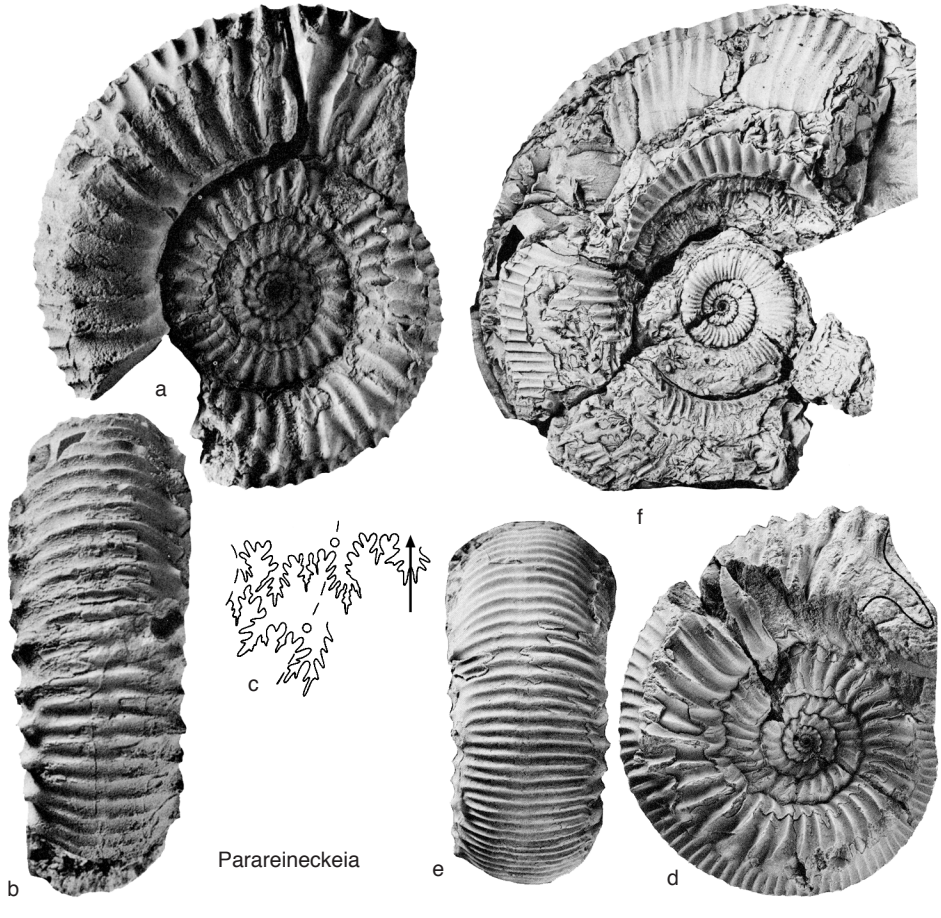

FIG. 13. Stephanoceratidae (p. 17).

on or close to the umbilical edge form a second row of tubercles at least on the inner whorls. Dimorphic: macroconchs with inflated, rounded and depressed body chamber, one whorl long, strongly ribbed to the end; microconchs with simple lappets in the adult mouth border. *Middle Jurassic (Bajocian, ?upper part):* Indonesia (Sula Islands, West Papua).——Fig. 14*a–f.* **I. moermanni* (KRUIZINGA); *a–b,* holotype, microconch, Sula Islands, Indonesia, ×0.75 (Jaworski, 1933, pl. 11,*7,* p. 321, fig. 6); *c–f,* Kemaboe Valley, West Irian, Indonesia; *c–d,* macroconch, ×0.75 (Westermann & Getty, 1970, pl. 59,*1a–b*); *e–f,* microconch, ×1 (Westermann & Getty, 1970, pl. 57,*1a,d*).

Subfamily GARANTIANINAE Wetzel, 1937

[*nom. transl.* CALLOMON, 1981, p. 123, 145, *ex* Garantianidae WETZEL, 1937, p. 147]

Moderately evolute medium-sized planulates with strong, sharp ribbing interrupted by a ventral groove or smooth band bordered by accentuated ends of the secondary ribs, sometimes as ventral tubercles; some genera have row of lateral tubercles at furcation points high on the whorl side. Dimorphic: macroconchs strongly ribbed up to the simple adult aperture, and ribs usually projected on the venter: microconchs with large to spatulate lappets. Some species are highly variable. All genera share the common character of interrupted ribbing on the venter.

The subfamily appears at the base of the upper Bajocian, and some of the early forms resemble *Cadomites* so strongly that there can be little doubt that the group is derived from earlier Stephanoceratinae

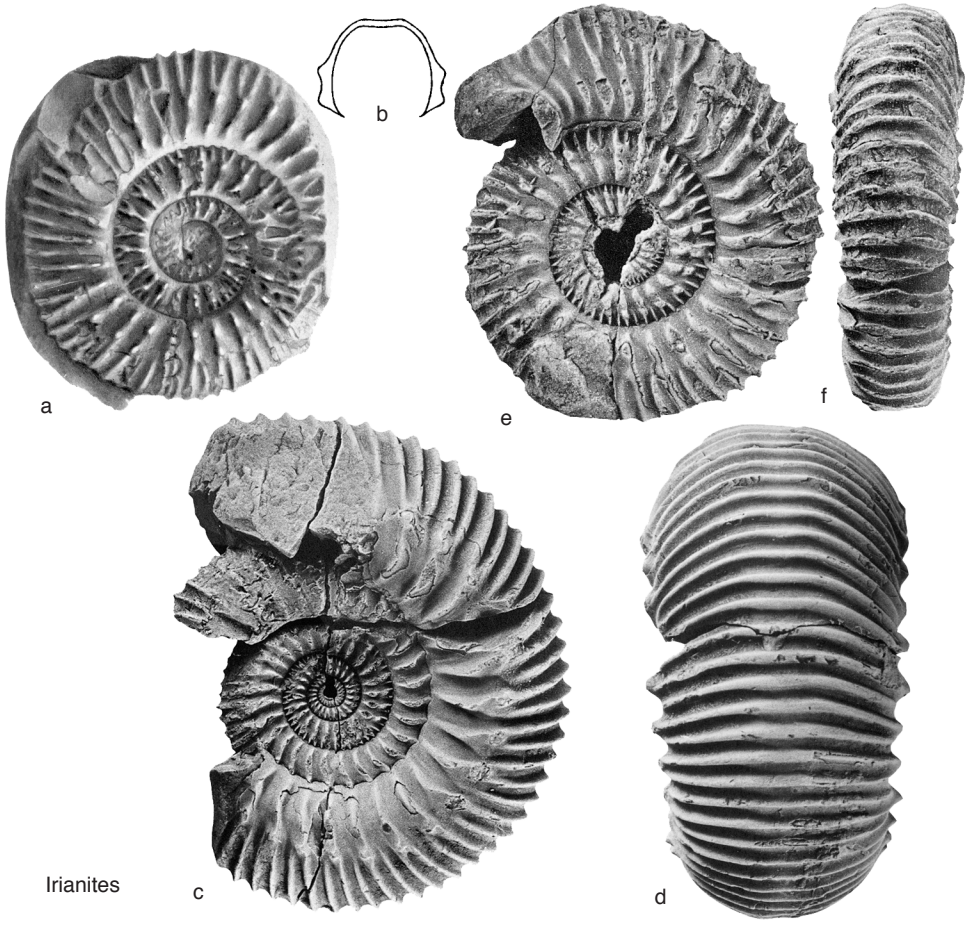

FIG. 14. Stephanoceratidae (p. 17–18).

rather than having any close connection with Perisphinctoidea. DOUVILLÉ, 1915; BENTZ, 1924, 1928; WETZEL, 1954; STURANI, 1971; PAVIA, 1973. *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone–upper Bathonian).* Europe, Russia, Caucasus, Azerbaijan, Egypt, Saudi Arabia, northern Africa, Madagascar, Mexico, Chile.

Garantiana MASCKE, 1907, p. 24, *non* HYATT, 1900, p. 583, *nom. nud.* [**Ammonites garantianus* D'ORBIGNY, 1846 in 1842–1851, p. 377; OD, ICZN Opinion 324, 1955a, p. 230] [=*Baculatoceras* MASCKE, 1907, p. 23 (type, *Ammonites baculatus* QUENSTEDT, 1856 in 1856–1858, p. 402, OD); =*Garantia* ROLLIER, 1909, p. 613, 615, obj.; =*Hlawiceras* BUCKMAN, 1921, pl. 240 (type, *H. platyrrymum,* OD); =*Odontolkites* BUCKMAN, 1925b, pl. 582 (type, *Ammonites parkinsoni longidens* QUENSTEDT, 1846 in 1845–1849, p. 144, OD); =*Pseudogarantiana* BENTZ, 1928, p. 198 (type, *P. dichotoma,* OD); =*Subgarantiana* BENTZ, 1928, p. 187 (type, *Garantiana subgaranti* WETZEL, 1911, p. 175, OD); ?=*Praeparkinsonia* SCHMIDTILL & KRUMBECK, 1931, p. 854 (type, *P. garantiformis,* SD ROMAN, 1938, p. 239); =*Paragarantiana* GAUTHIER, 2003, p. 262 (type, *Odontolkites longidoides* GAUTHIER, TRÉVISAN & JORON, 2000, p. 18, OD)]. Moderately evolute, whorl section quadrate, slightly compressed; primary ribs straight, usually biplicate high on whorl side, but some simple or triplicate ribs also occur; ventrolateral tubercles may occur at the point of bifurcation; secondary ribs moderately projected onto venter terminating at small ventral tubercles at the ventral smooth band, which may be as wide as the whole venter and form a tabulate whorl section. Dimorphic: macroconchs have simple, depressed peristomes slightly flared laterally and with a ventral projection; microconchs (*Pseudogarantiana*) have more single ribs throughout,

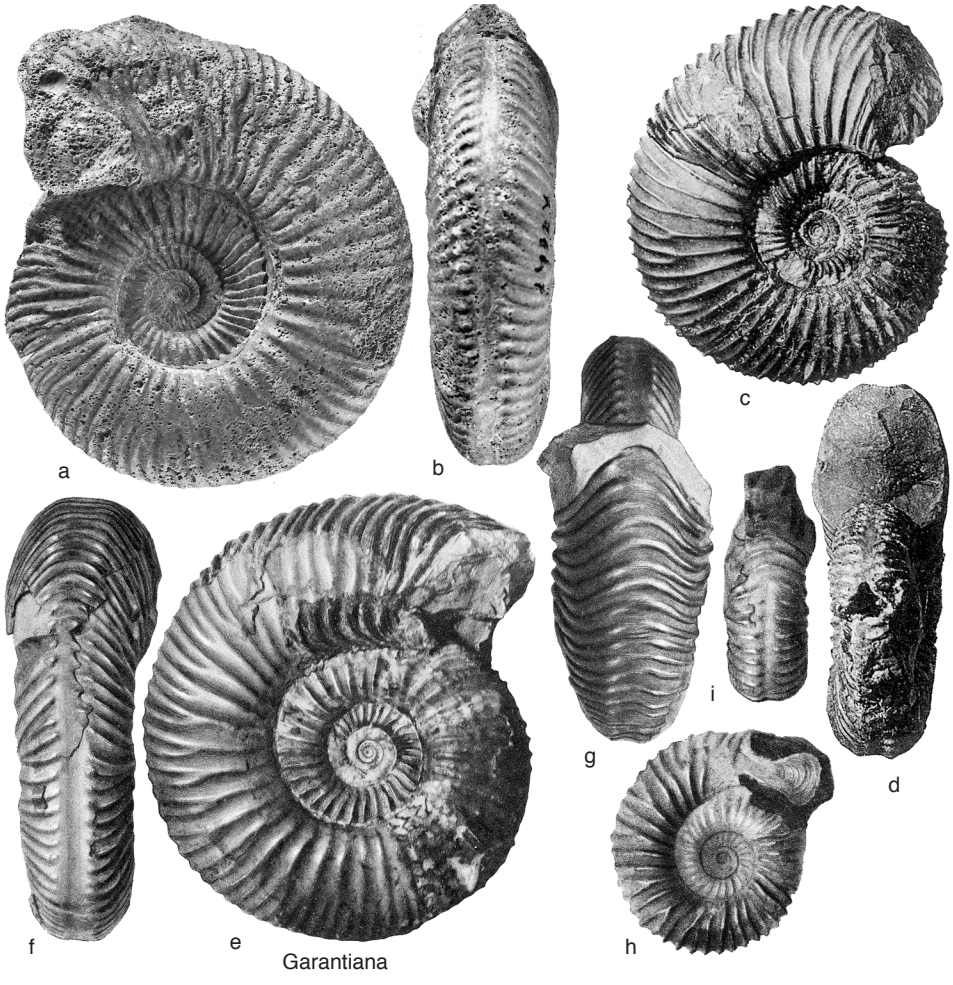

FIG. 15. Stephanoceratidae (p. 19–20).

and moderate to spatulate lateral lappets in the adult mouth border. *Middle Jurassic (upper Bajocian, upper* Subfurcatum *Zone–lower Bathonian).* Europe, northern Africa, Caucasus, Ukraine (Donetsk), Russia (Zabaykalsky Krai).——FIG. 15*a–b.* **G. garantiana* (D'ORBIGNY), lectotype (designated by ARKELL, 1956, pl. 35,*2*), macroconch, St.-Vigor-le-Grand, Calvados, France, ×0.7 (Fischer, 1994, pl. 47,*1a,c*).——FIG. 15*c–g. G. subgaranti* WETZEL, macroconch, *Garantiana* Zone, type species of *Subgarantiana,* Bethel, Bielefeld, Germany; *c–d,* holotype, macroconch, ×1 (Wetzel, 1911, pl. 13,*3–4*); *e–g,* topotype, complete macroconch, ×0.7 (Bentz, 1928, pl. 16,*1a–c*).——FIG. 15*h–i. G. dichotoma* BENTZ, holotype, complete microconch with spatulate lappets, Bethel, Bielefeld, Germany, ×1 (Bentz, 1928, pl. 19,*2a,c*).

Strenoceras HYATT, 1900, p. 583 [**Ammonites niortensis* D'ORBIGNY, 1846 in 1842–1851, p. 372; OD] [=*Orthogarantiana* BENTZ, 1928, p. 183 (type, *Garantiana schroederi* BENTZ, 1924, p. 156, OD)]. Evolute, whorl section rounded to slightly depressed; primary ribs strong and straight, simple or dividing into two or more secondaries at moderate to large ventrolateral tubercles; secondary ribs rectiradiate on the venter and terminate at tubercles bordering a narrow ventral smooth band. Dimorphic: adult macroconchs (*Orthogarantiana*) have contracted and collared perstomes; microconchs (*Strenoceras*) have lateral lappets in the adult mouth border, and more single ribs and larger tubercles in some. Differs from *Garantiana* in the more evolute whorls, stronger rectiradiate ribs, large ventrolateral tubercles and narrow ventral sulcus,

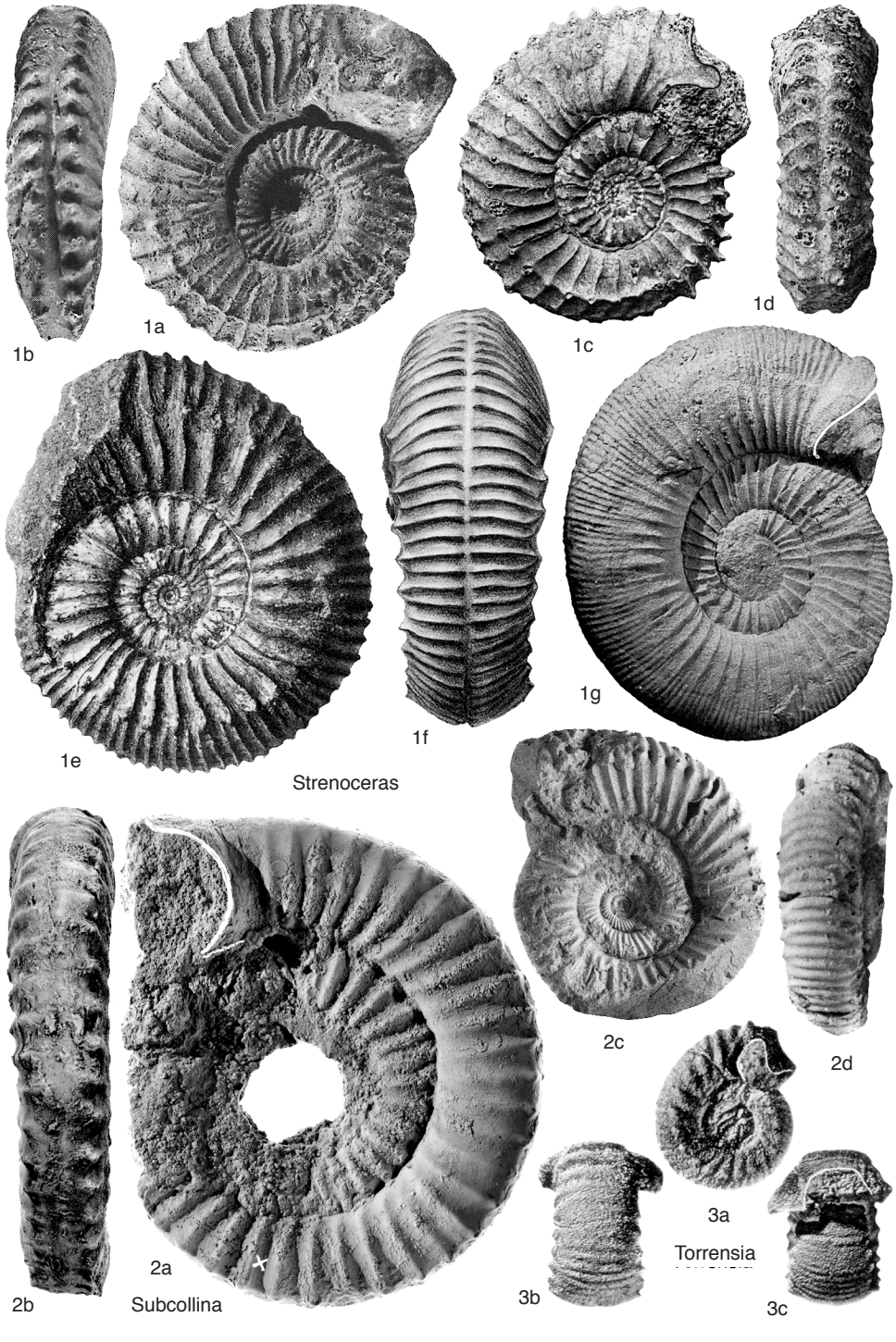

FIG. 16. Stephanoceratidae (p. 20–23).

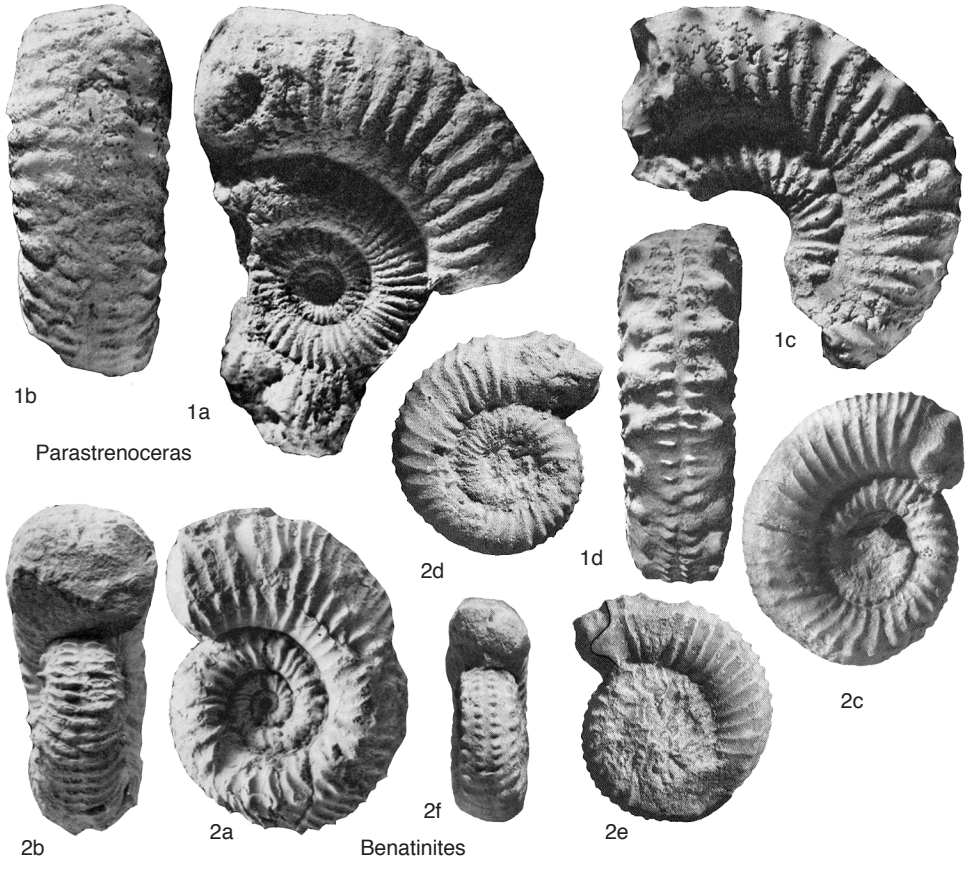

FIG. 17. Stephanoceratidae (p. 23–24).

although some early forms have dense secondary ribbing as in *Cadomites*. GAUTHIER & others, 2002. *Middle Jurassic (upper Bajocian, Subfurcatum–Garantiana Zones):* Europe, Russia (middle Volga River area), Caucasus, northern Africa.——FIG. 16,*1a–b*. **S. niortense,* neotype (designated by FISCHER, 1994, p. 107), microconch, Thorigné, Deux-Sèvres, France, ×1 (Fischer, 1994, pl. 44,*4a–b*).——FIG. 16,*1c–d*. *S. bajocense* (DE BLAINVILLE), holotype, microconch, Calvados, France, ×1 (Douvillé, 1909, pl. 133).——FIG. 16,*1e–f*. *S. schroederi* (BENTZ), lectotype (designated by BENTZ, 1928, p. 183), macroconch, *Subfurcatum* Zone, Lindenbruchweg, Bad Harzburg, Lower Saxony, Germany, ×0.7 (Bentz, 1924, pl. 5,*2a–b*).——FIG. 16,*1g*. *S. haugi* (PAVIA), holotype, macroconch with fine ribs and lipped peristome, *Subfurcatum* Zone, *Polygyralis* Subzone, Chaudon, 14 km southeast of Digne, Alpes-des-Haute Provence, France, ×0.7 (Pavia, 1973, pl. 18,*1*).

Subcollina SPATH, 1925b, p. 171 [**S. yeovilensis;* OD]. Evolute serpenticones; subquadrate whorl section, with flat to slightly concave venter; strong, straight primary ribs end at ventrolateral nodes or tubercles, from which two or three vestigial secondary ribs pass onto the flat venter and are usually interrupted by a narrow midventral smooth band; the ventrolateral nodes alternate on each side of the venter and secondary ribs alternate or zigzag between them; sutures simple with long slender lobes. Dimorphic: macroconchs with adult mouth border expanded laterally and projected on venter; microconchs poorly known, but probably adult at 40–50 mm in diameter, though the form of the mouth border is not known. SANDOVAL & WESTERMANN, 1986, PAVIA, 2000. *Middle Jurassic (Bajocian,* Humphriesianum–Subfurcatum *Zones):* England, France, Italy, ?Austria, Mexico.——FIG. 16,*2a–b*. **S. yeovilensis,* holotype, macroconch, Yeovil, Somerset, England, ×0.65 (new; The Natural History Museum, London, NHMUK C.1932).——FIG. 16,*2c–d*. *S. sandovali* PAVIA, holotype, almost complete microconch, Barranco de La Bolita, 18 km west-northwest of Tlaxiaco, Oaxaca State, Mexico, ×1 (Sandoval & Westermann, 1986, fig. 32-1, 32-2).

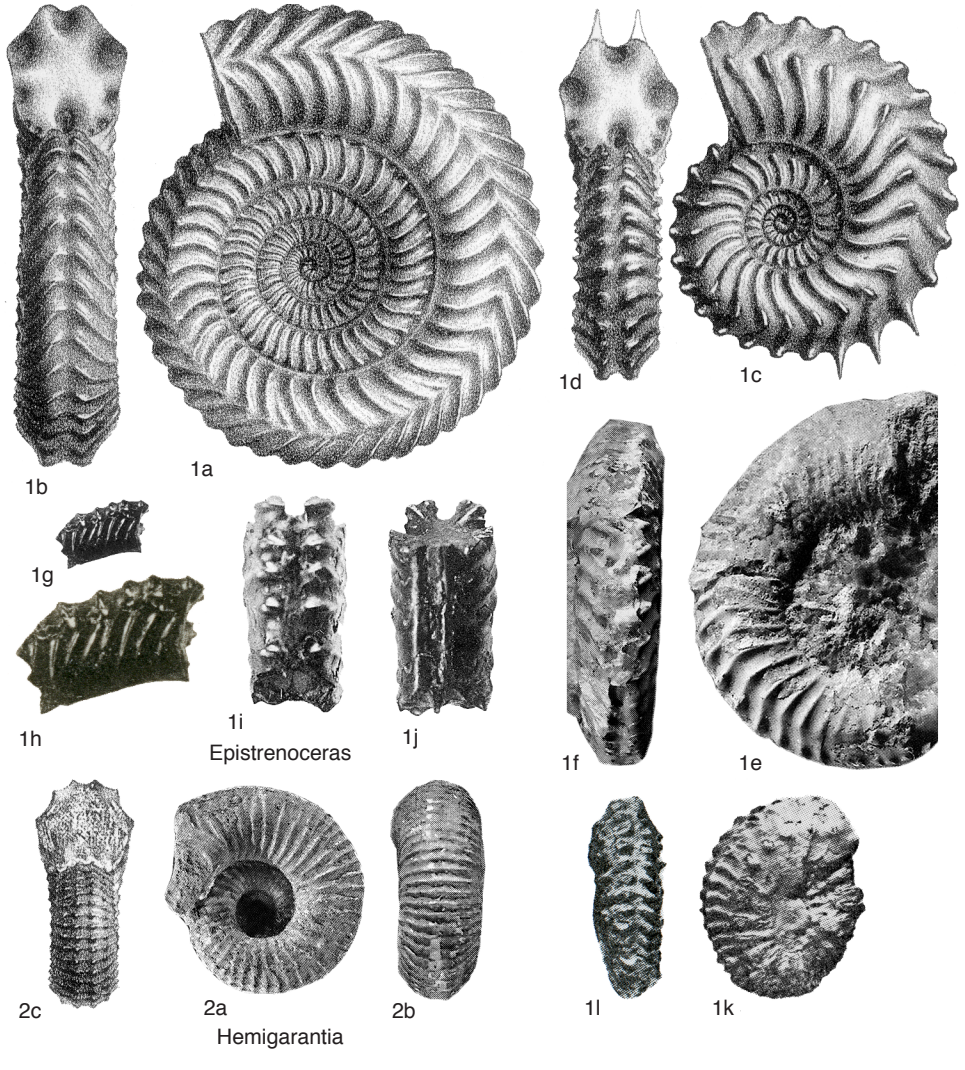

FIG. 18. Stephanoceratidae (p. 24).

Torrensia STURANI, 1971, p. 154 [**Stephanoceras gibbum* PARONA, 1896, p. 17; OD]. Microconchs; dwarf evolute cadicones; adult size only 6–9 mm in diameter; whorls enlarge in segments; strong, prorsiradiate primary ribs end at ventrolateral tubercles, from which single or bifurcating secondary ribs cross the venter, but are weakened at midventer. Microconchs: adult body chamber elliptically coiled and strongly contracted; adult mouth border with collar expanded laterally into shoulders at the base of long drooping spatulate lappets. Associated macroconchs not identified. STURANI, 1971. *Middle Jurassic (upper Bajocian,* Subfurcatum *Zone):* England, Italy (Venetian Alps).——FIG. 16,*3a–c.* **T. gibba* (PARONA), lectotype, microconch, Monte Longara, north of Gallio, Veneto, Italy, ×3 (Sturani, 1971, pl. 13,*14*).

Parastrenoceras OCHOTERENA, 1963, p. 5 [**P. mixteca;* OD]. Evolute, subquadrate, slightly depressed whorl section; single primary ribs end at, or are looped in pairs to, ventrolateral tubercles; feeble secondary ribs on the venter are interrupted at a smooth midventral groove, bordered by rows of fine but prominent tubercles. Dimorphic: macroconchs have a constriction and collar in the adult mouth border; microconchs with constriction and lateral lappet in mouth border. European species include *P. caumontii* (D'ORBIGNY, 1846 in 1842–1851, p. 406). STURANI, 1971 (p. 162). *Middle Jurassic (upper Bajocian):* France, Italy, Mexico.——FIG.

17,*1a–d. *P. mixteca,* San Juan Diquiyú, northwestern Oaxaca, Mexico; *a–b,* holotype, probable macroconch, ×0.8; *c–d,* probable microconch, ×0.8 (Ochoterena, 1963, pl. 1,*1a–b,* pl. 2,*1b–c*).

Benatinites Schlögl & others, 2006, p. 115 [**Parastrenoceras schlageri* Krystyn, 1972, p. 258; OD)] [=*Lugariceras* Schlögl & others, 2006, p. 118 (type, *Benatinites (Lugariceras) lugarensis,* OD)]. Small size, evolute, slightly depressed whorl section; single primary ribs end at ventrolateral tubercles; vestigial secondary ribs on venter are interrupted at a smooth midventral band or groove, bordered by rows of small tubercles. Dimorphic: macroconchs complete and adult at 37–45 mm in diameter, with a constriction and collar at the mouth border; microconchs (*Lugariceras*) are adult at about 15 mm in diameter, with a constriction and lateral lappets in the mouth border. Similar to the mainly Mexican–Central American genus *Parastrenoceras,* but much smaller in size, and with smaller tubercles in both dimorphs. *Middle Jurassic (upper Bajocian–lower Bathonian):* Austria, Slovakia, Spain, Azerbaijan (Nakhchivan), Morocco.——Fig. 17,*2a–f. *B. schlageri* (Krystyn); *a–b,* holotype, macroconch, Steinbruch Neumühle, Vienna, Austria, ×1 (Krystyn, 1972, pl, 8,*2a–b*); *c,* complete macroconch with constriction in mouth border, Pieniny Klippen Belt, Slovakia, ×1 (Schlögl & others, 2006, fig. 2,*1a*); *d–f,* complete microconch with lappets, holotype of type species of *Lugariceras,* Sierra del Lugar, Murcia, Spain, ×2 (Schlögl & others, 2006, fig. 6,*1a–b,d*).

Hemigarantia Spath, 1928b, p. 253 [**Ammonites julii* d'Orbigny, 1846 in 1842–1851, p. 420; OD]. Like *Garantiana* but with an additional row of ventrolateral tubercles making three rows on each side of the whorl; dimorphism unknown. Occurs just below *Epistrenoceras* and has a similar distribution, but is separated from *Garantiana* by a considerable stratigraphical gap, and the phylogentical relations are obscure. *Middle Jurassic (Bathonian):* France, Spain, Romania, Algeria, ?Mexico.——Fig. 18,*2a–c. *H. julii* (d'Orbigny), holotype, Niort, Deux-Sèvres, France, ×1 (*a–b,* Fischer, 1994, pl. 53,*5a,c; c,* d'Orbigny, 1846 in 1842–1851, pl. 145,*7*).

Epistrenoceras Bentz, 1928 (1 November), p. 161 [**Ammonites contrarius* d'Orbigny, 1846 in 1842–1851, p. 418; OD] [=*Pseudostrenoceras* Spath, 1928b (December), p. 253 (type, *Cosmoceras histricoides* Rollier, 1911, p. 290, *nom. nov. pro Ammonites contrarius* d'Orbigny, 1846 in 1842–1851, pl. 145,*3–4, non* pl. 145,*1–2,* OD); =*Sulcohamites* Wetzel, 1937, p. 135 (type, *S. eminensis,* OD); =*Sulcohamitoides* Beznosov in Beznosov & Kutuzova, 1990, p. 26 (type, *S. karaimanensis,* OD)]. Evolute, quadrate, with slightly compressed trapezoidal whorl section; primary ribs curve strongly forwards ending high on whorl side at subdued tubercles, from which single secondary ribs are angled strongly backwards ending in larger tubercles at narrow, sunken, smooth midventer. Dimorphic: microconchs differ only by smaller size and lappets in the adult mouth border. Similar to *Strenoceras* except for the marked chevron-type ribbing on the side of the whorl, but direct affinity seems unlikely in view of the large stratigraphical gap between the last known *Garantiana* in the *Garantiana* Zone, upper Bajocian, and *Epistrenoceras* which appears to be confined to the top of the middle Bathonian and the upper Bathonian. An alternative placement for *Epistrenoceras* is with the Spiroceratoidea as a recoiled spiroceratid, as suggested by Dietl (1978, p. 55) and discussed by Callomon (1981, p. 131). *Sulcohamites* and *Sulcohamitoides* are both known from single, small specimens only. *Sulcohamites* is a 13-mm-long fragment of a curved phragmocone at a whorl height of 7 mm, with ornament similar to the inner whorls of *Epistrenoceras,* and the evidence that it is part of a loosely coiled shell is unclear. *Sulcohamitoides* is 27.5 mm in diameter, apparently closely coiled, with an unknown amount of body chamber, and also has ornament similar to *Epistrenoceras.* Both are from the middle Bathonian or the basal part of the upper Bathonian, and are unlikely to be related to *Strenoceras.* Douvillé, 1915. *Middle Jurassic (upper middle–upper Bathonian,* Retrocostatum *[=*Orbis*] Zone):* Europe, Romania, Turkmenistan, India (Kutch, northern Gujarat), Madagascar, Mexico, Chile.——Fig. 18,*1a–f. E. contrarium* (d'Orbigny); *a–d,* Niort, Deux-Sèvres, France; *a–b,* syntype (now lost), ×1 (d'Orbigny, 1846 in 1842–1851, pl. 145,*1–2*); *c–d,* another syntype (now lost), possibly a microconch, ×1 (d'Orbigny, 1846 in 1842–1851, pl. 145,*3–4*); *e–f,* ?macroconch, Anse-de-Jard (Jard-sur-Mer), Vendée, France, ×1 (Fischer, 1994, pl. 54,*1a–b*).——Fig. 18,*1g–j. E. eminense* (Wetzel), holotype, Eimen, Lower Saxony, Germany; *g,* side view, ×1; *h–j,* side, ventral and dorsal views, ×2 (Wetzel, 1937, pl. 14,*8*).——Fig. 18,*1k–l. E. karaimanense* (Beznesov), holotype, Karaiman Wells, 39°58′N, 54°8′E, Balkan, western Turkmenistan, ×1 (Beznesov in Beznesov & Kutuzova, 1990, pl. 1,*8*).

Subfamily ERMOCERATINAE Howarth, nov.

A morphologically distinctive group, restricted geographically to the Arabian Peninsula and northern Africa. Although widely variable in morphology, all are more involute than Garantianinae, and consistently develop a midventral groove at some growth stage. The morphological variation is difficult to assess due to insufficient specimens collected from known horizons, and relatively poor preservation. For similar reasons, dimorphism is problematical: macroconchs and microconchs are known, but are difficult to associate, partly due to lack of sufficient specimens with mouth borders preserved. Their restricted distribution in epicontinental facies suggests that

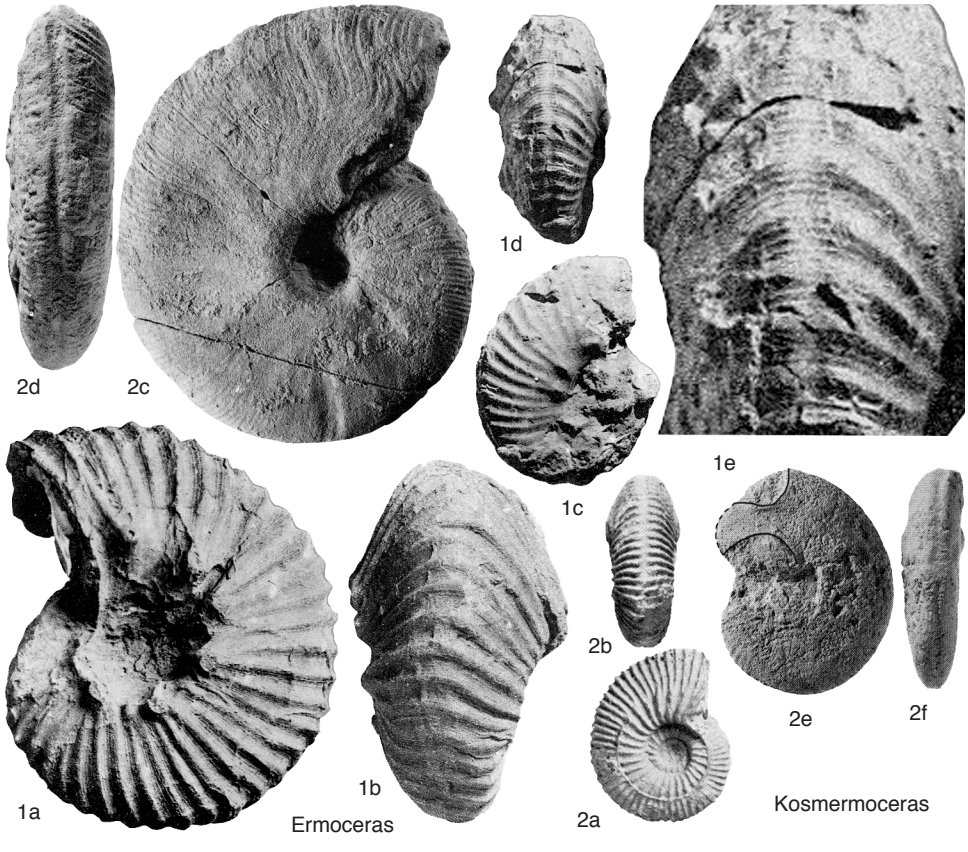

FIG. 19. Stephanoceratidae (p. 25–26).

they are the result of a short-lived evolutionary burst at the top of the lower Bajocian in relative geographical isolation. *Middle Jurassic (lower Bajocian, upper* Humphriesianum *Zone–upper Bajocian,* Garantiana *Zone):* Morocco, Algeria, Italy, Egypt, Saudi Arabia, Jordan.

Ermoceras H. DOUVILLÉ, 1916, p. 17 [**E. mogharense;* OD]. Involute with arched whorl section; short, strong, bullate primary ribs branch close to the umbilical edge, sometimes at a lateral tubercle, into sheaves of strong prorsiradiate secondary ribs that are interrupted by a deep midventral groove on inner whorls, but are continuous across the venter on outer whorls; radial strigation occurs between the secondary ribs; small nodes or tubercles border the midventral groove in some species. Dimorphism is uncertain, due to lack of evidence. *Middle Jurassic (Bajocian,* Humphriesianum-Subfurcatum *Zones):* Morocco, Algeria, Italy (Sicily), Egypt, Jordan, central Saudi Arabia.——FIG. 19,*1a–e.* **E. mogharense,* Gebel Aroussieh, Gebel Maghara (Jabal al Magharah), North Sinai, Egypt; *a–b,* holotype, ×1; *c–e,* paratype, showing striations across the venter; *c–d,* ×1; *e,* ×3 (Douvillé, 1916, pl. 2,*8–9*).

Kosmermoceras ARKELL, 1952a, p. 273 [**Ermoceras (Kosmermoceras) runcinatum;* OD]. Involute, with compressed, flat-sided whorls and narrow, tabulate venter; fine, sinuous, falcoid or falcate ribs divide irregularly about midwhorl into many secondary ribs, which curve forwards and end at a prominent midventral groove; no lateral tubercles, but rows of small tubercles sometimes border the ventral groove. Dimorphic: macroconchs with plain, sinuous mouth border; microconchs with lateral lappets in the adult mouth border. Smaller and more compressed than *Ermoceras,* with a flat venter, finer ribs, and no lateral tubercles. *Middle Jurassic (upper Bajocian):* Morocco, Algeria, Egypt (North Sinai), Saudi Arabia.——FIG. 19,*2a–b.* **K. runcinatum,* holotype, small inner whorls, 19 km southeast of Juraifa, Jebel Tuwaiq, Saudi Arabia, ×1 (Arkell, 1952a, pl. 22,*8a–b*).——FIG. 19,*2c–d. K. elegans* (DOUVILLÉ), large, nearly complete adult, macroconch or microconch uncertain, Juwai, 188 km northwest of Riyadh, Saudi Arabia, ×1 (Énay & Mangold, 1996, fig. 4*a–b*).——FIG. 19,*2e–f. K. inerme* (DOUVILLÉ), complete, weathered microconch with most of a

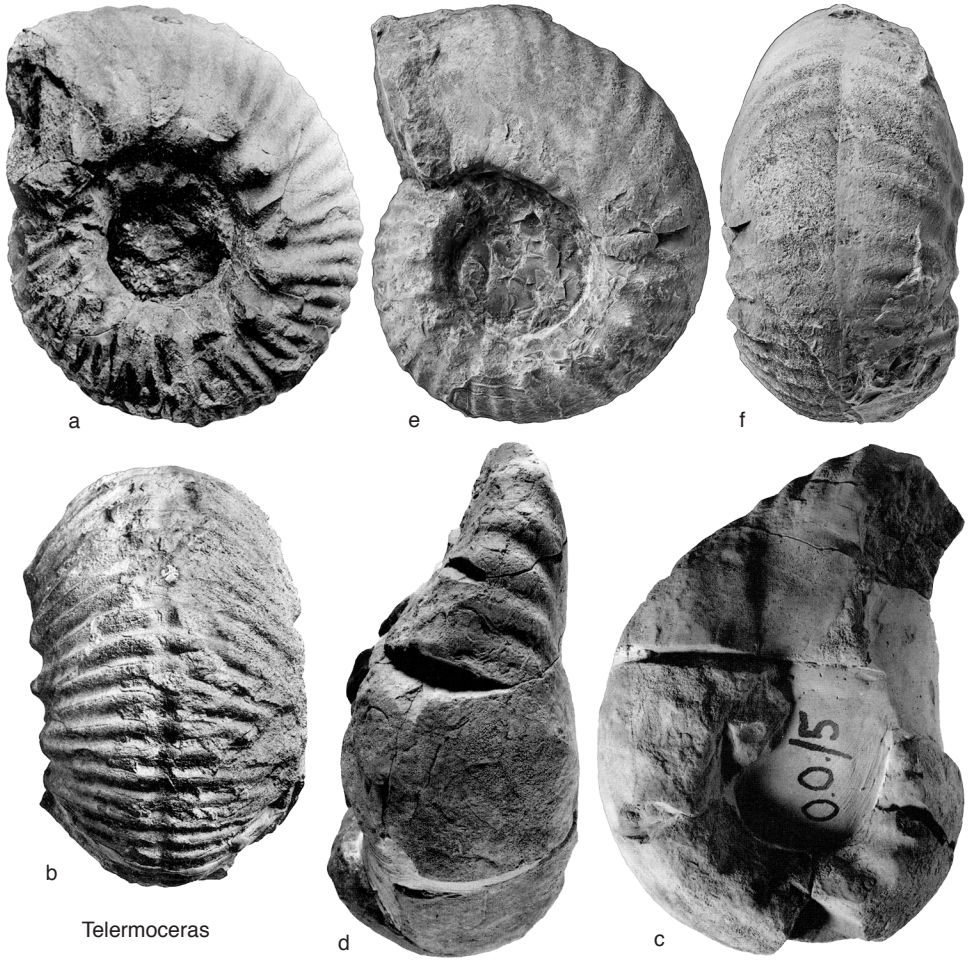

FIG. 20. Stephanoceratidae (p. 26).

lappet preserved, Dhurma area, Saudi Arabia, ×1 (Énay & Mangold, 1996, fig. 10*a–b*).

Telermoceras ARKELL, 1952a, p. 273 [**Coeloceras coronatoides* H. DOUVILLÉ, 1916, p. 24; OD]. Large, up to 250–300 mm in diameter; inflated cadicones, with rounded venter; very short primary ribs end at large lateral nodes or tubercles, from which coarse, prorsiradiate secondary ribs pass onto venter; a narrow, prominent midventral groove occurs on inner and middle whorls but is lost on outer whorls; mouth border plain with a ventral rostrum. Microconchs with lappets have not been identified, but the possibility of dimorphism on size alone with similar plain adult mouth borders in smaller microconchs has been discussed by ÉNAY & MANGOLD (1996). *Middle Jurassic (upper Bajocian):* Morocco, Algeria, Egypt, central Saudi Arabia.——FIG. 20*a–f.* **T. coronatoides* (DOUVILLÉ); *a–b,* holotype, Gebel Aroussieh, Gebel Maghara (Jabal al Magharah), North Sinai, Egypt, ×0.6 (Douvillé, 1916, pl. 1,*3*); *c–d,* large, weathered, poorly preserved adult macroconch, 290 mm in diameter, with plain mouth border and ventral rostrum, Bou Rached, south of Guercif, Morocco, ×0.25 (Énay & Mangold, 1996, fig. 1*a–b*); *e–f,* small adult, 102 mm in diameter, possible microconch, with contracted final quarter whorl and plain mouth border, Gebel Maghara (Jabal al Magharah), North Sinai, Egypt, ×0.5 (new; Natural History Museum, London, England, NHMUK C.71759; also figured by Énay & Mangold, 1996, fig. 3*a–b*).

Subfamily CADOMITINAE Westermann, 1956

[Cadomitinae WESTERMANN, 1956a, p. 251]

Strongly dimorphic descendents of Stephanoceratinae, appearing abruptly near the top of the lower Bajocian and persisting with little change into the lower Callovian.

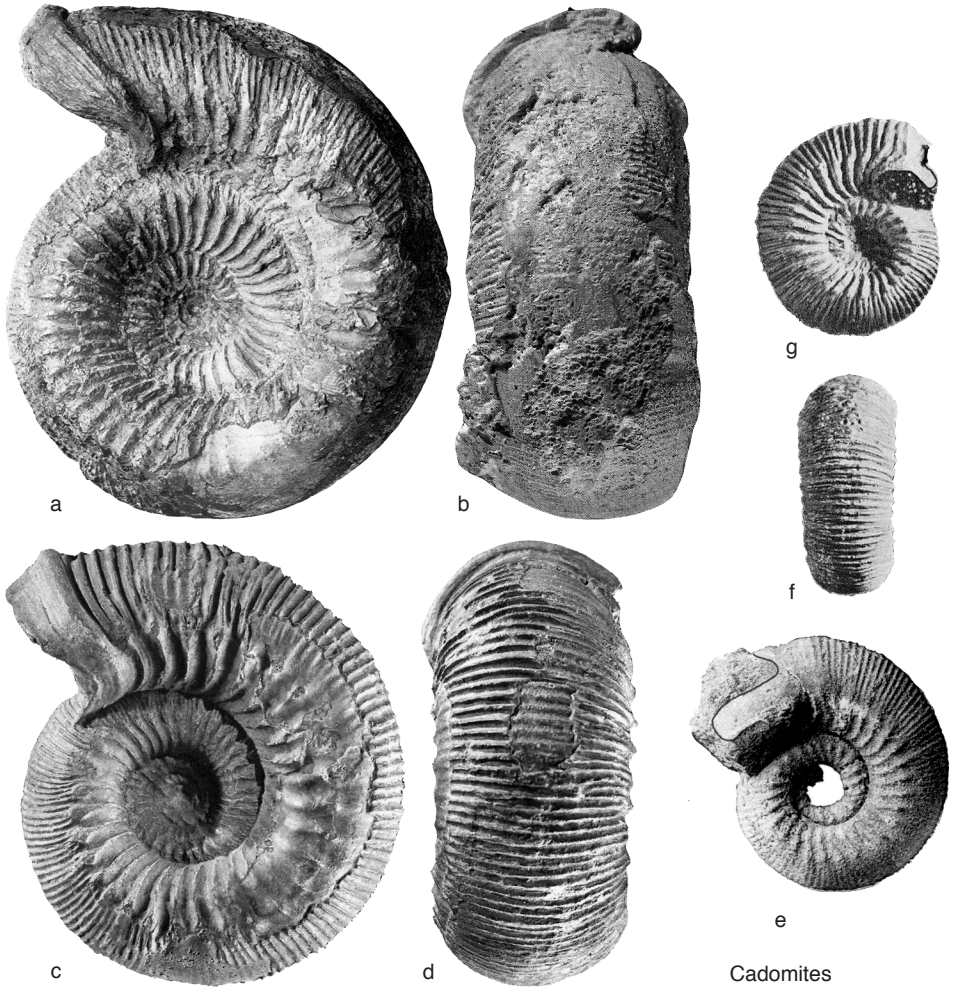

FIG. 21. Stephanoceratidae (p. 27–28).

Similar to *S. (Stephanoceras),* but more involute and inflated, with dense, fine secondary ribs emanating in sheaves from closely spaced midlateral tubercles. Septa have characteristic large second lateral saddles and barely retracted umbilical lobes resembling those of Otoitinae, and differ from those of Stephanoceratinae (WESTERMANN, 1956a; 1958). *Middle Jurassic (uppermost lower Bajocian–lower Callovian):* worldwide, except Boreal.

Cadomites MUNIER-CHALMAS, 1892, p. clxxii [**Ammonites deslongchampsi* D'ORBIGNY, 1846 in 1842–1851, p. 405; OD, ICZN Opinion 324, 1955a, p. 230, 236)] [=*Polyplectites* MASCKE, 1907, p. 23 (type, *Ammonites linguiferus* D'ORBIGNY, 1846 in 1842–1851, p. 402, OD); =*Polystephanus* BUCKMAN, 1922, pl. 311, *non* BRANDT, 1835, p. 12 (Coelenterata) (type, *Stephanoceras daubenyi* GEMMELLARO, 1877, p. 141, OD); =*Stegeostephanus* BUCKMAN, 1922, pl. 312 (type, *S. stegeus,* OD)]. Moderately evolute, with round to depressed, quickly expanding, inflated whorls; primary ribs divide at sharp midlateral tubercles into sheaves of fine secondaries passing over the venter without interruption; ribbing remains unaltered on the adult body chamber. Macroconchs of medium size, with contracting adult body chamber one-half to three-quarters whorl long, with thick, collared lip at the adult mouth border; microconchs (*Polyplectites*) with more involute final whorl and simple lappets in the mouth border. *Middle Jurassic (uppermost lower Bajocian–lower Callovian):* Europe (especially Tethys), northern Africa, Madagascar, Azerbaijan,

Iran, India (Kutch, northern Gujarat), Indonesia, New Guinea, Japan, Chile.——Fig. 21*a–b.* **C. deslongchampsi* (d'Orbigny), lectotype (designated by Bigot, 1905, p. 254), complete adult macroconch, upper Bajocian, Caen, Calvados, France; *a,* ×0.8 (Douvillé, 1909, pl. 132); *b,* ×0.8 (Fischer, 1994, pl. 46,*1c*).——Fig. 21*c–d. C. psilacanthus* (Wermbter), lectotype, complete adult macroconch with collared mouth border, upper Bajocian, Bayeux, Calvados, France, ×0.6 (Fischer, 1994, pl. 45,*4a,c*).——Fig. 21*e–g. C. linguiferum* (d'Orbigny); *e,* topotype (designated as neotype by Westermann, 1954, p. 339, 347, but invalid; see Fischer, 1994, p. 123–124, and ICZN Code, 1999, Article 75.8), type species of *Polyplectites,* middle Bathonian, adult microconch with lappet, Luçon, Vendée, France, ×1 (de Grossouvre, 1930, pl. 40,*10*); *f–g,* adult microconch with lappet, Thalmässing, Franconian Alb, Germany, ×1 (Westermann, 1954, pl. 32,*3a,c*).

Family KOSMOCERATIDAE Haug, 1887

[Kosmoceratidae Haug, 1887, p. 156, footnote 1, as Cosmoceratidae]

The Kosmoceratidae are one of the best-documented examples of an evolutionary lineage known in Jurassic ammonites. Their progress can be followed essentially monophyletically throughout their range: from the *Humphriesianum* Zone of the lower Bajocian (if their precursors, the Cadomitinae are included) to their end-members in the *Lamberti* Zone of the upper Callovian, covering 18 ammonite zones and 42 subzones, spanning perhaps 5 million years.

Early forms (Gowericeratinae) are round whorled, evolute, and densely ribbed as in *Cadomites,* and they evolve into more involute and compressed forms (Kosmoceratinae) with smooth, tabulate (runcinate) venters and lateral and ventrolateral tubercles. Strongly dimorphic: macroconchs have simple peristomes, microconchs have long, narrow lappets. Sutures are fairly simple with rather short, unretracted lobes. Aptychi, double-valved, thin, and concentrically ribbed (*Praestriaptychus*), are occasionally found in situ in *Kosmoceras.* Traditionally, it was thought that Kosmoceratidae were derived from Macrocephalitidae because of partial homeomorphism between certain members, such as *Kepplerites* and *Macrocephalites.* However, this similarity is only between macroconchs of Kosmoceratidae and microconchs of Macrocephalitidae, and both families are geographically restricted and mutually exclusive. The first Kosmoceratidae appear more or less simultaneously in the Boreal Bathonian of North America and Greenland as forms that are very similar to *Cadomites,* from which their direct descent in the Bathonian is not in doubt. Buckman, 1909–1930; R. Douvillé, 1915; Brinkmann, 1929a, 1929b; Makowski, 1952; Imlay, 1953a, 1953b; Tintant, 1964. *Middle Jurassic (middle Bathonian–upper Callovian):* worldwide in Boreal and Subboreal Provinces of the Northern Hemisphere.

Subfamily GOWERICERATINAE Buckman, 1926

[*nom. transl.* Callomon, 1981, p. 145, *ex* Gowericeratidae Buckman, 1926, p. 20] [="Runcinati" Seebach, 1864, p. 151; =Keppleritinae Tintant, 1964, p. 65]

Early forms are round whorled, resembling ancestral *Cadomites,* but usually with a double row of lateral tubercles, the inner one formed by thickening of the short bullate primary ribs. Later forms develop tabulate venters bordered by rows of ventrolateral tubercles, particularly in the microconchs. Strongly dimorphic: microconchs with lappets. *Middle Jurassic (middle Bathonian–lower Callovian):* Boreal and Subboreal Provinces of the northern hemisphere.

Kepplerites Neumayr & Uhlig, 1892, p. 53 [**Ammonites keppleri* Oppel, 1862 in 1862–1863, p. 151; OD] [=*Seymourites* Kilian & Reboul, 1909, p. 26 (type, *Ammonites loganianus* Whiteaves, 1876, p. 27, OD); =*Cerericeras* Buckman, 1922, pl. 286 (type, *C. cereale,* OD); =*Galilaeanus* Buckman, 1922, pl. 293 (type, *G. crucifer,* OD); =*Galilaeites* Buckman, 1922, pl. 294 (type, *G. curtilobus,* OD); =*Pepplerites* Petitclerc, 1926, pl. 3,*15,* misspelling; =*Yakounites* McLearn, 1927, p. 71 (type, *Y. plenus,* OD); =*Yakounoceras* McLearn, 1927, p. 71 (type, *Y. gitinsi,* OD)]. Large, moderately involute, inflated whorl section and rounded venter; short primary ribs are angled forwards on the umbilical wall and divide into several secondary ribs low on the whorl side, usually at a lateral tubercle; ribs pass over the venter without interruption. Dimorphic: adult whorl of macroconch becomes more evolute and contracts markedly towards the adult body chamber, ending in a simple aperture; microconchs much smaller with lappets in the adult aperture. Derived from ancestral *Cadomites,* early forms, with a tabulate venter on the

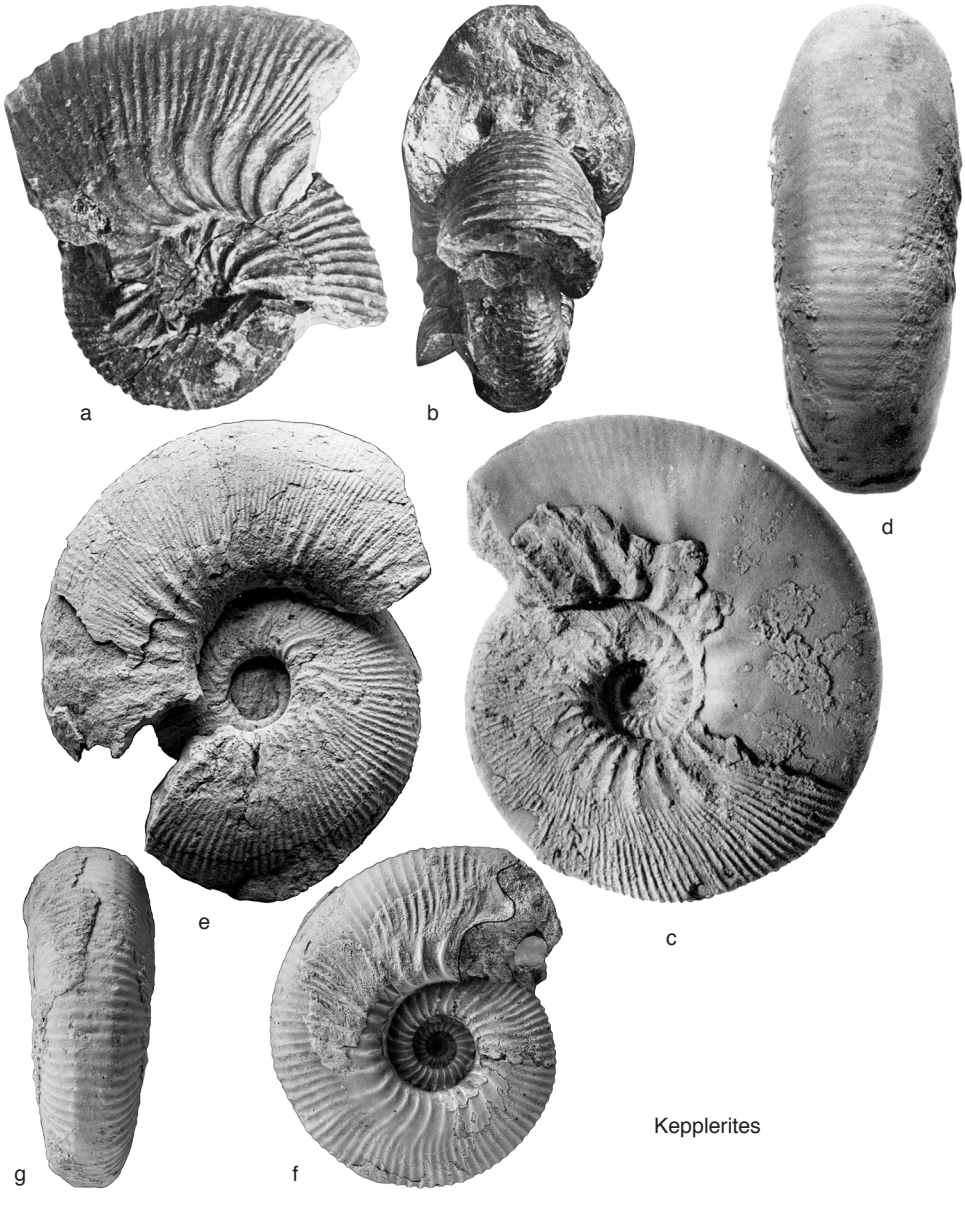

FIG. 22. Kosmoceratidae (p. 28–30).

inner whorls, were restricted to the middle and upper Bathonian of the Boreal Arctic, western Canada, and northern part of the Western Interior of the USA; in the upper Bathonian they spread southwards across the Russian Platform, then colonized the rest of Subboreal Europe in the earliest Callovian, where the sudden appearance of *K. keppleri* has been taken to define the base of the Callovian. *Middle Jurassic (middle Bathonian–lower Callovian):* northern and eastern Europe, Caucasus, Kazakhstan (Mangystau), Russia (Franz Josef Land), Japan, eastern Greenland, Norway (Svalbard), USA (southern Alaska, California, Oregon, Montana), Canada (Saskatchewan, British Columbia).——FIG. 22*a–b.* **K. keppleri* (OPPEL), lectotype, incomplete macroconch, lower Callovian, *Herveyi* Zone, Eningen, Achalm, Württemberg, Germany, ×0.7 (Schlegelmilch, 1985, pl. 39,*6*).——FIG. 22*c–d. K. curtilobus* (BUCKMAN), complete adult macroconch, Wiltshire, England, ×0.7 (Tintant, 1964, pl. 5,*1a,c*).——FIG. 22*e. K.*

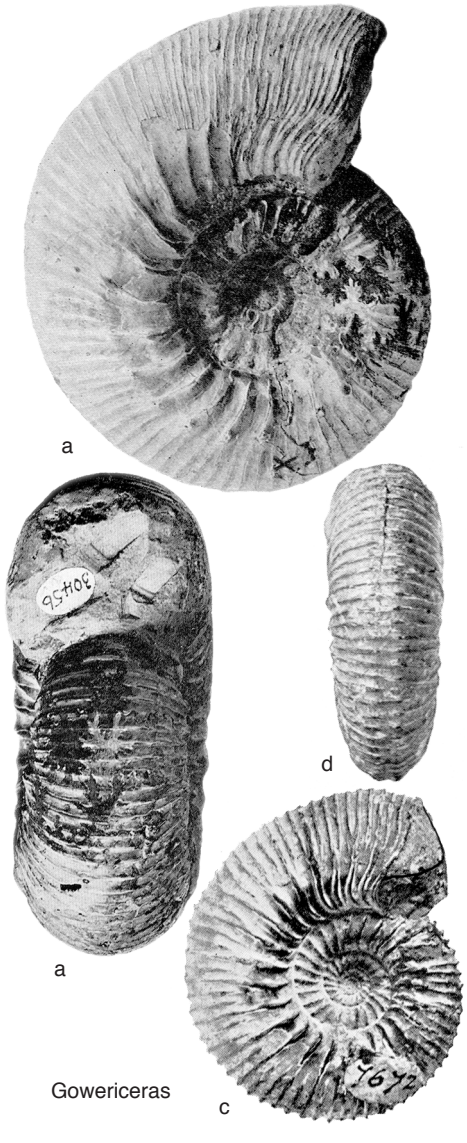

FIG. 23. Kosmoceratidae (p. 30).

stephanoides BIRKELUND & CALLOMON, holotype, the earliest form, middle Bathonian, *Cranocephaloide* Zone, Vardekløft, 70°36.1′N, 22°37.4′W, Jameson Land, eastern Greenland (see HIGGINS, 2010, for details of all Greenland localities in this paper), ×0.7 (Spath, 1932, pl. 26,*6*).——FIG. 22*f–g. K. curticornutus* (BUCKMAN), holotype, adult microconch with lappet, Kellaways, Wiltshire, England, ×1 (new; Natural History Museum, London, NHMUK C.76753).

Gowericeras BUCKMAN, 1921, p. 54 [**G. metorchum;* OD; =*Ammonites gowerianum* J. DE C. SOWERBY, 1827, p. 94] [=*Toricelliceras* BUCKMAN, 1922, pl. 292 (type, *Ammonites toricellii* OPPEL, 1862 in 1862–1863, p. 153, OD); =*Galilaeiceras* BUCKMAN, 1922, pl. 290 (type, *Ammonites galilaeii* OPPEL, 1862 in 1862–1863, p. 152, OD); =*Toricellites* BUCKMAN, 1922, pl. 336 (type, *T. approximatus,* OD)]. Similar to *Kepplerites,* but smaller, more evolute, inner whorls with well-defined tabulate venter, more strongly ribbed, with mainly triplicate secondaries, and fine fasciculate ribbing confined to the last part of the adult body chamber. Dimorphic: macroconchs with simple adult mouth border; microconchs with small lappets. The earliest forms involute and round whorled; later forms develop tabulate venters and finally small ventrolateral tubercles on the margins of a narrow, smooth venter, and are transitional to *Kosmoceras. Middle Jurassic (upper Bathonian–lower Callovian,* Calloviense *Zone):* northern Europe, Caucasus, eastern Greenland, USA (?southern Alaska).——FIG. 23*a–b. *G. metorchum* BUCKMAN, holotype, complete adult macroconch, *Calloviense* Zone, *Koenigi* Subzone, Chippenham, Wiltshire, England, ×0.8 (Buckman, 1921, pl. 254).——FIG. 23*c–d. G. approximatus* (BUCKMAN), holotype, adult microconch with lappet, *Calloviense* Zone, *Koenigi* Subzone, Kellaways Clay, Rampisham, Dorset, England, ×1 (BUCKMAN, 1922, pl. 336,*1,3*).

Sigaloceras HYATT, 1900, p. 587 [*Ammonites calloviensis* J. SOWERBY, 1815, p. 3, pl. 104, *non* D'ORBIGNY, 1847 in 1842–1851, p. 455; OD, ICZN Opinion 324, 1955a, p. 231] [=*Gulielmina* BUCKMAN, 1925b, pl. 586 (type, *G. quinqueplicata*, OD)]. Moderately involute, compressed to trigonal whorl section, markedly tabulate venter; primary ribs divide into many secondaries on the lower half of whorl side; secondaries continuous across the venter. Dimorphic: the adult whorl of macroconchs becomes more evolute and contracts towards a simple aperture, and ribbing fades leaving widely spaced undulations near the umbilical edge; microconchs (*Gulielmina*) more evolute and compressed, with smooth venter and small ventrolateral tubercles on inner whorls, and ribbed to the end of the adult whorl, with short lappets. Smaller than *Kepplerites* and *Gowericeras* and tabulate venter more persistent. *Middle Jurassic (lower Callovian,* Calloviense *Zone and Subzone):* northern and eastern Europe, Caucasus, Kazakhstan (Mangystau), eastern Greenland.——FIG. 24,*1a–d. *S. calloviense* (J. SOWERBY), Kellaways, Wiltshire, England; *a–b,* lectotype, incomplete macroconch, ×0.65 (new; Natural History Museum, London, NHMUK 43924a); *c–d,* complete adult macroconch, ×0.65 (new; Natural History Museum, London, NHMUK 36819).——FIG. 24,*1e–f. S. quinqueplicatum* (BUCKMAN), holotype, microconch, Kellaways, Wiltshire, England, ×1 (Buckman, 1925b, pl. 586,*1–2*).

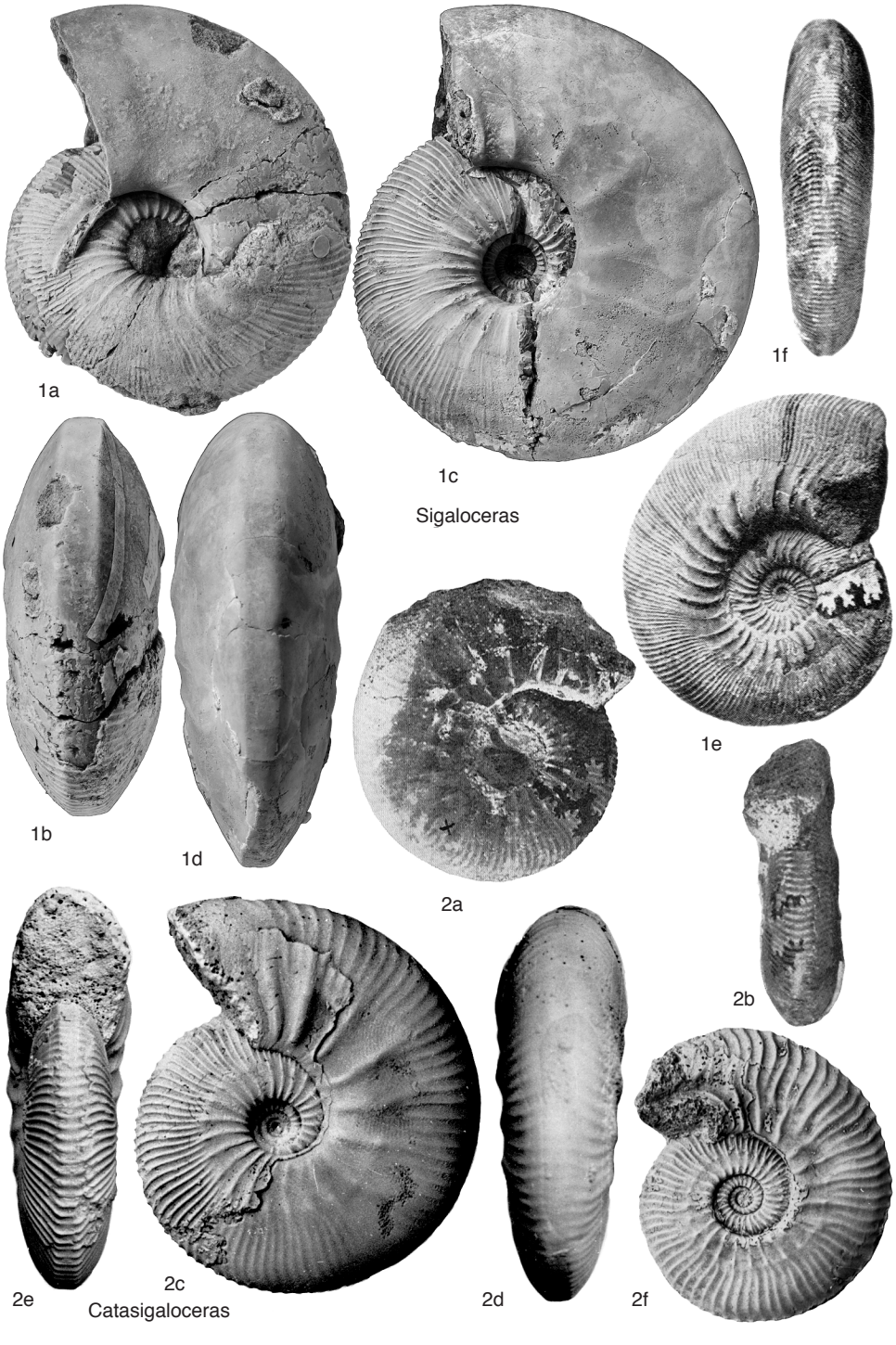

FIG. 24. Kosmoceratidae (p. 30–32).

Catasigaloceras Buckman, 1923a, pl. 417 [**C. planicerclus;* OD; =*Cosmoceras enodatum* Nikitin, 1881b, p. 112]. Moderately involute, compressed whorl section; smooth, bituberculate, tabulate venter on inner and middle whorls; primary ribs bifurcate at small tubercles near middle of whorl side; secondary and intercalated ribs curve forwards onto the tabulate venter. Dimorphic: macroconch with contracting adult whorl and rounded venter, more widely spaced ribs, and a simple sigmoidal aperture; microconchs strongly ribbed to the end, with long lappets in the adult mouth border. Smaller, more compressed and less densely ribbed than *Sigaloceras. Middle Jurassic (lower Callovian,* Calloviense *Zone):* northern and central Europe, Kazakhstan (Mangystau), Caucasus.——Fig. 24,*2a–e.* **C. planicerclus* Buckman, Kellaways Rock, South Cave, Yorkshire, England; *a–b,* holotype, macroconch, ×1 (Buckman, 1923a, pl. 417); *c–e,* topotype, macroconch, ×1 (new; J. H. Callomon Collection, from C. W. Wright Collection).——Fig. 24,*2f. C. anterior* (Brinkmann), microconch, with long lappet, *Calloviense* Zone, *Enodatum* Subzone, South Cave, Yorkshire, England, ×1 (new; J. H. Callomon Collection, 356, from C. W. Wright Collection).

Subfamily KOSMOCERATINAE Haug, 1887

[*nom. transl.* Tintant, 1964, p. 224, *ex* Kosmoceratidae Haug, 1887, p. 156] [=Gulielmiceratidae Buckman, 1926, p. 20]

Evolute to involute, planulate to compressed, with smooth tabulate venters bordered by rows of ventrolateral tubercles or clavi; ribs and tubercles are highly variable in a single population, ranging from fine and regularly polyplicate (with double row of small lateral tubercles) to coarse and irregular (with one row of lateral tubercles, nodes or bullae), sometimes changing from one style to the other at different ontogenetic stages in the same individual. In early forms in the middle Callovian, the secondary ribs terminate at single ventrolateral tubercles. In later forms in the upper Callovian, the secondary ribs reunite in pairs or bundles at the ventral edge; this character (bundling) appears almost simultaneously over the whole range of morphologies, from finest to coarsest, and in both macroconchs and microconchs. Strongly dimorphic; microconchs with long, slender lappets. This group occurs in very large numbers in expanded stratigraphic successions in France and northern Germany and is probably the most studied of all ammonites, providing insight into fundamental problems of morphological variability of populations, dimorphism, bioprovincialism, and phylogeny. Douvillé, 1915; Krenkel, 1915; Brinkmann, 1929a, 1929b; Tintant, 1964; Lominadze & Sakharov, 1985. *Middle Jurassic (middle–upper Callovian):* northern hemisphere (Subboreal Province, occasionally in Submediterranean Province, but not Boreal Province).

Gulielmites Buckman, 1923a, pl. 418 [**G. conlaxatum;* OD] [=*Gulielmiceras* Buckman, 1920, pl. 194 (type, *Ammonites gulielmi* J. Sowerby, 1821, pl. 311, OD); =*Anakosmokeras* Buckman, 1924, pl. 531 (type, *Ammonites stutchburii* Pratt, 1842, p. 163, OD)]. The earliest Kosmoceratinae, successors of *Catasigaloceras,* with which the microconchs are very similar, but differing in the smooth, flat, bituberculate venter throughout growth and small umbilical tubercles. Moderately involute, compressed whorl section, narrow tabulate venter; primary ribs arise from small tubercles at the umbilical edge, then divide at low to midlateral tubercles into dense secondary ribs curving forwards to end at small tubercles bordering the flat smooth venter; rib density and size of tubercles variable. Dimorphic: ribs fade on the adult whorl of macroconchs and final mouth border is sinuous; in microconchs (*Gulielmiceras*) ribs remain up to the adult mouth border, which has long lappets; dimorphic size ratio of complete adults about 2:1. *Middle Jurassic (middle Callovian,* Jason *Zone):* Europe (Subboreal Province), eastern Greenland.——Fig. 25,*1a.* **G. conlaxatum,* holotype, macroconch, Backwater, Radipole, Weymouth, Dorset, England, ×0.7 (Buckman, 1923a, pl. 418).——Fig. 25,*1b–e. G. gulielmi* (J. Sowerby), Wiltshire, England; *b–c,* holotype, microconch, ×1 (new; The Natural History Museum, London, NHMUK C.72470); *d–e,* topotype, complete microconch with long lappet, ×1 (new; The Natural History Museum, London, NHMUK C.69271).

Zugokosmokeras Buckman, 1923a, pl. 389 [**Z. zugium;* OD] [=*Zugocosmoceras* Stoll, 1934, p. 35, unjustified emendation]. Phyletic descendents of *Gulielmites,* differing by fine, dense ribs persisting to the end of growth with sheaves of secondary ribs branching from short, bullate primary ribs, not looped or bundled at the ventral edge, and crossing the venter on the adult body chamber of the macroconch; associated microconch is usually included in "*Gulielmiceras,*" but the exact species has yet to be identified. *Middle Jurassic (middle Callovian, Coronatum Zone):* Europe, Caucasus, Kazakhstan (Mangystau).——Fig. 25,*2.* **Z. zugium,* holotype, north bank of River Brora, Fascally, Brora, Sutherland, Scotland, ×0.5 (Buckman, 1923a, pl. 389).

Epicosmoceras Model & Model, 1938, p. 654 [**Aspidoceras fuchsi* Neumayr, 1871, p. 45; OD]. Macroconchs with coarse, bullate ribs, large, clavate

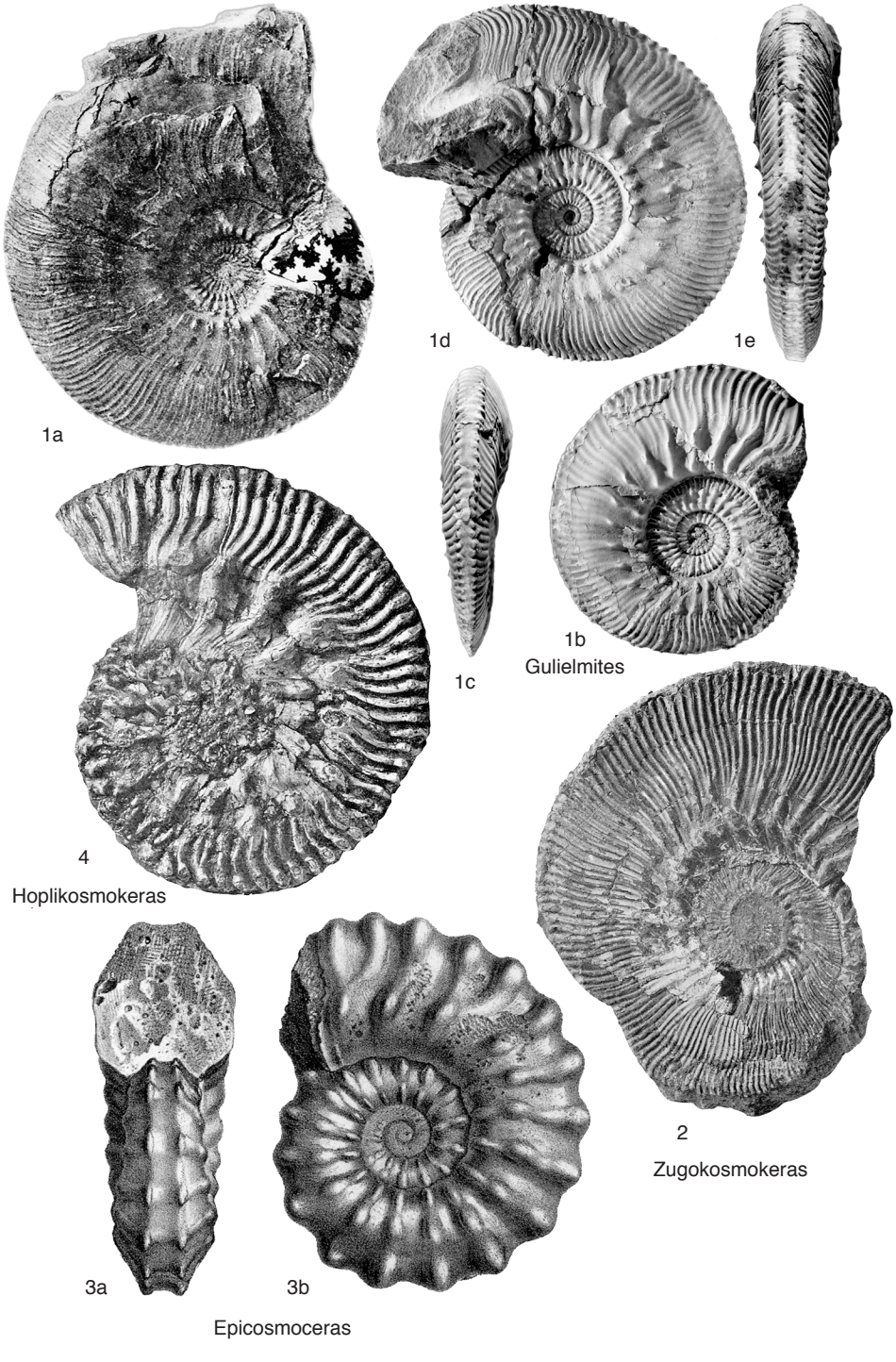

FIG. 25. Kosmoceratidae (p. 32–36).

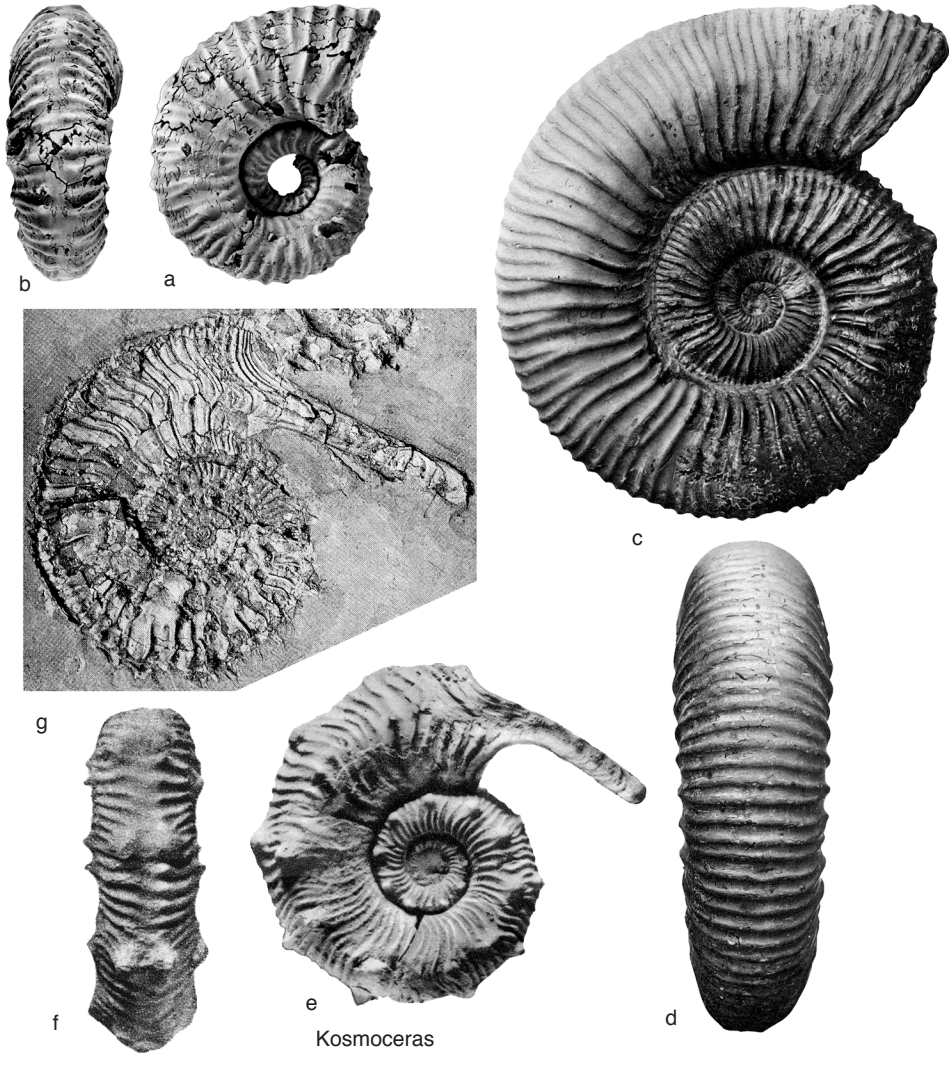

FIG. 26. Kosmoceratidae (p. 34–35).

midlateral tubercles, and large ventrolateral tubercles bordering a smooth, concave venter; occasional ribs bifurcate at the lateral tubercle. *Middle Jurassic (middle Callovian,* Coronatum *Zone):* Poland, central Russia.——FIG. 25,*3a–b*. **E. fuchsi* (NEUMAYR), holotype, Czerna, Krakow, Poland, ×0.75 (Neumayr, 1871, pl. 15,*3a–b*).

Kosmoceras WAAGEN, 1869, p. 248 [**Ammonites spinosus* J. DE C. SOWERBY, 1826, p. 78; SD, ICZN Opinion 303, 1954c, p. 275] [=*Cosmoceras* NEUMAYR, 1869, p. 393, *nom. null,* misspelling; =*Spinikosmokeras* BUCKMAN, 1924, pl. 486A (type, *S. acutistriatum,* OD); =*Katakosmokeras* BUCKMAN, 1925a, pl. 548 (type, *K. degradatum,* OD)]. Evolute, polygonal to compressed whorl section with flat or concave venter on inner whorls; weak primary ribs, sometimes issuing from small tubercles at the umbilical edge, end at strong midlateral tubercles, carrying long spines on the test, from which flexuous, irregular secondary ribs issue in pairs or bundles and lead to ventrolateral tubercles bordering a narrow, smooth venter; the ventrolateral tubercles sometimes alternate across the venter, especially in microconchs. Dimorphic: macroconchs with rounded whorl section on outer whorls, on which somewhat irregular ribs remain up to the simple final aperture, but the tubercles are lost; ribs and tubercles remain on the adult whorl of microconchs, which has long lappets in the adult mouth border; dimorphic size ratio about 3:1;

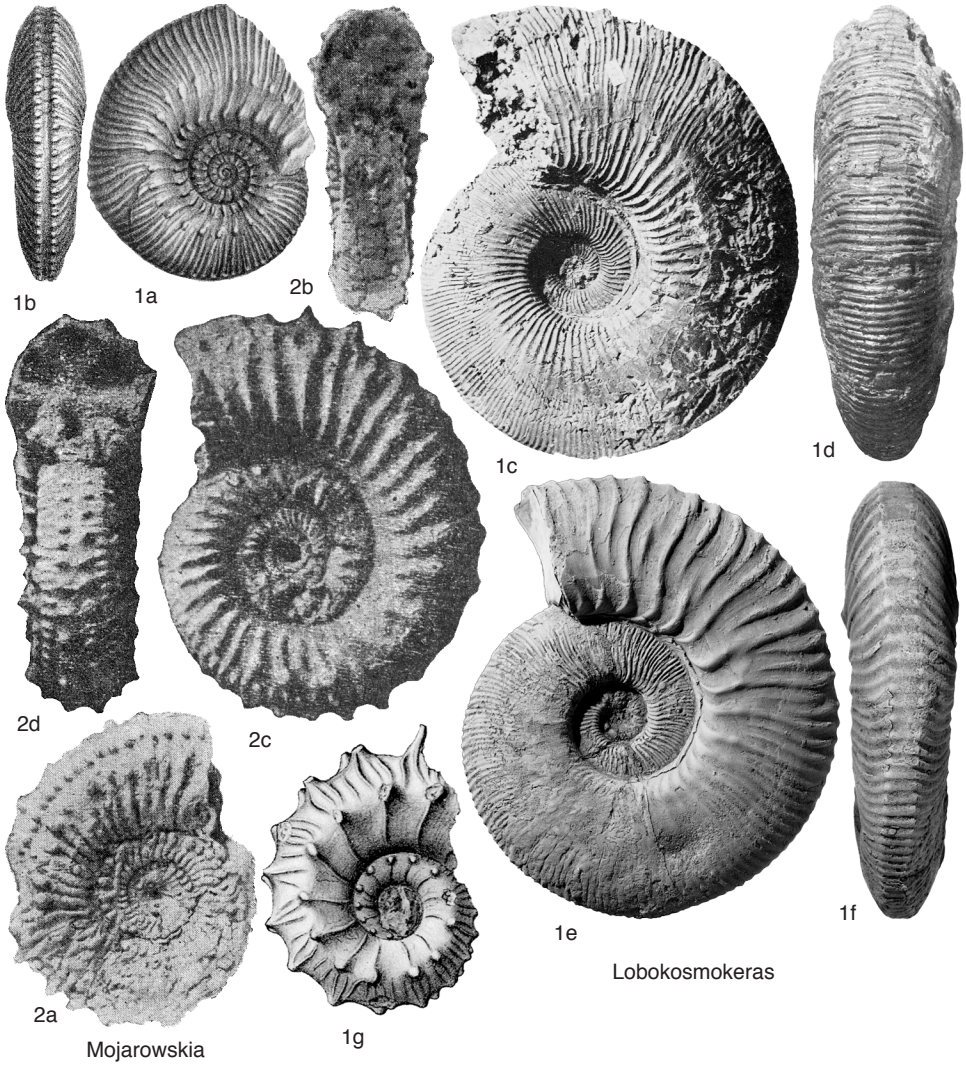

FIG. 27. Kosmoceratidae (p. 36).

size and density of ribs and tubercles vary greatly in both dimorphs. *Middle Jurassic (middle–upper Callovian):* northern Europe, Bulgaria, Caucasus, Kazakhstan (Mangystau), eastern Greenland.——FIG. 26*a–f.* **K. spinosum* (J. DE C. SOWERBY); *a–b,* lectotype, a wholly septate nucleus, *Lamberti* Zone, Dorset, England, ×1 (new; The Natural History Museum, London, NHMUK 43937a); *c–d,* a complete adult macroconch, *Lamberti* Zone, Villers-sur-Mer, Calvados, France, ×0.55 (Douvillé, 1915, pl. 24,*1,1b*); *e–f,* complete adult microconch with very long narrow lappets, Łuków, Poland, ×1.5 (Makowski, 1963, pl. 2,*3,* pl. 3,*2b*).——FIG. 26*g. K. acutistriatum* (BUCKMAN), holotype, adult microconch with very long lappet, lower *Athleta* Zone, Christian Malford, Wiltshire, England, ×0.8 (Buckman, 1924, pl. 486A).

Hoplikosmokeras BUCKMAN, 1924, pl. 488 [*H. hoplistes;* OD]. An extreme tuberculate form of *Kosmoceras,* retained as a separate genus because the very large lateral tubercles remain on the adult body chamber of the macroconchs. Very coarse, irregular, widely spaced ribs bear strong lateral tubercles, which give to many secondary ribs that are occasionally looped at the edge of the venter; microconchs not identified. The morphological forerunner of *Kosmoceras gemmatum* (PHILLIPS) and *K. aculeatum* (EICHWALD). *Middle Jurassic (upper Callovian, lower* Athleta *Zone):* Europe.——FIG. 25,*4.* **H. hoplistes,* holotype, Christian Malford,

Oxfordshire, England, ×0.5 (Buckman, 1924, pl. 488).

Lobokosmokeras Buckman, 1923b, pl. 436 [**Kosmoceras proniae* Teisseyre, 1884, p. 557; OD] [=*Bikosmokeras* Buckman, 1926, pl. 625 (type, *B. geminatum,* OD); =*Kuklokosmokeras* Buckman, 1926, pl. 626 (type, *K. kuklikum,* OD)]. Moderately involute, compressed whorl section; flat, tabulate venter; weak primary ribs link small umbilical tubercles to lateral tubercles; on inner and middle whorls secondary ribs are often looped or bundled to ventrolateral tubercles or clavi at edge of smooth venter; ribs are less dense and tend to fade on adult body chamber of macroconch. Both dimorphs are similar to those of *Kosmoceras,* but generally more compressed and finely ribbed, and on inner and middle whorls the secondary ribs are more frequently and regularly looped or bundled in sheaves to tubercles or clavi bordering the smooth venter. *Middle Jurassic (upper Callovian):* northern and eastern Europe, Caucasus, Kazakhstan (Mangystau), Uzbekistan, eastern Greenland.——Fig. 27,*1a–b. *L. proniae* (Teisseyre), lectotype (designated by Buckman, 1923b, pl. 436), ?macroconch, *Athleta* Zone, Pronya, Ryazan, Russia, ×1 (Teisseyre, 1884, pl. 3,*15a–b*).——Fig. 27,*1c–d. L. kuklikum* (Buckman), holotype, macroconch, upper *Athleta* Zone, Brickyard, Upper Wolvercote, Oxford, England, ×0.5 (Buckman, 1926, pl. 626A, 626B,*2*).——Fig. 27,*1e–f. L. rowlstonense* (Young & Bird), topotype, complete adult macroconch, Hackness Rock, Scarborough, Yorkshire, England, ×0.5 (new; The Natural History Museum, London, NHMUK 39540).——Fig. 27,*1g. L. aculeatum* (Eichwald, 1830, p. 29), neotype (designated by Brinkmann, 1929b, p. 78), upper Callovian, Papilé (Popilani), Lithuania, ×1 (Krenkel, 1915, pl. 22,*3*).

Mojarowskia Nikolaeva in Kiparisova, Markovski, & Radchenko, 1956, p. 80 [**M. mojarowskii* Nikolaeva & Rozhdestvenskaya in Kiparisova, Markovski, & Radchenko, 1956, p. 81; OD]. Evolute, rounded whorl section, narrow flat venter; small, closely spaced ventrolateral tubercles form a third row between the midlateral tubercles and the tubercles bordering the smooth midventer. Small forms, poorly known, probably microconchs. *Middle Jurassic (upper Callovian):* Russia (Saratov).——Fig. 27,*2a–d. *M. mojarowskii; a–b,* holotype, Kurdyumov, Saratov, Russia, ×1 (Nikolaeva in Kiparisova, Markovski, & Radchenko, 1956, pl. 17,*10a–b*); *c–d,* topotype, lower Volga area, Russia, ×1 (Krimholz, 1958, pl. 35,*3a–b*).

Family OTOITIDAE Mascke, 1907

[Otoitidae Mascke, 1907, p. 23, 25].

Early whorls cadicone or sphaerocone; outer whorls much more evolute, with long, contracted adult body chambers and eccentric umbilical seam. Strongly dimorphic: macroconchs large, sometimes with nearly smooth body chambers, with contracted, lipped and collared adult apertures; microconchs small, with long, drooping lappets. Sutures complex and highly incised as in *Stephanoceras.* First occurrences are at base of lower Bajocian, probably descended from Erycitinae (e.g., from *Abbasites*). Otoitidae is retained as the family-group name under the provisions of ICZN Code, 1999, Article 40.1, despite *Otoites* Mascke, 1907, being regarded herein as a junior synonym of *Emileia.* Buckman, 1898; Arkell & Playford, 1954; Westermann, 1954, 1964b, 1969; Imlay, 1964, 1973. *Middle Jurassic (lower Bajocian):* worldwide.

Docidoceras Buckman, 1919b, pl. 133A–133B [**D. cylindroides;* OD] [=*Trilobiticeras* Buckman, 1919b, pl. 140 (type, *T. trilobitoides,* OD); =*Docodoceras* Cossmann in Lemoine & Cossmann, 1919, p. 77, misspelling]. Evolute, depressed whorl section with broad, rounded venter; strong primary ribs divide, and secondaries are intercalated, at midwhorl to high lateral tubercles. Dimorphic: macroconchs large, outer and adult whorls becoming more compressed and rounded, ending at a lipped and collared adult mouth border; microconchs much smaller, coarsely ribbed to the end of the adult whorl, with large, drooping lappets. *Middle Jurassic (lower Bajocian,* Discites–Ovalis *Zones):* Europe, northern Africa, ?Iran, New Guinea, USA (Oregon) Western Australia.——Fig. 28,*1a–b. *D. cylindroides,* holotype, complete adult macroconch, *Discites* Zone, Bradford Abbas, Sherborne, Dorset, England, ×0.7 (Buckman, 1919b, pl. 133A).——Fig. 28,*1c–e. D. trilobitoides* (Buckman), holotype, complete adult microconch with lappets, Fossil Bed, Bradford Abbas, Dorset, England, ×1.25 (Buckman, 1919b, pl. 140,*1–2,4*).

Pseudocidoceras Westermann, 1969, p. 136 [**Docidoceras (Pseudocidoceras) widebayense;* OD]. Whorls less depressed, whorl section more rounded, and ribs coarser than in *Docidoceras;* primary ribs tend to be bullate up to prominent midlateral tubercles, and secondary ribs are characteristically strongly prorsiradiate over the venter, with an impersistent midventral interruption. Probably dimorphic: macroconchs with a strongly prorsiradiate adult collar; microconchs poorly known, but have lappets in the adult mouth border. *Middle Jurassic (lower Bajocian,* Discites–Laeviuscula *Zones):* USA (Alaska).——Fig. 28,*2a–c. *P. widebayense,* southeast shore of Wide Bay, Alaska Peninsula, Alaska, USA; *a–b,* holotype, complete adult macroconch, ×0.85 (Westermann, 1969, pl. 34,*1a,d*); *c,* microconch with part of a lappet, ×1 (Westermann, 1969, pl. 36,*3*).

Emileia Buckman, 1898, p. 456 [**Ammonites brocchii* J. Sowerby, 1818, p. 233; OD] [=*Otoites* Mascke,

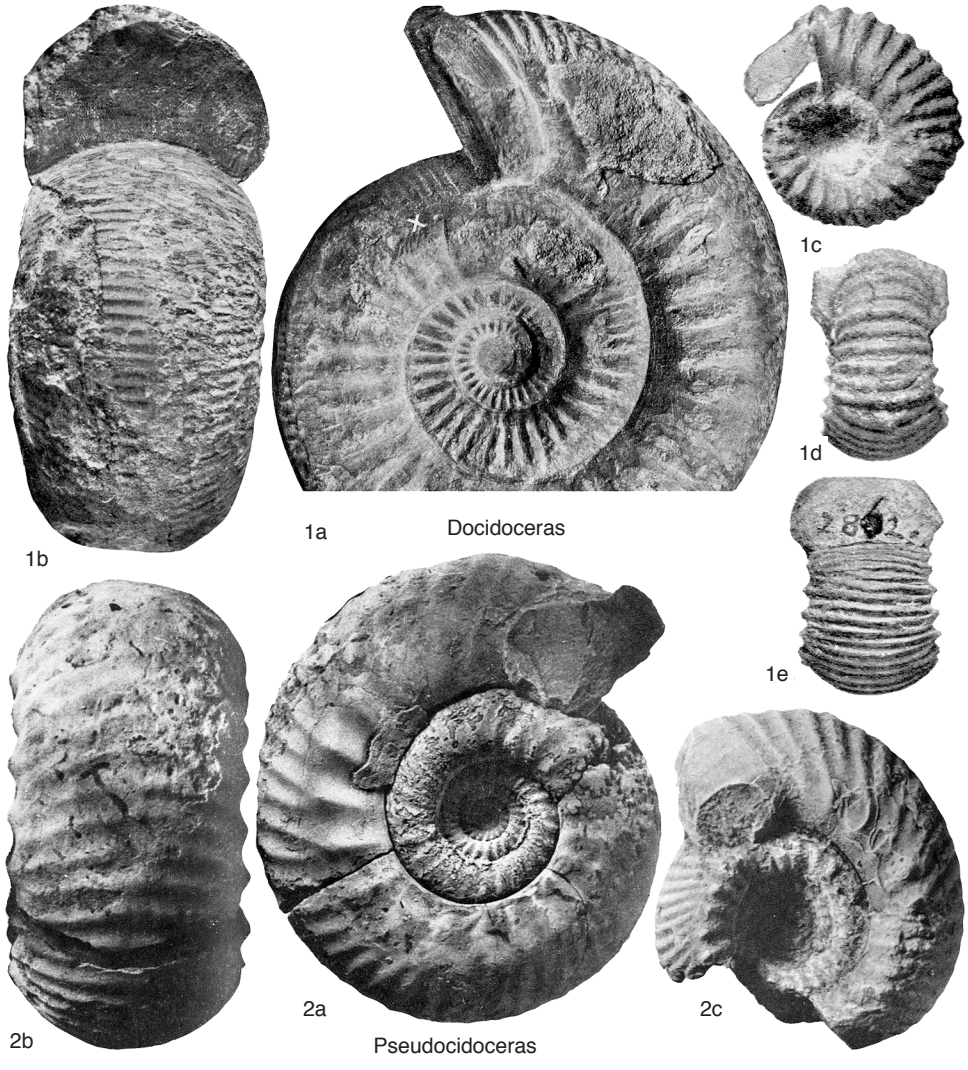

FIG. 28. Otoitidae (p. 36).

1907, p. 23 (type, *Ammonites sauzei* D'ORBIGNY, 1846 in 1842–1851, p. 407, OD)]. Involute, inflated whorls with broad, rounded venter on inner whorls, becoming contracted and compressed with an uncoiling umbilical seam on the adult body chamber; subdued bullate primary ribs end at tubercles or nodes low on the side of the whorl; fine, dense secondary ribs continuous across the venter. Dimorphic: macroconchs large, tending to become compressed and smooth on the body chamber, with a simple mouth border; microconchs (*"Otoites"*) much smaller, with coarser secondary ribs, mainly bifurcating from the lateral nodes, with a contracted, elliptically coiled adult body chamber and with prominent lappets, sometimes long, spatulate, and drooping. A valid primary type specimen (lectotype or neotype) for *Ammonites sauzei* D'ORBIGNY, the type species of *Otoites,* has yet to be selected from D'ORBIGNY's original type series. The neotype designated by WESTERMANN (1954, p. 85, pl. 1,*1*) is invalid because the type series still existed and a lectotype had not been designated (ICZN Code, 1999, Article 75.1). This difficult problem has been discussed at length by PAVIA (in FISCHER, 1994, p. 127–128), who found 8 syntypes in the D'ORBIGNY collection, and after eliminating several that did not correspond well to the original drawing (D'ORBIGNY, 1846 in 1842–1851, pl. 139,*1–2*), he found that syntype number 2155 A-1 is a very close match for D'ORBIGNY's original drawing up to

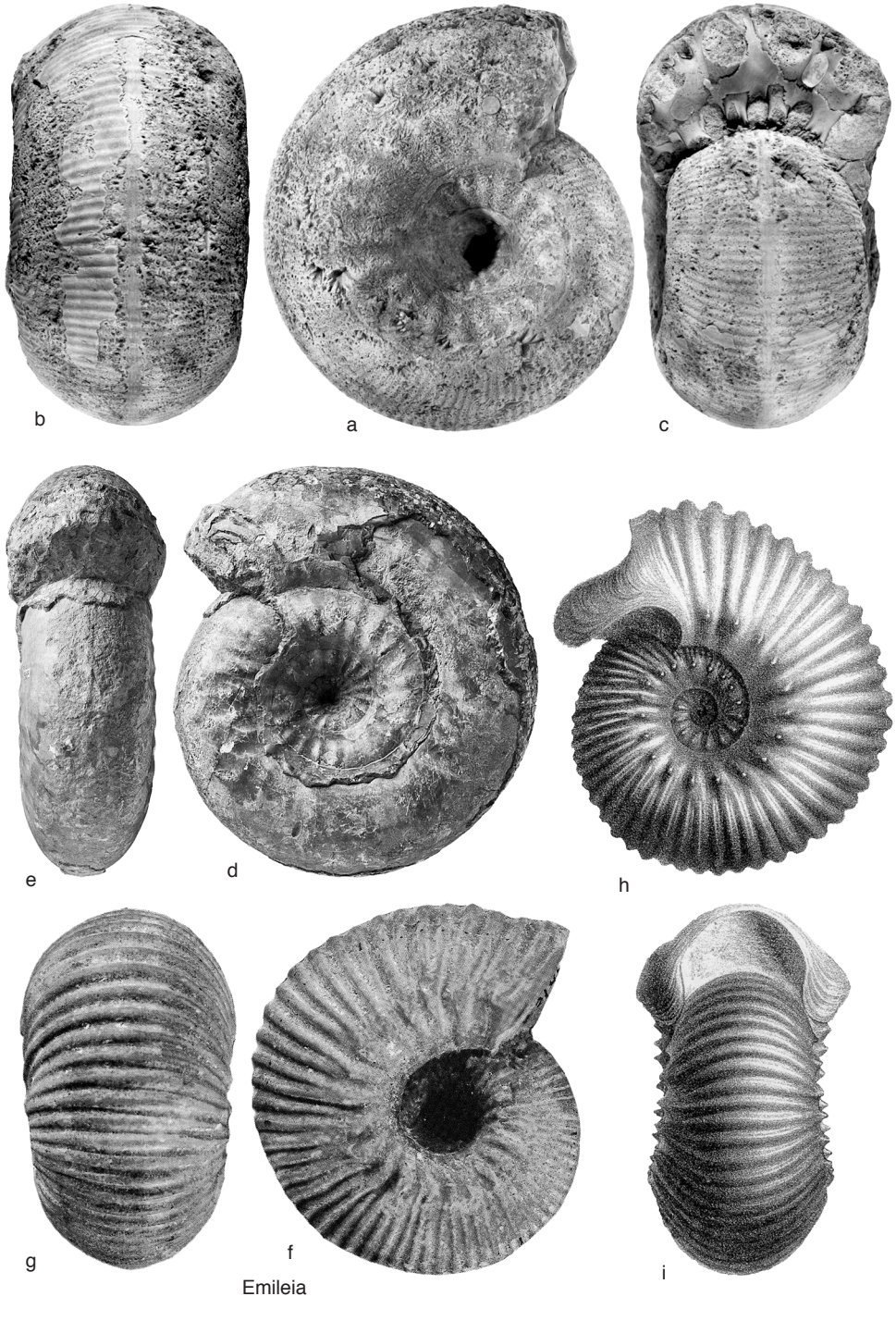

Fig. 29. Otoitidae (p. 36–40).

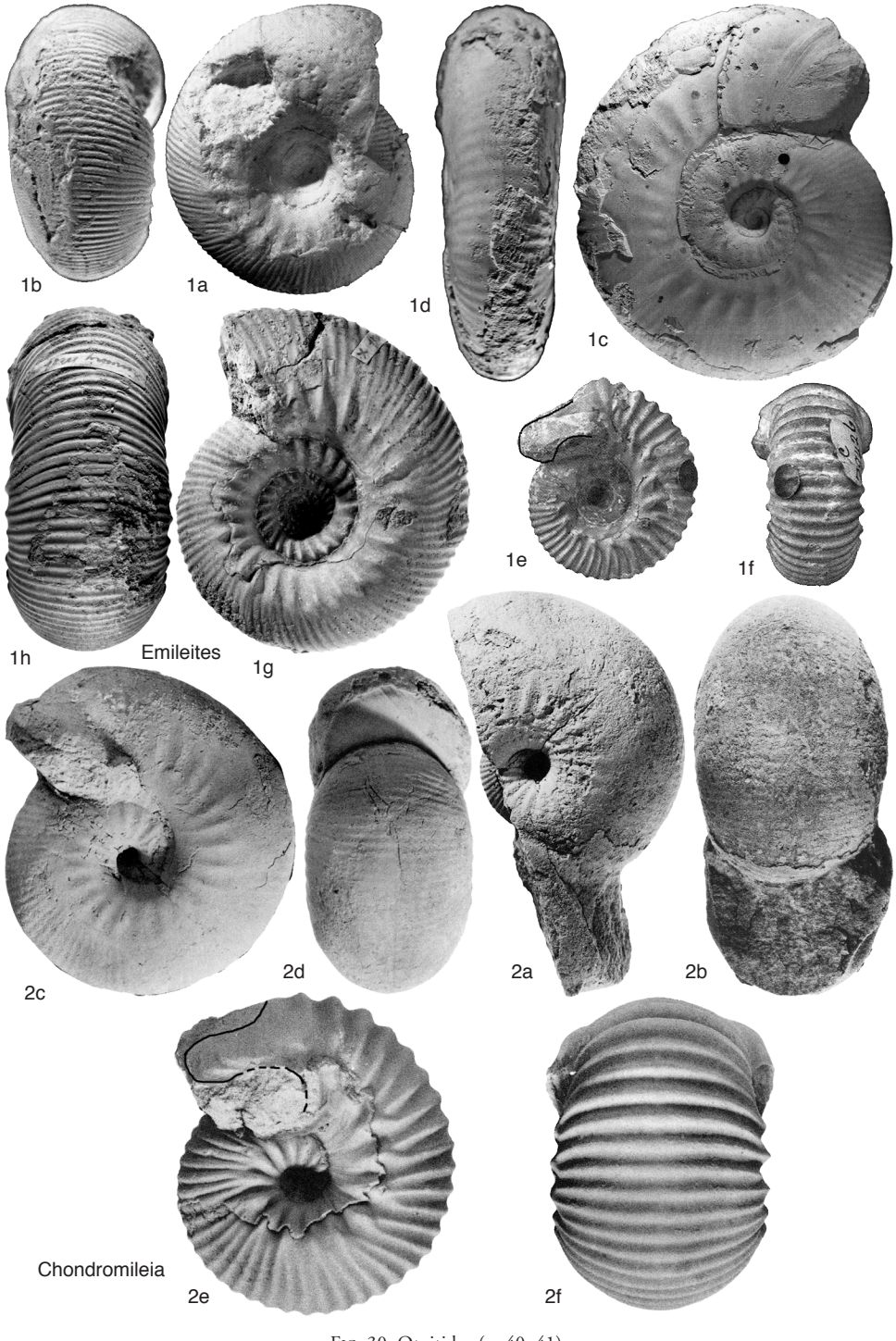

FIG. 30. Otoitidae (p. 40–41).

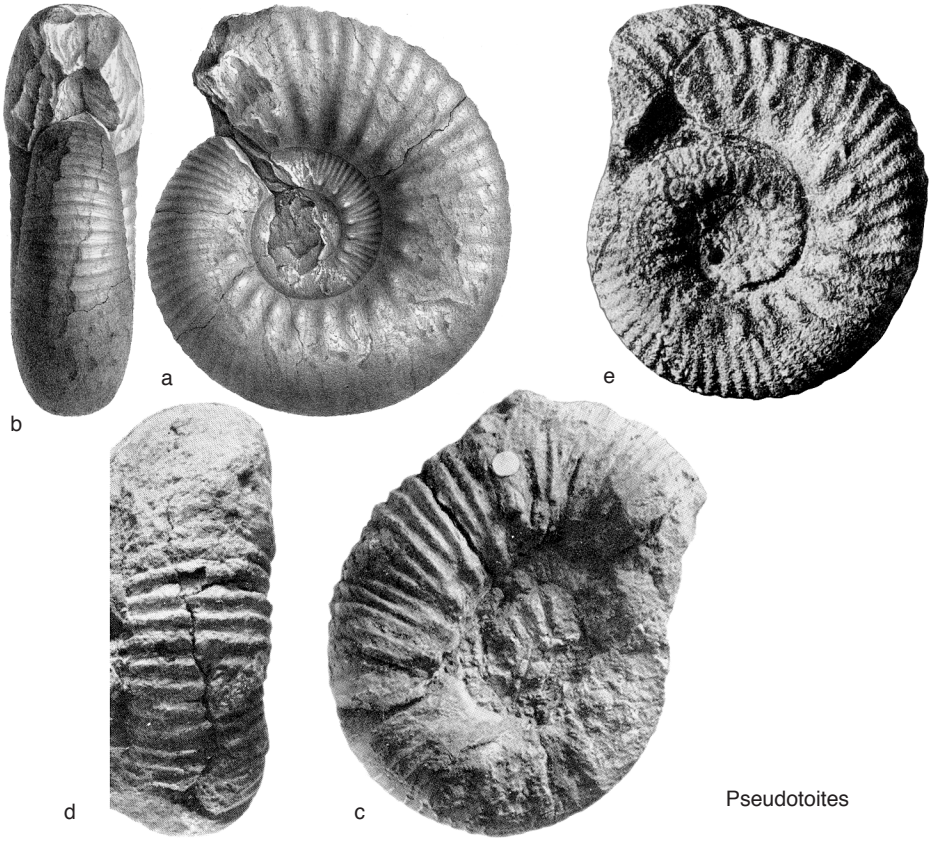

FIG. 31. Otoitidae (p. 41–42).

the end of the adult body chamber, except for the absence of the lappets. In view of the importance of selecting a type specimen for *Otoites sauzei,* both the original drawing and D'ORBIGNY Collection no. 2155 A-1 are refigured here, and that syntype is selected by HOWARTH, herein as the lectotype of *Ammonites sauzei.* WESTERMANN, 1964b. *Middle Jurassic (lower Bajocian,* Ovalis–Sauzei *Zones):* Europe, northern Africa, Caucasus, Tajikistan (Pamirs), Iran, Japan, USA (Alaska, Oregon), Venezuela, Argentina, Chile, Western Australia.——FIG. 29*a–e.* **E. brocchii* (J. SOWERBY); *a–c,* lectotype (designated by BUCKMAN, 1908a, pl. 4; see ARKELL, 1956, p. 768, pl. 35, footnote), phragmocone of macroconch, Sandford Lane Quarry, Sherborne, Dorset, England, ×0.5 (new; The Natural History Museum, London, NHMUK 43906a); *d–e,* topotype, adult macroconch, with mouth border, Sherborne, Dorset, England, ×0.35 (new; The Natural History Museum, London, NHMUK C.86510).——FIG. 29*f–i. E. sauzei* (D'ORBIGNY), Niort, Deux-Sèvres, France; *f–g,* lectotype (designated by HOWARTH, herein), complete microconch except for lappets, ×0.8 (Fischer, 1994, pl. 39,*3a,c;* d'Orbigny Collection 2155A-1); *h–i,* D'ORBIGNY's original figure, ×0.7 (d'Orbigny, 1846 in 1842–1851, pl. 139,*1–2*).

Emileites BUCKMAN, 1927a, p. 46 [**E. malenotatus;* OD] [=*Parsemileites* DIETZE & CHANDLER, 2008, p. 168 (type, *Docidoceras liebi* MAUBEUGE, 1955, p. 42, OD)]. Smaller than *Emileia,* more evolute, and more compressed on outer whorls of macroconch, and ribs tend to be prorsiradiate with smaller lateral tubercles or nodes. Macroconchs have contracted and collared adult mouth border; microconchs have long lateral lappets. *Middle Jurassic (lower Bajocian,* Ovalis–Sauzei *Zones):* Europe.——FIG. 30,*1a–h. E. malenotatus; a–b,* holotype, phragmocone of macroconch, Dundry, Somerset, England, ×1 (Dietze & Chandler, 2008, p. 169, fig. 1*a–b*); *c–d,* complete adult macroconch, Sandford Lane Quarry, Sherborne, Dorset, England, ×0.65 (Dietze & Chandler, 2008, p. 169, fig. 1*g–h*); *e–f,* complete adult microconch with large lappets in mouth border, ×1 (Dietze & Chandler, 2008, p. 169, fig. 1*i,m*); *g–h,* topotype, immature macroconch, Dundry, Somerset, England, ×1 (new; The Natural History Museum, London, NHMUK C.78550).

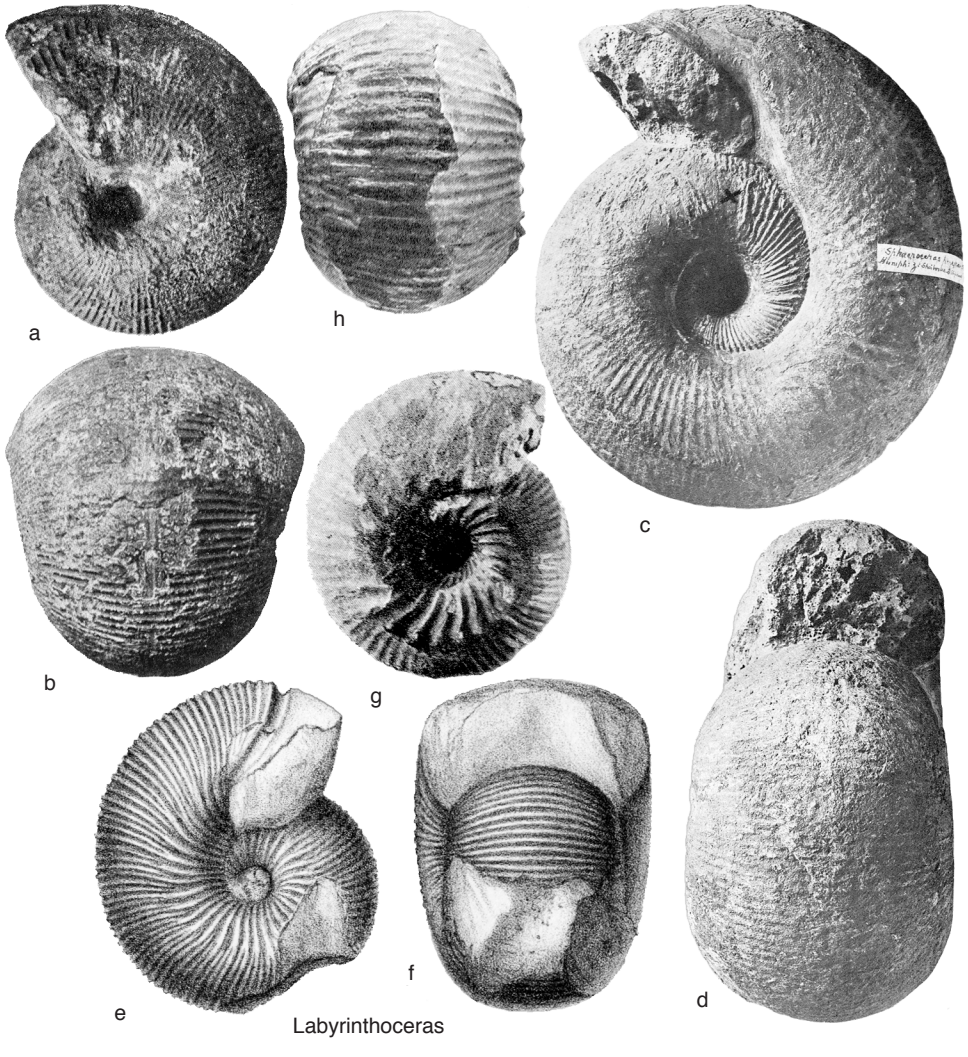

FIG. 32. Otoitidae (p. 42).

Chondromileia WESTERMANN & RICCARDI, 1979, p. 129 [**Stephanoceras giebeli* GOTTSCHE, 1878, p. 15; OD]. Sphaeroconic inner whorls; whorl cross- section contracts on outer whorls and umbilical seam uncoils on adult whorl of both dimorphs; primary ribs end at nodes or radial clavi at midwhorl, giving rise to secondary ribs curving slightly forwards across the venter. Dimorphic: macroconchs up to 150 mm in diameter, with ribs fading on middle and outer whorls, then whorl section contracts towards simple, prominently constricted and flared adult mouth border; microconchs up to 60 mm in diameter, ribs and clavi remaining strong up to the adult mouth border with moderately long lappets. Intermediate between *Emileia* and *Chondroceras. Middle Jurassic (lower Bajocian,* Laeviuscula–Sauzei *Zones):* Argentina, Chile, USA (Oregon).——FIG. 30,*2a–f.* **C. giebeli* (GOTTSCHE); *a–b,* holotype, large macroconch with part of the adult body chamber (at bottom of figures), Paso del Espinacito, 50 km southwest of Barreal, San Juan province, Argentina, ×0.6 (Westermann & Riccardi, 1979, pl. 6,*1a,c*); *c–f,* Cerro Charahuilla, Neuquén province, Argentina; *c–d,* complete adult macroconch with constricted and flared mouth border, ×0.6 (Westermann & Riccardi, 1979, pl. 7,*1a–b*); *e–f,* complete adult microconch with large lappets, ×1 (Westermann & Riccardi, 1979, pl. 10,*4a–b*).

Pseudotoites SPATH, 1939, p. 124 [**Stephanoceras leicharti* NEUMAYR, 1885, p. 140; OD] [=*Latotoites* WESTERMANN, 1964b, p. 53 (type, *Ammonites (Stephanoceras) australe* CRICK, 1894, p. 391, OD)]. Evolute,

rounded to compressed whorls; short primary ribs end at tubercles or bullae low on the whorl, with secondary ribs issuing in pairs or bundles and are slightly prorsiradiate over the venter. Dimorphic: in macroconchs ribs and tubercles tend to strengthen on adult body chamber, ending in simple collared and lipped aperture; microconchs (*Latotoites*) have lappets in the adult mouth border. Smaller, more evolute and more compressed than *Emilea,* with tubercles lower on the flank. ARKELL & PLAYFORD, 1954; WESTERMANN, 1964b, 1969. *Middle Jurassic (lower Bajocian,* Discites–Sauzei *Zones):* Western Australia, Indonesia, USA (southern Alaska, Oregon), Canada, Argentina, Chile.——Fig. 31*a–b.* **P. leicharti* (NEUMAYR), holotype, macroconch, Moore River, northeast of Guilderton, western Australia, ×0.5 (Neumayr, 1885, pl. 1,*4a–b*).——Fig. 31*c–d. P. australis* (CRICK), holotype, microconch, Champion Bay, Geraldton, Western Australia, ×1 (Arkell & Playford, 1954, pl. 31,*1a–b*).——Fig. 31*e. P. evolutus* (TORNQUIST), holotype, microconch, Paso del Espinacito, 50 km southwest of Barreal, San Juan province, Argentina, ×1 (Westermann, 1964b, pl. 9,*5*).

Labyrinthoceras BUCKMAN, 1919b, pl. 134 [**L. perexpansum;* OD] [=*Frogdenites* BUCKMAN, 1921, pl. 215 (type, *F. spiniger,* OD); =*Manselites* GALÁCZ, 1990, p. 345 (type, *Ammonites manselii* J. BUCKMAN, 1881, p. 64, OD)]. Highly inflated, depressed sphaerocones; fine prorsiradiate ribs divide at small lateral tubercles and tend to bend backwards over the venter. Dimorphic: macroconchs uncoil and become much more evolute on middle and outer whorls and adult aperture is constricted with a strong ventral projection; microconchs remain sphaeroconic and depressed, and are more strongly ribbed on adult body chamber, with a moderately contracted aperture with small lappets. *Labyrinthoceras* is a link between Otoitinae and Sphaeroceratidae, intermediate in size and coiling, but still strongly dimorphic, though the lappets in the microconch are diminished in size. *Middle Jurassic (lower Bajocian,* Sauzei–Humphriesianum *Zones):* Europe, China (Tibet), USA (Alaska, Oregon).——FIG. 32*a–f.* **L. perexpansum,* Clatcombe, Sherborne, Dorset, England; *a–b,* holotype, phragmocone of macroconch, ×1 (Buckman, 1919b, pl. 134A); *c–d,* topotype, complete adult macroconch, ×0.5 (Buckman, 1919b, pl. 134C–134D); *e–f,* complete adult microconch, holotype of *Ammonites manselii* J. BUCKMAN, 1881, ×1 (Buckman, 1882, pl. 2,*3a–b*).——FIG. 32*g–h. L. spiniger* (BUCKMAN), holotype, microconch, Frogden Quarry, Oborne, Dorset, England, ×1 (Buckman, 1921, pl. 215,*1,3*).

Family SPHAEROCERATIDAE Buckman, 1920

[Sphaeroceratidae BUCKMAN, 1920, p. 22]

Dwarf, small or medium-sized sphaerocones and cadicones, with involute, highly inflated inner whorls, followed by contracted adult body chambers with eccentrically coiled umbilical seams; ribs persist to the end of growth and the adult mouth borders are constricted and hooded. The dimorphs differ in size only, and have similar peristomes, though the final hoods and mouth borders in microconchs can become highly complex. Descent from Otoitinae of the *Sauzei* Zone via forms like *Labyrinthoceras* seems clear, from which they differ in the form of dimorphism, the microconchs having no lappets. ARKELL, 1952b; WESTERMANN, 1956b; MAKOWSKI, 1963; STURANI, 1971. *Middle Jurassic (lower Bajocian,* Sauzei *Zone–upper Bathonian)–Upper Jurassic (lower–lower middle Oxfordian–?lower Kimmeridgian):* worldwide.

Subfamily SPHAEROCERATINAE Buckman, 1920

[*nom. transl.,* WESTERMANN, 1964b, p. 50, *ex* Sphaeroceratidae BUCKMAN, 1920, p. 22]

Medium-sized to dwarf sphaerocones, at least on the inner whorls, with small to occluded umbilicus in many forms. At 4 mm maximum diameter, some microconchs of *Sphaeroceras* are amongst the smallest known adult ammonites. Derived from *Labyrinthoceras* in the *Sauzei* Zone. *Middle Jurassic (lower Bajocian,* Sauzei *Zone–middle Bathonian):* worldwide.

Chondroceras MASCKE, 1907, p. 24 [**Ammonites gervillii* J. SOWERBY, 1817, p. 189; OD] [=*Defonticeras* MCLEARN, 1927, p. 72 (type, *D. defontii,* OD); =*Saxitoniceras* MCLEARN, 1927, p. 72 (type, *S. allani,* OD)]. Sphaerocones, umbilicus small, but not occluded, then widening on the contracted adult body chamber, with an uncoiling umbilical seam; whorl section rounded to depressed; prorsiradiate ribs divide high on the whorl side; ribs are retained to end of the adult body chamber, but the primaries become thickened and bullate on the final half whorl; adult mouth border with strong constriction followed by a hooded collar. Dimorphic, differing only in size, macroconchs are 2–5 times larger than microconchs. Derived from *Labyrinthoceras,* differing in its less depressed whorls and a slightly more open umbilicus. The predominant groups are *Chondroceras gervillii* in Europe and *Defonticeras* in North America, but both

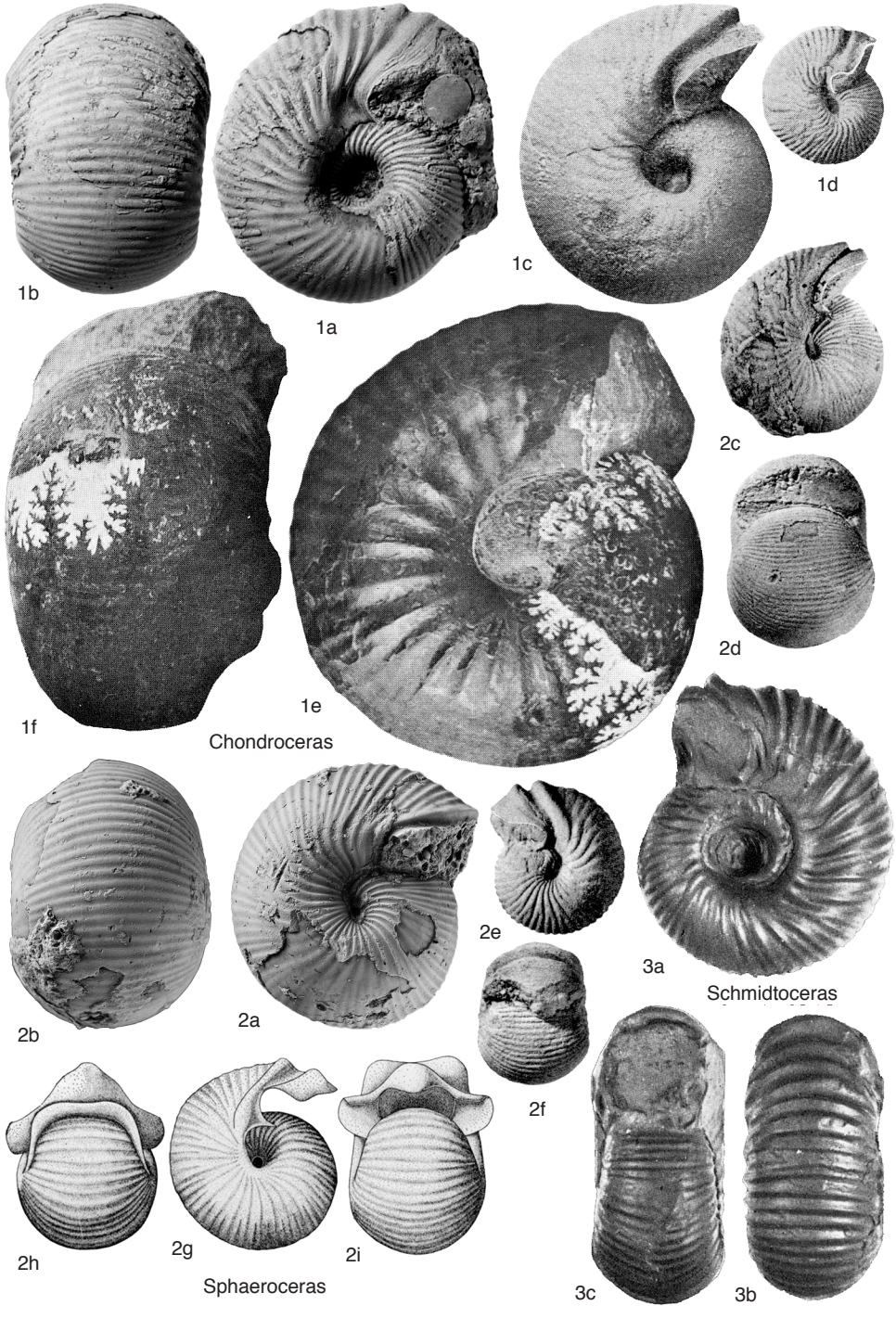

FIG. 33. Sphaeroceratidae (p. 42–45).

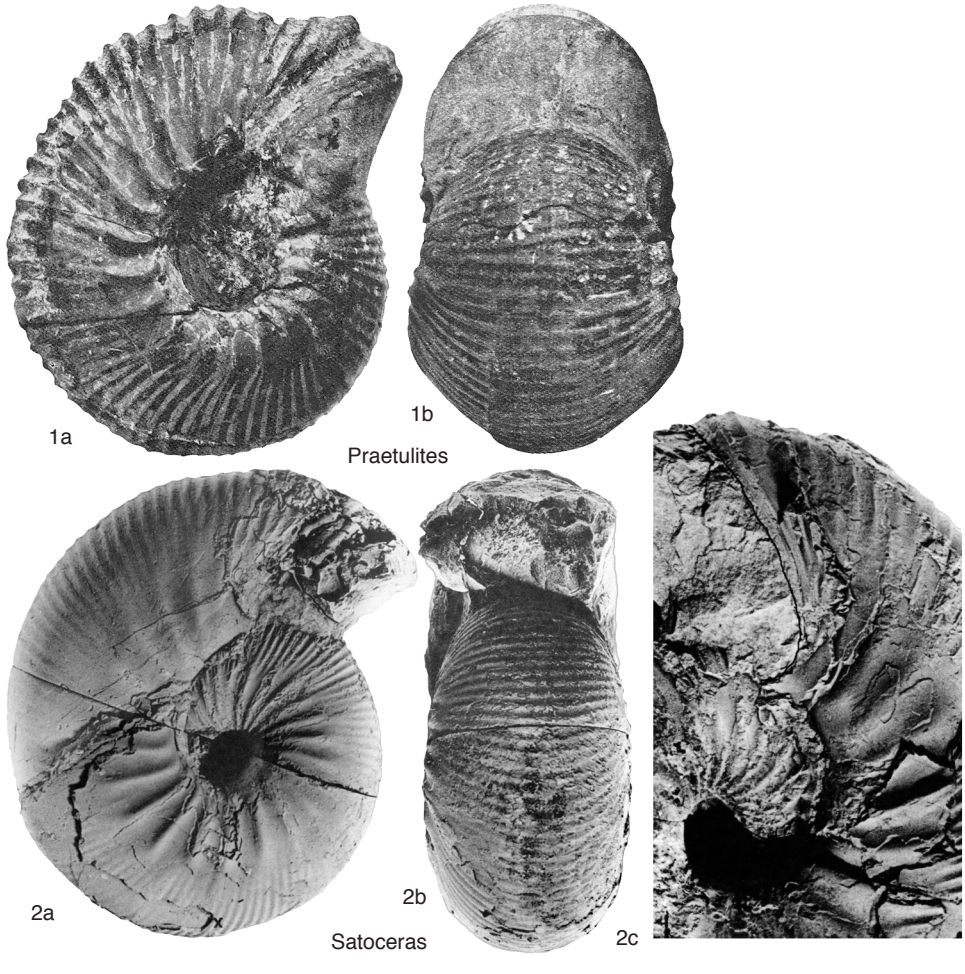

FIG. 34. Sphaeroceratidae (p. 45).

groups are so variable that no consistent differences worthy of generic separation are apparent. *Middle Jurassic (Bajocian,* Sauzei–Subfurcatum *Zones):* Europe, northern Africa, Caucasus, Russia (eastern Siberia), New Guinea, Canada (British Columbia, Alberta), USA (southern Alaska, Montana, Oregon, California), Chile.——FIG. 33,*1a–b.* **C. gervillii* (J. SOWERBY), holotype, macroconch, *Humphriesianum* Zone, Bayeux, Calvados, France, ×1.5 (new; The Natural History Museum, London, NHMUK C.36735).——FIG. 33,*1c–d. C. canovense* (DE GREGORIO), a dimorphic pair, *Subfurcatum* Zone, Longara di Sotto, north of Gallio, Italy, ×2 (Sturani 1971, p. 147, fig. 44.1).——FIG. 33,*1e–f. C. defontii* (MCLEARN), holotype, macroconch, *Humphriesianum* Zone, Richardson Bay, 53°11.5′N, 132°4.7′E, south Maude Island, Haida Gwaii (Queen Charlotte Islands), British Columbia, Canada, ×1 (Frebold 1964, pl. 13,*2a–b*).

Sphaeroceras BAYLE, 1878, pl. 52, 53, *non* HOPE, 1840 (Coleoptera), ICZN Opinion 300,1954b, p. 239 [**Ammonites brongniarti* J. SOWERBY, 1817, p. 190; SD H. DOUVILLÉ, 1879, p. 91] [=*Spheroceras* LISSON, 1908, p. 22a, misspelling]. Small to dwarf sphaerocones; phragmocone globular, with occluded umbilicus; whorl section contracts on the adult body chamber, resulting in a comma-shaped umbilical seam; fine primary ribs bifurcate high on the whorl side into secondary ribs that are continuous across the venter; all ribs are usually confined to the outer surface of the shell, with an almost smooth internal mold. Dimorphic: both dimorphs with constriction before the adult mouth border, preceded in some forms by a flared collar that is sometimes raised ventrally into a node; mouth border with a rounded or pointed lateral

projection immediately above the umbilical seam, above which the remainder of the mouth border is smooth in macroconchs, while microconchs have a variety of ventral projections and ears. Macroconchs 3–6 times larger than microconchs; some microconchs are complete and adult at diameters as small as 4.1 mm. STURANI, 1971. *Middle Jurassic (Bajocian, upper* Humphriesianum–Garantiana *Zones):* Europe, northern Africa, ?Iran, USA (southern Alaska), New Zealand.——FIG. 33,*2a–f.* **S. brongniarti* (J. SOWERBY); *a–b,* holotype, adult macroconch, Bayeux, Calvados, France, ×1.5 (new; The Natural History Museum, London, NHMUK C.36734); *c–d,* adult macroconch, *Humphriesianum* Zone, St.-Vigor-le-Grande, Bayeux, Calvados, France, ×1 (Sturani, 1971, pl. 10,*6;* previously figured by Bayle, 1878, pl. 53,*3*); *e–f,* adult microconch, *Humphriesianum* Zone, Troch, Monte Longara, north of Gallio, Veneto, Italy, ×2.5 (Sturani, 1971, pl. 10,*9*).——FIG. 33,*2g–i. S. auritum* STURANI, holotype, complete adult microconch with complex hood on mouth border, Monte Melleta, Veneto, Italy, ×2.5 (Sturani, 1971, p. 139, fig. 42-1).

Schmidtoceras WESTERMANN, 1956b, p. 66 [**Chondroceras (Schmidtoceras) schmidti;* OD]. Small, evolute; rounded, compressed whorls; short, strong primary ribs branch into 2–4 secondaries at blunt midlateral tubercles. Dimorphism poorly known. *Middle Jurassic (lower Bajocian,* Humphriesianum *Zone):* Germany, Switzerland, Italy, Spain.——FIG. 33,*3a–c.* **S. schmidti,* holotype, macroconch, Gerzen, near Alfeld, Lower Saxony, Germany, ×1.5 (Westermann, 1956b, pl. 3,*7a–c*).

Praetulites WESTERMANN, 1956a, p. 257 [**Chondroceras (Praetulites) kruizingai, nom. nov. pro Sphaeroceras godohense* KRUIZINGA, 1926, p. 52, *non* BOEHM, 1912, p. 151; OD]. Large, coronate whorls with high arched venter; bullate primary ribs divide at midlateral tubercles into 2–4 secondary ribs; ribs remain strong to end of adult body chamber, which terminates in a constriction and collar. Only macroconchs are known. Not closely related to *Tulites.* WESTERMANN & CALLOMON, 1988: *Middle Jurassic (uppermost Bajocian–lower Bathonian):* Indonesia (New Guinea, Sula Islands).——FIG. 34,*1a–b.* **P. kruizingai* (WESTERMANN), holotype, macroconch, Wai Menanga, 1°43′S, 124°50′E, 5 km inland from river mouth, 35 km east of Tikong, Taliabu, Sula Islands, Indonesia, ×0.67 (Kruizinga, 1926, pl. 14,*2–3*).

Satoceras WESTERMANN & CALLOMON, 1988, p. 39 [**S. satoi;* OD]. Sphaerocones; small umbilicus, rounded whorl section; primary ribs curve slightly forwards and divide at small tubercles at midwhorl into 3–4 secondaries that are continuous across the venter. Macroconchs uncoil and contract on the last half whorl of the adult body chamber to end in a forwardly curving mouth border; microconchs not definitely identified. Differs from *Praetulites* in more rounded umbilical walls and umbilical edge and weaker ribs throughout. *Middle Jurassic (lower–middle Bathonian):* Indonesia (Papua New Guinea, Sula Islands), Japan.——FIG. 34,*2a–c.* **S. satoi,* holotype, macroconch, Homejo, Kemabo Valley, Irian Jaya, Indonesia; *a–b,* ×0.6; *c,* showing well-preserved adult mouth border, ×1 (Westermann & Callomon, 1988, pl. 16,*1a–c*).

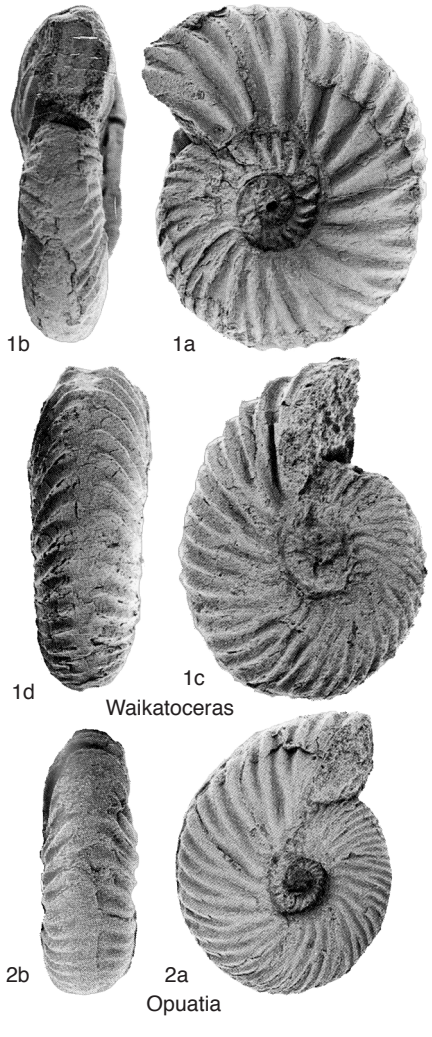

FIG. 35. Sphaeroceratidae (p. 46).

Subfamily WAIKATOCERATINAE Westermann, 2000

[Waikatoceratinae WESTERMANN in WESTERMANN, HUDSON, & GRANT-MACKIE, 2000, p. 48]

Sphaeroconic inner whorls become much more evolute on body chamber; small, reaching only 50 mm in diameter; ribs divide from midflank and are interrupted in middle of tabulate venter; small to prominent ventrolateral tubercles. Size dimorphic;

both dimorphs have similar oblique adult mouth borders with ventral rostrum. Probably evolved from *Chondroceras* (Sphaeroceratinae) in the Australasian area. *Middle Jurassic (lower Bajocian, top* Humphriesianum *Zone–upper Bajocian):* New Zealand.

Waikatoceras Westermann in Westermann, Hudson, & Grant-Mackie, 2000, p. 49 [**W. crassum;* OD]. Small sphaeroconic inner whorls, becoming more evolute with widening umbilicus up to adult body chamber; tabulate venter throughout growth; strong, prorsiradiate ribs bifurcate on mid- to upper flank and are projected further forwards onto venter and interrupted at midventer; develops ventrolateral tubercles or bullae. Size dimorphic: both dimorphs have ventral rostrum in adult mouth border, macroconchs are adult at 32–48 mm in diameter, microconchs at 15–20 mm. *Middle Jurassic (upper Bajocian):* New Zealand.——Fig. 35,*1a–d. *W. crassum,* Opuatia Cliff, southwestern Auckland; *a–b,* holotype, complete macroconch, ×1; *c–d,* complete microconch, ×2 (Westermann, Hudson, & Grant-Mackie, 2000, fig. 8A–B,H–I).

Opuatia Westermann in Westermann, Hudson, & Grant-Mackie, 2000, p. 51 [**O. circularis;* OD]. Smaller, more sphaeroconic, more involute, and tubercles less developed than in *Waikatoceras;* tabulate venter with midventral interruption of ribs only develops on adult body chamber of macroconchs. Both dimorphs have strongly oblique adult aperture; macroconchs adult at about 36 mm in diameter; microconchs are smaller. *Middle Jurassic (lower Bajocian, uppermost* Humphriesianum *Zone–upper Bajocian):* New Zealand.——Fig. 35,*2a–b. *O. circularis,* holotype, complete macroconch, Opuatia Cliff, southwestern Auckland, New Zealand, ×1 (Westermann, Hudson, & Grant-Mackie, 2000, fig. 8R,T).

Subfamily EURYCEPHALITINAE Thierry, 1978

[Eurycephalitinae Thierry, 1978, p. 142 (Thierry, 1976, p. 375, *nom. nud.,* no differentiating characters given)] [=Paracephalitinae Tintant & Mouterde, 1981, p. 97]

This subfamily is characteristic of the Circum-Pacific Province, with occurrences from the western borders of the Americas, through Alaska, the far northeast of Siberia, Indonesia (New Guinea), New Zealand and Antarctica. Derived in the *Subfurcatum* Zone, upper Bajocian, from *Sphaeroceras* along the eastern border of the Pacific, Eurycephalitinae differ from Sphaeroceratinae in their larger size, and the smooth outer and adult whorls of the macroconchs. Dimorphism is probably present in the whole subfamily, but association of dimorphs is difficult due to lack of collections from single horizons, incomplete preservation, and lack of significant morphological features in microconchs other than size difference. Consequently, most of the fourteen genera were proposed for macroconchs. Both dimorphs have been satisfactorily associated only in *Iniskinites* and *Warrenoceras,* and they are probably correctly associated in *Megasphaeroceras* and *Stehnocephalites. Xenocephalites* is a genus containing only microconchs, which almost certainly belong to three or more macroconch genera, but the associations remain to be determined. Riccardi & Westermann, 1991. *Middle Jurassic (upper Bajocian)–Upper Jurassic (low middle Oxfordian):* Circum-Pacific Province only.

Eocephalites Imlay, 1967, p. 96 [**E. primus;* OD] [=*Gukerites* Repin & others, 2007, p. 133 (type, *G. stolbovi,* OD)]. Moderately involute, globose to slightly compressed whorls; primary ribs curve forwards and divide at middle of whorl side; ribs persist, but become blunt, on adult body chamber, which attains sizes up to 100 mm in diameter, with a constriction at the mouth border; suture with broad lobes and saddles. *Middle Jurassic (upper Bajocian):* USA (Wyoming, Idaho, Utah), Chile, Russia (Franz Josef Land).——Fig. 36,*1a–e. *E. primus; a–b,* holotype, Twin Creek Limestone, Pine Creek, near Cokeville, Lincoln County, Wyoming, USA, ×0.75 (Imlay, 1967, pl. 16,*11,13*); *c–d,* paratype, showing ribs on the phragmocone, Twin Creek Limestone, 16 km southwest of Woodruff, Rich County, Utah, USA, ×0.75 (Imlay, 1967, pl. 15,*4–5*); *e,* another paratype showing broad saddles in suture, Twin Creek Limestone, South Eden Canyon, Rich County, Utah, USA, ×1 (Imlay, 1967, pl. 15,*16*).

Parachondroceras Imlay, 1967, p. 94 [**P. andrewsi;* OD]. Whorls involute, whorl section compressed or trigonal, with bluntly angled venter on inner whorls, rounded venter on the body chamber; umbilicus small on inner whorls, widening and uncoiling up to the adult mouth border; primary ribs on inner whorls divide into several secondaries at midwhorl and angled forwards over venter; ribs fade on adult body chamber except on venter. Macroconchs only; microconchs unknown. Similar to *Warrenoceras,* but umbilicus wider on all whorls and retains ribs on venter of adult whorl. *Middle Jurassic (upper Bajocian):* USA (Montana, Utah, Wyoming).——Fig. 36,*2a–b. *P. andrewsi,* holotype, Twin Creek Limestone, Red Dome, 45°13′N,

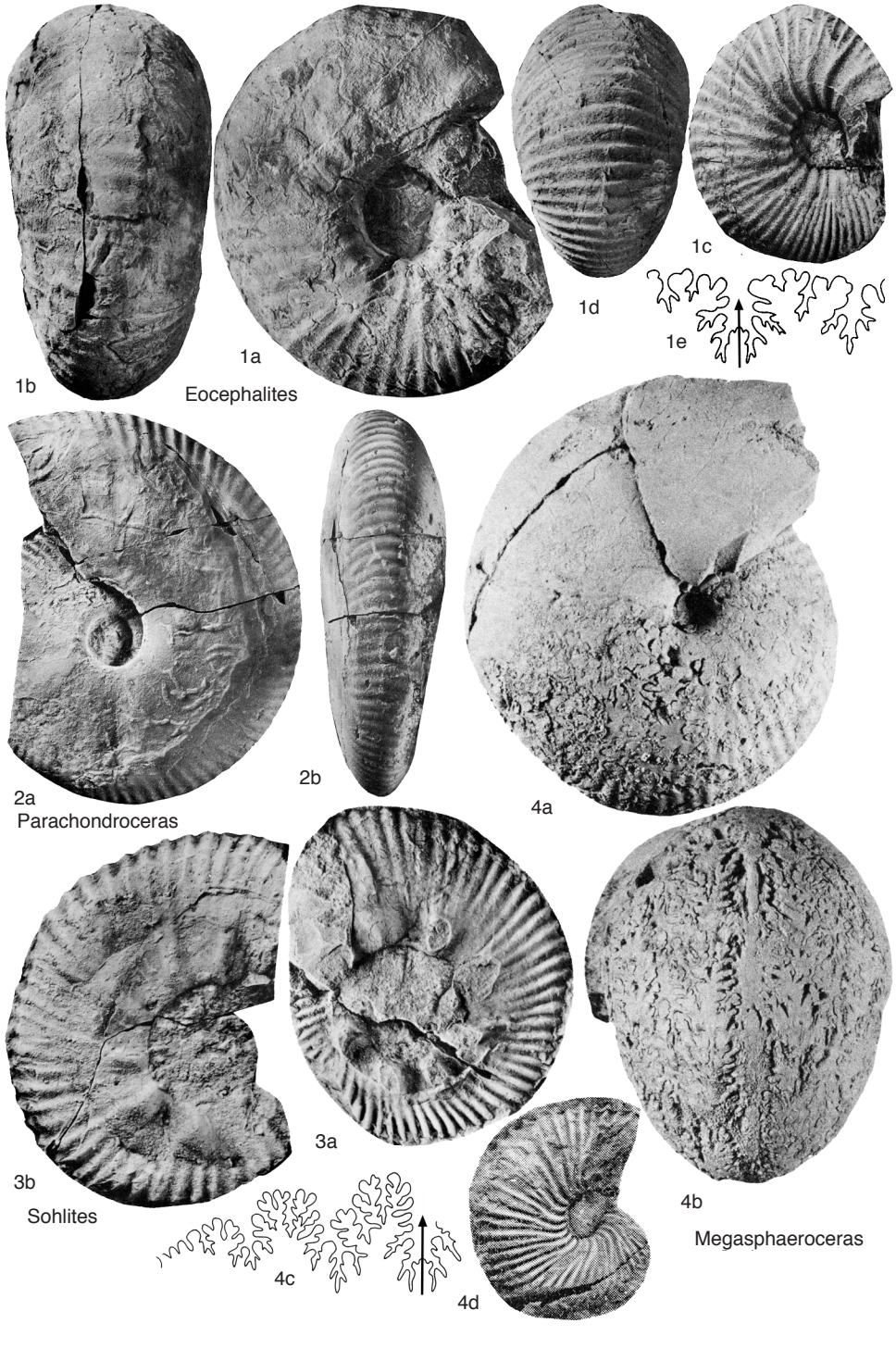

FIG. 36. Sphaeroceratidae (p. 46–49).

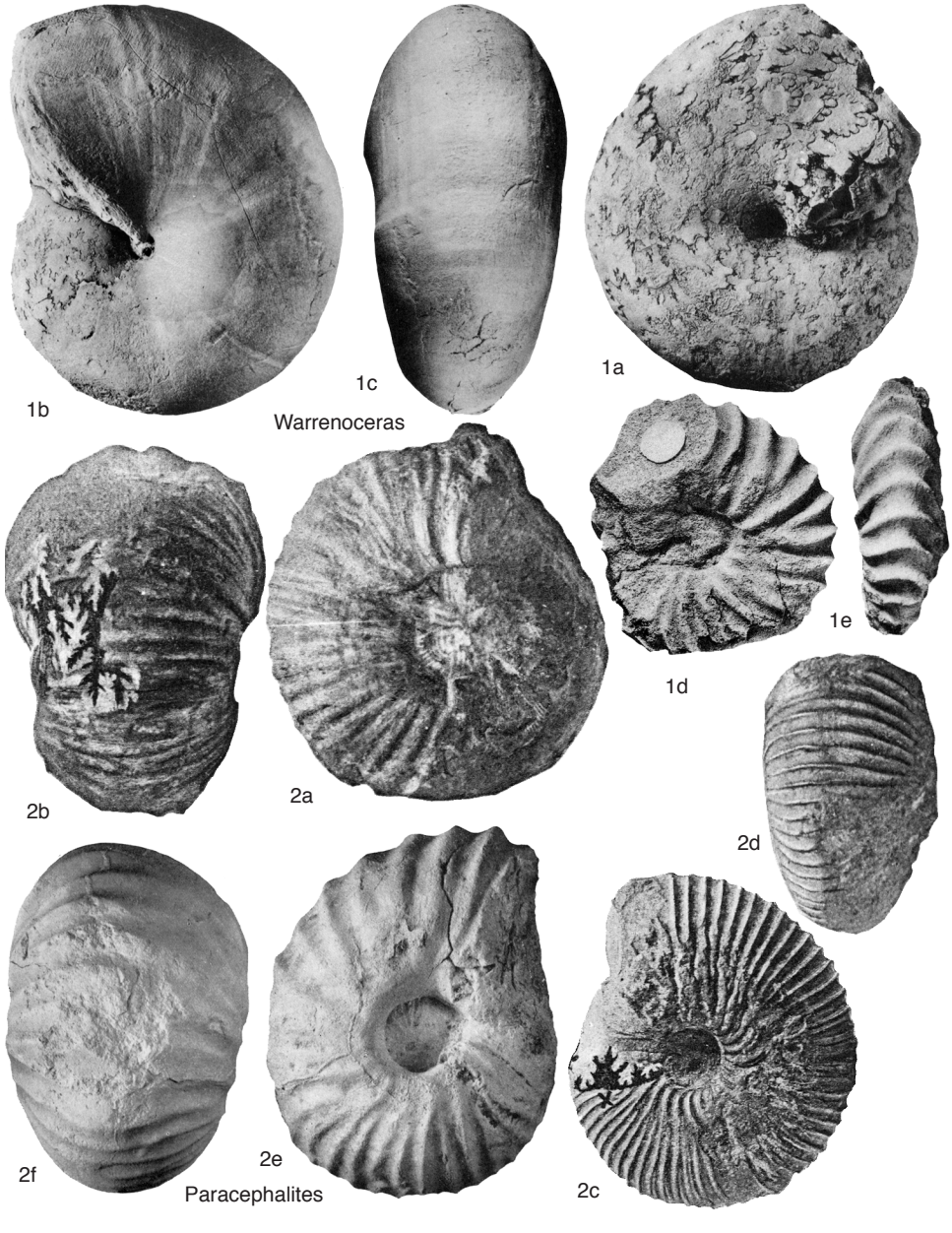

FIG. 37. Sphaeroceratidae (p. 48–49).

108°49′W, 11 km southeast of Bridger, Carbon county, Montana, USA, ×0.6 (Imlay, 1967, pl. 12,*15,18*).

Sohlites IMLAY, 1967, p. 91 [**S. spinosus;* OD]. Similar to *Parachondroceras,* but with wider umbilicus and large radially elongated tubercles near the umbilicus on the inner whorls; tubercles give rise to strong prorsiradiate ribs that are continuous over the venter; outer whorls and body chambers unknown. Probably macroconchs. *Middle Jurassic (upper Bajocian):* USA (Montana, Utah, Wyoming).——FIG. 36,*3a–b.* **S. spinosus* IMLAY, Twin Creek Limestone, Boulder River, Sweet Grass County, Montana, USA; *a,* holotype, ×1; *b,* paratype, ×0.75 (Imlay, 1967, pl. 11,*18,20*).

Warrenoceras FREBOLD, 1963, p. 13 [**Ammonites henryi* MEEK & HAYDEN, 1865, p. 123]. Oval,

slightly compressed whorls with very narrow or occluded umbilicus; angled venter on inner whorls becomes rounded on outer whorls; fine to strong, bifurcating ribs on inner whorls gradually fade, leaving outer whorls smooth. Dimorphic: microconchs moderately to strongly ribbed up to adult mouth border. *Middle Jurassic (middle Bathonian–basal upper Bathonian):* USA (South Dakota, Wyoming, Alaska), Canada (Alberta).——Fig. 37,*1a–c.* **W. henryi* (Meek & Hayden); *a,* holotype, macroconch, southwestern base of Black Hills, South Dakota, ×0.67 (Imlay, 1953a, pl. 5,*11*); *b–c,* macroconch with half a whorl of (?adult) body chamber, Custer County, South Dakota, ×0.67 (Imlay, 1953a, pl. 5,*13,15*).——Fig. 37,*1d–e. W. crassicostatum* (Imlay), holotype, microconch, Sundance Formation, Platte County, southeastern Wyoming, ×1 (Imlay, 1953a, pl. 3,*1–2*).

Megasphaeroceras Imlay, 1961, p. 470 [**M. rotundum;* OD] [=*Umaltites* Sey & Kalacheva, 1979, p. 37 (type, *Sphaeroceras era* Krimholz, 1939, p. 29, OD)]. Large sphaerocones with very small umbilicus; sharp ribs divide into two or three secondaries low on whorl side, and ribbing fades on adult body chamber; umbilicus widens slightly on adult whorl and the aperture has a broad constriction. Probably dimorphic: probable microconchs are more compressed and retain ribs to the end of final whorl. *Middle Jurassic (upper Bajocian):* Russia (Far East Region), Canada (British Columbia), USA (southern Alaska, Oregon, Idaho, Wyoming, Utah), ?Mexico, Peru, Argentina, Chile, Antarctica.——Fig. 36,*4a–c.* **M. rotundum,* holotype, macroconch, Inisikin Peninsula, Cook Inlet, Alaska, USA, ×1 (Imlay, 1961, pl. 63,*2–3,6*).——Fig. 36,*4d. M. era* (Krymholz), ?microconch, Sologne River, Bureya, Amur Oblast, Russia, ×1 (Sey & Kalacheva, 1980, pl. 10,*6*).

Talkeetnites Imlay, 1980, p. 35 [**T. cadiformis;* OD]. Macroconchs; inner whorls subcircular or slightly depressed, with fine to moderate, bifurcating ribs; outer whorls become highly depressed and cadicone, with a broad, arched venter, angled umbilical edge, and coarse primary ribs on lower part of whorl side. *Middle Jurassic (upper Bajocian–lowest Bathonian):* USA (southern Alaska).——Fig. 38,*1a–b.* **T. cadiformis,* holotype, macroconch, Boulder Creek, Talkeetna Mountains, 25 km northeast of Chickaloon, Alaska, USA, ×0.75 (Imlay, 1980, pl. 9,*4,6,8*).

Paracephalites Buckman, 1929, p. 8 [**P. jucundus;* OD] [=*Metacephalites* Buckman, 1929, p. 11 (type, *M. metastatus,* OD); =*Metastites* Frebold, 1963, p. 9, misspelling of *Metacephalites* Buckman; =*Miccocephalites* Buckman, 1929, p. 14 (type, *M. miccus,* OD); =*Oligocadoceras* Meledina, 1977, p. 87 (type, *Cadoceras shoshonense* Imlay, 1948, p. 22, OD)]. Moderately involute, globose to slightly compressed whorls; moderate to strong primary ribs divide at midwhorl and are straight across the venter; ribs fade on body chamber. Similar to *Eocephalites,* but younger in age, adults are larger and smooth on the final body chamber, except for remnants of ribs on venter. *Middle Jurassic (top lower–basal upper Bathonian):* Canada (Alberta), USA (Wyoming).——Fig. 37,*2a–b.* **P. jucundus,* holotype, Blairmore, Alberta, ×1 (Buckman, 1929, pl. 2,*2–3*).——Fig. 37,*2c–d. P. metastatus* (Buckman), holotype of type species of *Metacephalites,* Blairmore, Alberta, Canada, ×1 (Buckman, 1929, pl. 3,*1,3–4*).——Fig. 37,*2e–f. P. shoshoense* (Imlay), holotype of type species of *Oligocadoceras,* Shoshone River, 2 miles west of Cody, Wyoming, USA, ×0.7 (Imlay, 1948, pl. 7,*16–17*).

Iniskinites Imlay, 1975, p. 23 [**Kheraiceras magniforme* Imlay, 1953b, p. 79; OD] [=*Chinitnites* Imlay, 1975, p. 17 (type, *C. chinitnaensis,* OD); =*Loucheuxia* Poulton, 1987, p. 62 (type, *L. bartletti,* OD)]. Involute, globose to sphaeroconic whorls with depressed whorl section and small umbilicus; primary ribs bifurcate or secondaries are intercalated at midwhorl, and ribs are continuous across broad, rounded venter, curving slightly forwards; ribs strong throughout growth and may become stronger on final whorl of larger macroconchs. Dimorphic: macroconchs adult at 80–140 mm in diameter, highly depressed or sphaeroconic, and umbilicus widens on adult half whorl, with a constriction and collar in mouth border; microconchs ("*Chinitnites*") adult at 22–30 mm in diameter with similar, uncoiling final half whorl and constriction in the adult mouth border, but have less depressed whorls throughout. *Middle Jurassic (upper Bajocian–upper Bathonian):* USA (southern Alaska, western USA), Canada, Argentina, Chile, New Zealand.——Fig. 38,*2a–b.* **I. magniformis* (Imlay), holotype, adult macroconch, east shore of Iniskin Bay, Cook Inlet, southern Alaska, USA, ×0.6 (Imlay, 1953b, pl. 31,*7–8*).——Fig. 38,*2c–d. I. intermedius* (Imlay), holotype, adult macroconch, northwest shore of Chisik Island, Tuxedni Bay, Cook Inlet, southern Alaska, ×0.7 (Imlay, 1953b, pl. 31,*3–4*).——Fig. 38,*2e–f. I. chinitnaensis* Imlay, holotype, adult microconch, Little Telchina River, 62°07′N, 147°42′W, Talkeetna Mountains, Alaska, ×1.5 (Imlay, 1975, pl. 2,*29–30*).——Fig. 38,*2g–h. I. parviformus* (Imlay), holotype, adult microconch, Bowser Creek, Iniskin Peninsula, Cook Inlet, Alaska, ×1.5 (Imlay, 1953b, pl. 33,*8,10*).

Stehnocephalites Riccardi, Westermann, & Elmi, 1990, p. 567 [**Indocephalites gerthi* Spath, 1928b, p. 175; OD]. Moderately evolute, subcircular whorls, broad, arched venter; prorsiradiate primary ribs curve forwards and divide on upper part of whorl and are continuous across the venter. Adults complete at 70–155 mm in diameter and have a constriction at the mouth border. Possible dimorphism expressed only as two overlapping size groups with little or no morphological differences. More evolute and whorls more depressed than *Eurycephalites* and *Lilloettia* and ribs retained to end of body chamber. *Middle Jurassic (upper Bathonian–lower Callovian):* Argentina.——Fig. 39,*1a–b.* **S. gerthi* (Spath), holotype, complete adult, Chacay Melehue, Neuquén, Argentina; *a,* ×0.7 (Stehn, 1923, pl. 8,*4*); *b,* ×0.7 (Riccardi, Westermann, & Elmi, 1990, pl. 6,*2*).

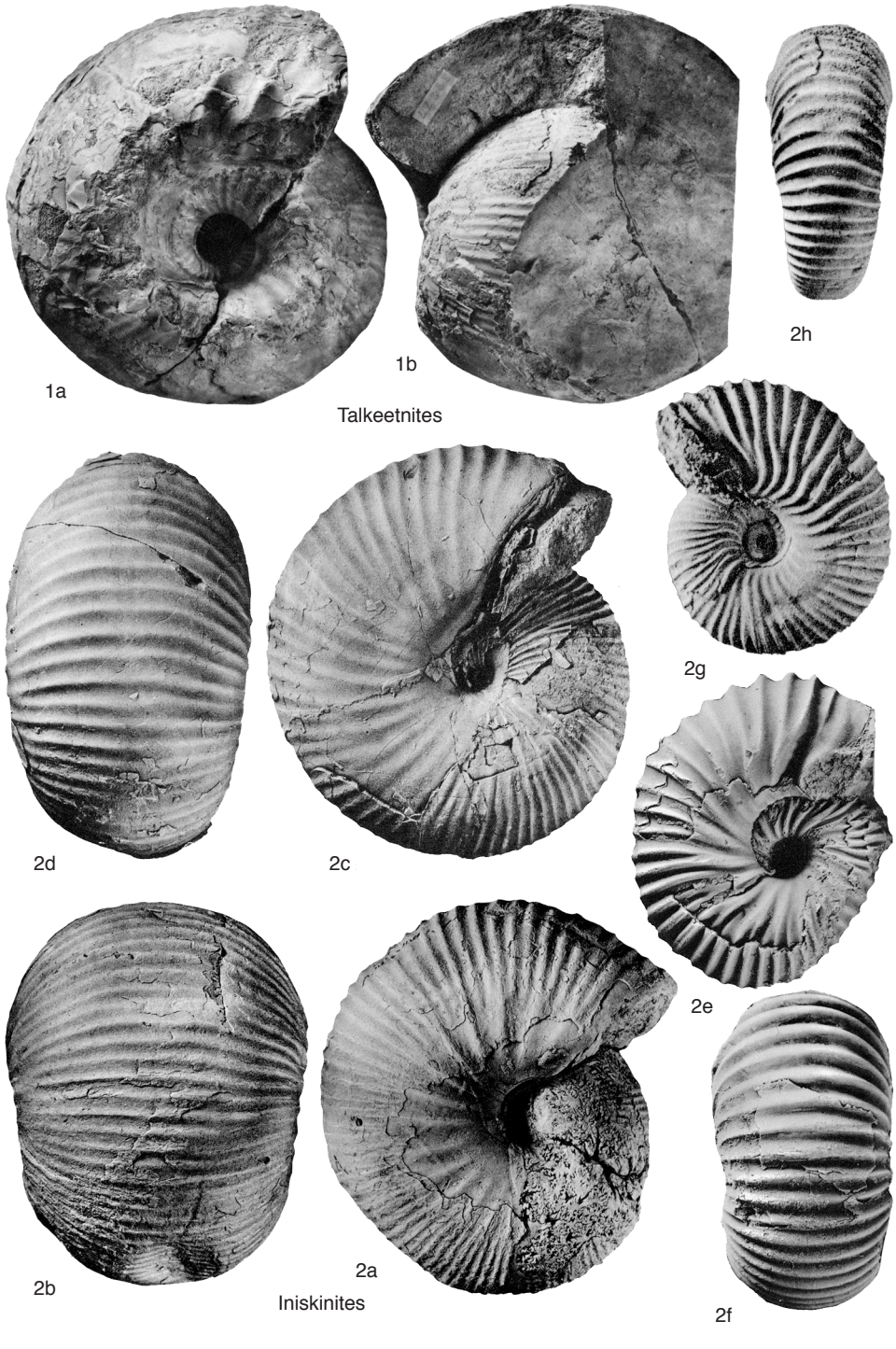

FIG. 38. Sphaeroceratidae (p. 49).

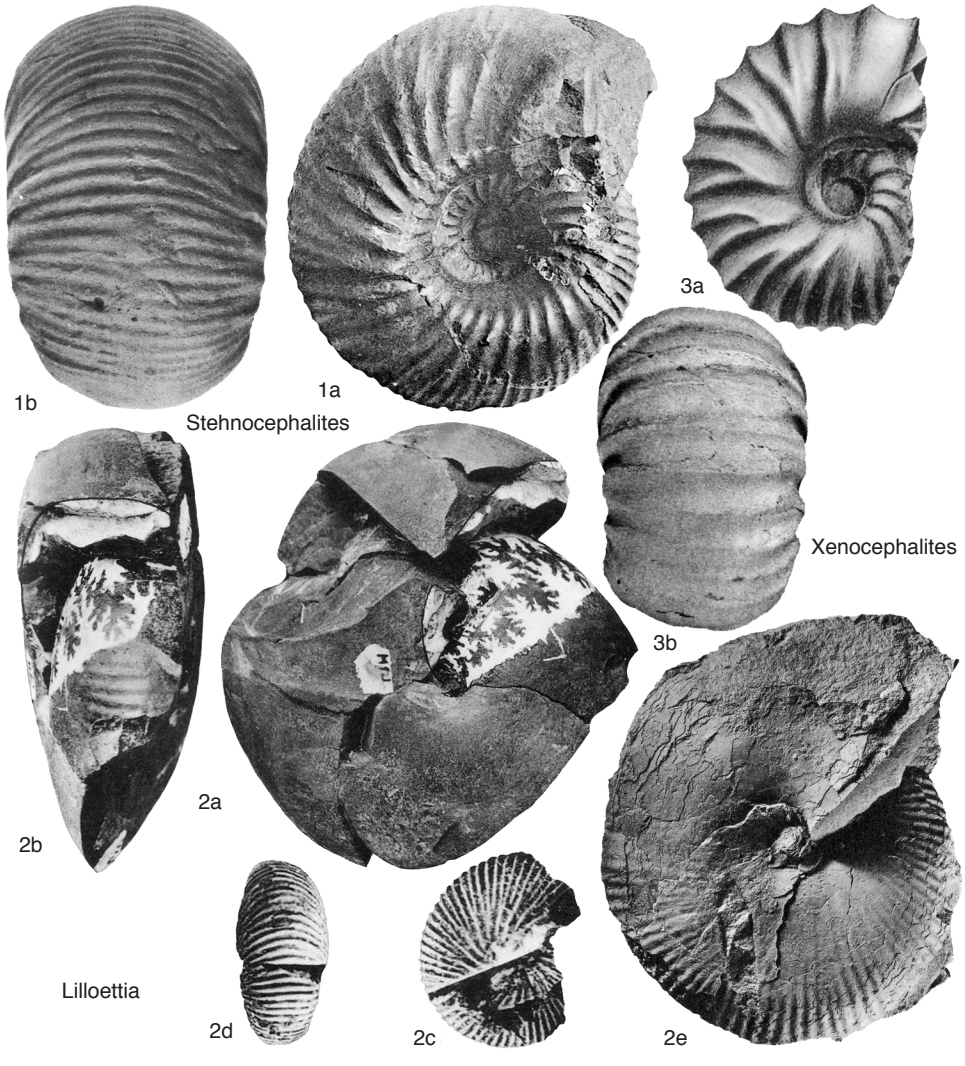

FIG. 39. Sphaeroceratidae (p. 49–52).

Lilloettia CRICKMAY, 1930, p. 60 [**L. lilloetensis;* SD ARKELL, 1957, p. 294]. Involute, compressed whorls, with rounded venter and very small or occluded umbilicus; slightly prorsiradiate ribs divide at midflank and secondary ribs are continuous across the venter; ribs fade on larger whorls. Dimorphism not identified. Similar to *Eurycephalites* but larger, with more compressed whorls, and umbilicus usually smaller or occluded. *Middle Jurassic (upper Bathonian–lower Callovian):* USA (Alaska, Oregon, Idaho, California), Canada (British Columbia), New Zealand.——FIG. 39,*2a–e. *L. lilloetensis; a–d,* holotype, complete adult with part of mouth border, Billhook Creek, 5 miles west of Harrison Lake, British Columbia, Canada; *a–b,* final suture shown at end of phragmocone, ×0.6; *c–d,* inner whorls, ×1 (Crickmay, 1930, pl. 18,*1–4*); *e,* adult with phragmocone and half a whorl of body chamber, north side of Wide Bay, Alaska Peninsula, Alaska, USA, ×0.6 (Imlay, 1953b, pl. 30,*1*).

Eurycephalites SPATH, 1928b, p. 175 [**Macrocephalites vergarensis* BURCKHARDT, 1903, p. 21; OD]. Globose, involute sphaerocones; whorl section evenly rounded to highly depressed; umbilicus very small, umbilical wall rounded; primary ribs slightly flexuous and projected, dividing into 2 or 3 secondaries about midflank and crossing the venter without interruption; ribs tend to fade on

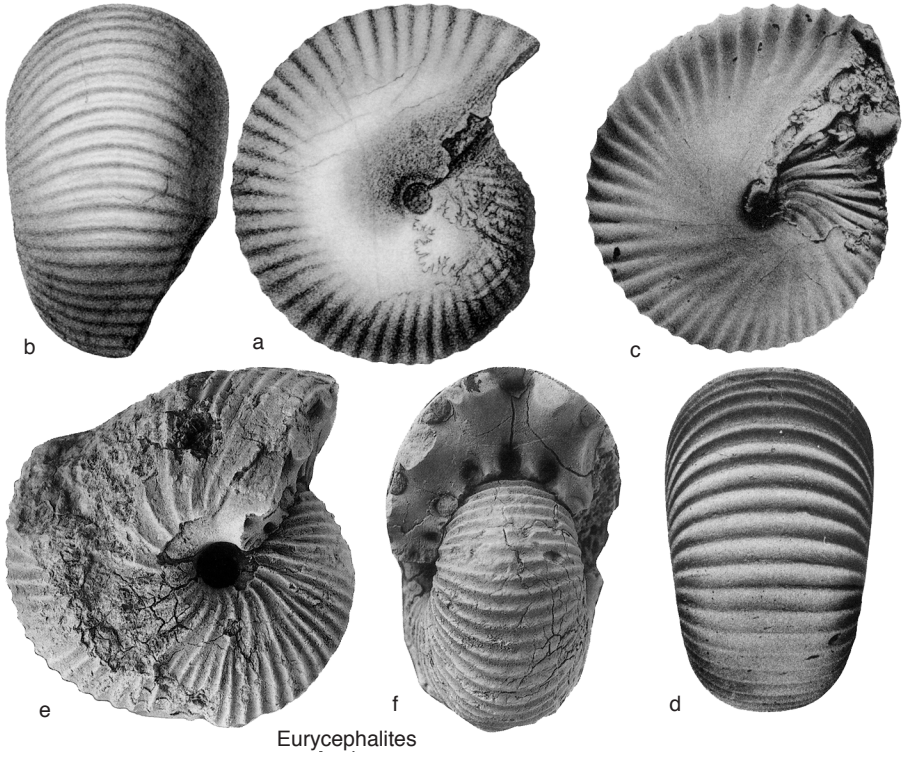

FIG. 40. Sphaeroceratidae (p. 51–52).

inner flank of body chamber, but remain across the venter. Macroconchs; adult at 50–110 mm in diameter; corresponding microconchs not identified. RICCARDI & WESTERMANN, 1991; HILLEBRANDT & GRÖSCHKE, 1995. *Middle Jurassic (lower Callovian)–Upper Jurassic (lower Oxfordian):* Argentina, Chile, Mexico, ?New Zealand.——FIG. 40*a–d.* **E. vergarensis* (BURCKHARDT); *a–b,* lectotype (now lost; designated by RICCARDI, WESTERMANN, & ELMI, 1990, p. 565), macroconch, lower Callovian, Paso Vergara, Mendoza, Argentina, ×0.75 (Burckhardt, 1903, pl. 2,*19;* pl. 3,*4*); *c–d,* complete adult macroconch, lower Callovian, Chacay Melehue, Neuquén, Argentina, ×0.75 (Riccardi & Westermann, 1991, pl. 2,*2a–b*).——FIG. 40*e–f. Eurycephalites* sp., lower Oxfordian, Cerro Amarillo, 100 km east of Antofagasta, northern Chile, ×0.75 (Hillebrandt & Gröschke, 1995, pl. 5,*3a–b*).

Xenocephalites SPATH, 1928b, p. 175 [**Macrocephalites neuquensis* STEHN, 1923, p. 86; OD] [=*Tuxednites* IMLAY, 1980, p. 34 (type, *Arctocephalites? alticostatus* IMLAY, 1962, p. 22, OD)]. Microconchs up to 75 mm in diameter; whorls only moderately involute, with rounded to slightly depressed whorl section and broad, rounded venter; ribs fine and bifurcating on inner whorls, becoming strong and widely spaced on adult body chamber on which the umbilical seam tends to uncoil, ending in a simple aperture. Larger than microconchs of *Iniskinites* with coarser ribs on the body chamber. Associated macroconchs have not been identified. *Middle Jurassic (middle Bathonian–lower Callovian):* Indonesia (New Guinea), New Zealand, western Canada, USA (southern Alaska, Western Interior), Mexico, Argentina, Chile.——FIG. 39,*3a–b.* **X. neuquensis* (STEHN), lectotype (designated by RICCARDI, WESTERMANN, & ELMI, 1990, p. 566), microconch, Chacay Melehue, Neuquén, Argentina, *a,* ×1 (Stehn, 1923, pl. 1,*3*); *b,* ×1 (Riccardi & Westermann, 1991, pl. 16,*6b*).

Buckmaniceras CRICKMAY, 1930, p. 62 [**B. buckmani;* M] [=*Imlayoceras* FREBOLD, 1963, p. 20 (type, *I. miettense,* OD)]. Highly depressed sphaerocones with very narrow umbilicus; whorl breadth greatly exceeds whorl height on inner and middle whorls; moderately strong primary ribs bifurcate at midflank into secondary ribs that bend slightly backwards onto venter; ribs fade on adult body chamber. Probably macroconchs, but accompanying microconchs not identified. *Middle Jurassic (uppermost Bathonian–lower Callovian):* USA (Alaska), Canada (Alberta, British Columbia).——FIG. 41*a–d.* **B. buckmani,* holotype, Billhook Creek, 5 miles west of Harrison Lake, British Columbia,

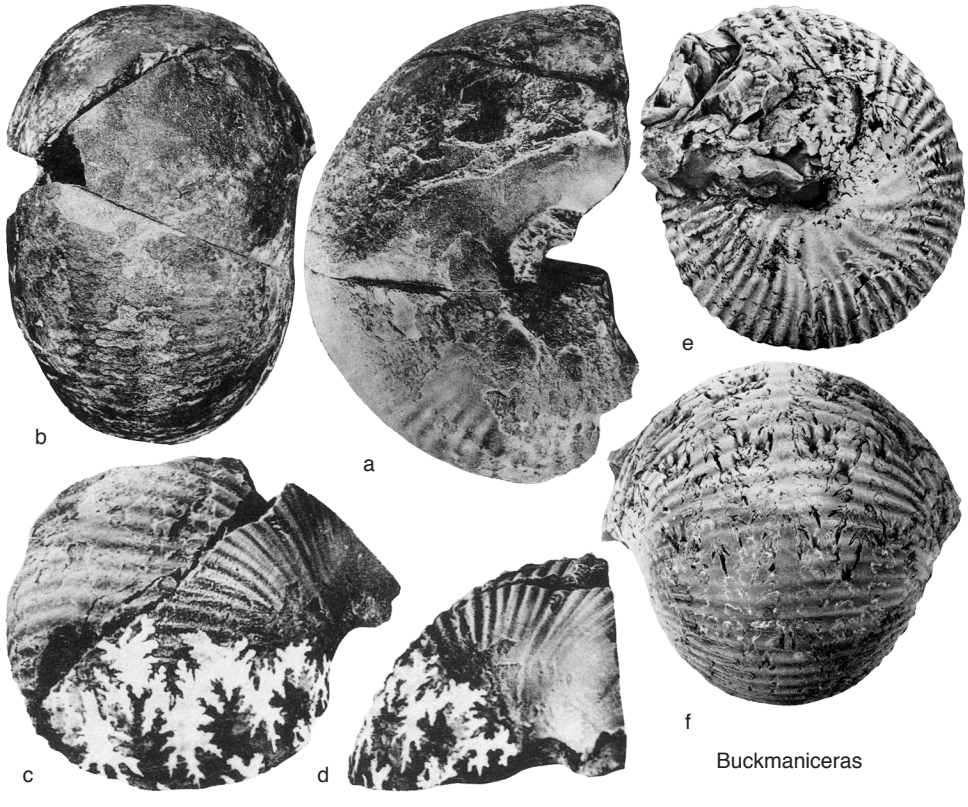

FIG. 41. Sphaeroceratidae (p. 52–53).

Canada; *a–b,* complete specimen with most of the adult body chamber, ×0.65; *c–d,* end of penultimate whorl, with highly depressed whorl section, ×1 (Crickmay, 1930, pl. 20,*1–4*).——FIG. 41,*e–f. B. miettense* (FREBOLD), holotype, complete phragmocone, Rocky River, 26 km northeast of Jasper, Alberta, Canada, ×0.65 (Frebold, 1963, pl. 8,*1a,c*).

Araucanites WESTERMANN & RICCARDI in STIPANICIC, WESTERMANN, & RICCARDI, 1976, p. 290 [**Mayaites (Araucanites) stipanicici;* OD]. Oval, compressed whorls, with very small umbilicus on inner whorls, occluded umbilicus on middle and outer whorls and rounded venter; primary ribs moderate to strong, bifurcating at midwhorl side and continuous over the venter. Dimorphic: macroconchs with ribs quickly fading on side of whorl, but remaining on venter of adult body chamber; microconchs retain strong ribs on adult body chamber, on which the umbilicus opens and uncoils slightly. *Araucanites* was originally proposed as a subgenus of the middle Oxfordian–lower Kimmeridgian genus *Mayaites* (Mayaitinae), but occurrences in the lower Callovian in New Zealand (WESTERMANN, HUDSON, & GRANT-MACKIE, 2002) appear to show that it belongs to the Eurycephalitinae. *Araucanites* was probably derived from *Lilloettia,* differing in its occluded umbilicus, more compressed whorl section, and earlier disappearance of the ribs, though this conclusion is still the subject of debate (e.g., ÉNAY, 2009, p. 42, 58–59). *Middle Jurassic (lower Callovian)–Upper Jurassic (low middle Oxfordian):* Argentina, Chile, New Zealand.——FIG. 42*a–c. *A. stipanicici,* holotype, Aguada de Campos, Sierra de Reyes, Mendoza, Argentina; *a,* complete specimen with body chamber three-quarters of a whorl long, ×0.35; *b–c,* complete phragmocone, ×0.5 (new; Museum La Plata, Argentina, MLP 12240).——FIG. 42*d–e. A. spellmani* WESTERMANN, HUDSON, & GRANT-MACKIE, 2002, complete microconch with small lappet, Spellman Cliff, Awakino River, North Island, New Zealand, ×1 (Westermann, Hudson, & Grant-Mackie, 2002, fig. 9C–D).

Subfamily MAYAITINAE Spath, 1928

[*nom. transl.* WESTERMANN, 1964c, p. 130, *ex* Mayaitidae SPATH, 1928b, p. 165, 222] [=Grayiceratidae SPATH, 1925a, p. 145 (*nom. dub.*), ICZN Opinion 471, 1957, p. 203]

Sphaerocones to compressed platycones, with rounded venter, moderate to very small

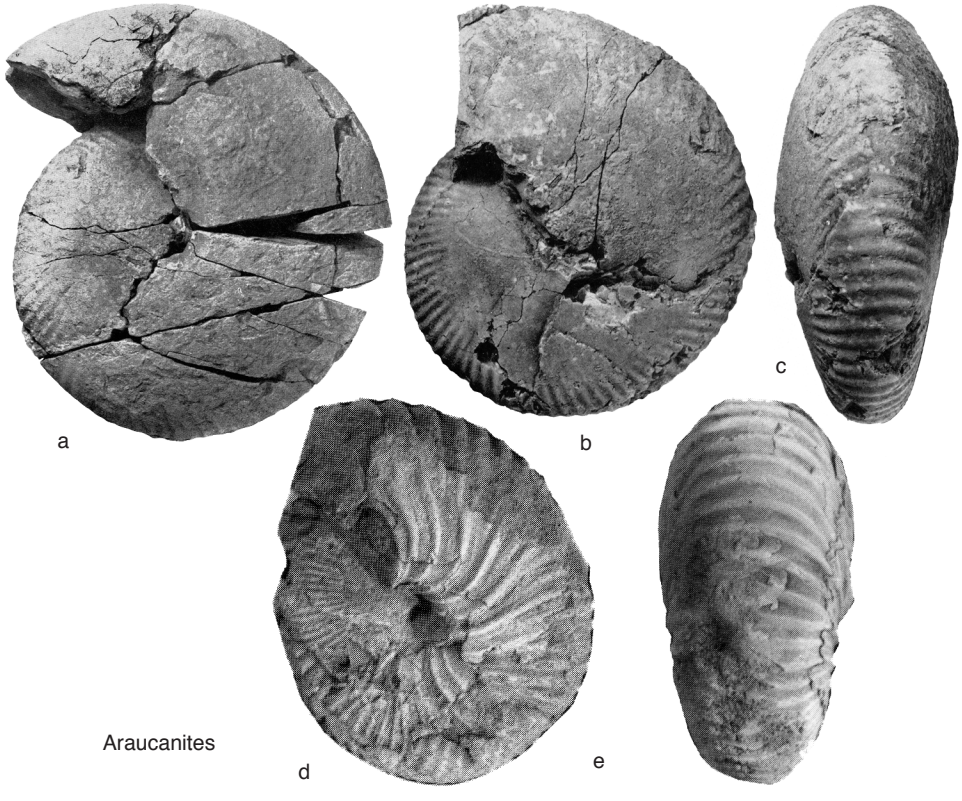

FIG. 42. Sphaeroceratidae (p. 53).

umbilicus, and strong, dividing ribs that fade at large sizes. Dimorphism probably occurs, but has been little investigated; macroconchs large, up to 400 mm in diameter, while specimens that might be microconchs are adult at 100–200 mm in diameter; both dimorphs have similar, plain mouth borders, but convincing associations have not yet been established. Mayaitinae are confined to the Indian Ocean Province.

The origin of the Mayaitinae has been much debated. They were originally thought to have been derived from Pachyceratidae (Perisphinctoidea) in the middle Oxfordian, but their suture-line development results in a complexly divided and sometimes strongly retracted dorsal part of the umbilical lobe and includes the lobe-element U_n, which contrasts with the absence of U_n and the simpler umbilical lobe in Pachyceratidae (THIERRY, 1975, p. 1543). For this reason, derivation from the Macrocephalitinae (with which they are homeomorphic in many features) or the Eucycloceratinae was considered more likely (CALLOMON, 1981, p. 148; RICCARDI & WESTERMANN, 1991, p. 32, fig. 4), though no morphologically similar connecting specimens are known from the upper Callovian and lower Oxfordian. However, following the discovery of morphologically similar examples of *Eurycephalites* in the upper Callovian and lower Oxfordian of northern Chile (HILLEBRANDT & GRÖSCHKE, 1995), derivation of the Mayaitinae from the Eurycephalitinae in the lower Oxfordian now appears to be more likely (Fig. 3). *Upper Jurassic (middle Oxfordian–lower Kimmeridgian):* Tanzania,

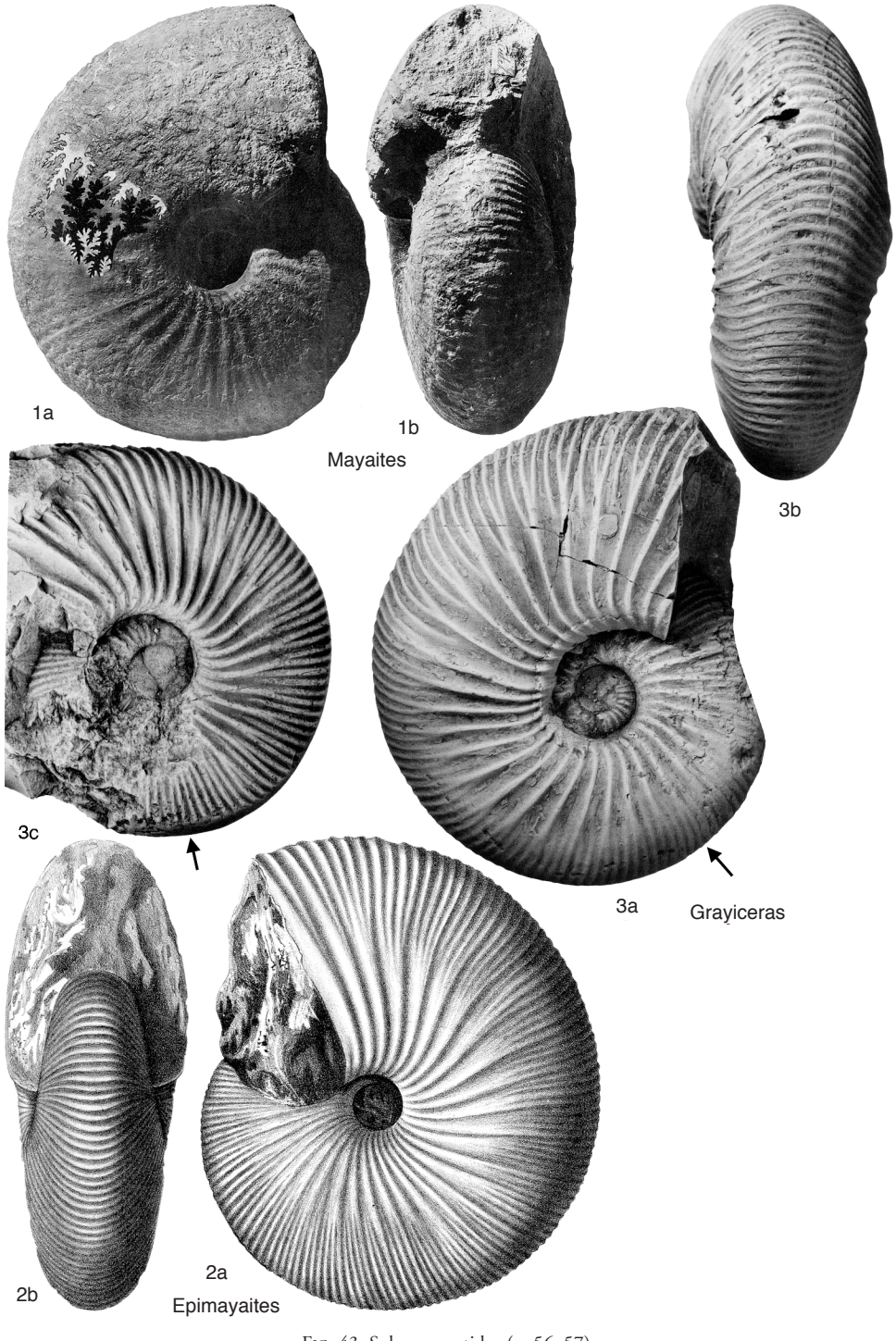

FIG. 43. Sphaeroceratidae (p. 56–57).

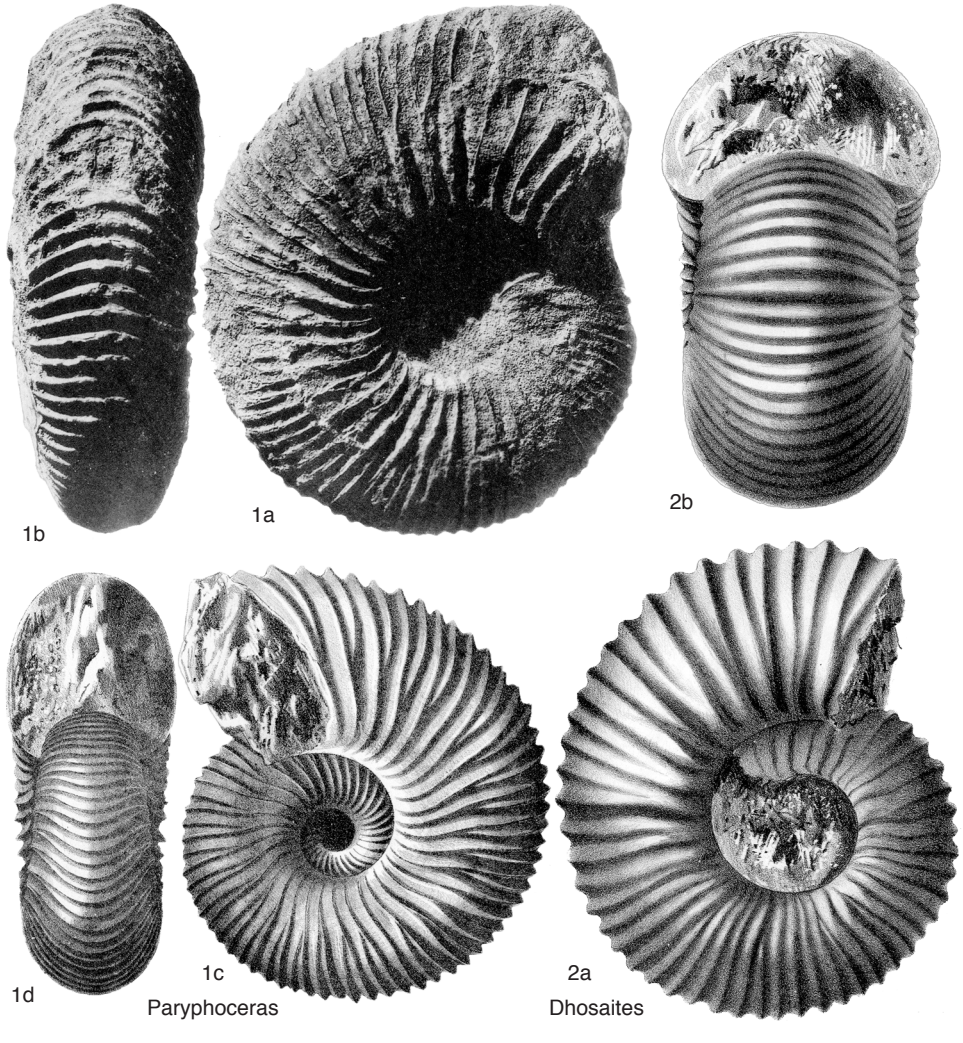

FIG. 44. Sphaeroceratidae (p. 57).

Kenya, Madagascar, Yemen, India, Nepal, Thailand, Indonesia, Papua New Guinea, New Zealand, Antarctica.

Mayaites SPATH, 1924, p. 9 [**Ammonites maya* J. de C. SOWERBY, 1840b, p. 719, pl. 61,*8;* OD]. Very large; inflated to sphaeroconic whorls, rounded whorl section, small umbilicus; moderate to coarse primary ribs divide at midwhorl and secondaries are continuous over the venter; ribs fade on outer whorls. Homeomorphic with some species of *Macrocephalites. Upper Jurassic (middle Oxfordian–lower Kimmeridgian):* Kenya, Tanzania, Madagascar, India (Kutch, northern Gujarat; Spiti Valley, Himachal Pradesh), Pakistan (Attock, Punjab), Nepal, Indonesia (Sula Islands).——FIG. 43,*1a–b. M. maya* (J. DE C. SOWERBY), holotype, Kutch, northern Gujarat, ×0.33 (Spath, 1928b, pl. 31,*1a,* pl. 32,*6*).

Epimayaites SPATH, 1928b, p. 223 [**Stephanoceras transiens* WAAGEN, 1875, p. 111; OD]. More involute and whorl section more compressed than *Mayaites;* also ribs finer, dividing into 2–4 secondaries, or secondaries are intercalated at midwhorl, and projected slightly forwards on venter. *Upper Jurassic (middle Oxfordian–lower Kimmeridgian):* Kenya, India (Kutch, northern Gujarat; Spiti Valley, Himachal Pradesh), Nepal, Yemen, Thailand, New Zealand.——Fig. 43,*2a–b. *E. transiens* (WAAGEN), lectotype (designated by SPATH, 1928b, p. 240), northwest of Soorka, Kutch, India, ×0.5 (Waagen, 1875, pl. 32,*2*).

Grayiceras SPATH, 1923, p. 306 [**Ammonites nepaulensis* GRAY, 1830 in 1830–1835, pl. 100,*1–2;* SD SPATH, 1924, p. 11; =*Grayiceras blanfordi* SPATH, 1924, p. 11, obj.]. Similar to *Epimayaites,* but more evolute; primary ribs somewhat stronger, and dividing at midflank into only 2 or 3 secondaries. The lectotype and paralectotype have body chambers about three-quarters of a whorl long and might be microconchs, adult at 110 to 125 mm in diameter; no corresponding macroconchs are known. *Grayiceras* has a long and complicated history, summarized by ARKELL (in ICZN Opinion 471, 1957) and WESTERMANN and WANG YI-GANG (1988, p. 322). SPATH (1923, 1924) originally considered the genus to be Tithonian in age and possibly related to *Kossmatia* (Ataxioceratidae), but later he included it in the Mayaitidae (SPATH, 1928b, p. 224). It is now well established as a Mayaitinid of upper Oxfordian to lower Kimmeridgian age (JANA, BARDHAN, & HALDER, 2005, p. 885; ÉNAY, 2009). [Although GRAY (1830 in 1830–1835, pl. 100) gave the locality of his figured specimens as "Sulgranees, Nepal," BLANFORD (1903, p. 345) stated that no locality with that name existed in Nepal, and that GRAY had probably misinterpreted the term "Saligram," a name for black limestone nodules containing ammonites that are prized as holy stones or charms by Hindu pilgrims (HAGN, 1977). The locality name "Saligramam" has been used for Muktinath, 190 km northwest of Kathmandu, Nepal, where Saligrams have been found for many years in the Kali Gandaki River valley, and this is the most likely locality of GRAY's specimens]. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian):* India (Spiti Valley, Himachal Pradesh), Nepal.——FIG. 43,*3a–c. *G. nepaulense* (GRAY), probably Muktinath, 190 km northwest of Kathmandu, Nepal; *a–b,* lectotype (designated by WESTERMANN & WANG YI-GANG, 1988, p. 323), ×0.6; *c,* paralectotype, ×0.6; the arrow indicates the last suture in both specimens (Westermann & Wang, 1988, pl. 22,*1,3,* pl. 23,*1;* also figured by Gray, 1830 in 1830–1835, pl. 100,*1–2*, reversed; Salter & Blanford, 1865, pl. 14,*1a–b;* and Uhlig, 1910, pl. 45A,*1a–b*).

Paryphoceras SPATH, 1928b, p. 224, 247 [**P. badiense;* OD] [=*Prograyiceras* SPATH, 1928b, p. 224, 250 (type, *Dhosaites grayi* SPATH, 1924, p. 10, OD)]. Whorls rounded-quadrate; more evolute than *Grayiceras,* ribs generally stronger, a few are single, but most bifurcate at midwhorl side; ribs remain up to the adult mouth border. Possibly microconchs, but association with macroconchs uncertain. *Upper Jurassic (middle Oxfordian–lower Kimmeridgian):* Kenya, India (Kutch, northern Gujarat; Spiti Valley, Himachal Pradesh), Nepal, Yemen.——FIG. 44,*1a–b. *P. badiense,* holotype, Dhosa Oolite, Badi, Kutch, northern Gujarat, India, ×0.8 (Spath, 1928b, pl. 40,*7*).——FIG. 44,*1c–d. P. grayi,* holotype, Huntcote, Kutch, northern Gujarat, India, ×0.5 (Waagen, 1875, pl. 35,*2*).

Dhosaites SPATH, 1924, p. 10 [**D. elephantoides* SPATH, 1928b, p. 244; SD SPATH, 1925a, p. 159, as "Genotype: *Stephanoceras elephantinum* (Sowerby), Waagen, XXXI, 3" (i.e., WAAGEN, 1875, plate XXXI, fig. 3); the identity of the type species is now fixed by HOWARTH, herein (under the provisions of Article 70.3.2 of the ICZN *Code,* 1999, p. 74), as *Dhosaites elephantoides* SPATH, 1928b, p. 244, this being the taxonomic species actually involved in SPATH's misidentification of SOWERBY's (1840a, p. 329) species]. Evolute, whorl section rounded and depressed; strong primary ribs divide low on the whorl side and are radial across the venter; ribs persist to end of growth. More evolute and more depressed than any other mayaitinid. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian):* Kenya, India (Kutch, northern Gujarat), Madagascar.——FIG. 44,*2a–b. *D. elephantoides,* lectotype (designated by SPATH, 1928b, p. 244), Dhosa Oolite, Lodai, Kutch, northern Gujarat, India, ×1 (Waagen, 1875, pl. 31,*3*).

Family MACROCEPHALITIDAE Salfeld, 1921

[*nom. correct.* BUCKMAN, 1922, p. 24, *ex* Macrocephalinae SALFELD, 1921, p. 344]

Mostly sphaerocones and cadicones, though some later forms are more evolute and compressed; they are strongly dimorphic in size only, with no lappets on the microconchs. The earliest subfamily, the Macrocephalitinae, was probably derived from *Satoceras* (Eurycephalitinae) in the upper part of the middle Bathonian. Macrocephalitinae then gave rise to the more evolute and more compressed Eucycloceratinae at the top of the lower Callovian. Mayaitinae are homeomorphic in many features with the Macrocephalitinae, but they are separated from them by a stratigraphical gap in the upper Callovian and lower Oxfordian, and derivation of Mayaitinae from *Eurycephalites* (Eurycephalitinae) in the lower Oxfordian now appears to be more probable. WAAGEN, 1875; BUCKMAN, 1909–1930; LEMOINE, 1910–1911; BOEHM, 1912; SPATH, 1927–1933; BASSE & PERRODON, 1952; CALLOMON, 1955, 1971; JEANNET, 1955; LOMINADZE, 1967. *Middle Jurassic (uppermost middle Bathonian–middle Callovian):* Tethyan and sub-Mediterranean Provinces, Northern and Southern Hemispheres, not Boreal.

Subfamily MACROCEPHALITINAE Salfeld, 1921

[Macrocephalinae Salfeld, 1921, p. 344]

Involute forms with arched whorl section and rounded venter at all growth stages, ranging from sphaerocones to more compressed forms, with dense, sharp, somewhat flexuous prorsiradiate ribbing, bifurcating or polyfurcating low on the side of the whorl and some intercalatory ribs. Strongly dimorphic: the macroconchs become smooth on final whorls, the umbilical seam uncoils somewhat, and the adult body chamber contracts and terminates in a simple, sinuous peristome; microconchs are strongly ribbed to the end of the body chamber, without modification except for some approximation of ribbing near the adult aperture, which is also simple, never collared, flared, or constricted. Sutures show the heterochronous element U_n in early ontogeny characteristic of the Stephanoceratoidea and become elaborate with many incised, slender lobes in the macroconchs.

The first occurrences are in the middle Bathonian in Indonesia and New Guinea in the western Pacific and are thought to have been derived from *Satoceras* (Sphaeroceratinae) in the New Guinea-Japan area of the western Pacific. The subfamily then spread rapidly to most of the circum-Tethys region from India to eastern and northern Africa, Europe, southern Russia, and southern China, but not to any more northerly or Boreal regions. In these Tethyan areas, the earliest occurrences were originally considered to define the base of the Callovian, but they have now been dated as upper Bathonian, and they became more abundant in the lower Callovian.

The traditional classification into genera and subgenera was based on differences in whorl shape, size of umbilicus, and rib density. Large collections from known stratigraphical horizons in southern Germany (Callomon, Dietl, & Niederhöfer, 1992) and Kutch, northern Gujarat, western India (Krishna & Westermann, 1987; Bhaumik & others, 1993) have now shown that intraspecific variability at single horizons embraces most of the differences between the existing generic names. Consequently, the classification adopted herein differs radically from previous morphological classifications, with most of the previous generic names being placed in synonymy with *Macrocephalites.* In western India, where the largest collections have been obtained, there are six successive horizons, each with a characteristic species, but all show continuous variation covering most of the morphological range of *Macrocephalites* as now defined herein. Thierry, 1978; Westermann & Callomon, 1988. *Middle Jurassic (top middle Bathonian–middle Callovian):* Europe, northern Africa, southern Russia, southern China, Indian Ocean Province, Indonesia, New Zealand, Antarctica.

Macrocephalites Zittel, 1884, p. 470 [**Ammonites macrocephalus* Schlotheim, 1813, p. 70; SD Lemoine, 1910 in 1910–1911, p. 151] [=*Pleurocephalites* Buckman, 1922, pl. 284 (type, *P. lophopleurus,* OD); =*Macrocephaliceras* Buckman, 1922, pl. 313, obj.; =*Kamptokephalites* Buckman, 1922, pl. 347 (type, *K. kamptus,* OD); =*Dolikephalites* Buckman, 1923a, pl. 372 (type, *D. dolius,* =*Macrocephalites typicus* Blake, 1905, p. 42, OD); =*Tmetokephalites* Buckman, 1923a, pl. 373 (type, *T. bathymetus,* OD); =*Indocephalites* Spath, 1928b, p. 171 (type, *I. kheraensis,* OD); =*Platystomaceras* Corroy, 1932, p. 101 (type, *Ammonites platystomus* Quenstedt, 1856 in 1856–1858, p. 478, *non* Quenstedt, 1846, p. 184, =*Platystomaceras vesaignense* Corroy, 1932, p. 102, pl. 5,*1–2,* lectotype, OD; see Arkell, 1954, p. 119, for discussion of the highly problematical genus *Platystomaceras*]. Medium to very large, inflated sphaerocones; umbilicus usually small, but variable in some, with rounded umbilical edge and steep umbilical walls; whorls rounded and highly variable in width from compressed to depressed (30% to 120% of the diameter); ribs fine to medium, dividing or intercalated at low to midwhorl side, and continuous across the venter. Dimorphic: macroconchs (*Macrocephalites, "Tmetokephalites,"* and *"Indocephalites"*) are 2–3 times larger than microconchs ("*Pleurocephalites,*" *"Kamptocephalites,"* and *"Dolicephalites"*); both dimorphs with moderately contracting adult whorls, slightly uncoiling umbilical seams, and simple, sinuous adult mouth borders; ribs in macroconchs tend to fade on adult whorl; ribs in microconchs unaltered to end of final whorl. The earliest species tend to be the most involute and finely ribbed,

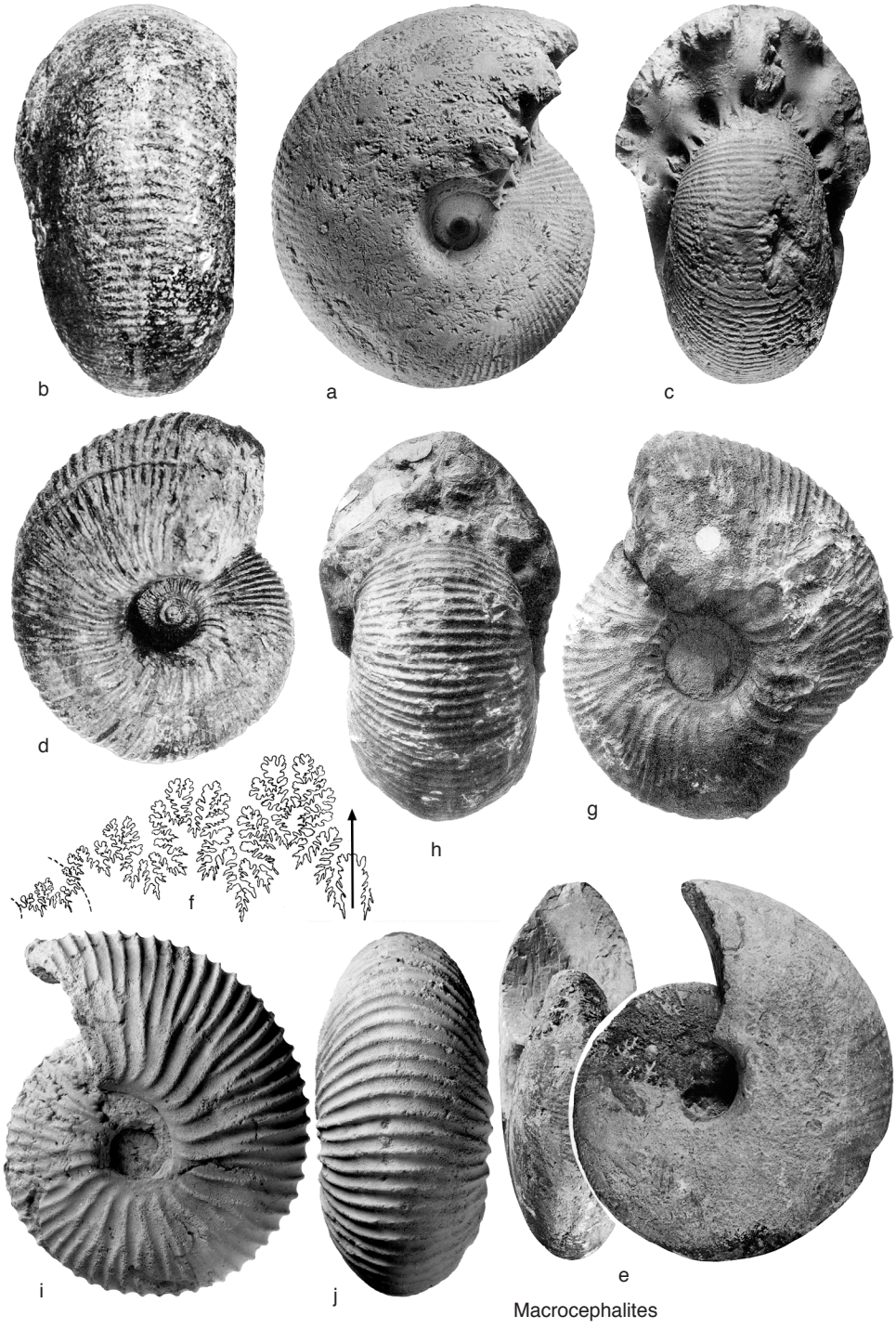

Fig. 45. Macrocephalitidae (p. 58–60).

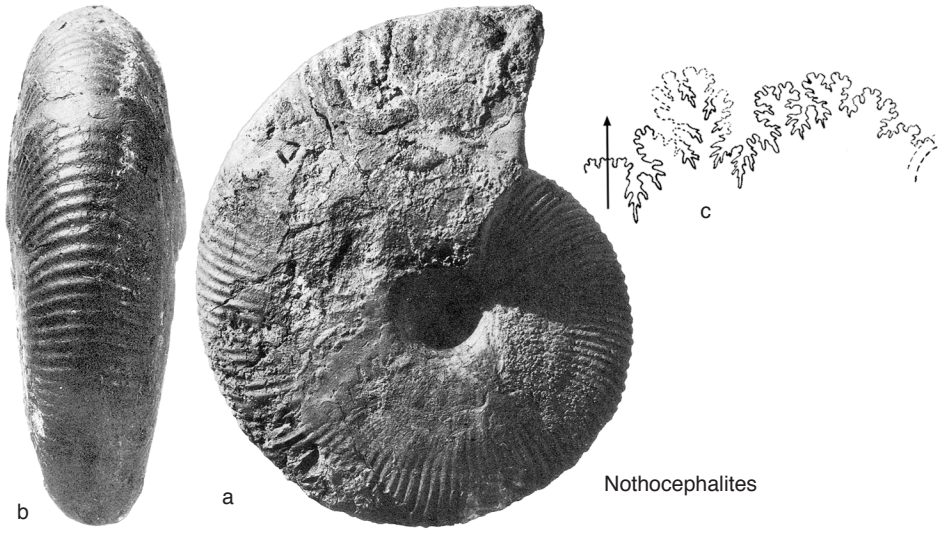

FIG. 46. Macrocephalitidae (p. 60).

while late species are more compressed and evolute and slightly more strongly ribbed. Homeomorphic with some genera of Mayaitinae. The search for a primary type specimen of *Macrocephalites macrocephalus* (SCHLOTHEIM) has a long and complicated history; a neotype (Fig. 45*a–c*) was finally selected by CALLOMON (1971, p. 121) and ratified in ICZN Opinion 1275 (1984, p. 34), and the determination of its correct locality and stratigraphical horizon in southern Germany was described in detail by CALLOMON, DIETLL, and NIEDERHÖFER (1992, p. 22–28). *Middle Jurassic (top middle Bathonian–low middle Callovian):* Europe, Russia, Caucasus, Kazakhstan (Mangystau), Tadzhikistan, northern Africa, Kenya, Tanzania, Somalia, Madagascar, Pakistan (Baluchistan), India (Kutch, northern Gujarat), Nepal, China (Tibet), Indonesia, New Guinea.——FIG. 45*a–f.* **M. macrocephalus* (SCHLOTHEIM); *a–d,* Ipf, Bopfingen, Swabian Alb, Germany; *a–c,* neotype, phragmocone of macroconch; *a,c,* ×0.4 (Callomon in Callomon, Dietl, & Niederhöfer, 1992, p. 23, fig. 8); *b,* ×0.4 (Callomon, 1971, pl. 16); *d,* topotype, adult microconch, ×0.6 (Callomon in Callomon, Dietl, & Niederhöfer, 1992, pl. 5,*1*); *e,* adult macroconch with smooth body chamber, three-quarters of a whorl long, uncoiling umbilical seam, and complete peristome, Nevers, Nièvre, France, ×0.27 (Thierry, 1978, pl. 8,*2*); *f,* suture, Lochen, Württemberg, Germany, ×0.5 (Spath 1928b, pl. 33,*4*).——FIG. 45*g–h. M. kheraensis* (SPATH), holotype of type species of *Indocephalites,* macroconch, Chari (Charri, Chhari), 69°16.3′E, 23°31.5′N, 3 km south of Fuley, Kutch, northern Gujarat, India, ×0.5 (Spath, 1928a, pl. 19,*1a;* Spath, 1928b, pl. 21,*5*).——FIG. 45*i–j. M. kamptus* (BUCKMAN), holotype of type species of *Kamptokephalites,* complete microconch with adult body chamber three-quarters of a whorl long and uncoiling umbilical seam, lower Callovian, *Herveyi* Zone, *Kamptus* Subzone, Peterborough, England, ×0.5 (new; British Geological Survey, Keyworth, Nottingham, England, GSM 8650).

Nothocephalites SPATH, 1928b, p. 173, 206 [**N. asaphus;* OD]. Smaller, more involute and more compressed than *Macrocephalites,* with fine ribs fading on the body chamber. Dimorphism as in *Macrocephalites:* dimorphs differ only in size, macroconchs about 2 times larger than microconchs. Late forms, transitional to *Eucycloceras. Middle Jurassic (upper part of the lower–middle Callovian):* Europe, northern Africa, Madagascar, India (Kutch, northern Gujarat), Indonesia.——FIG. 46*a–c.* **N. asaphus,* holotype, possibly a microconch, lower Callovian, Khera (Keera, Kira), 69°14.1′E, 23°34.2′N, 1 km northeast of Tal, Kutch, northern Gujarat, India, ×0.7 (Spath, 1928b, pl. 28,*2a–b,* pl. 37,*2*).

Subfamily EUCYCLOCERATINAE Spath, 1928

[*nom. transl.* BASSE, 1952, p. 629, *ex* Eucycloceratidae SPATH, 1928b, p. 165, 203]

Descendants of *Nothocephalites,* appearing in the top of the lower Callovian and persisting to the top of the *Anceps* Zone, middle Callovian, leaving no known descendants. The most evolute and compressed sphaeroceratids, they differ from *Nothocephalites* mainly in the coarse, persistent ribs on the outer whorls of the macroconchs; the

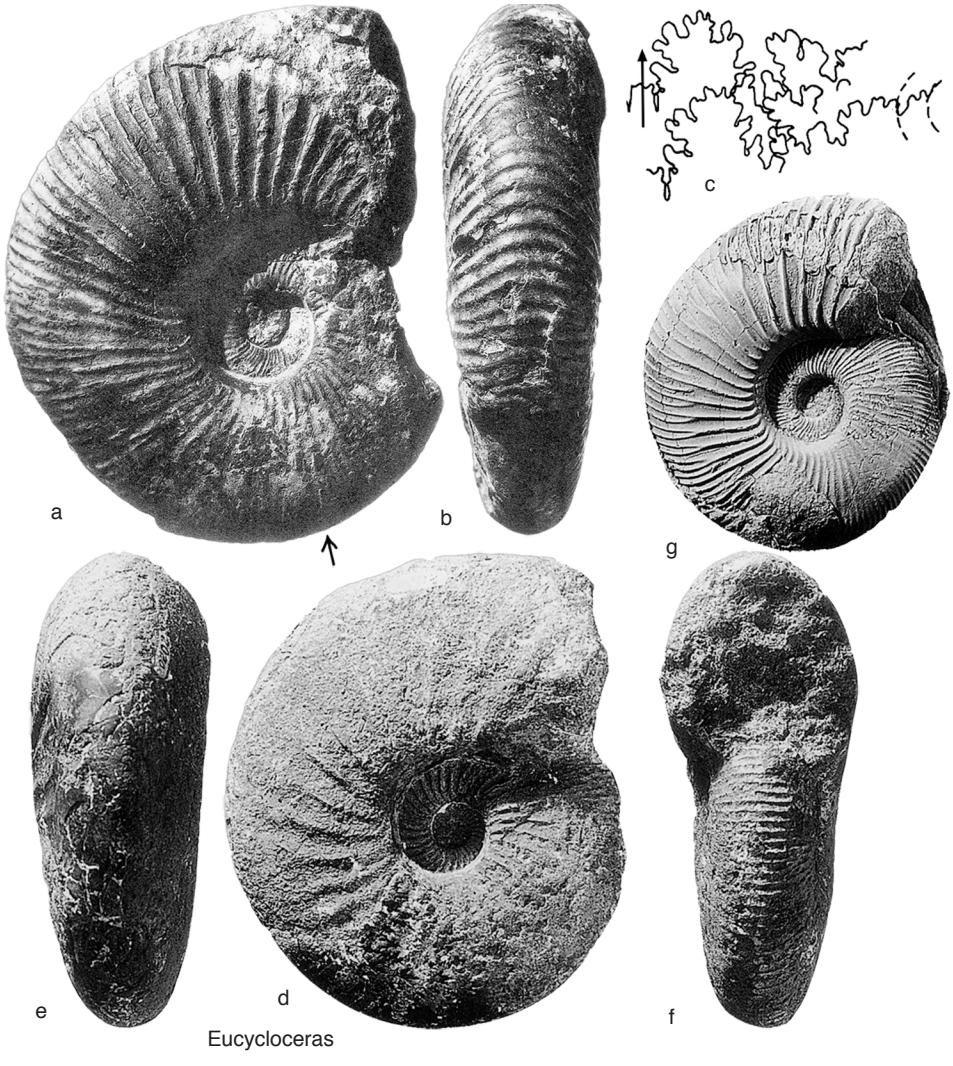

FIG. 47. Macrocephalitidae (p. 61–62).

secondary ribs are characteristically prorsiradiate on the venter. Strongly dimorphic in size only, though macroconchs have more variable ribbing than microconchs, and ribbing tends to disappear on the venter of the final whorl of macroconchs. *Middle Jurassic (top lower Callovian–middle Callovian,* Anceps *Zone [=Jason Zone]):* India, China (Tibet), eastern Africa, Indonesia.

Eucycloceras SPATH, 1924, p. 8 [**Stephanoceras eucyclum* WAAGEN, 1875, p. 142; OD; =*Ammonites opis* J. DE C. SOWERBY, 1840a, p. 329] [=*Subkossmatia* SPATH, 1924, p. 11 (type, *Ammonites opis* J. DE C. SOWERBY, 1840a, pl. 23,*9,* OD)]. Moderately involute, compressed oval whorls; fine, slightly prorsiradiate ribs bifurcate high on the whorl side. Dimorphic: macroconchs reach 220 mm in diameter, microconchs are about half that size; both dimorphs with plain adult mouth borders; ribs become coarser, distant, and subdued on the adult body chamber of macroconchs, but remain unaltered on microconchs. Derived from *Nothocephalites* at the top of the lower Callovian, differing mainly in the coarse, subdued ribs on the body chamber of macroconchs. JANA, BARDHAN, & HALDER, 2005. *Middle Jurassic (top lower Callovian–middle Callovian,* Anceps *Zone [=Jason Zone]):* India (Kutch,

northern Gujarat), Madagascar, China (southern Tibet), Indonesia, New Guinea.——Fig. 47*a–g. E. opis* (J. de C. Sowerby), Khera (Keera, Kira), 69°14.1′E, 23°34.2′N, 1 km northeast of Tal, Kutch, northern Gujarat, India; *a–c,* holotype, ?microconch, arrow indicates last suture; *a–b,* ×0.7 (Spath, 1928b, pl. 39,*2a–b); c,* final sutures, ×1.4 (Spath, 1928b, pl. 36,*2*); *d–f,* holotype of *Stephanoceras eucyclum* (Waagen), macroconch with incomplete body chamber, ×0.5 (Jana, Bardhan, & Halder, 2005, pl. 1,*1a–c*); *g,* microconch with complete adult body chamber, ×0.5 (Jana, Bardhan, & Halder, 2005, pl. 3,*10*).

Idiocycloceras Spath, 1928b, p. 205, 206, 215 [**I. perisphinctoides;* OD]. Successors to *Eucycloceras,* differing in their larger size, more evolute whorls and stronger, coarse ribs; ribs remain to the end of the adult body chamber of the macroconch, but venter tends to have central smooth band. Dimorphic size ratio about 2.5:1, with macroconchs reaching 270 mm in diameter. *Middle Jurassic (middle Callovian,* Anceps *Zone [=Jason Zone]):* India (Kutch, northern Gujarat), ?Madagascar.——Fig. 48*a–f. *I. perisphinctoides; a–b,* holotype, immature macroconch, Habay (Habye, Habo) Hills, Kutch, northern Gujarat, India, ×0.5 (Spath, 1928b, pl. 38,*3a,c*); *c–f,* Khera (Keera, Kira), 69°14.1′E, 23°34.2′N, 1 km northeast of Tal, Kutch, northern Gujarat, India; *c–e,* macroconch with one-sixth of a whorl of adult body chamber, ×0.35 (Jana, Bardhan, & Halder, 2005, pl. 9,*1a–b*); *f,* complete adult microconch, ×0.5 (Jana, Bardhan, & Halder, 2005, pl. 6,*2*).

Family CARDIOCERATIDAE Siemiradzki, 1891

[Cardioceratidae Siemiradzki, 1891, p. 24]

The many new discoveries in Arctic North America, eastern Greenland, and northern Russia have given an almost continuous picture of the evolution of this family from its upper Bajocian ancestors to its final extinction in the lower Kimmeridgian. The earliest forms, Arctocephalitinae, were derived from *Chondroceras* (Sphaeroceratinae) at the base of the upper Bajocian, and they retain the involute, inflated coiling of these ancestors. Dimorphism is prominent throughout the family, although lateral lappets are never developed, being replaced in the microconchs by equally characteristic long ventral rostra, and the prominent terminal constrictions of adult macroconchs persist up to *Cadoceras* of the lower Callovian. Another feature characteristic of the family is the wide variation of the inflation of the shell: at almost every level up to the middle Oxfordian, collections from single horizons encompass forms ranging from compressed to sphaeroconic.

The realization that the existing morphological classification for Cardioceratidae was unsatisfactory was expressed by Arkell in his phylogenetic diagram (1941, p. lxxiii) and again when he wrote the following.

> The present study has shown again how ammonite material, if sufficiently plentiful, will defeat any attempt at classification, however 'natural' and well-balanced its author may consider it to be, … [that] in at least some cases (and perhaps in all), the possibility of defining species depends on deficiency of material, and especially on its geographical limitations… [and that] with some families, therefore, it is only gaps in our knowledge, whether geographical or stratigraphical, or the result of "collection failure," that make any classification appear natural, or any differentiation of species within subgenera obvious. (Arkell, 1948, p. 380)

However, in cases where material is sufficiently abundant and closely defined stratigraphically, there is a strong impression that the whole range of variation at a single horizon belongs to a single, biospecific population, and these are the units that need to be identified. Such wide variation occurs at successive levels in *Cadoceras, Quenstedtoceras, Cardioceras, Amoeboceras,* and *Amoebites.* Finally, the family and the whole superfamily comes to an end with *Nannocardioceras* in the lower Kimmeridgian, leaving no descendants. In addition to these main genera, sharp-ventered oxycones evolved independently as phylogenetic side-branches at least twice, in the lower and upper Callovian, before the family as a whole developed ventral keels in the lower Oxfordian. Septal sutures have the heterochronous element U_n, and broad, shallow, moderately incised lobes on a straight baseline on outer whorls.

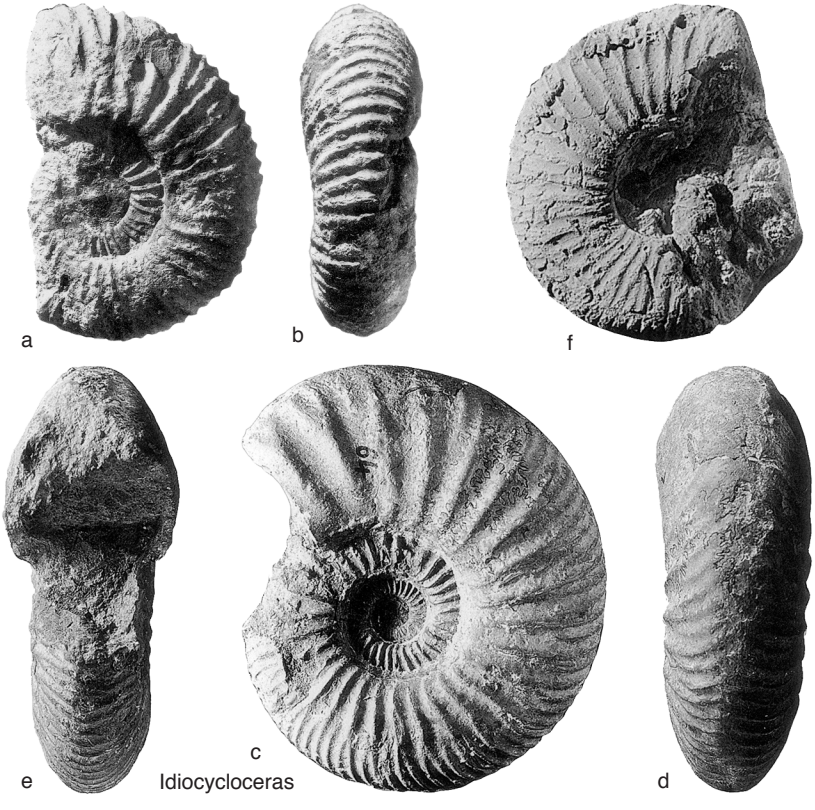

FIG. 48. Macrocephalitidae (p. 62).

The family originated from upper Bajocian Sphaeroceratidae of North America, the northern Pacific, and parts of the Arctic, then retreated into the Arctic, evolving in isolation for most of the Boreal Bathonian and leaving an almost continuous record in the shelf deposits of Arctic North America, Greenland, the Barents Shelf, Russia, and northern Siberia. During this time no representatives are known from the Tethyan or sub-Tethyan realms or from the southern hemisphere. At the beginning of the Callovian, the Cadoceratinae invaded the Subboreal province in Europe, and then in the upper Oxfordian the Cardioceratinae penetrated as far south as the sub-Tethyan areas of western Europe, the Caucasus and California, and some local faunas developed in the isolated shallow epicontinental seas of the Western Interior of North America. CALLOMON (1984, 1985, 1993). *Middle Jurassic (upper Bajocian)–Upper Jurassic (lower Kimmeridgian):* Boreal, Subboreal, North-west European, and sub-Tethyan Provinces.

Subfamily ARCTOCEPHALITINAE Meledina, 1968

[Arctocephalitinae MELEDINA, 1968, p. 418] [=Chamoussetitinae ALEKSEEV & REPIN, 1989, p. 133]

Mostly involute, moderately to highly inflated forms with rounded umbilical edge and arched whorl cross section; short primary ribs bifurcate or polyfurcate into sheaves of fine, sharp secondaries, at least on inner whorls. Strongly dimorphic: macroconchs tend to become smooth on the adult body chamber that expands laterally and flattens on the venter near the mouth border, which has an oblique terminal constriction and ventral projection; microconchs ribbed to the adult mouth border.

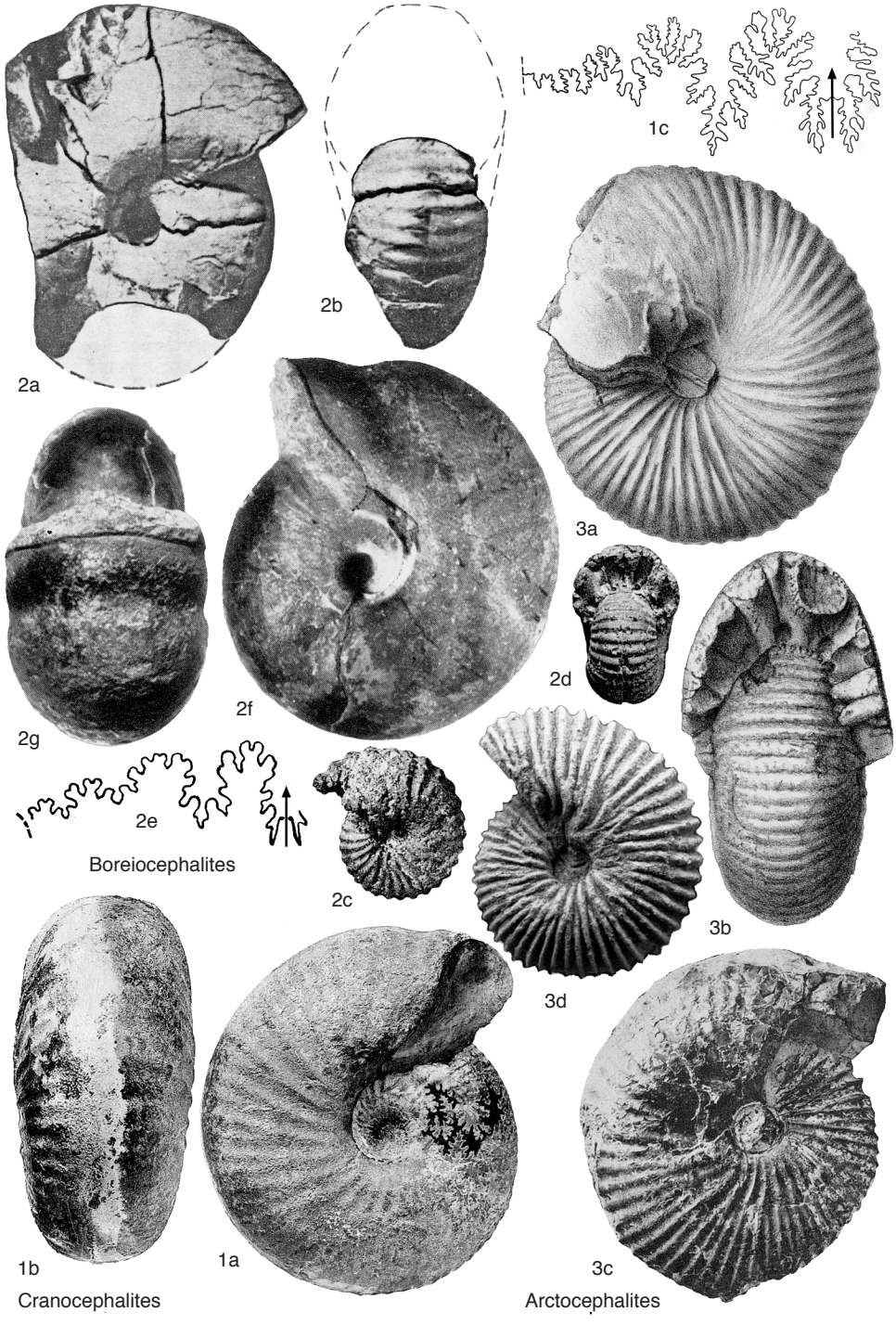

FIG. 49. Cardioceratidae (p. 65–67).

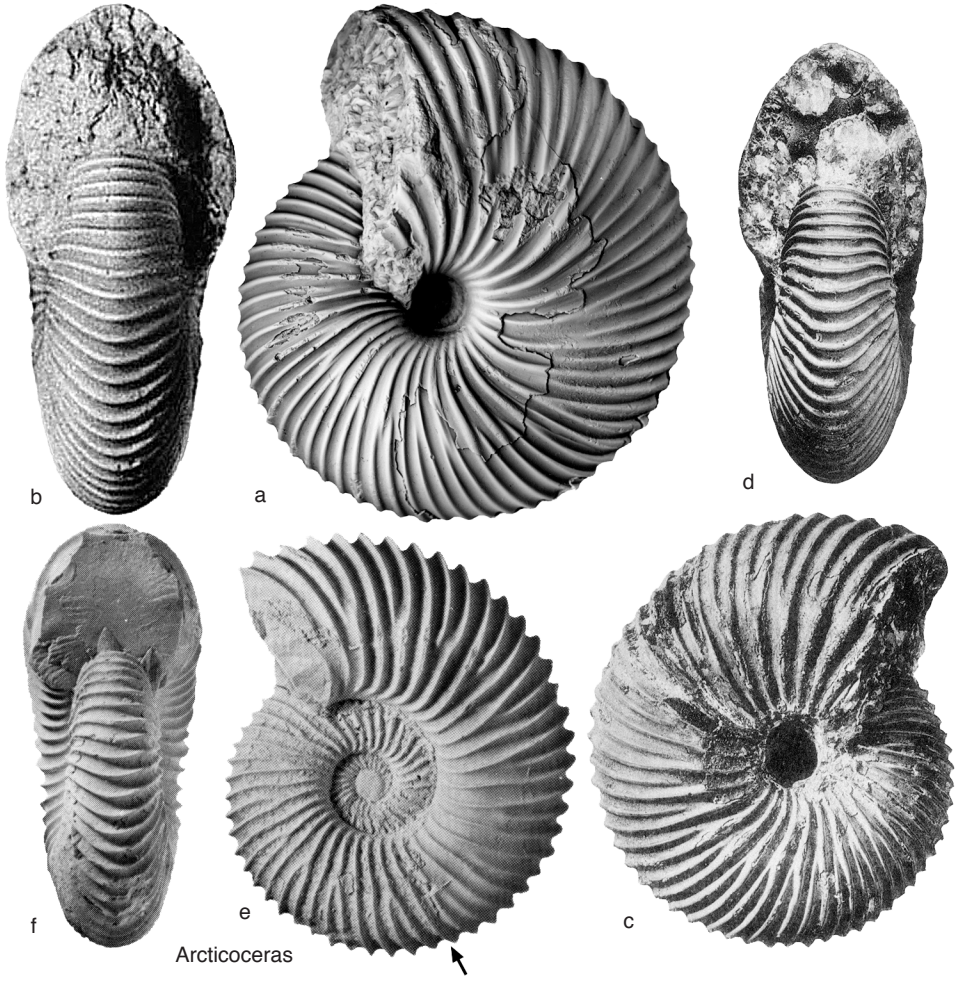

FIG. 50. Cardioceratidae (p. 67).

SPATH, 1932; IMLAY, 1953b, 1962, 1967; CALLOMON, 1959; FREBOLD, 1963; FREBOLD & TIPPER, 1970; MELEDINA, 1973. *Middle Jurassic (upper Bajocian–lower Callovian,* Calloviense *Zone):* Russia (northern Siberia, eastern Barents Shelf), eastern Greenland, Canada (Nunavut, British Columbia), USA (Alaska, Georgia, Western Interior), ?Indonesia, ?New Guinea, Chile, Argentina.

Cranocephalites SPATH, 1932, p. 14 [**C. vulgaris;* OD; =*Macrocephalites pompeckji* MADSEN, 1904, p. 189] [=*Pachycephalites* MELEDINA, 1973, p. 55 (type, *P. spathi,* OD)]. Inner whorls extremely involute; whorl section compressed at first, becoming broader and rounded; ribs moderately dense and sharp. Dimorphs differ in size only, and both have slightly constricted and collared mouth border: adult macroconchs tend to become smooth, some developing smooth venters or ventral smooth band only; microconchs ribbed to the end. *Middle Jurassic (upper Bajocian,* Indistinctus–Pompeckji *Zones [=upper* Subfurcatum–Parkinsoni *Zones]):* eastern Greenland, Norway (Svalbard), Russia (Novaya Zemlya, northern Siberia), Canada (Nunavut), USA (southern Alaska).——Fig. 49,*1a–b.* **C. vulgaris,* holotype, macroconch, *Pompeckji* Zone, Cathedral Mountain, 70°52.8′N, 22°57.1′W, Jameson Land, eastern Greenland, ×0.9 (Spath, 1932, pl. 1,*4a–b*).——Fig. 49,*1c. C. pompeckji*

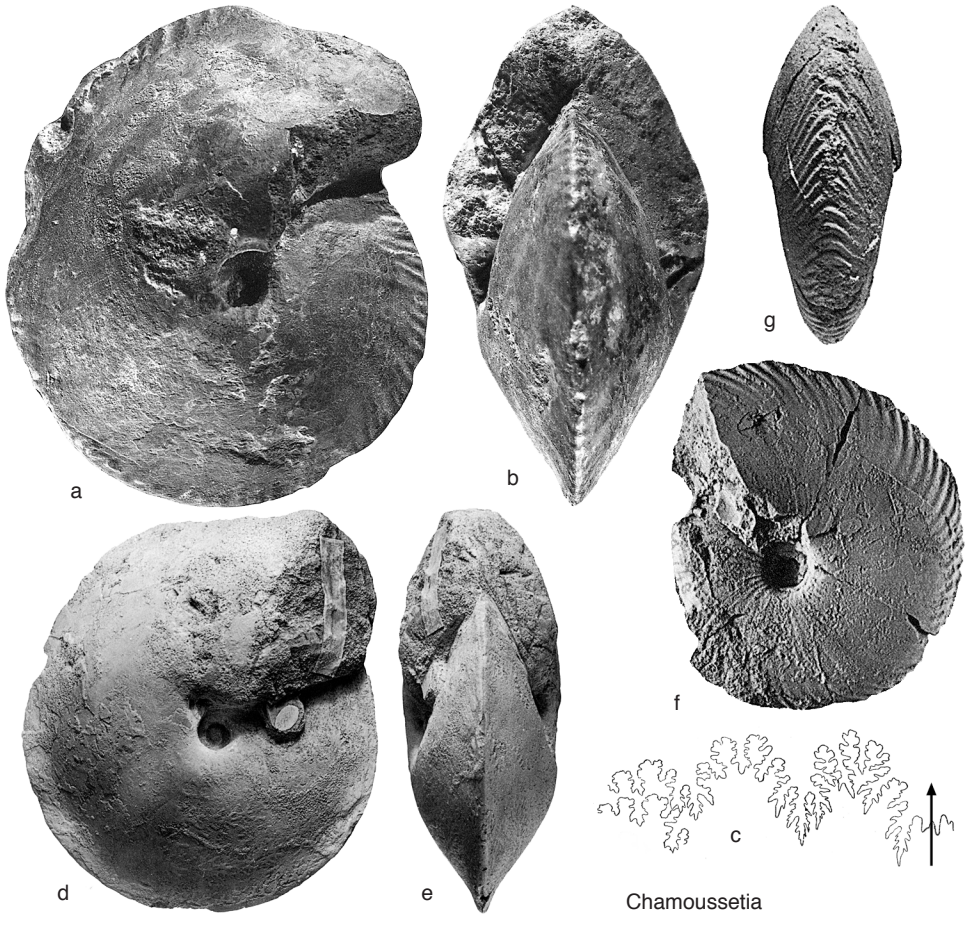

FIG. 51. Cardioceratidae (p. 67).

(MADSEN), adult suture, northern Siberia, Russia, ×1 (Meledina 1973, p. 45, fig. 17).

Boreiocephalites MELEDINA, 1967, p. 106 [**B. pseudoborealis;* OD; =*Xenocephalites borealis* SPATH, 1932, p. 44]. Occurs in the zone below *Cranocephalites,* and is smaller, more involute, with coarser ribs that are rursiradiate on the inner whorls; macroconchs become smooth on the adult body chamber with a broad, shallow, oblique terminal constriction and flared peristome. *Middle Jurassic (upper Bajocian,* Borealis *Zone [=lower* Subfurcatum *Zone]):* eastern Greenland, Russia (northern Siberia), Canada (Yukon, Nunavut).——Fig. 49,*2a–b.* **B. pseudoborealis,* holotype, macroconch, northern Siberia, Russia, ×1 (Meledina, 1973, pl. 1,*1a–b*).——Fig. 49,*2c–g. B. borealis* (SPATH); *c–e,* holotype, ?macroconch, inner whorls of phragmocone, Mount Hjørnefjaeld, 71°12.4′N, 22°49.3′W, Jameson Land, eastern Greenland; *a–b,* ×1; *c,* ×4 (Spath, 1932, pl. 14,*4a–b,d*); *f–g,* complete adult macroconch with constriction and flare at aperture, Ugle Elve, north ridge of Teebjerg, 70°52.0′N, 22°44.9′W, Jameson Land, eastern Greenland, ×1 (Callomon, 1959, pl. 17,*1a–b*).

Arctocephalites SPATH, 1928b, p. 174 [**Ammonites (Macrocephalites) ishmae var. arcticus* NEWTON in NEWTON & TEALL, 1897, p. 500; OD]. Highly involute, compressed whorls; fine, sharp ribs. Dimorphic: ribs tend to fade on body chamber of macroconchs, which have a pronounced flattening of the venter at the peristome; microconchs become more evolute and ribbed to the adult mouth border. More involute than *Cranocephalites* and reduced ribs remain on adult whorls. *Middle Jurassic (upper Bajocian, upper* Pompeckji *Zone–middle Bathonian, lower* Ishmae *Zone [*=Parkinsoni–Progracilis *Zones]):* eastern Greenland, Russia (Franz Josef Land, Novaya Zemlya, northern and eastern Siberia), Canada (Yukon Territory, Axel Heiberg Island).——FIG. 49,*3a–d.* **A. arcticus* (NEWTON);

a–d, Windy Gulley, east of Elmwood, Cape Flora, Northbrook Island, Franz Josef Land, Russia; *a–b,* holotype, phragmocone of macroconch, ×0.8 (Newton & Teall, 1897, pl. 40,*1,1a*); *c,* topotype, macroconch with half a whorl of body chamber, ×0.8 (Spath, 1932, pl. 12,*2*); *d,* complete adult microconch, Jameson Land, eastern Greenland, ×1 (new; J. H. Callomon-T. Birkelund Collection 1971, no. 4230, sect. 35, bed 8; also figured by Callomon, 1985, p. 66, fig. 8e).

Arcticoceras Spath, 1924, p. 7 [**Ammonites ishmae* Keyserling, 1846, p. 331; OD] [=*Costacadoceras* Rawson, 1982, p. 96 (type, *C. bluethgeni,* OD)]. Macroconchs (*Arcticoceras*) larger than *Arctocephalites,* more coarsely and strongly ribbed to a later growth stage, with secondaries projected and accentuated on narrowly arched venter; microconchs (*Costacadoceras*) are adult at up to about 60 mm in diameter, more finely ribbed and more evolute on the adult whorl. *Middle Jurassic (middle Bathonian,* Ishmae–Cranocephaloide *Zones* [=Progracilis–Hodsoni *Zones]):* eastern Greenland, Norway (Svalbard), Russia (Komi Republic, Franz Josef Land, Novaya Zemlya, northern Siberia), Canada (Yukon, Prince Patrick Island).——Fig. 50*a–d.* **A. ishmae* (Keyserling); *a–d,* River Izhma (Ishma), Komi Republic, Russia; *a–b,* holotype, macroconch; *a,* ×0.75 (new; Museum of the Mining Institute, St. Petersburg, Russia, not numbered); *b,* ×0.75 (Sachs, 1976, pl. 9,*1b*); *c–d,* topotype, macroconch, ×0.75 (Spath, 1932, pl. 15,*7a–b*).——Fig. 50,*e–f. A. bluethgeni* (Rawson), holotype, microconch, nearly complete with half a whorl of adult body chamber, Kongsøya, Kong Karls Land, Svalbard, Norway, ×1 (Rawson, 1982, pl. 1,*7–8*).

Chamoussetia R. Douvillé, 1911, p. 132 [**Ammonites chamousseti* d'Orbigny, 1847 in 1842–1851, p. 437; SD R. Douvillé, 1912, p. 19] [=*Platychamoussetia* Repin, 2002, p. 475 (type, *Chamoussetia (Platychamousettia) dertevi,* OD)]. Inner whorls involute, compressed, with fine ribs, as in ancestral *Arcticoceras;* outer whorls trigonal or lanceolate in whorl section, with loss of ribbing except on venter, which is acute and serrated with forwardly projecting chevrons. Dimorphs differ mainly in size: macroconchs 100–200 mm in diameter; microconchs 40–70 mm in diameter and retain the ribs longer. *Chamoussetia* is an offshoot from some forms of *Arcticoceras* in the upper *Ishmae* Zone that have acute venters but retain ribs longer on the side of the whorl. *Middle Jurassic (lower Callovian,* Calloviense *Zone):* England, France, Germany, Russia, Caucasus, eastern Greenland.——Fig. 51*a–c.* **C. chamousseti* (d'Orbigny); *a–b,* holotype, macroconch with one-third whorl of body chamber, Mont du Chat, Savoie, France; *a,* ×0.75 (new; d'Orbigny Collection 3167-1, Museum d'Histoire Naturelle, Paris, France); *b,* ×0.75 (Fischer, 1994, pl. 59,*2b*); *c,* suture of another specimen, Montigny-sur-Vence, Ardennes, France, ×1 (Douvillé, 1912, p. 19, fig. 13).——Fig. 51*d–g. C. phillipsi* Callomon & Wright, 1989; *d–e,* neotype (designated by Callomon & Wright, 1989, p. 803), adult macroconch with half a whorl of body chamber, Scarborough, Yorkshire, England, ×0.5 (Callomon & Wright, 1989, pl. 88,*1a–b*); *f–g,* complete adult microconch with five-eighths whorl of body chamber, Kellaways Rock, Cayton Bay, Scarborough, Yorkshire, England, ×1 (Callomon & Wright, 1989, pl. 89,*4a,c*).

Subfamily CADOCERATINAE Hyatt, 1900

[*nom. transl.* Spath, 1932, p. 47, *ex* Cadoceratidae Hyatt, 1900, p. 580]

Inner whorls compressed and moderately involute; moderately dense, sharp ribs bifurcate or polyfurcate into secondary ribs that sweep forwards over the arched venter. Strongly dimorphic, microconch-macroconch size ratio approximately 1:3. Microconchs remain with compressed, rounded, or ventrally angled whorls and are sharply ribbed to the end of the adult body chamber. Macroconchs become much inflated and cadiconic to sphaeroconic on middle and outer whorls, but always retain a craterlike umbilicus with sloping walls and a sharp or prominent umbilical edge; ribs fade on the final whorl, though remnants of ribs or nodes at or near the umbilical edge may remain until the end of the contracting adult body chamber, which is typically up to one whorl long; the mouth border is preceded by a broad, shallow constriction and has a ventral peristome.

Early forms are derived from *Arcticoceras* and are strictly Boreal. Then rare stragglers appear in the basal Callovian of northwestern Europe, to be followed by a major invasion in the *Calloviense* Zone extending to the northern edge of the Sub-Mediterranean Province.

The microconchs of Cadoceratinae and some Arctocephalitinae have been identified as various species of *Pseudocadoceras* (including its subgenera and synonyms *Novocadoceras, Costacadoceras,* and *Percacosticeras*) at many horizons in the upper Bathonian and lower–middle Callovian. However, the type species of *Pseudocadoceras, P. boreale,* accompanies *C. (Cadoceras) sublaeve* and *C. (Cadoceras) tolpe* Buckman (1923a, pl. 406)

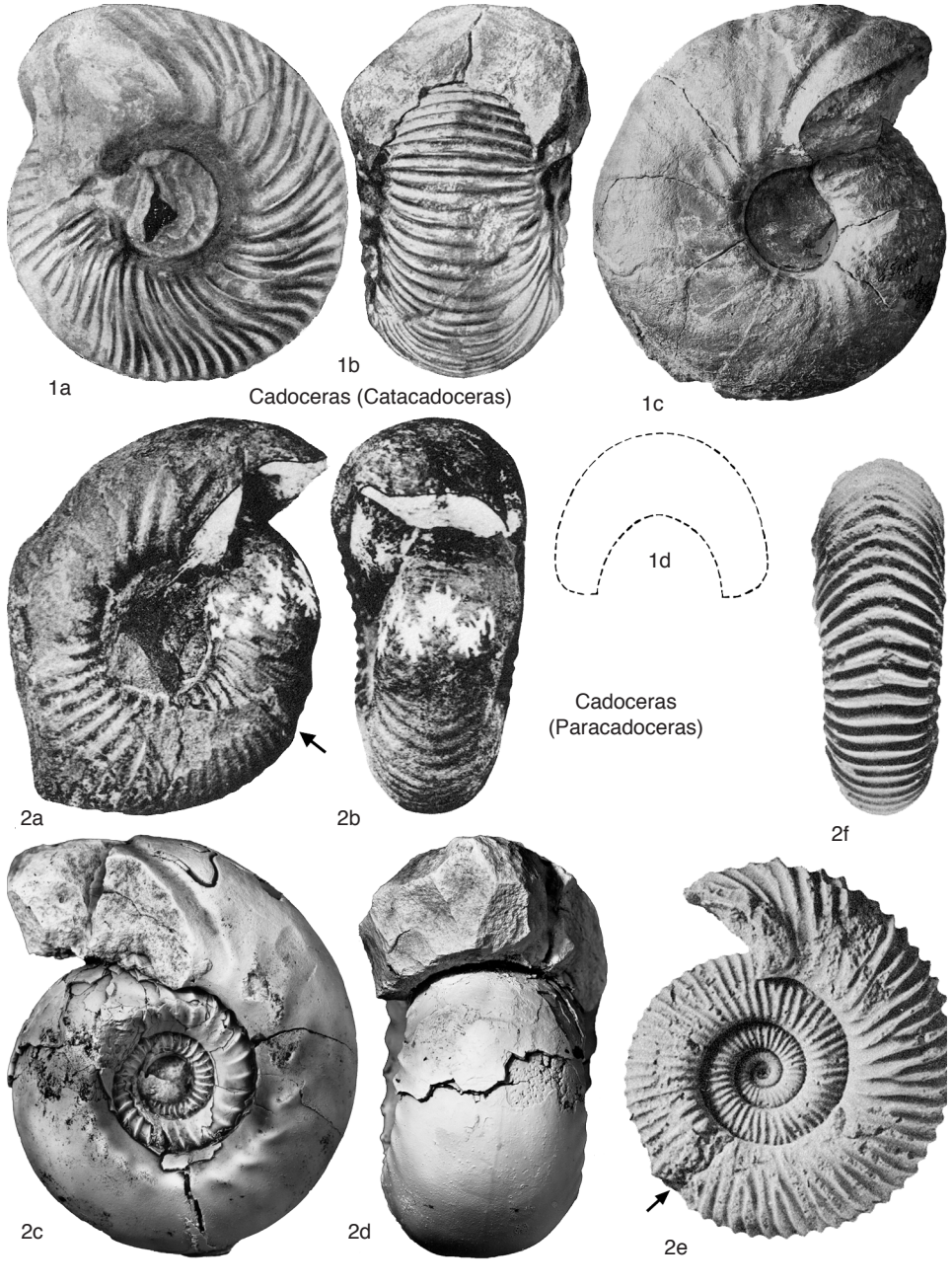

FIG. 52. Cardioceratidae (p. 69–70).

in the *Koenigi* and *Calloviense* Zones, of which it is the microconch. *Pseudocadoceras* is, therefore, placed in the synonymy of *C. (Cadoceras)* here, and the other generic names based on microconchs are united with the macroconch genera that they accompany. BUCKMAN, 1909–1930; DOUVILLÉ, 1912; SOKOLOV, 1912; SPATH, 1932; IMLAY, 1953b; SAZONOV, 1957; BODYLEVSKY, 1960; VORONETS, 1962; FREBOLD, 1964; CALLOMON

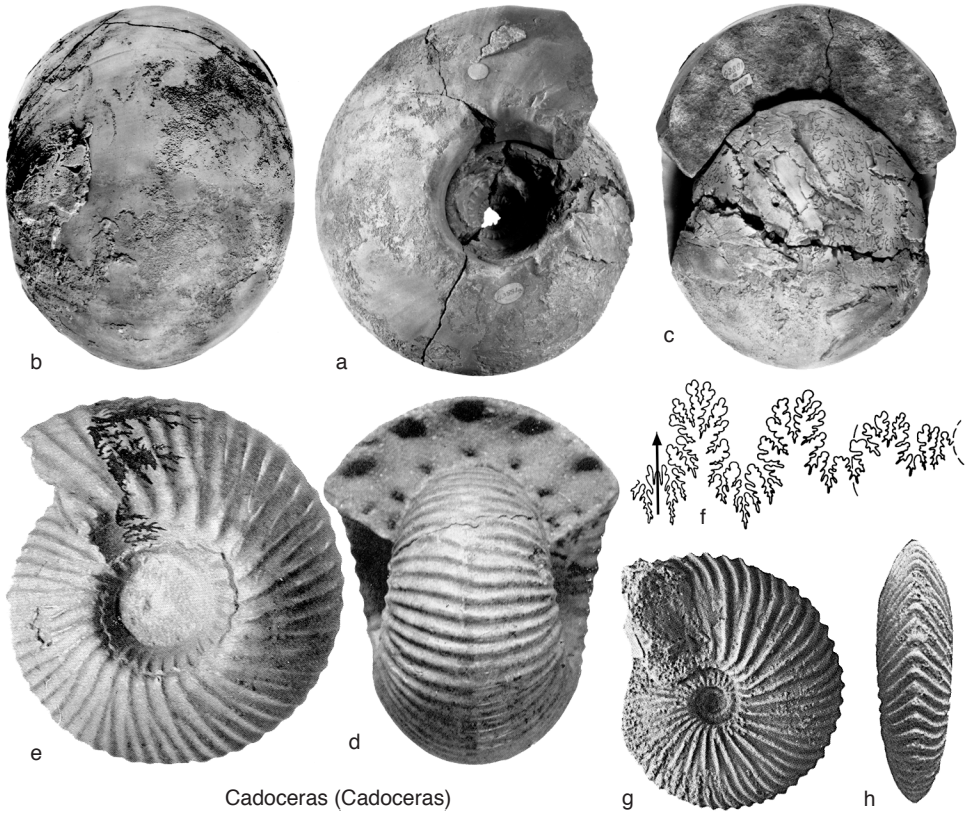

FIG. 53. Cardioceratidae (p. 70–71).

& WRIGHT, 1989. *Middle Jurassic (upper Bathonian–Callovian)–Upper Jurassic (lower Oxfordian, lower* Mariae *Zone):* northern and central Europe, Caucasus, Russia (Siberia), Norway (Svalbard), eastern Greenland, Canada (Nunavut), USA (Alaska).

Cadoceras FISCHER, 1882, p. 394 [**Ammonites sublaevis* J. SOWERBY, 1814, p. 117; SD SPATH, 1932, p. 58, ICZN Opinion 324, 1955a, p. 229]. Species of *Cadoceras* occur from the base of the *Variabile* Zone, upper Bathonian, to the top of the *Coronatum* Zone, middle Callovian. In eastern Greenland abundant specimens have been collected from 23 separate horizons in this range. At some horizons they are continuously variable between highly different extremes, especially in the amount of whorl inflation, the inference being that most horizons consist of a single, variable species. Both dimorphs are present at most levels, though the macroconchs are often much more abundant than microconchs. Although all the species could be satisfactorily accommodated in the single genus *Cadoceras,* there are subtle differences between the populations as they evolve upwards through the different horizons and zones, and these differences are given subgeneric status here. *Middle Jurassic (upper Bathonian,* Variabile *Zone–middle Callovian,* Coronatum *Zone).*

C. (**Catacadoceras**) BODYLEVSKY, 1960, p. 64 [**C. (C.) laptievi;* OD] [=*Greencephalites* REPIN in REPIN & others, 2007, p. 134 (type, *Cadoceras freboldi* SPATH, 1932, p. 65, OD)]. The earliest forms, with an open umbilicus and steep umbilical wall, strongly and coarsely ribbed to the adult mouth border. *Middle Jurassic (upper Bathonian,* Variabile–Calyx *Zones [*=Orbis–*lower* Discus *Zones]):* Russia (Siberia), eastern Greenland, Canada (Axel Heiberg Island).——Fig. 52,*1a–b. *C. (C.) laptievi,* holotype, macroconch, northern Siberia, Russia, ×0.5 (Bodylevsky, 1960, pl. 2,*1a–b*).——Fig. 52,*1c–d. C. (C.) variabile* SPATH, holotype, adult macroconch with approximated final sutures and complete mouth border, Vardekloft, Hurry Inlet, 70°36.1′N, 22°37.4′W, Jameson Land, eastern Greenland, ×0.4 (Spath, 1932, pl. 18,*1a–b*).

C. (**Paracadoceras**) CRICKMAY, 1930, p. 55 [**P. harveyi;* M] [=*Streptocadoceras* MELEDINA,

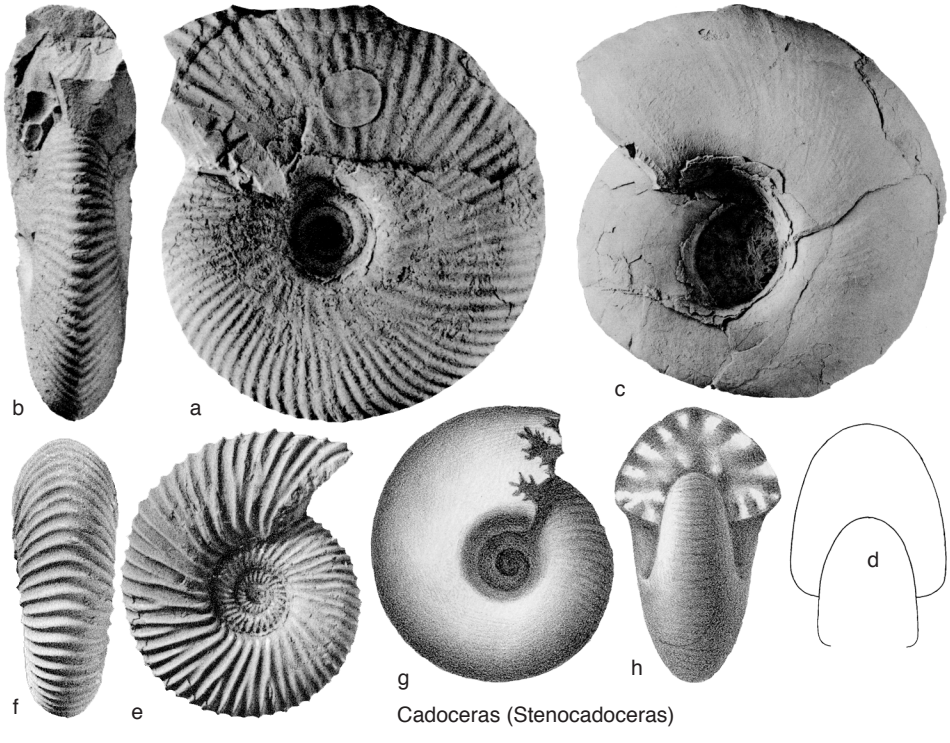

FIG. 54. Cardioceratidae (p. 72).

1977, p. 83 (type, *Cadoceras subtenuicostatum* VORONETS, 1962, p. 110, OD)]. Evolute, compressed inner whorls, becoming inflated and depressed on middle and adult whorls, but with open, steep-walled umbilicus and rounded or bluntly angled umbilical edge; ribs moderately strong, prorsiradiate, and bifurcating. Dimorphic: macroconchs inflated cadicones, with ribs fading on the final whorls, except for short clavi on the umbilical edge; microconchs evolute platycones with rounded whorl section and strongly ribbed to the end. Includes *C. (P.) elatmae* NIKITIN of the Russian *Elatmae* Zone (=*Herveyi* Zone) and *C. (P.) breve* BLAKE from the English Upper Cornbrash (*Herveyi* Zone). Slightly more evolute than *C. (Catacoeloceras)* and smooth on adult whorl of macroconch. *Middle Jurassic (lower Callovian,* Apertum–Nordenskjoeldi *Zones [=upper* Discus–*upper* Herveyi *Zones]):* England, Russia (northern Siberia), eastern Greenland, Canada (British Columbia, Nunavut), USA (southern Alaska).——Fig. 52,*2a–b.* **C. (P.) harveyi,* holotype, macroconch, complete with mouth border, arrow marks end of phragmocone, Deer Creek, west side of Harrison Lake, British Columbia, Canada, ×1 (Crickmay, 1930, pl. 16,*1–2*).——Fig. 52,*2c–d. C. (P.) elatmae* (NIKITIN), lectotype (designated by MELEDINA, 1977, p. 70), complete adult macroconch, Elatma, Russia, ×0.55 (new; Nikitin Collection, Leningrad Museum, no. 34/1344; figured by Nikitin, 1881b, pl. XI (IV),*20*).——Fig. 52,*2e–f. C. (P.) apertum* CALLOMON & BIRKELUND, adult microconch with complete mouth border, south slopes of Olympen, 71°26.5′N, 23°31.1′W, Jameson Land, eastern Greenland, ×1 (Callomon & Birkelund, 1985, pl. 3,*1a–b*).

C. (Cadoceras) [=*Pseudocadoceras* BUCKMAN, 1918, p. *xiv* (type, *P. boreale,* OD); =*Catacephalites* BUCKMAN, 1922, pl. 283 (type, *C. durus,* OD, a single crushed nucleus); =*Bryocadoceras* MELEDINA, 1977, p. 60 (type, *Cadoceras falsum* VORONETS, 1962, p. 49, OD); =*Dolganites* REPIN, 2002, p. 472 (type, *D. adzvensis,* OD)]. Sphaeroconic cadicones with wide funnel-shaped umbilicus, prominent umbilical edge, and whorl width about 90% of diameter, with only slight variation; ribs prorsiradiate and bifurcating. Dimorphic: macroconchs with ribs fading on final whorls except for remnants at umbilical edge; microconchs (*Pseudocadoceras*) much more involute and compressed, with angled venter throughout and ribs remain strong up to adult mouth border. *Middle Jurassic (lower Callovian,* Koenigi–Calloviense *Zones):* northern and central Europe, Caucasus, Russia (northern Siberia, Novaya Zemlya, Franz Josef Land, New Siberian

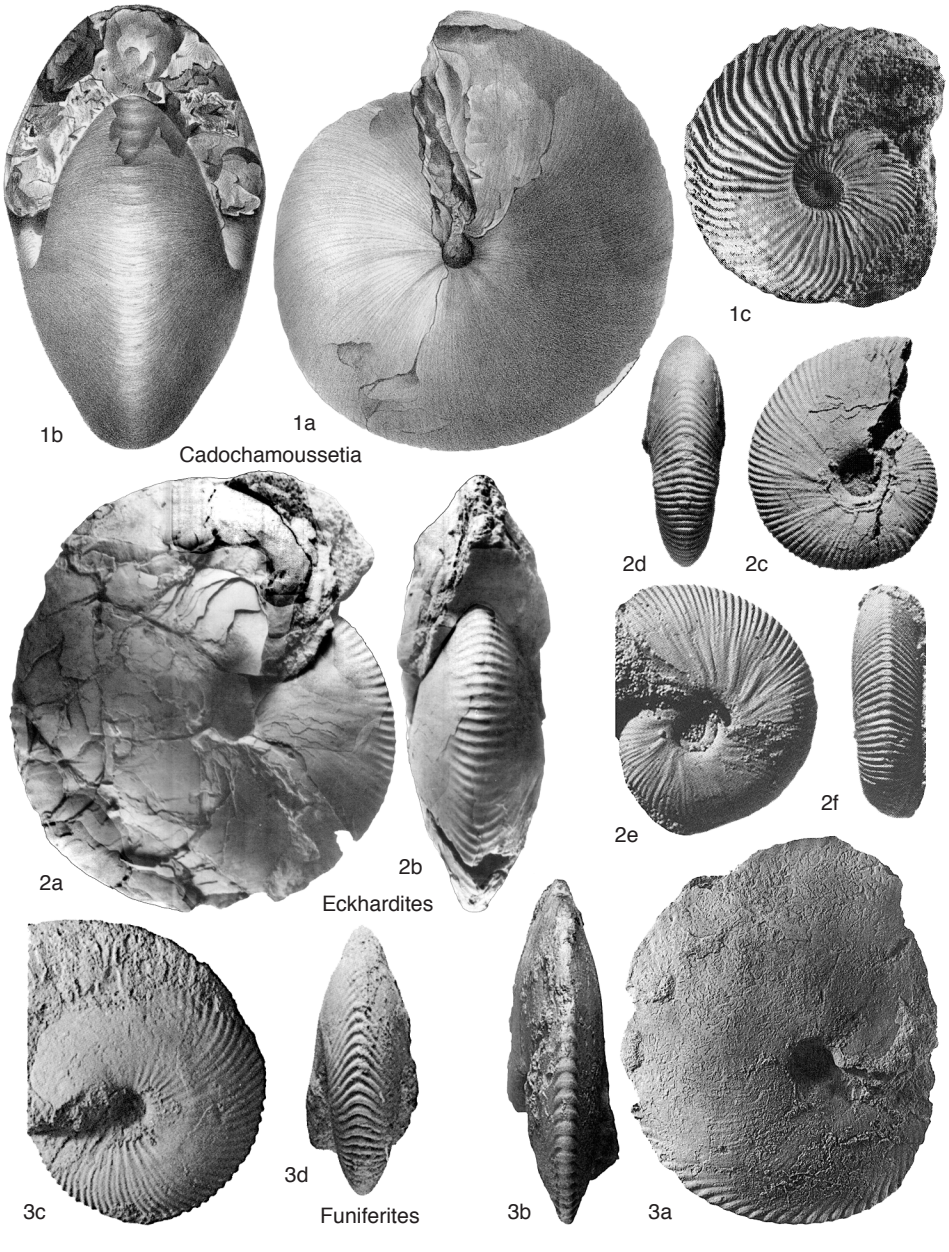

FIG. 55. Cardioceratidae (p. 72–73).

Islands), Norway (Svalbard), eastern Greenland, Canada (British Columbia, Nunavut), USA (southern Alaska).——FIG. 53*a–e*. **C. (C.) sublaeve* (J. SOWERBY), Kellaways, Wiltshire, England; *a–c*, lectotype, adult macroconch, ×0.6 (new; The Natural History Museum, London, NHMUK 43881a); *d–e,* topotype, macroconch phragmocone, *Calloviense* Zone and Subzone, ×0.8 (Buckman, 1922, pl. 275,*1,3*).——FIG. 53*f. C. (C.) glabrum* IMLAY, holotype, suture, Wide Bay, Alaska Peninsula, Alaska, USA,×0.75 (Imlay, 1953b, pl. 37,*6*).——FIG. 53*g–h. C. (C.) boreale* (BUCKMAN), holotype, complete adult microconch, *Koenigi* Zone, Scarborough, Yorkshire, England, ×1 (Callomon & Wright, 1989, pl. 94,*1a–b*).

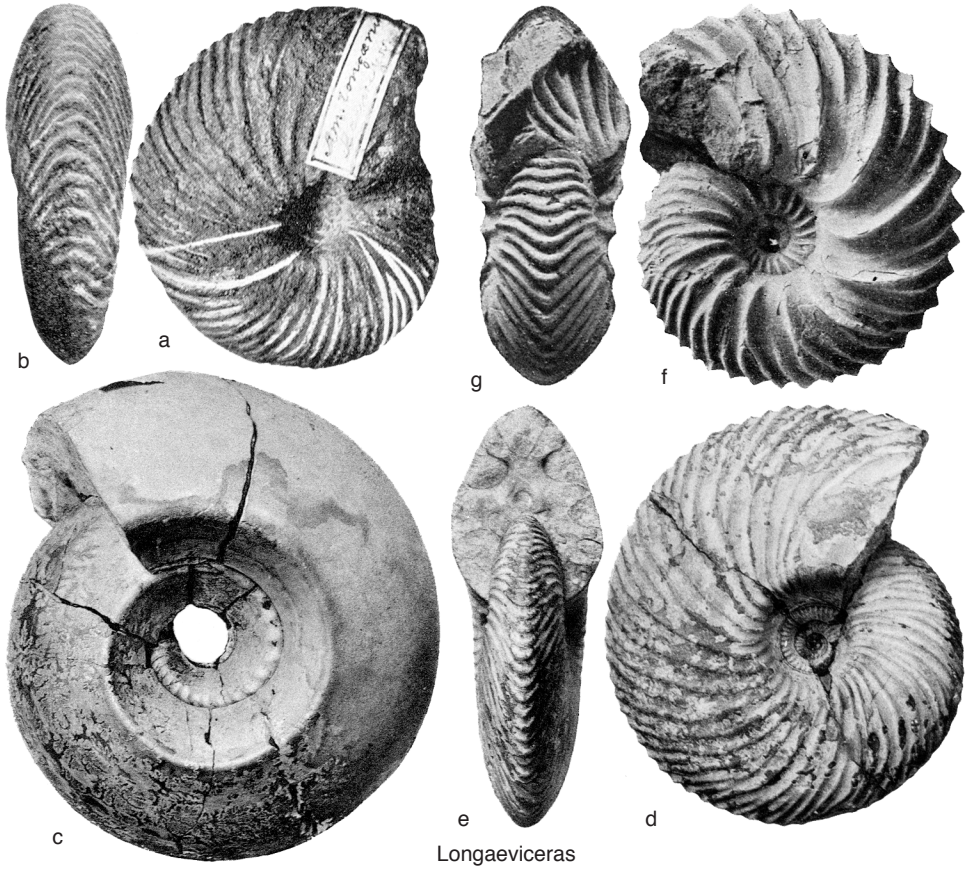

FIG. 56. Cardioceratidae (p. 73).

C. (Stenocadoceras) IMLAY, 1953b, p. 46 [**C. (S.) multicostatum;* OD] [=*Rondiceras* TROIZKAYA in KIPARISOVA, MARKOVSKI, & RADCHENKO, 1956, p. 79 (type, *Stephanoceras milaschevici* NIKITIN, 1881a, p. 66, OD); =*Novocadoceras* SAZONOV, 1965, p. 34 (type, *N. suraense,* OD)]. Inner whorls involute, compressed with subcarinate venter; rather fine, slightly flexuous ribs bifurcate at midwhorl. Dimorphic: macroconchs large, evolute, inflated, and depressed, with ribs fading first on flat whorl side, then outer whorls become entirely smooth; microconchs small, up to 60 mm in diameter, more involute, compressed, and ribbed up to adult mouth border. *Middle Jurassic (middle Callovian,* Jason–Coronatum *Zones):* Russia (Volga Basin, Siberia), Canada (Yukon Territories), USA (southern Alaska).——FIG. 54*a–f.* **C. (S.) multicostatum; a–d,* western shore of Chisik Island, Tuxedni Bay, Cook Inlet, southern Alaska, USA; *a–b,* holotype, macroconch, phragmocone, ×1; *c–d,* complete adult macroconch, ×0.5 (Imlay, 1953b, pl. 44,*1–2,13,15*); *e–f,* complete adult microconch, southern shore of Chinitna Bay, Alaska Peninsula, USA, ×1 (Imlay, 1953b, pl. 49,*5–6*).——FIG. 54*g–h. C. (S.) milaschevici* (NIKITIN), lectotype (designated by HOWARTH, herein), phragmocone, already entirely smooth, River Volga, Bolobanovo, near Selekhovo Selikovo), 58°2.5′N, 38°23.5′E, Yaroslavl Oblast, Russia, ×0.8 (Nikitin, 1881a, pl. 3,*25*).

Cadochamoussetia MITTA in GERASIMOV & others, 1996, p. 37 [**Ammonites subpatruus* NIKITIN, 1885, p. 58; OD]. Inner whorls involute, compressed with rounded venter; straight, single ribs bifurcate from midwhorl and are angled forwards across venter; middle whorls cadicone, inflated, and rapidly lose the ribs; outer whorls very involute, with trigonal whorl section, rounded venter, and mainly smooth, but traces of ribs may remain on venter. Dimorphic: microconchs complete and adult at about 40 mm in diameter and strongly ribbed to the end; macroconchs adult at 120–180

mm in diameter with smooth final whorl. Differs from ancestral *Cadoceras* in the trigonal whorl section and rounded venter in the adult. *Middle Jurassic (lower Callovian):* Russia.——Fig. 55,*1a–b.* **C. subpatruum* (Nikitin), lectotype (designated by Mitta, 1999, p. 129), adult macroconch, Kurmysch, Nizhniy Novgorod Oblast, Russia, ×0.5 (Nikitin, 1885, pl. (XI) XIII,*58*).——Fig. 55,*1c. C. saratovensis* (Callomon & Wright), microconch, with half a whorl of body chamber, River Unzha, Makaryev, Kostroma Oblast, Russia, ×1 (Mitta, 1999, p.135, fig. 9C).

Eckhardites Mitta, 1999, p. 132 [**Macrocephalites pavlowi* Smorodina, 1929, p. 423]. Involute, venter narrowly rounded; inner whorls compressed; primary ribs branch into 2–5 secondary ribs at midwhorl and cross the venter with slight forwards projection; middle and outer whorls with thicker, trigonal whorl section, and become smooth on side of whorl, though ribs remain across the venter. More compressed than *Cadochamoussetia,* but less compressed than *Chamoussetia* or *Funiferites;* may have originated from Arctocephalitinae (Mitta, 2009, p. 55). *Middle Jurassic (lower Callovian):* Russia.——Fig. 55,*2a–d.* **E. pavlowi* (Smorodina), Unzha River, Manturovo, Kostroma Region, central Russia; *a–b,* lectotype (designated by Mitta & Starodubsteva, 1998, p. 12), macroconch, complete adult with three-quarters of a whorl of body chamber, ×0.33 (Mitta & Starodubsteva, 1998, pl. 1, pl. 2,*1*); *c–d,* topotype, inner whorls, ×1.5 (Mitta, 2009, pl. 6,*6a,c*).——Fig. 55,*2e–f. E. dietli* Mitta, paratype, ?adult microconch, Unzha River, near Makaryev, Kostroma Oblast, Russia, ×1 (Mitta, 2009, pl. 6,*5a–b*).

Funiferites Kiselev, Gulyaev, & Rogov, 2003, p. 223 [**Ammonites funiferus* Phillips, 1829, p. 142; OD]. Involute oxycone, compressed whorl section, small umbilicus, and sharply angled or keeled venter; primary ribs on inner whorls bifurcate at midwhorl, and secondary ribs project strongly forwards, forming crenulations on venter; ribs fade on middle and outer whorls, but crenulations remain on venter. Dimorphic: dimorphs differing only in adult size. Possibly a development from *Cadochamoussetia,* having more compressed whorl section throughout growth. *Middle Jurassic (middle Callovian,* Jason *Zone–upper Callovian,* Athleta *Zone):* England, France, Germany, Russia.——Fig. 55,*3a–d.* **F. funifera* (Phillips), *Athleta* Zone, Scarborough, Yorkshire, England; *a–b,* holotype, macroconch, with beginning of body chamber, ×0.5; *c–d,* microconch, with approximated final sutures and beginning of body chamber, ×1 (Callomon & Wright, 1989, pl. 92,*2a–b,4a,c*).

Longaeviceras Buckman, 1918, p. *xiv* [**L. longaevum* Buckman, 1918, p. *xiv;* OD; *ex* Bean MS in Leckenby, 1859, p. 11; ?=*Ammonites stenolobus* Keyserling, 1846, p. 329] [=*Percacosticeras* Kiselev, 1996, p. 388 (type, *Longaeviceras polonicum* Callomon & Wright, 1989, p. 828, OD); =*Longoceras* Repin, 2002, p. 473 (type, *Cadoceras nikitini* Sokolov, 1912, p. 24, OD); =*Platylongoceras* Repin, 2002, p. 474 (type, *P. petchoricum,* OD)]. Inner whorls compressed with narrow, rounded venter or incipient keel; outer whorls become evolute and inflated, with sharp umbilical edge as in *Cadoceras;* strong primary ribs bifurcate high on whorl side, with some intercalatories, and secondary ribs sweep well forwards on venter. Dimorphic: macroconchs become cadiconic, inflated, depressed, and smooth on the final whorls; microconchs remain compressed and strongly ribbed up to adult mouth border. Callomon & Wright, 1989. *Middle Jurassic (upper Callovian,* Athleta–Lamberti *Zones [including part of the* Keyserlingi *Zone of the Boreal Province in Siberia])–Upper Jurassic (lower Oxfordian, basal* Mariae *Zone):* northern Europe, Russia (Siberia, Novaya Zemlya), Norway (Svalbard), eastern Greenland, ?USA (Alaska).——Fig. 56*a–b.* **L. longaevum,* lectotype, macroconch inner whorls, *Athleta* Zone, Castle Rock, Scarborough, Yorkshire, England, ×1 (Buckman, 1919a, pl. 121A).——Fig. 56*c–e. L. nikitini* (Sokolov, 1912), holotype, macroconch, Fluss, Wischera, Petchora, Russia; *c,* with half a whorl of adult body chamber, ×0.5; *d–e,* inner whorls of same specimen, ×1 (Sokolov, 1912, pl. 1,*3a,c–d*).——Fig. 56*f–g. L. polonicum* Callomon & Wright, type species of *Percacosticeras* Kiselev, complete adult microconch, Łuków, Poland, ×0.8 (Makowski, 1952, pl. 6,*2,2a*).

Subfamily CARDIOCERATINAE Siemiradzki, 1891

[*nom. transl.* Arkell, 1950, p. 363, *ex* Cardioceratidae Siemiradzki, 1891, p. 24] [=Quenstedtoceratinae Meledina, 1977, p. 98; =Amoeboceratinae Tintant & Mouterde, 1981, p. 97]

Descendents of Cadoceratinae, having lost the sharp umbilical edge of *Cadoceras* and becoming more or less keeled, at least on inner whorls. In the earliest forms (*Quenstedtoceras*), the secondary ribs merely form angular chevrons on the venter; later, in *Cardioceras,* proper keels develop, which, combined with the low point of maximum whorl thickness and well-rounded ventrolateral shoulder, give the whorl section the characteristic cardioform outline. Finally, the whorl section becomes subquadrate with a flat venter and a minutely crenulated keel (*Amoeboceras* and *Amoebites*).

The subfamily is marked by an especially wide variation in gross morphology at most biostratigraphical levels, particularly in evoluteness and whorl inflation (ranging from cadicone to oxycone), which, combined with marked dimorphism, has made existing morphological classifications unbalanced and inconsistent. Where necessary, genera

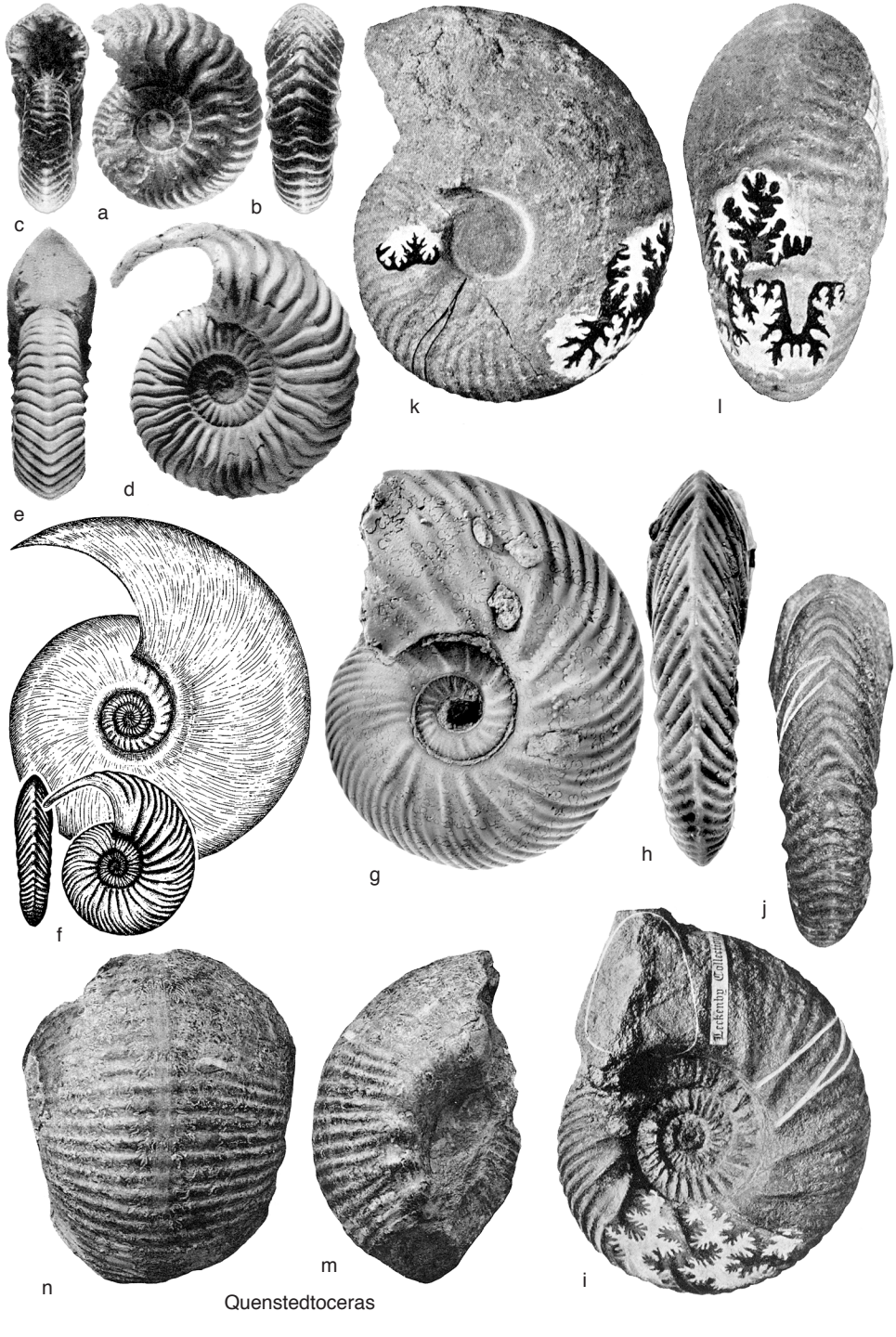

FIG. 57. Cardioceratidae (p. 75).

are reassessed and combined herein to reflect the wide variability at some biostratigraphical levels and more recent ideas on the phylogeny of the subfamily, rather than the polyphyletic lineages derived from the purely morphological taxonomy widely used previously—e.g., by BUCKMAN (1909–1930) and ARKELL (1941, p. lxxiii; 1948, p. 380). Although this can be achieved with some success in *Quenstedtoceras, Cardioceras, Amoeboceras,* and *Amoebites,* there are still some genera for which a mainly morphological definition has been retained (e.g., in *Vertebriceras* and *Cawtoniceras*). ARKELL, 1939, 1935–1948; SYKES & CALLOMON, 1979; GYGI & MARCHAND, 1982; WRIGHT, 1983; CALLOMON, 1985; CALLOMON & WRIGHT, 1989. *Middle Jurassic (upper Callovian,* Lamberti *Zone)–Upper Jurassic (lower Kimmeridgian,* Autissiodorensis *Zone):* widespread in the Boreal Province, sometimes predominant in the Subboreal Province, rarely extending into the sub-Mediterranean Province.

Quenstedtoceras HYATT, 1877, p. 390, incorrect original spelling as *Quenstedioceras,* corrected in ICZN, 1955a, Opinion 324, p. 238; see ARKELL, 1951, p. 225 [**Ammonites leachi* J. SOWERBY, 1819, p. 73; M] [=*Quenstedticeras* TEISSEYRE, 1889, p. 148, misspelling; =*Quenstedticeras* PARONA & BONARELLI, 1897, p. 125, misspelling; =*Eboraciceras* BUCKMAN, 1918, p. *xiv* (type, *Ammonites dissimilis* BROWN, 1849 in 1837–1849, p. 246, OD); =*Prorsiceras* BUCKMAN, 1918, p. *xiv* (type, *Ammonites gregarius* LECKENBY, *ex* BEAN MS, 1859, p. 11, OD); =*Vertumniceras* BUCKMAN, 1918, p. *xiv* (type, *Ammonites vertumnus* LECKENBY, *ex* BEAN MS, 1859, p. 9, OD, =*Ammonites leachi* J. SOWERBY); =*Lamberticeras* BUCKMAN, 1920, p. 14, *non Lamberticeras* KILIAN, 1910, p. 194, *nom. nud.,* ICZN Opinion 324, 1955a, p. 230, 232 (see ARKELL, 1951, p. 225) (type, *Ammonites lamberti* J. SOWERBY, 1819, p. 73, OD); =*Bourkelamberticeras* BUCKMAN, 1920, p. 17 (obj. of *Lamberticeras*); =*Weissermeliceras* BUCKMAN, 1920, p. 20 (type, *W. longilobatum,* OD); =*Eichwaldiceras* BUCKMAN, 1920, p. 20 (type, *Ammonites carinatus* EICHWALD, 1868 IN 1865–1868, p. 1072, OD); =?*Sutherlandiceras* BUCKMAN, 1922, pl. 320A (type, *S. albisaxeum,* OD); =*Transilongoceras* REPIN, 2002, p. 474 (type, *T. lambertiforme,* OD)]. Inner whorls vary from compressed (*Lamberticeras*) to moderately inflated (*Eboraciceras*), and from moderately involute to more evolute (*Prorsiceras*); venter angled; widely spaced primary ribs, with or without nodes or bullae near umbilical edge, bifurcate into 2–4 secondary ribs high on whorl side and swing forwards on venter. Microconchs retain this morphology, with compressed to rounded whorl section and strong ribbing, up to the adult mouth border, which is simple with a long ventral rostrum. Macroconchs become 2–4 times larger than microconchs, some remaining compressed (*Lamberticeras*), others becoming inflated to sphaeroconic, with rounded venters (*Eboraciceras*); ribs are lost on the smooth body chamber, and adult mouth border has a long ventral rostrum, as in microconchs. *Quenstedtoceras* is one of the most variable genera in Cardioceratidae, forming dimorphic populations that are highly and continuously variable at single biostratigraphical horizons, these being single (bio)species that embrace the morphology of all the existing generic names that are given above as synonyms. *Quenstedtoceras* differs from its Cadoceratinid ancestors in its rounded umbilical edge and angled venter, at least on the inner whorls. *Middle Jurassic (upper Callovian,* Lamberti *Zone)–Upper Jurassic (lower Oxfordian,* Mariae *Zone):* Europe, Caucasus, Ukraine (Donetsk), Russia (northern Siberia, Franz Josef Land), Kazakhstan (Mangystau), Norway (Svalbard), eastern Greenland, USA (southern Alaska, Montana, Wyoming).——FIG. 57*a–e.* **Q. leachi* (J. SOWERBY); *a–c,* neotype, microconch, *Lamberti* Zone, Tidmoor Point, Weymouth, Dorset, England, ×1 (Arkell, 1939, pl. 10,*5a–c*); *d–e,* microconch with peristome, *Lamberti* Zone, Łuków, Poland, ×1 (Makowski, 1963, pl. 20,*2a–b*).——FIG. 57*f. Q. praelamberti* MAIRE, adult dimorphs, Łuków, Poland, macroconch ×0.32, microconch, ×0.4 (Makowski, 1963, p. 37, text-pl. V).——FIG. 57*g–h. Q. lamberti* (J. SOWERBY), topotype, macroconch phragmocone, type species of *Lamberticeras,* Weymouth, Dorset, England, ×0.9 (new; The Natural History Museum, London, NHMUK C.70978).——FIG. 57*i–j. Q. gregarium* (LECKENBY), lectotype, macroconch, type species of *Prorsiceras,* Castle Rock, Scarborough, Yorkshire, England, ×0.7 (Buckman, 1918, pl. 117A).——FIG. 57*k–l. Q. dissimile* (BROWN), holotype, macroconch, type species of *Eboraciceras,* Scarborough, Yorkshire, England, ×0.8 (Buckman, 1918, pl. 118A).——FIG. 57*m–n. Q. grande* ARKELL (1939); *a–b,* lectotype (designated by ARKELL, 1939, p. 176), Villers-sur-Mer, Calvados, France, ×0.9 (Douvillé, 1912, pl. 4(X),*5*7).

Pavloviceras BUCKMAN, 1920, p. 18 [**Quenstedtoceras pavlowi* DOUVILLÉ, 1912, p. 74; OD]. Inner whorls have rounded, slightly depressed whorls and an angled venter; outer whorls quickly become highly depressed and inflated; strong, coarse, biplicate ribbing persists to late stages, and the secondary ribs cross the venter with only a gentle projection forwards. Microconchs are strongly ribbed to the end; macroconchs become smooth on the adult body chamber. *Pavloviceras* is kept distinct from

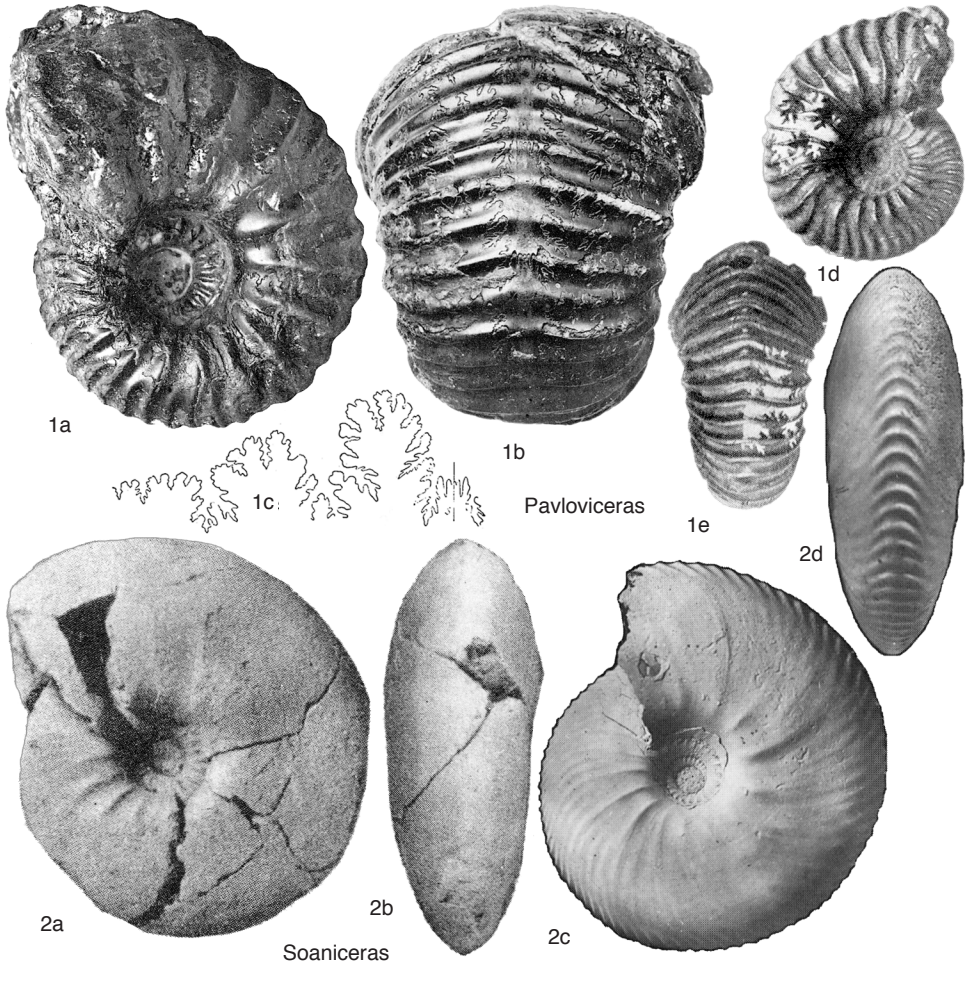

FIG. 58. Cardioceratidae (p. 75–76).

Quenstedtoceras only because it occurs biostratigraphically higher in the *Mariae* Zone, and as yet it is unclear whether such highly depressed and very coarse ribbed examples form part of the wide range of variation of *Quenstedtoceras. Upper Jurassic (lower Oxfordian,* Mariae *Zone–?lower* Cordatum *Zone):* Europe, Ukraine (Donetsk), USA (Wyoming).——FIG. 58,*1a–c.* **P. pavlowi* DOUVILLÉ, *Mariae* Zone, Villers-sur-Mer, Calvados, France; *a–b,* holotype, phragmocone, macroconch, ×0.75; *c,* suture of a topotype, ×1; (Douvillé, 1912, pl. 5(XI),*13,13a;* p. 74, fig. 83).——FIG. 58,*1d–e. P. omphaloides* (J. SOWERBY), neotype (designated by ARKELL, 1939, p. 151), microconch, phragmocone, *Mariae* Zone, Weymouth, England, ×1 (Buckman, 1921, pl. 195,*1,3*).

Soaniceras MELEDINA, 1977, p. 154 [**Quenstedtoceras (Soaniceras) angustatum;* OD] [=*Anabariceras* STOLYAROVA, 2007, p. 242 (type, *A. meledinae,* OD)]. Involute, compressed, rounded whorl sides and narrowly rounded venter; well-spaced primary ribs curve gently forwards and divide into 2–4 secondaries about midwhorl, and some secondaries are intercalated; secondaries angled forwards across narrow venter; ribbing fades on the outer whorls, but chevrons remain on the angled venter. More involute, less strongly ribbed, and ribs fade earlier than in *Quenstedtoceras;* probably a local form in northern Siberia. *Middle Jurassic (upper Callovian, Lamberti Zone)–Upper Jurassic (lower Oxfordian,* Mariae *Zone):* Russia (northern Siberia).——FIG. 58,*2a–b.* **S. angustatum,* holotype, River Innokentevna, Bolshevik Island, Krasnoyarsk Krai, Russia, ×1 (Meledina, 1977, pl. 46,*1*).——FIG. 58,*2c–d. S. meledinae* (STOLYAROVA), paratype, Anabar River, Sakha Republic, Russia, ×0.75 (Stolyarova, 2007, pl. 4,*2b–c*).

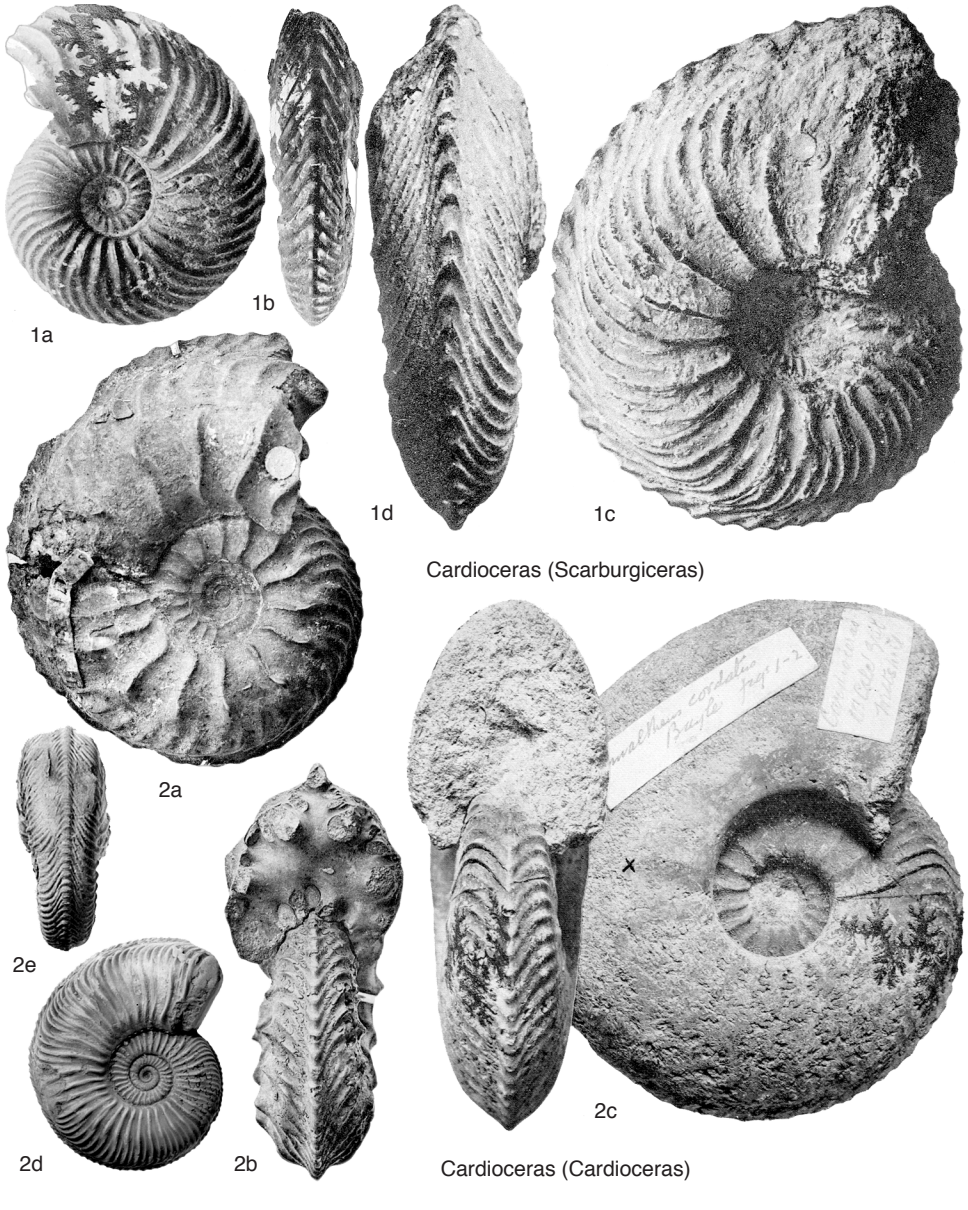

FIG. 59. Cardioceratidae (p. 78–81).

Cardioceras NEUMAYR & UHLIG, 1881, p. 140 [**Ammonites cordatus* J. SOWERBY, 1813, p. 51; SD BUCKMAN, 1920, p. 15]. A strong keel flanked by concave areas on venter and trapezoid (cardiform) whorl section distinguish *Cardioceras* from the angled venter of ancestral *Quenstedtoceras;* well-spaced, flexuous primary ribs on middle whorls are accentuated by incipient ventrolateral tubercles; secondary ribs strongly projected on the venter and pass over keel without interruption; ribbing fades on adult body chamber of macroconchs. As in *Quenstedtoceras,* whorl inflation varies from compressed to depressed and inflated. This high variability comes to an end in the *Densiplicatum* Zone, and is not found again at higher levels. The highly inflated, sphaeroconic *Goliathiceras* might be the most inflated end of this variation in *Cardioceras,* but the relationship between *Cardioceras* and *Goliathiceras* is still unclear; so *Goliathiceras* is kept distinct herein as a subgenus

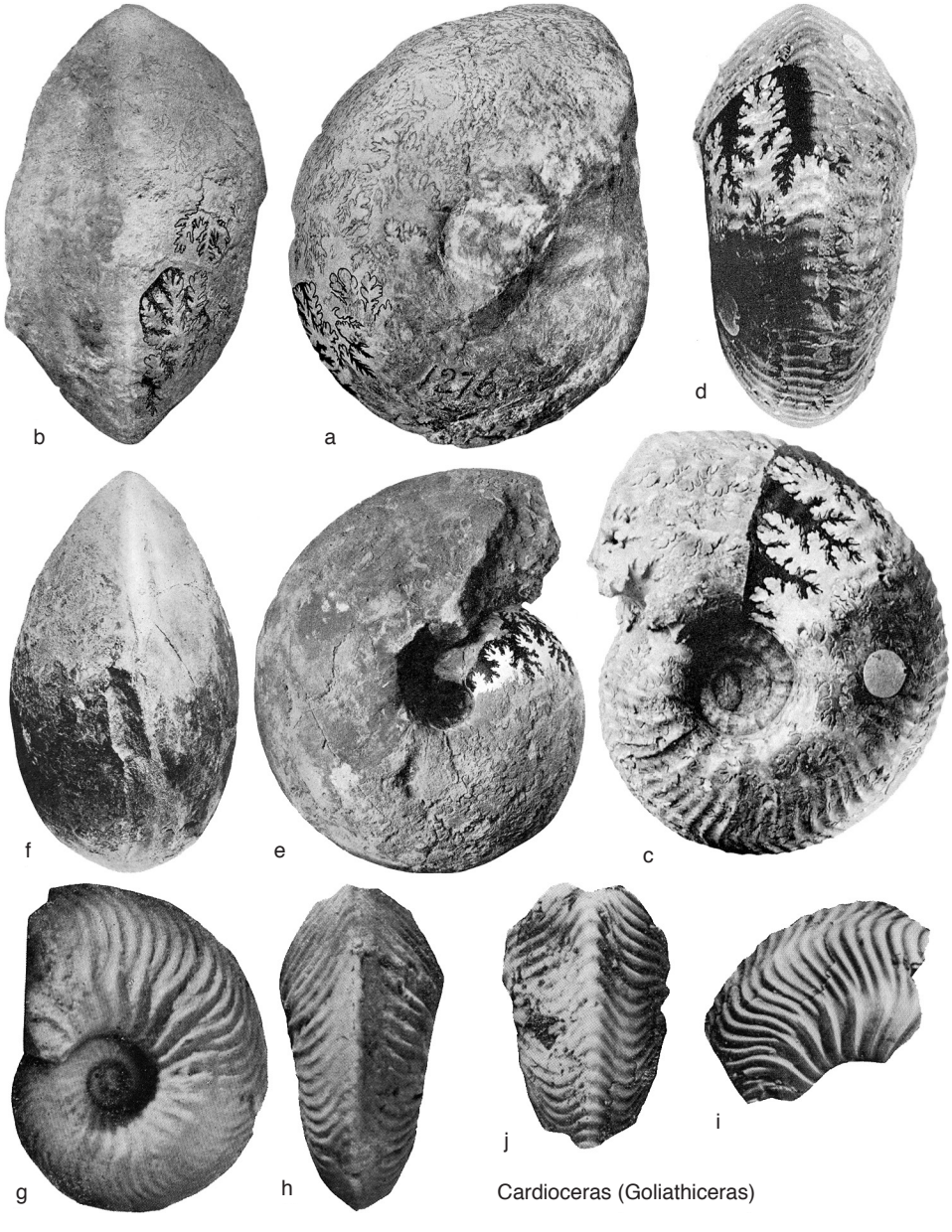

FIG. 60. Cardioceratidae (p. 81).

of *Cardioceras* until better evidence becomes available. *Upper Jurassic (lower Oxfordian,* Mariae *Zone*–Densiplicatum *Zone).* Europe, Caucasus, Ukraine (Donetsk), Russia (northern Siberia), Kazakhstan (Mangystau), Norway (Svalbard), eastern Greenland, Canada (British Columbia, Axel Heiberg Island), USA (Alaska, Georgia, Wyoming).

C. (Scarburgiceras) BUCKMAN, 1924, pl. 508 [**Ammonites scarburgensis* YOUNG & BIRD, 1828, p. 265; OD] [=*Protocardioceras* SCHIRARDIN, 1958, p. 24 (type, *Quenstedticeras praecordatum* DOUVILLÉ, 1912, p. 62, OD)]. Early forms in the *Mariae* Zone, with compressed whorl section and differentiated ventral keel that is more prominent in the macroconchs; secondary ribs curved, moder-

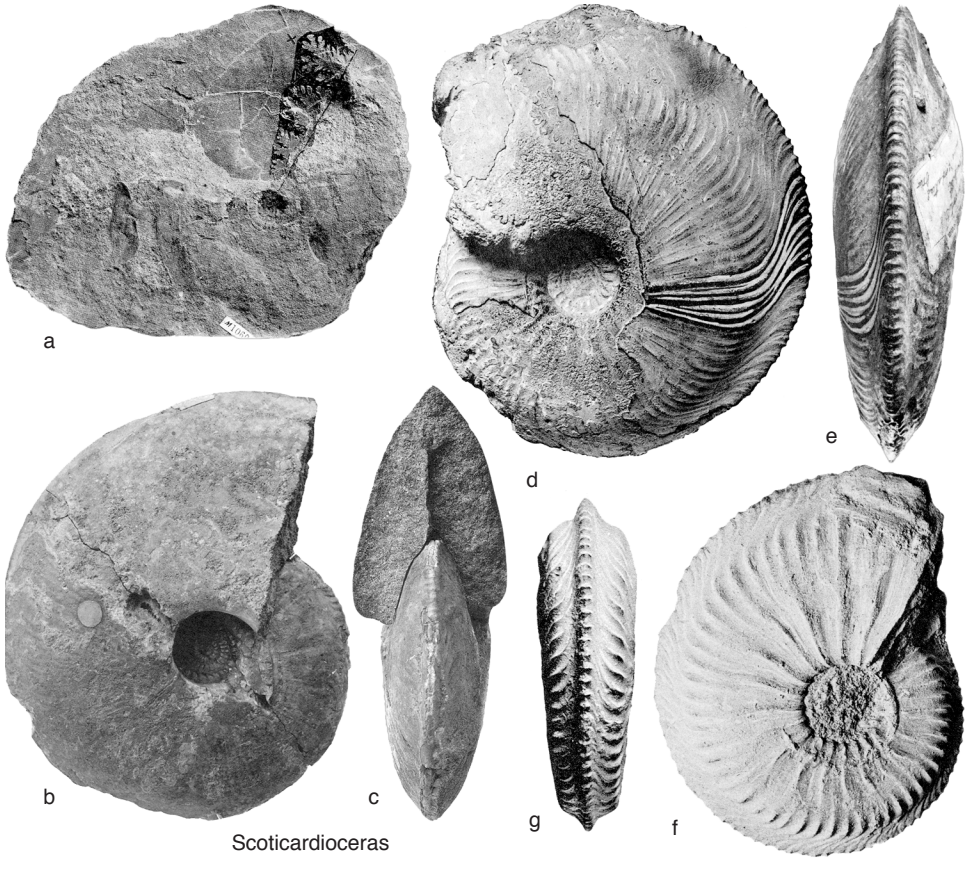

FIG. 61. Cardioceratidae (p. 81).

ately projected, and less flexuous than in later forms. Dimorphic, with ribs remaining on adult whorls of both dimorphs. *Upper Jurassic (lower Oxfordian,* Mariae *Zone):* Europe, Caucasus, Ukraine (Donetsk), Russia (northern Siberia), eastern Greenland, Canada (British Columbia, Axel Heiberg Island), USA (Alaska, Georgia, Wyoming).——FIG. 59,*1a–b. *C. (S.) scarburgense* (YOUNG & BIRD), neotype (designated by HOWARTH, 1962, p. 127), phragmocone of microconch, *Mariae* Zone, *Scarburgense* Subzone, Scarborough, Yorkshire, England, ×1 (Buckman, 1924, pl. 508).——FIG. 59,*1c–d. C. (S.) alphacordatum* SPATH, holotype, macroconch, probably of *C. (S.) praecordatum* (DOUVILLÉ), *Mariae* Zone, *Praecordatum* Subzone, Warboys, Huntingdonshire, England, ×1 (Arkell, 1946, pl. 69,*8a–b*).

C. (Cardioceras) [=*Anacardioceras* BUCKMAN, 1923a, pl. 420 (type, *A. cordatiforme,* OD); =*Plasmatoceras* BUCKMAN, 1925a, p. 66; 1925b, pl. 617 (type, *P. plastum,* OD); =*Paracardioceras* BUCKMAN, 1925b, pl. 588 (type, *P. persecans,* OD); =*Pachycardioceras* BUCKMAN, 1926, pl. 634 (type, *P. robustum,* OD); =*Pechoracardioceras* REPIN in REPIN & others, 2006, p. 110 (type, *Cardioceras (Pechoracardioceras) boreale,* M)]. Differs from *Scarburgiceras* in its subquadrate whorl section with strong keel, flexuous primary ribs, small and clavate ventrolateral tubercles, and secondary ribs strongly projected on venter, passing over the corded keel without interruption. Ribs weaken on adult whorl of microconchs, but fade on macroconchs. *Plasmatoceras* is included as a synonym on the basis of the identification of the horizon of its type specimen as *Cordatum* Zone by ARKELL (1941, p. lxxvii) and SYKES and CALLOMON (1979, p. 847). *Upper Jurassic (lower Oxfordian,* Cordatum *Zone–lower* Densiplicatum *Zone):* Europe, Russia (northern Siberia), Norway (Svalbard), Canada (British Columbia), USA (southern Alaska, Georgia, Wyoming).——FIG. 59,*2a–b. *C. (C.) cordatum* (SOWERBY), lectotype (designated by ICZN, 1954a, Opinion 235, p. 313), microconch, phragmocone, *Cordatum* Zone and Subzone, Send, Wiltshire, England, ×1 (Healey, 1905, pl. 94,*4,4a*).——FIG. 59,*2c. C. (C.) robustum* BUCKMAN, holotype, macroconch with ¼ whorl

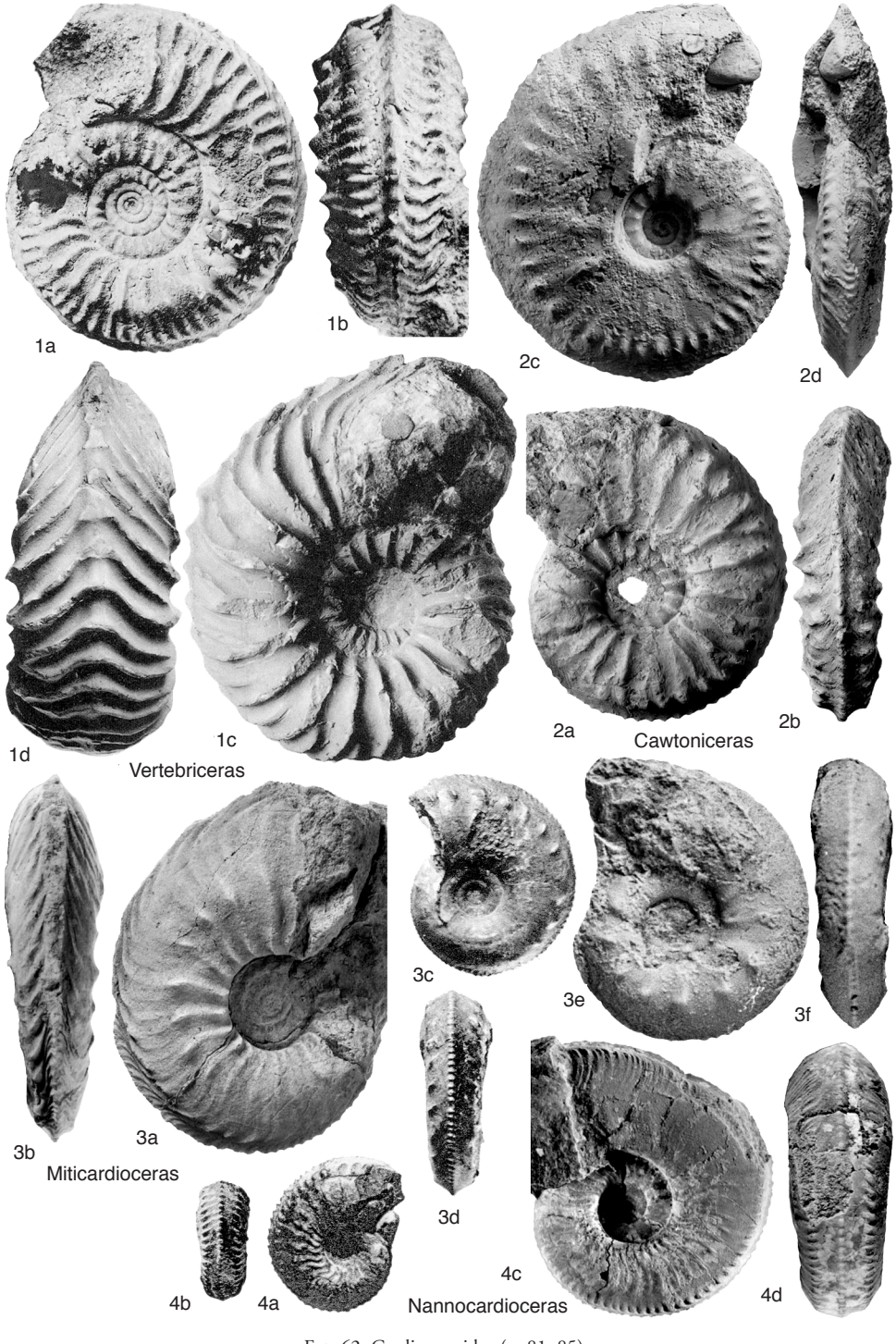

FIG. 62. Cardioceratidae (p. 81–85).

of adult body chamber, probably the macroconch of *C. (C.) cordatum, Cordatum* Zone, Lower Calcareous Grit, Calne, Wiltshire, England, ×0.7 (Buckman, 1926, pl. 634).——Fig. 59,*2d–e. C. (C.) plastum* (Buckman), holotype, microconch, *Cordatum* Zone, Wooton Bassett, Wiltshire, England, ×1 (new; British Geological Survey, Keyworth, Nottingham, England, GSM 30524).

C. (Goliathiceras) Buckman, 1919b, pl. 132 [**Nautilus ammonoides* Young & Bird, 1828, p. 271; OD] [=*Korythoceras* Buckman, 1920, p. 17 (type, *K. korys,* OD); =?*Chalcedoniceras* Buckman, 1922, pl. 295 (type, *Nautilus chalcedonicus* Young & Bird, 1828, p. 271, OD); =*Hortoniceras* Buckman, 1922, pl. 296 (type, *H. sidericum,* OD); =*Goliathites* Arkell, 1943, p. lxxxi (type, *Ammonites goliathus* d'Orbigny, 1849 in 1842–1851, p. 519, OD); =?*Herznachites* Jeannet, 1951, p. 34 (type, *H. helveticus,* OD)]. Large, inflated sphaerocones, smooth with rounded or bluntly angled venter on outer whorls of macroconchs; inner whorls of both dimorphs involute and inflated, with secondary ribs curving backwards before sweeping sharply forwards from the lateral shoulders, crossing the low ventral keel as small chevrons. Microconchs (*Korythoceras*) maintain this morphology to the end of growth, while macroconchs become much larger, sphaeroconic, and smooth. *Goliathiceras* has been used conventionally for any large, inflated to sphaeroconic, smooth form with rounded venter on adult body chamber; its inner whorls cover almost all the morphological range found in *Cardioceras,* and this highly inflated morphology comes to an abrupt end in the *Densiplicatum (=Plicatilis)* Zone). Nevertheless, its relationship with *Cardioceras* is still unclear. *Upper Jurassic (lower Oxfordian,* Cordatum *Zone–middle Oxfordian,* Densiplicatum *Zone):* Europe, Russia (northern Siberia), Kazakhstan (Mangystau), USA (Wyoming).——Fig. 60*a–d. *C. (G.) ammonoides* (Young & Bird); *a–b,* holotype, complete phragmocone of macroconch, ?Malton, Yorkshire, England, ×0.3 (Buckman, 1919b, pl. 132A–132B); *c–d,* macroconch, phragmocone, *Plicatilis* Zone, Cowley, Oxford, England, ×0.7 (Arkell, 1943, pl. 56,*3b,* pl. 57,*4*).——Fig. 60*e–f. C. (G.) titan* Arkell, almost complete adult macroconch, *Densiplicatum (=Plicatilis)* Zone, Headington, Oxford, England, ×0.2 (Arkell, 1943, p. 258–259, fig. 91*a,c*).——Fig. 60*g–j. C. (G.) korys* (Buckman), Loch Staffin, Isle of Skye, Scotland; *g–h,* holotype, microconch, ×1 (Turner, 1970, pl. 2,*A–B;* also figured by Buckman, 1922, pl. 361); *i–j,* topotype, microconch, ×1 (Turner, 1970, pl. 2,*F–G*).

Scoticardioceras Buckman, 1925b, pl. 599 [**S. scoticum;* OD; ?=*Ammonites excavatus* (J. Sowerby), 1815, p. 5] [=*Galecardioceras* Buckman, 1926, pl. 647 (type, *G. galeiferum,* OD); =*Cuneicardioceras* Arkell, 1941, p. lxxvi (type, *C. cuneiforme,* OD)]. Involute, discoidal whorls, with tall, finely serrated keel; straight primary ribs divide at ventrolateral clavi into strongly projected secondary ribs that form serrations on the keel; ribs fade quickly to sigmoidal striations and venter becomes acutely angled on outer and adult whorls. Macroconchs; associated microconchs have not been identified. *Upper Jurassic (Oxfordian,* Cordatum–Tenuiserratum *Zones):* Europe, Russia (northern Siberia), USA (Wyoming).——Fig. 61*a. *S. scoticum,* holotype, poorly preserved and crushed, Ardassie Point, Brora, Sutherland, Scotland, ×0.4 (Buckman, 1925b, pl. 599).——Fig. 61*b–e. S. excavatum* (J. Sowerby); *b–c,* holotype, macroconch with part of body chamber, Shotover Hill, Oxford, England, ×0.5 (Healey, 1905, pl. 92); *d–e,* macroconch, phragmocone, *Densiplicatum* Zone, Horspath, Oxford, England, ×0.6 (Arkell, 1941, pl. 49,*1a–b*).——Fig. 61*f–g. S. expositum* (Buckman), macroconch, inner whorls, ?Marcham, Oxford, England, ×0.8 (Arkell, 1941, pl. 50,*1a–b*).

Vertebriceras Buckman, 1920, p. 16 [**V. dorsale;* OD] [=*Sagitticeras* Buckman, 1920, p. 19 (type, *S. sagitta,* OD); =*Subvertebriceras* Arkell, 1941, p. lxxviii (type, *Cardioceras vertebrale* var. *densiplicata* Boden, 1911, p. 159, OD)]. Evolute, subquadrate whorl section; strong, rectiradiate primary ribs divide high on the whorl side at lateral tubercles into secondary ribs that bend sharply forward at weak tubercles on the ventrolateral shoulders to join the keel as forwardly projecting crenulations; keel weak or absent in the most inflated forms. All known specimens are microconchs, strongly ribbed to the end; associated macroconchs have not been identified. Differs from *Cardioceras* mainly in the form of the secondary ribs. *Upper Jurassic (lower–middle Oxfordian,* Cordatum–*lower* Tenuiserratum *Zones):* Europe, Russia (northern Siberia), eastern Greenland, USA (?Wyoming).——Fig. 62,*1a–b. *V. dorsale,* holotype, microconch, *Plicatilis* Zone, *Vertebrale* Subzone, Horspath Road Quarry, Cowley, England, ×0.6 (Arkell, 1942, pl. 54,*3a–b*).——Fig. 62,*1c–d. V. sagitta* (Buckman), holotype, microconch, *Cordatum* Zone, *Costicardia* Subzone, Red Nodule Beds, Weymouth, Dorset, England, ×0.7 (Arkell, 1946, pl. 70,*15a–b*).

Cawtoniceras Buckman, 1923b, pl. 454 [**Ammonites cawtonensis* Blake & Hudleston, 1877, p. 370, 392, 403; OD] [=*Maltoniceras* Arkell, 1941, p. lxxvii (type, *Ammonites maltonensis* Young & Bird, 1822, p. 252, OD)]. Similar to *Vertebriceras,* but more involute and compressed, and secondary ribs terminate at small ventrolateral tubercles, continuing only as weak striae across the almost smooth venter up to the minutely serrated keel. Macroconchs (*Maltoniceras*) become smooth on adult whorl; microconchs ribbed to the end. *Upper Jurassic (middle Oxfordian,* Densiplicatum *[=*Plicatilis*]*–Tenuiserratum *Zones):* Europe, Russia (northern Siberia), Canada (British Columbia), USA (Wyoming).——Fig. 62,*2a–b. *C. cawtonense* (Blake & Hudleston), lectotype

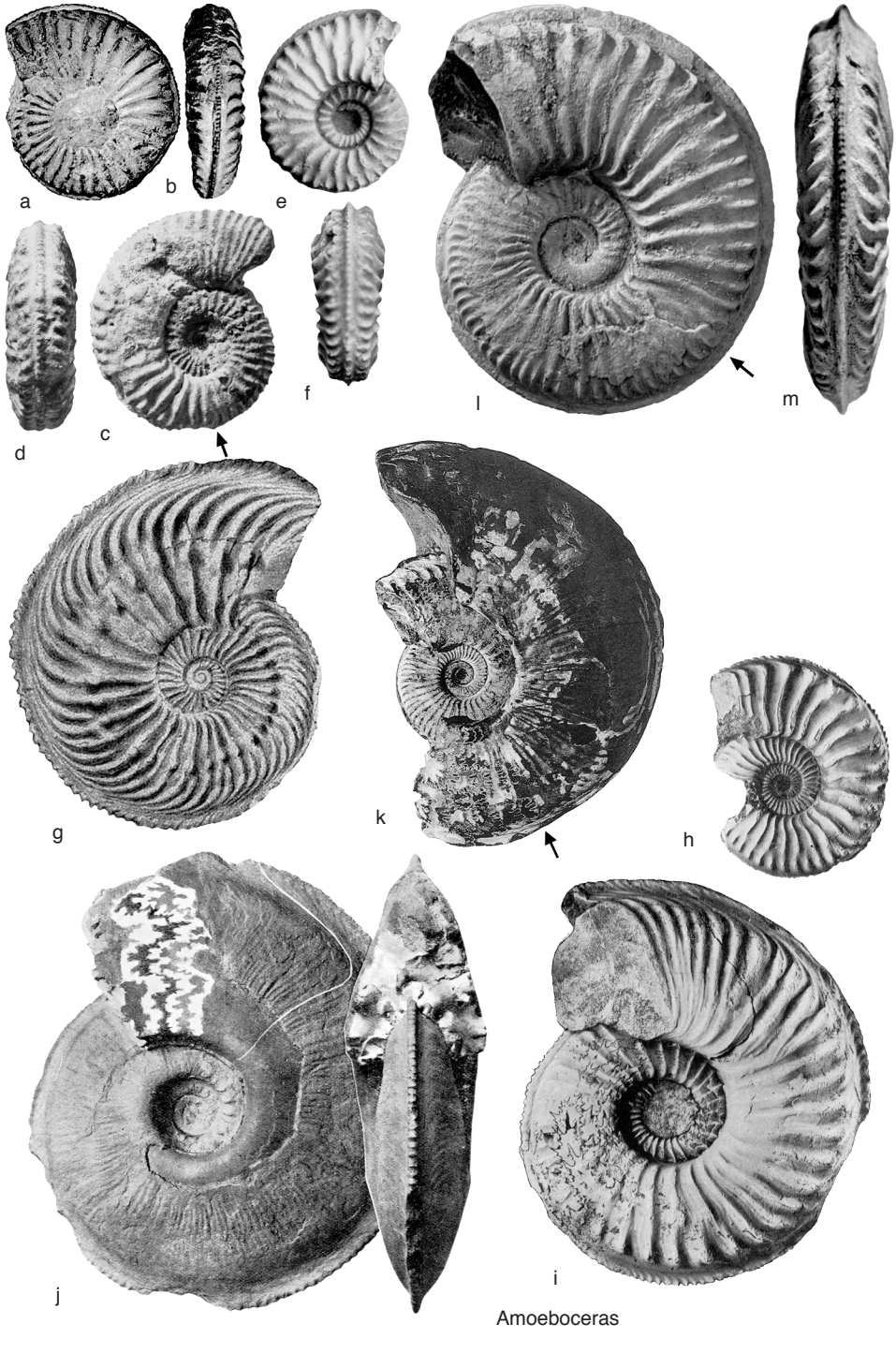

FIG. 63. Cardioceratidae (p. 83).

(designated by ARKELL, 1941, p. lxxviii), microconch, phragmocone, *Plicatilis* Zone, *Antecedens* Subzone, Cawton, Yorkshire, England, ×0.75 (new; British Geological Survey, Keyworth, Nottingham, England, GSM 46265).——FIG. 62,*2c–d. C. maltonense* (YOUNG & BIRD), neotype (designated by ARKELL, 1941, p. 232), macroconch, *Antecedens* Subzone, Highworth, Wiltshire, England, ×0.6 (new; Oxford University Museum, England, OUM J2983; also figured by Arkell, 1941, pl. 51,*1a–b*).

Miticardioceras BUCKMAN, 1923a, pl. 375 [**M. mite;* OD]. Small, moderately involute forms, with compressed whorls and prominent, serrated keel; smooth on inner whorls except for the serrated keel; middle and outer whorls develop weak, well-spaced primary ribs, small lateral or ventrolateral tubercles, and secondary ribs continuous to the keel. Both dimorphs retain weak ribs to the end of growth; microconchs include *Cardioceras zieteni* (ROUILLIER in ROUILLIER & VOSINSKY, 1849, p. 364, 368) and *C. tenuiserratum* (OPPEL, 1863 in 1862–1863, p. 200), which are characteristic of the basal upper Oxfordian. *Upper Jurassic (middle Oxfordian,* Tenuiserratum *Zone–lower Kimmeridgian):* Europe, Russia, eastern Greenland, USA (Wyoming).——FIG. 62,*3a–d. *M. mite; a–b,* holotype, ?macroconch, *Tenuiserratum* Zone, Worminghall, Buckinghamshire, England, ×1 (new; British Geological Survey, Keyworth, Nottingham, England, GSM 47171); *c–d,* an uncrushed phragmocone of a probable microconch, St. Ives Rock, Huntingdonshire, England, ×1 (Arkell 1942, pl. 52,*18a–b*).——FIG. 62,*3e–f. M. tenuiserratum* (OPPEL), lectotype, microconch, Birmensdorf, Baden, Aargau, Switzerland, ×2 (new; Eidgenössische Technische Hochschule (ETH), Zürich, no. Ve S.4; also figured by Oppel, 1862–1863, pl. 53,*2a–c*).

Amoeboceras HYATT, 1900, p. 580 [**Ammonites alternans* VON BUCH, 1831, pl. 7,*4;* OD] [=*Prionodoceras* BUCKMAN, 1920 (June), p. 17, *nom. nov. pro Prionoceras* BUCKMAN, 1920 (March), pl. 155, *non* HYATT, 1883, p. 328 (Cheiloceratidae, Paleozoic), (type, *P. prionodes,* OD; =*Ammonites serratus* J. SOWERBY, 1813, p. 65); =*Paramoeboceras* (GERASIMOV MS) MESEZHNIKOV, KALCHEVA, & ROTKITE, 1989, p. 81, 95 (type, *Cardioceras ilovaiskii* SOKOLOV, 1929, p. 11, 30, OD)]. *Amoeboceras* and later genera are successors of *Cardioceras* in the upper Oxfordian, where they repeat much of the same range of morphology, except for the absence of the inflated forms found previously from the Boreal Bathonian upwards, and are characterized by a minutely serrated keel on tabulate venter, flanked on inner whorls by smooth bands or shallow sulci. In the lower Kimmeridgian dimorphism becomes less conspicuous, with both dimorphs retaining strong, dense, almost straight ribbing to the end of growth. The last forms are very small, the family (and superfamily) becoming extinct in the middle of the *Autissiodorensis* Zone at the top of the lower Kimmeridgian. Inner whorls of *Amoeboceras* subquadrate, with a strong, serrated keel; primary ribs variable, but usually strong and gently curved up to high lateral or ventrolateral tubercles, from which secondaries bifurcate or are intercalated and swing strongly forwards on the venter. Microconchs retain this morphology up to the adult mouth border, which has long, narrow rostrum. On middle and outer whorls of macroconchs (*Prionodoceras*) the whorl section becomes trigonal with high, serrated ventral keel, and ribs and tubercles gradually fade to striae; the adult whorl is smooth with a long, narrow ventral rostrum in mouth border. SYKES & CALLOMON, 1979. *Upper Jurassic (upper Oxfordian–lower Kimmeridgian):* Europe, Caucasus, Ukraine (Donetsk), Russia (western Russia, northeastern Siberia, Novaya Zemlya), Kazakhstan (Mangystau), Norway (Andoe Island, Lofoten, Svalbard), eastern Greenland, Canada (Northwest Territories, Mackenzie King Island), USA (northern Alaska, Georgia).——FIG. 63*a–f.* **A. alternans* (VON BUCH); *a–b,* lectotype (now lost), microconch, *Bimammatum* Zone, Streitberg, Franconia, Germany, ×1 (Salfeld, 1915, pl. 16,*3a–b); c–d,* neotype (designated by SYKES & CALLOMON, 1979, p. 864), complete adult microconch, *Bimammatum* Zone, Lochenstein, 6 km south of Balingen, Germany, ×1 (new; Tübingen University, Germany, Quenstedt Collection; also figured by Quenstedt, 1887 in 1882–1888, pl. 91,*6;* Salfeld, 1915, pl. 16,*6a–b); e–f,* paralectotype, microconch phragmocone, Streitberg, Franconia, Germany, ×2 (new; von Buch collection, Museum für Naturkunde, Berlin, Germany).——FIG. 63*g. A. ilovaiskii* (SOKOLOV), holotype, type species of *Paramoeboceras,* macroconch, Verkhnee Myachkovo (Miatchkovo), 10 km southwest of Bykovo, Moscow Oblast, Russia, ×1 (Ilovaïsky, 1904, pl. 11,*6*).——FIG. 63*h–i. A. leucum* SPATH, both specimens from the same bed, River Boyarka, approximately 70°36′N, 94°19′E, Krasnoyarsk Krai, Russia; *h,* adult microconch, ×0.6; *i,* macroconch, ×0.6; (Mesezhnikov, 1967, pl. 1,*3a,* pl. 2,*1*).——FIG. 63*j. A. prionodes* (BUCKMAN), holotype, glacial drift, ex *Serratum* Zone, St. Ives, Huntingdonshire, England, ×0.6 (Buckman, 1920, pl. 155).——FIG. 63*k–m. A. serratum* (J. SOWERBY), glacial drift, ex *Serratum* Zone, St. Ives, Huntingdonshire, England; *k,* neotype (designated by ARKELL, 1937, p. 67, footnote), ×0.6 (Salfeld, 1915, pl. 18,*1c*); *l–m,* topotype, ×0.75 (new; Geology Department, University of Birmingham, England, no. 1901; also figured by Sykes & Callomon, 1979, pl. 117,*2*).

Amoebites BUCKMAN, 1925a, pl. 550 [**A. akanthophorus;* OD; =*A. kitchini* SALFELD, 1915, p. 189] [=*Euprionoceras* SPATH, 1935, p. 13, 26 (type, *E. kochi,* OD); =*Hoplocardioceras* SPATH, 1935, p. 13, 36 (type, *H. decipiens;* OD)]. Compressed whorls with flat venter and high, serrated keel bordered by smooth areas on inner whorls; primary ribs dense and straight, curving forwards onto venter; occasional short, intercalatory secondary ribs; tubercle size varies between the small ventrolateral tubercles in many specimens, trituberculate forms with bold umbilical, midlateral, and ventrolateral tubercles,

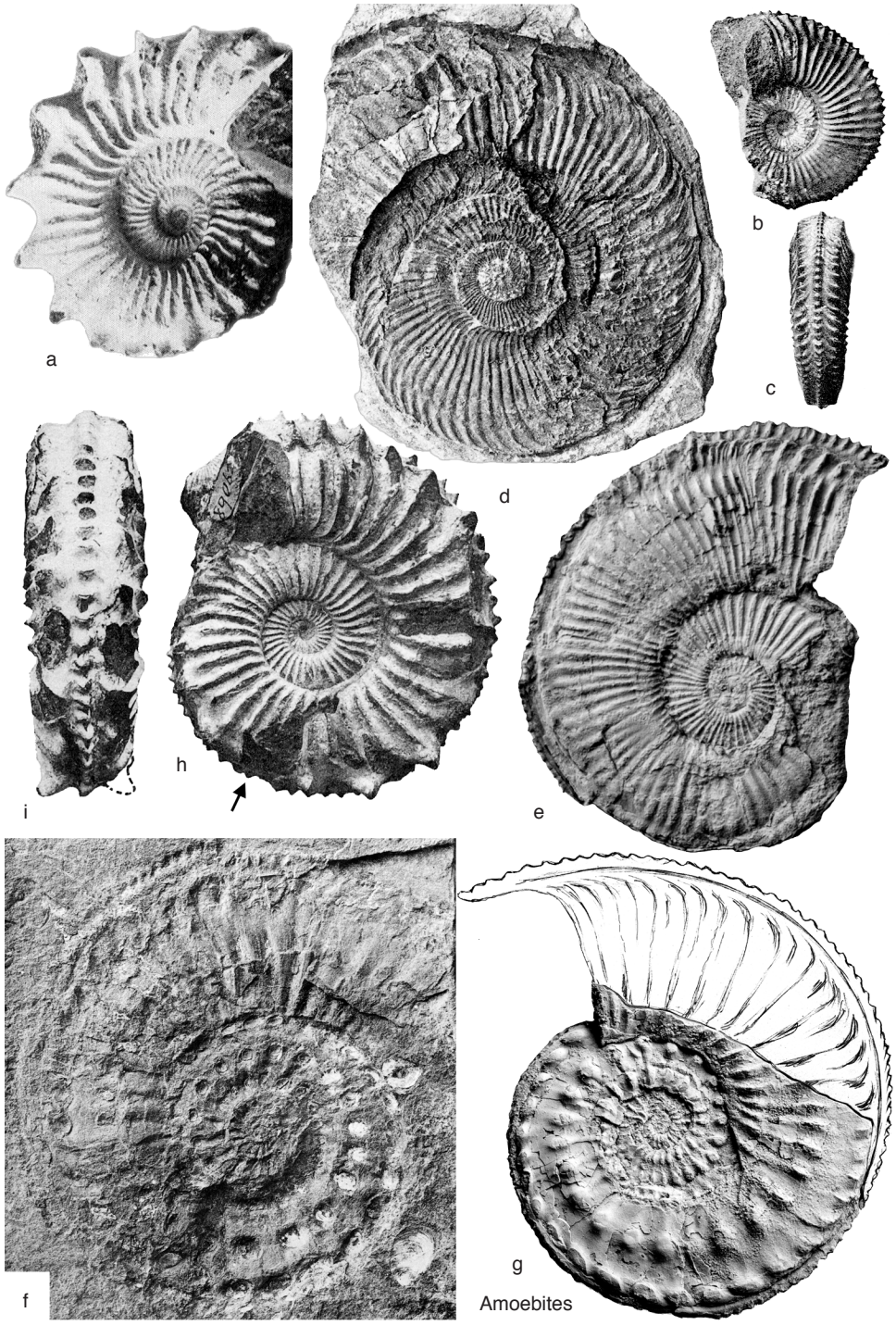

FIG. 64. Cardioceratidae (p. 83–85).

and extreme forms (e.g., holotype of type species) with large ventrolateral tubercles or nodes, to which two or three ribs are looped; tubercles fade on outer whorls, but ribs are retained on adult whorl of both dimorphs; adult mouth border of microconch (*Amoebites*) has a long ventral rostrum; rostrum is similar, but less long, in macroconch (*Euprionoceras*). Amoebites is a successor to *Amoeboceras* in the lower Kimmeridgian, differing its straight, mainly single ribs that are retained to adult mouth border in both dimorphs. SPATH, 1935; BIRKENMAJER & WIERZBOWSKI, 1991. *Upper Jurassic (lower Kimmeridgian,* Baylei–Eudoxus *Zones):* northern Europe, Norway (Andoya Island, Lofoten Archipelago, Svalbard), Russia (west and northeastern Siberia, Franz Josef Land), eastern Greenland, Canada (Mackenzie King Island, Northwest Territories), USA (northern Alaska, California).——Fig. 64*a. *A. akanthophorus,* holotype, microconch, lower Kimmeridgian, ?*Cymodoce* Zone, shore at Ethie, 4 km south of Cromarty, Highland, Scotland, ×1 (Buckman, 1925a, pl. 550,*1*).——Fig. 64*b–c. A. beaugrandi* (SAUVAGE), microconch, ?Cymodoce Zone, Culgower, Scotland, ×1 (Spath, 1935, pl. 5,*4a–b*).——Fig. 64*d–e. A. kochi* SPATH, Milne Land, eastern Greenland; *d,* holotype, macroconch, shore below Hartz Mountain, 70°42.1′N, 25°16.6′W, ×0.65 (Spath, 1935, pl. 5,*2a*); *e,* topotype, macroconch, ×0.9 (new; University Museum, Copenhagen, GGU 137427, 1970).——Fig. 64*f–g. A. decipiens* SPATH, Milne Land, eastern Greenland; *f,* holotype, macroconch, Pinnadal (Pinna valley), 70°42.6′N, 25°17.8′W, Hartz Mountain, ×0.5 (Spath, 1935, pl. 3,*2*); *g,* macroconch, ×0.6 (new; University Museum, Copenhagen, GGU 137438).——Fig. 64*h–i. A. kichini* (SALFELD); complete adult microconch with mouth border, Cromarty, Highland, Scotland, ×1 (Spath, 1935, pl. 1,*9a–b*).

Nannocardioceras SPATH, 1935, p. 13 [**Cardioceras anglicum* SALFELD, 1915, p. 199; OD]. Dwarf forms with quadrate whorls and flat sides; highly variable, ranging from forms with serrated ventral keel and primary ribs that thicken to small midlateral and ventrolateral tubercles, to forms with rounded venter that are almost wholly smooth throughout. Dimorph associations unclear despite abundant occurrence in shell beds. *Upper Jurassic (lower Kimmeridgian,* Autissiodorensis *Zone):* England, northern Germany, Russia.——FIG. 62,*4a–d. *N. anglicum* (SALFELD), Ringstead Bay, Weymouth, Dorset, England; *a–b,* lectotype (designated by HOWARTH, herein), ×2.25 (Salfeld, 1915, pl. 20,*4c–d*); *c–d,* topotype, ×4 (new; The Natural History Museum, London, NHMUK C.78555).

UNAVAILABLE NAMES IN STEPHANOCERATOIDEA

Germanites MASCKE, 1907, p. 23 (*nom. nud.,* because type species is *nom. nud.*).

Germanites HILTERMANN, 1939, p. 116 (*nom. nud.*).

Metaxytes MASCKE, 1907, p. 23 (*nom. nud.,* because type species is *nom. nud.*)

Praecardioceras KOPIK, 1967, p. 100 (*nom. nud.*).

In his description of *Cadomites,* ROCHÉ (1939, p. 175–176) named seven subdivisions of that genus which he called "sections," and each is a valid subgeneric name under Article 10.4 of the ICZN *Code* (1999): "A … name proposed for a genus-group division of a genus … is deemed to be a subgeneric name even if the division is denoted by the term 'section.'" However, only *Dolichoecus* is an available name, having only one species included in the original description, which is therefore the type species by monotypy; it is a synonym of *Stephanoceras (Skirroceras).* The other six names proposed by ROCHÉ were *Bayleia, Blagdenia, Brodiaeia, Deslongchampsia, Freycinetia,* and *Romania;* all are unavailable because they were proposed after 1930 without fixation of the type species in the original publication, contrary to the requirements of the ICZN *Code* (1999, Article 13.3), and subsequent designations of their type species are not allowed under the *Code.*

Superfamily SPIROCERATOIDEA Hyatt, 1900

[*nom. transl.* ARKELL, 1950, p. 359, *ex Spiroceratidae* HYATT, 1900, p. 584]

Uncoiled ammonites, probably derived from genera of the Garantianinae (Stephanoceratoidea), although an alternative derivation from *Tmetoceras* (Hildoceratidae) has been suggested by CALLOMON (1981, p. 131). Shell morphology is often variable within a single species, from loosely coiled, planispiral or helicoid, to slightly curved or straight. A benthonic mode of life has been postulated (DIETL, 1978, p. 65). The most recent, major descriptions are by DIETL (1978, 1981), and CALLOMON (1981, p. 127–131, 155) provided extensive comments. POTONIÉ (1929). *Middle Jurassic (upper Bajocian; upper Bathonian–middle Callovian,* Jason *Zone);* worldwide, except central and eastern Asia and Australasia.

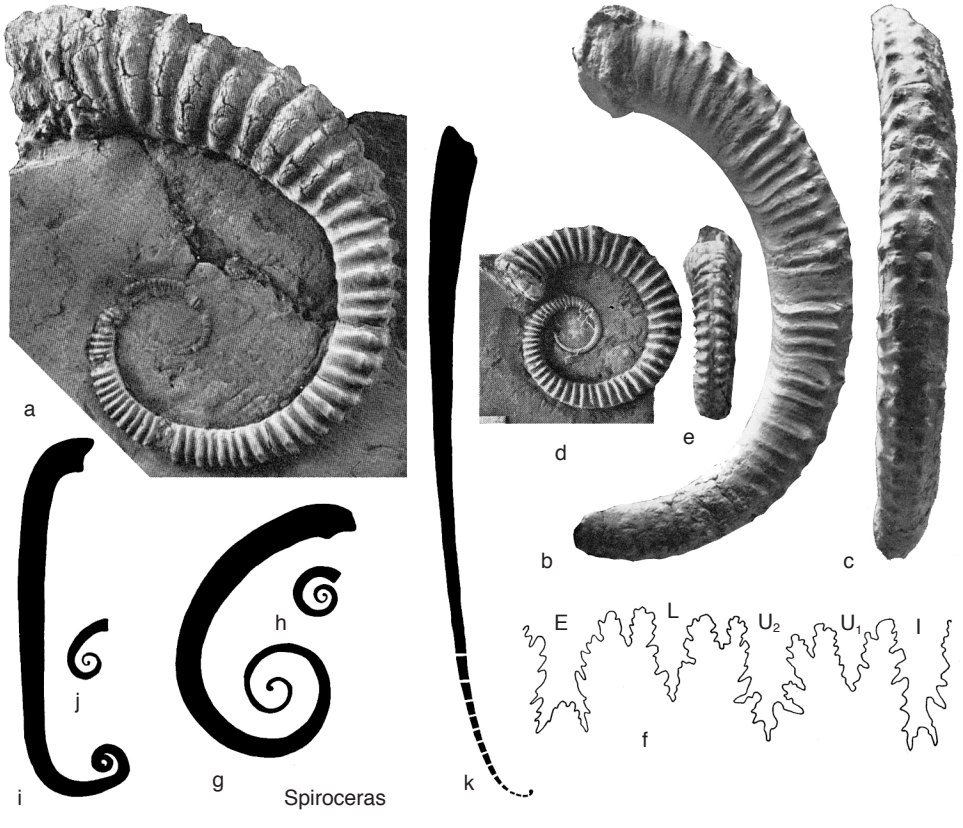

FIG. 65. Spiroceratidae (p. 86–88).

Family SPIROCERATIDAE Hyatt, 1900

[*Spiroceratidae* HYATT, 1900, p. 584]

Two subfamilies are recognized on the basis of probable separate derivation from *Strenoceras* and *Epistrenoceras. Middle Jurassic (upper Bajocian; upper Bathonian–middle Callovian,* Jason *Zone).*

Subfamily SPIROCERATINAE Hyatt, 1900

[*nom. transl.* SPATH, 1933, p. 681, *ex Spiroceratidae* HYATT, 1900, p. 584]

The only genus, *Spiroceras,* is confined to the upper Bajocian, and has a variable shell form, loosely coiled initially, then becoming slightly curved or straight. Derivation is probably from *Strenoceras,* with which *Spiroceras* has a similar, but somewhat more simplified suture. *Middle Jurassic (upper Bajocian).*

Spiroceras QUENSTEDT, 1856 in 1856–1858, p. 407 [**S. bifurcatum* HYATT, 1900, p. 584; by subsequent monotypy by HYATT, 1900, p. 584 (ICZN *Code,* 1999, Article 69.3); =*Toxoceras orbignyi* BAUGIER & SAUZÉ, 1843, p. 6] [=*Patoceras* MEEK, 1876, p. 485 (type, *Helicoceras teilleuxii* BAUGIER & SAUZÉ, 1843, p. 15, OD); =*Apsorroceras* HYATT, 1900, p. 584 (type, *Hamites baculatus* QUENSTEDT, 1856 in 1856–1858, p. 403, OD); =*Rhabdodites* BUCKMAN, 1923a, pl. 374 (type, *R. rhabdodes,* OD); =*Plagiamites* BUCKMAN, 1925a, pl. 539 (type, *Ancyloceras costatus* MORRIS, 1845, p. 33, OD)]. Shell form variable: initial two whorls usually loosely coiled in planar, helicoid, or irregular (twisted) spiral, then becomes straight or slightly curved; adult with hook and flared, and sometimes collared, aperture. Often small, but can attain sizes up to 600 mm in total length and 40 mm dorsal to ventral whorl size (the largest figured specimens are QUENSTEDT, 1886 in 1882–1888, pl. 70,*12,38,* from Germany). Single, straight ribs end at rows of ventrolateral

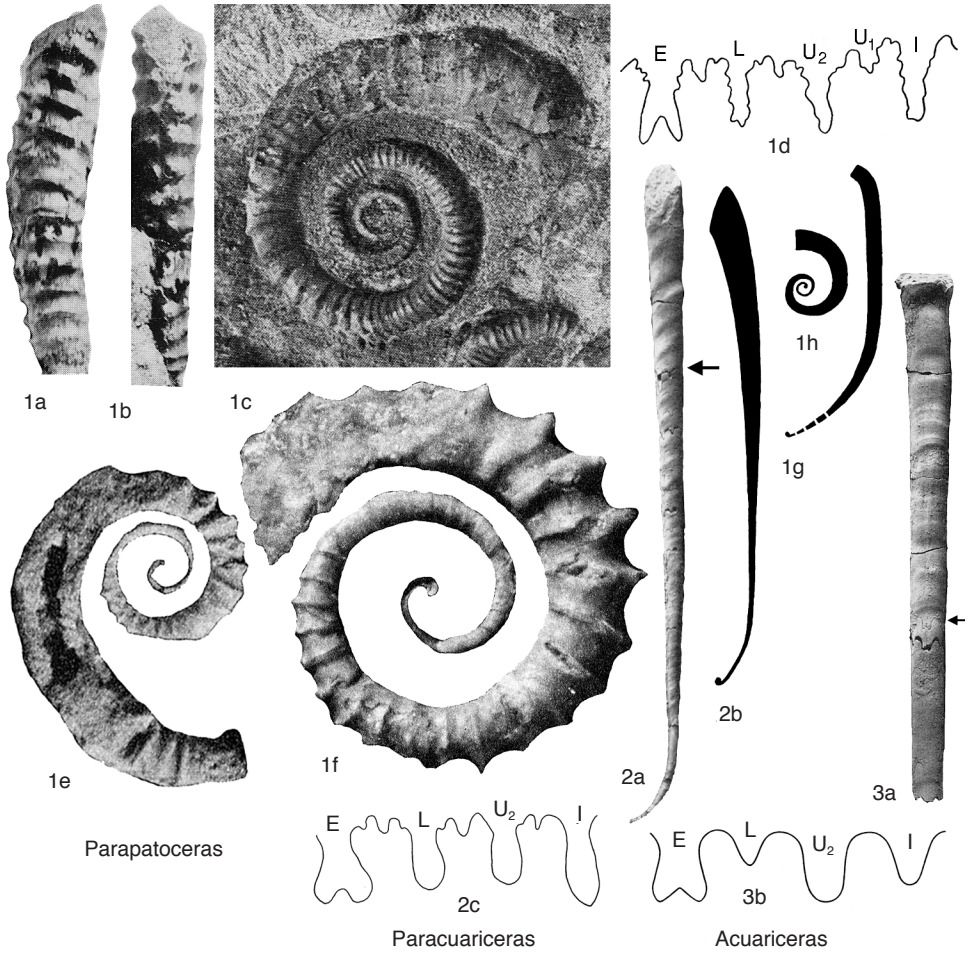

FIG. 66. Spiroceratidae (p. 88).

and ventral tubercles or spines bordering a narrow midventral groove or smooth area; ribs projected forwards on the flat dorsum and weaken or disappear. Dimorphic: macroconchs 2–4 times larger than microconchs; macroconchs usually with long, nearly straight body chamber, hooked and flared at adult aperture, and body chambers are known up to 260 mm long; microconchs have flared and collared adult aperture, often while still at the loosely coiled stage. Specimens are found as fragments, but reconstructions of complete adults of both dimorphs are shown here in the figures. Because no available species were referred to *Spiroceras* by QUENSTEDT (1856 in 1856–1858, p. 407), the designation of its type species, and the selection of a neotype were discussed by HOWARTH and MELVILLE (1984). *Middle Jurassic (upper Bajocian,* Subfurcatum–Parkinsoni *Zones):* Germany, France, Spain, Italy, Switzerland, England, Poland, Hungary, Armenia, Algeria, Kenya, Egypt (Sinai), Saudi Arabia, Canada (Alberta), USA (Alaska, Wyoming), Peru, Argentina, Chile.——FIG. 65*a. *S. bifurcatum* HYATT, neotype (designated by HOWARTH & MELVILLE, 1984, p. 132), Ehningen, Reutlingen, Germany, ×1 (Dietl, 1978, pl. 3,*2;* also figured by Quenstedt, 1886 in 1882–1888, pl. 70,*36*).——FIG. 65*b–f. S. orbignyi* (BAUGIER & SAUZÉ); *b–c,* lectotype, macroconch (original of BAUGIER & SAUZÉ, 1843, pl. 1,*1*), Mougon, near Niort, Deux-Sèvres, France, ×0.5 (Dietl, 1978, pl. 1,*1a–b*); *d–e,* adult microconch, Eningen, Reutlingen, Germany, ×1 (Dietl, 1978, pl. 1,*2a–b;* original of QUENSTEDT, 1886 in 1882–1888, pl. 70,*40*); *f,* suture at 11.7 mm whorl height, Eningen, Reutlingen, Germany (Dietl, 1978, p. 53, fig. 11*e*).——FIG. 65*g–k.* Reconstructions of

complete adults; *g–h,* macroconch and microconch of *S. orbignyi* (Baugier & Sauzé); *i–j,* macroconch and microconch of *S. annulatum* (Deshayes); *k,* macroconch of *S. sauzeanum* (d'Orbigny); ×0.33 (Dietl, 1978, p. 26, fig. 7*a,c,e*).

Subfamily PARAPATOCERATINAE Buckman, 1926

[*nom. transl.* Dietl, 1978, p. 43, *ex* Parapatoceratidae Buckman, 1926, p. 20] [=Acuariceratidae Schindewolf, 1961, p. 731]

Similar to Spiroceratinae, but ribs more continuous across the dorsum and not projected forwards. Later genera, *Paracuariceras* and *Acuariceras,* become straighter and smoother, with no tubercles, and suture becomes progressively reduced. Probably derived independently from *Epistrenoceras* in the upper Bathonian, there being no records of spiroceratids from the lower or middle Bathonian that might link them to the highest *Spiroceras* in the upper Bajocian. *Middle Jurassic (upper Bathonian–middle Callovian,* Jason *Zone).*

Parapatoceras Spath, 1924, p. 12 [**Ancyloceras calloviense* Morris, 1845, p. 32; OD; =*Ancyloceras tuberculatum* Baugier & Sauzé, 1843, p. 11] [=*Crioconites* Buckman, 1925a, pl. 538A–538B (type, *C. crioconus,* OD); =*Metapatoceras* Schindewolf, 1963, p. 134 (type, *M. semiserratum,* OD); =*Infrapatoceras* Ocheterena, 1966, p. 7 (type, *I. biserratum,* OD)]. Smaller than *Spiroceras,* and after the initial, two, loosely coiled, sometimes helicoid, whorls, the shell becomes generally straighter, ending in a gently curved hook and flared aperture; bituberculate ribs similar to *Spiroceras* on side and venter, but ribs pass over the dorsum with no forwards projection and only slight weakening along the mid-dorsal line. Dimorphic: microconchs usually become adult while still in the coiled stage; macroconchs are 2–4 times larger and gently curved or straight up to the flared adult mouth border. *Middle Jurassic (upper Bathonian,* Retrocostatum *[=*Orbis*] Zone–middle Callovian,* Jason *Zone):* Germany, France, England, Spain, Italy, Poland, Hungary, Romania, Russia (Kostroma Oblast), India (Kutch, northern Gujarat), ?Algeria, Madagascar, Mexico, Argentina, Chile.——Fig. 66,*1a–b.* **P. calloviense* (Morris), lectotype (designated by Buckman, 1924, p. 33; see also Buckman, 1925a, p. 80, corrigenda for p. 33), Kellaways, Chippenham, Wiltshire, England, ×1 (Buckman, 1925a, pl. 537,*1–2;* originally figured by Morris, 1845, pl. 6,*3a*).——Fig. 66,*1c. P. distans* (Baugier & Sauzé), Cocklebury Hill, Chippenham, Wiltshire, England, ×1.5 (Buckman, 1925a, pl. 538B).——Fig. 66,*1d. P. tuberculatum* (Baugier & Sauzé), suture at 5.5 mm whorl height, Gammelshausen, Württemberg, Germany (Dietl, 1978, p. 58, fig. 13d).——Fig. 66,*1e–f. P. biserratum* Ochoterena, holotype, 3 km southwest of Huamuxtitlán, Guerrero, Mexico; *e,* ×2; *f,* inner whorls ×4 (Ochoterena, 1966, pl. 1,*1a–b*).——Fig. 66,*1g–h.* Reconstructions of complete adults; *g,* macroconch of *P. tuberculatum* (Baugier & Sauzé); *h,* microconch of *P. distans* (Baugier & Sauzé); ×0.33 (Dietl, 1978, p. 26, fig. 7*f–g*).

Paracuariceras Schindewolf, 1963, p. 127 [**P. incisum;* OD] [=*Lytospiroceras* Patrulius, 1996, p. 16 (type, *Paracuariceras (Lytospiroceras) perconstrictum,* OD)]. Small, up to 100 mm maximum length; slightly curved after the protoconch, then quickly becomes straight, with circular to oval cross section, and may end in a gently curved hook and flared aperture; low, rounded, straight ribs angled forwards from dorsum to venter and are replaced by constrictions in some forms; ribs become weak on dorsum and venter; no tubercles; suture more reduced than in *Parapatoceras.* Probably dimorphic, but poorly known. Dietl, 1981. *Middle Jurassic (lower Callovian,* Herveyi *Zone–middle Callovian,* Jason *Zone):* Germany, France, Romania.——Fig. 66,*2a.* **P. incisum,* holotype, Gammelshausen, Württemberg, Germany, ×2 (Dietl, 1978, pl. 9,*6*).——Fig. 66,*2b–c. P. giganteum* Dietl; *b,* complete adult macroconch, Klingenbachtal, Swabia, Germany, ×0.33 (Dietl, 1981, p. 6, fig. 2a); *c,* suture at 4.7 mm whorl height, Bisingen, Baden-Württemberg, Germany, ×2 (Dietl, 1981, p. 5, fig. 1a).

Acuariceras Spath, 1933, p. 681 [**Baculites acuarius* Quenstedt, 1848 in 1845–1849, p. 295] [=*Leioceras* Hörnes, 1884, p. 325, non *Leioceras* Hyatt, 1867, p. 101, obj.]. Known mainly from straight fragments, perhaps reaching 100–150 mm when complete; apical end slightly curved; rounded cross section; adult mouth border probably flared or collared; smooth or with low, broad, undulating ribs and occasional constrictions angled forwards on side of shell, weakening or smooth on venter and dorsum; suture much reduced. *Middle Jurassic (middle Callovian,* Jason *Zone):* Germany, Romania.——Fig. 66,*3a–b.* **A. acuarius* (Quenstedt), Gammelshausen, Württemberg, Germany; *a,* neotype (designated by Dietl, 1978, p. 49), ×2 (Dietl, 1978, pl. 9,*8*); *b,* suture at 2 mm whorl height (Schindewolf, 1963, p. 124, fig. 1b).

The following are excluded from the Spiroceratoidea:

Ancyloceras ischeri Favre, 1876, p. 60, from the upper Oxfordian of the Swiss Alps. A tectonically deformed perisphinctoid.

Ancyloceras mosellense Terquem, 1857, p. 160, from the Toarcian of France. Not an ammonite.

Arcuceratidae Arkell, 1950, p. 359, proposed for *Arcuceras* Potonié, 1929, p. 226, as the only genus, based on a single specimen that was subsequently identified as possibly the stem or

arm of a crinoid (Donovan & Hölder, 1958, p. 218).

Helicoceras alpinum Thalmann, 1924, p. xxiii, from the Aalenian of the Swiss Alps. Probably a *Tmetoceras.*

REFERENCES

Alekseev S. N., & Yu. S. Repin. 1989. Problemy zonal'nogo raschleneniya nizhnego kelloveya russkoy platformy [Problems of zonal subdivision of Lower Callovian of the Russian Platform]. *In* Ministerstvo Geologii SSSR, Metodicheskiye aspekty stratigraficheskikh issledovaniy v neftegazonosnykh basseynakh (Sbornik nauchnykh trudov) [USSR Ministry of Geology, Methodical Aspects of Stratigraphical Investigations in Oil and Gas Basins (collection of scientific papers)]. Vsesoyuznym Ordena Trudovogo Krasnogo Znameni Neftyanoy Nauchno-Issledovatel'skiy Geologorazvedochnyy Institut (VNIGRI). Leningrad. p. 122–134. In Russian.

Arkell, W. J. 1933. The Jurassic System in Great Britain. Clarendon Press. Oxford. xii + 681 p., 41 pl.

Arkell, W. J. 1935–1948. A monograph of the ammonites of the English Corallian Beds, parts 1–14. Monograph of the Palaeontographical Society, London. (v) + lxxxiv + 420 p.

Arkell, W. J. 1937. Report on ammonites collected at Long Stanton, Cambridgeshire, and on the age of the Ampthill Clay. Summary of Progress of the Geological Survey for 1935 (part 2):64–68.

Arkell, W. J. 1939. The ammonite succession at the Woodham Brick Company's pit, Akeman Street Station, Buckinghamshire, and its bearing on the classification of the Oxford Clay. Quarterly Journal of the Geological Society of London 95:135–222, pl. 8–11.

Arkell, W. J. 1941. A monograph of the ammonites of the English Corallian Beds, part 7. Monograph of the Palaeontographical Society, London. p. lxxiii–lxxx, 217–238, pl. 48–51.

Arkell, W. J. 1942. A monograph of the ammonites of the English Corallian Beds, part 8. Monograph of the Palaeontographical Society, London. p. 239–254, pl. 52–55.

Arkell, W. J. 1943. A Monograph of the Ammonites of the English Corallian Beds, part 9. Monograph of the Palaeontographical Society, London. p. lxxxi–lxxxiv, 255–268, pl. 56–60.

Arkell, W. J. 1946. A Monograph of the Ammonites of the English Corallian Beds, part 11. Monograph of the Palaeontographical Society, London. p. 297–332, pl. 67–70.

Arkell, W. J. 1948. A Monograph of the Ammonites of the English Corallian Beds, part 14. Monograph of the Palaeontographical Society, London. p. (i)–(v), 379–420.

Arkell, W. J. 1950. A classification of the Jurassic ammonites. Journal of Paleontology 24:354–364, 1 fig.

Arkell, W. J. 1951. Proposed addition to the "Official List of Generic Names in Zoology" of the names of twenty-one genera of Jurassic ammonites (Class Cephalopoda, Order Ammonoidea) and matters incidental thereto. Bulletin of Zoological Nomenclature 2:224–233.

Arkell, W. J. 1952a. Jurassic ammonites from Jebel Tuwaiq, central Arabia. Philosophical Transactions of the Royal Society of London (B) 236:241–313, pl. 15–31.

Arkell, W. J. 1952b. Monograph of English Bathonian Ammonites, part 3. Monograph of the Palaeontographical Society, London. p. 73–102, pl. 9–11.

Arkell, W. J. 1954. Monograph of English Bathonian Ammonites, part 4. Monograph of the Palaeontographical Society, London. p. 103–128, pl. 12–15.

Arkell, W. J. 1956. Jurassic Geology of the World. Oliver & Boyd. Edinburgh & London. xv + 806 p., 46 pl.

Arkell, W. J. 1957. *In* R. C. Moore, ed., Treatise on Invertebrate Paleontology. Part L, Mollusca 4, Cephalopoda, Ammonoidea. The Geological Society of America & University of Kansas Press. New York & Lawrence, Kansas. xxii + 490 p., 558 fig.

Arkell, W. J., & P. E. Playford. 1954. The Bajocian ammonites of Western Australia. Philosophical Transactions of the Royal Society of London (B) 237(651):547–605, pl. 27–40.

Basse, Éliane. 1952. Cephalopodes, Nautiloidea, Ammonoidea. *In* Jean Piveteau, ed., Traité de Paléontologie, vol. 2. Masson. Paris. p. 522–688, 60 fig., 24 pl.

Basse, Éliane, & Monique Perrodon. 1952. Macrocéphalitidés du sud-ouest de Madagascar. Mémoires de la Société géologique de France (new series) 65:1–100, pl. 1–7 (7–13).

Baugier, A., & J. C. Sauzé. 1843. Notice sur quelques coquilles de la famille des Ammonidées: Recueillies dans le terrain Jurassique des Deux-Sèvres. Mémoire lu à la Société de Statistique. Imprimerie de Robin et C^ie^. Niort. 16 p., 4 pl.

Bayle, Emile. 1878. Fossiles Principaux des Terraines. Service de la Carte Géologique Détaillée. Explication de la Carte Geologique de la France 4, part 1 (atlas). Imprimerie Nationale. Paris. 158 pl.

Bentz, A. 1924. Die Garantienschichten von Norddeutschland mit besonderer Berücksichtigung des Braunienisen-Oolithhorizontes von Harzburg. Jahrbuch der Preussischen Geologischen Landesanstalt 45:119–193, pl. 4–9.

Bentz, A. 1928. Über Strenoceraten und Garantianen insbesondere aus dem mittleren Dogger von Bielefeld. Jahrbuch der Preussischen Geologischen Landesanstalt 49:138–206, pl. 14–19.

Beznosov, N. V., & V. V. Kutuzova. 1990. Systematics of the Middle Jurassic heteromorphic ammonites. Paleontological Journal 24(4):19–26, 1 pl. Also published in Paleontologicheskii Zhurnal 1990 (4):23–30, pl. 1.

Beznosov, N. V., & V. V. Mitta. 2000. Geologiya i Ammonity Yurskikh otlozheniy bol'shogo Balkhana (zapadnyy Turkmenistan) [Jurassic geology and ammonites of Great Balkhan (western Turkmenistan)]. Byulleten' Kollektsionnogo Fonda Vserossiyskiy Nauchno-Issledovatel'skiy Geologicheskiy Neftyanoy Institut (VNIGNI) 2000 (5):115 p., 30 pl. In Russian.

Bhaumik, Debasish, Kalyanbrata Datta, S. K. Jana, & Subhendu Bardhan. 1993. Taxonomy and intraspecific

variation of *Macrocephalites formosus* (Sowerby) from the Jurassic Chari Formation, Kutch, western India. Journal of the Geological Society of India 42:163–179, 2 pl.

Bigot, A. 1905. Catalogue critique de la collection Defrance conservé au Musée d'histoire naturelle de Caen. 2: Céphalopodes, arthopodes et vers. Bulletin de la Société Linnéenne de Normandie (5)8:251–273.

Birkenmajer, Krzysztof, & Andrzej Wierzbowski. 1991. New Kimmeridgian ammonite fauna from east Spitsbergen and its phyletic significance. Polar Research 9(2):169–179, 10 fig.

Blake, J. F. 1905. A monograph of the fauna of the Cornbrash. Part 1. Monograph of the Palaeontographical Society, London. 100 p., 9 pl.

Blake, J. F., & W. H. Hudleston. 1877. On the Corallian rocks of England. Quarterly Journal of the Geological Society 33:260–405, pl. 12–17.

Blanford, W. T. 1903. Note on the supposed locality "Sulgranees," whence Dr. J. E. Gray's type-specimens of Indian Jurassic ammonites were said to have been obtained. Journal of Molluscan Studies 1903:345.

Boden, Karl. 1911. Die Fauna des unteren Oxford von Popilany in Litauen. Geologische und Palaeontologische Abhandlungen (Neue Folge) 10(2):125–200, pl. 1(20)–8(27).

Bodylevsky, V. I. 1960. Kelloveyskie ammonity Severnoy [Callovian ammonites from northern Siberia]. Zapiski Leningradskogo Ordenov Lenina i Trudovogo Krasnogo Znameni Gornogo Instituta 37(2):49–82, 10 pl. In Russian.

Boehm, G. 1912. Beiträge zur Geologie von Niederländisch-Indien. 1. Die Südküsten der Sula-Inseln Taliabu und Mangoli. Part 4. Unteres Callovien. Palaeontographica, Supplement 4(4):121–179, pl. 32–44.

Brandt, J. F. 1835. Prodromus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione observatorum. Fascicle I. *Polypos, Acalephas Discophoras* et *Siphonophoras,* nec non Echinodermata continens. Academie Imperiale des Sciences. St. Petersburg. 75 p., 1 pl.

Brinkmann, Roland. 1929a. Statistischbiostratigraphische Untersuchungen an mitteljurassischen Ammoniten über Artbegriff Stammesentwicklung. Abhandlungen der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse (Neue Folge) 13(3):249 p., 5 pl.

Brinkmann, Roland. 1929b. Monographie der Gattung *Kosmoceras.* Abhandlungen der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse (Neue Folge) 13(4):vii + 123 p., 1 pl.

Brown, Thomas. 1837–1849. Illustrations of the Fossil Conchology of Great Britain and Ireland, with Descriptions and Localities of all the Species. Smith, Elder. London. viii + 275 p., 98 pl.

Bruguière, J. G. 1789–1792. Histoire Naturelle des Vers. Part of Encyclopédie Méthodique. Panckoucke. Paris. i–xviii, 1–344 (1789); p. 345–757 (1792).

Buch, Leopold von. 1831. Récueil de Planches de Pétrifactions Remarquables. Imprimerie de l'Académie Royale. Berlin. 20 p., 8 pl.

Buckman, James. 1881. On the termination of some Ammonites from the Inferior Oolite of Dorset and Somerset. Quarterly Journal of the Geological Society of London 37:57–66.

Buckman, S. S. 1882. Some new species of *Ammonites* from the Inferior Oolite. Proceedings of the Dorset Natural History and Antiquarium Field Club 4:137–146, 4 pl.

Buckman, S. S. 1887. A monograph of the Inferior Oolite ammonites of the British Islands, part 1. Monograph of the Palaeontographical Society, London. p. 1–24, pl. 1–6.

Buckman, S. S. 1898. On the grouping of some divisions of so-called 'Jurassic' time. Quarterly Journal of the Geological Society of London 54:442–462.

Buckman, S. S. 1908a. Illustrations of type specimens of Inferior Oolite ammonites in the Sowerby collection. Monograph of the Palaeontographical Society, London. 7 pl.

Buckman, S. S. 1908b. The genera of *Stephanoceras* and allies. Annals and Magazine of Natural History (series 8) 2:145–149.

Buckman, S. S. 1909–1930. Yorkshire Type Ammonites, vol. 1–2, and Type Ammonites, vol. 3–7. Wheldon & Wesley. London. 790 pl.

Buckman, S. S. 1918. Yorkshire Type Ammonites, vol. 2, parts 15–17. Wheldon & Wesley. London. p. xi–xiv, pl. 109–119, 124–129.

Buckman, S. S. 1919a. Yorkshire Type Ammonites, vol. 2, part 18. Wheldon & Wesley. London. p. *xv–xvi,* A–H, pl. 120–123, 130.

Buckman, S. S. 1919b. Type Ammonites, vol. 3, parts 19–20. Wheldon & Wesley. London. p. 5–8, pl. 131–147.

Buckman, S. S. 1920. Type Ammonites, vol. 3, parts 21–24. Wheldon & Wesley. London. p. 9–30, pl. 132B, 139B–E, 148–194.

Buckman, S. S. 1921. Type Ammonites, vol. 3, parts 25–30. Wheldon & Wesley. London. p. 1–4, 31–64, pl. 133B, 134C–D, 195–266.

Buckman, S. S. 1922. Type Ammonites, vol. 4, parts 31–37. Wheldon & Wesley. London. p. 5–28, pl. 267–362.

Buckman, S. S. 1923a. Type Ammonites, vol. 4, parts 38–41. Wheldon & Wesley. London. p. 1–4, 29–68, pl. 23A, 131A, 267B, 337A, 338A, 355B, 356, 363–422.

Buckman, S. S. 1923b. Type Ammonites, vol. 5, parts 42–43. Wheldon & Wesley. London. pl. 423–457.

Buckman, S. S. 1924. Type Ammonites, vol. 5, parts 44–49. Wheldon & Wesley. London. p. 5–48, pl. 64, 99, 126, 199, 342, 396, 440, 458–536.

Buckman, S. S. 1925a. Type Ammonites, vol. 5, parts 50–52A. Wheldon & Wesley. London. p. 1–4, 49–88, pl. 154, 179, 259, 307, 440, 486, 511, 513, 531, 537–576.

Buckman, S. S. 1925b. Type Ammonites, vol. 6, parts 53–55. Wheldon & Wesley. London. pl. 528, 577–621.

Buckman, S. S. 1926. Type Ammonites, vol. 6, parts 56–61. Wheldon & Wesley. London. p. 5–42, pl. 138, 353, 354, 412, 482, 520, 537, 562, 580, 590, 602, 622–693.

Buckman, S. S. 1927a. Type Ammonites, vol. 6, parts 62–63A. Wheldon & Wesley. London. p. 1–4, 43–62, pl. 68, 135, 157, 502, 506, 639, 694–717.

Buckman, S. S. 1927b. Type Ammonites, vol. 7, parts 64–67. Wheldon & Wesley. London. p. 5–10, pl. 31, 89, 446, 506, 518, 620, 638, 718–760.

Buckman, S. S. 1928. Type Ammonites, vol. 7, parts 68–70. Wheldon & Wesley. London. p. 11–14, pl. 652, 718, 761–790.

Buckman, S. S. 1929. Mesozoic Palaeontology of Blairmore Region, Alberta; Jurassic Ammonoidea. Bulletin of the Department of Mines, Ottawa, Canada 58 (Geological series, number 50):1–26, 109–113, pl. 1–3.

Burckhardt, C. 1903. Beiträge zur Kenntniss der Jura- und der Kreide-Formation der Cordillere; part 1. Palaeontographica 50:1–72, pl. 1–10.

Burckhardt, C. 1927. Cefalopodos del jurasico medio de Oaxaca y Guerrero. Boletin Instituto Geológico de México 47:108 p., 34 pl.

Callomon, J. H. 1955. The ammonite succession in the Lower Oxford Clay and Kellaways Beds at Kidlington, Oxfordshire, and the zones of the Callovian Stage. Philosophical Transactions of the Royal Society (B) 239:215–264, pl. 3–4.

Callomon, J. H. 1959. The ammonite zones of the Middle Jurassic beds of East Greenland. Geological Magazine 96:505–513, pl. 17–18.

Callomon, J. H. 1971. On the type species of *Macrocephalites* Zittel, 1884, and the type specimen of *Ammonites macrocephalus* Schlotheim, 1813. Palaeontology 14:114–130, pl. 15–18.

Callomon, J. H. 1981. *In* D. T. Donovan, J. H. Callomon, & M. K. Howarth. 1981. Classification of the Jurassic Ammonitina. Systematics Association, London, Special Volume 18. Academic Press. London. p. 101–155.

Callomon, J. H. 1984. A review of the biostratigraphy of the post-Lower Bajocian ammonites of western and northern North America. Geological Association of Canada, Special Paper 27:143–174.

Callomon, J. H. 1985. The evolution of the Jurassic ammonite family Cardioceratidae. Special Papers in Palaeontology 33:49–77.

Callomon, J. H. 1993. The ammonite succession in the Middle Jurassic of East Greenland. Bulletin of the Geological Society of Denmark 40:83–113, 3 pl.

Callomon, J. H. 2003. The Middle Jurassic of western and northern Europe: Its subdivisions, geochronology and correlations. Bulletin of the Geological Survey of Denmark and Greenland 1:61–73.

Callomon, J. H., & Tove Birkelund. 1985. Appendix: Description of three new species. *In* J. H. Callomon, The Evolution of the Jurassic ammonite family Cardioceratidae. Special Papers in Palaeontology 33:78–86, 4 pl.

Callomon, J. H., Gerd Dietl, & H.-J. Niederhöfer. 1992. On the true stratigraphic position of *Macrocephalites macrocephalus* (Schlotheim, 1813) and the nomenclature of the standard Middle Jurassic "*Macrocephalites* Zone." Stuttgarter Beiträge zur Naturkunde (B) 185:65 p., 10 pl.

Callomon, J. H., & J. K. Wright. 1989. Cardioceratid and Kosmoceratid ammonites from the Callovian of Yorkshire. Palaeontology 32:799–836, pl. 88–96.

Chandler, R. B., & Volker Dietze. 2004. New data on the Lower Bajocian (Middle Jurassic) ammonite genus *Mollistephanus* Buckman, 1922, from southern England. Proceedings of the Geologists Association 115:221–234, 6 fig.

Chandler, R. B., & Volker Dietze. 2008. *Parsemileites* n. gen., a new genus of the ammonite family Otoitidae Mascke from the Lower Bajocian (Middle Jurassic) of southern England and new information on the Otoitidae from southern England. Palaeodiversity 1:167–179, 1 pl.

Chandler, R. B., John Whicher, Wolfgang Grulke, & Andy Cowap. 2013. The Middle Jurassic stephanoceratid ammonite *Kumatostephanus* from Dorset and Somerset, UK, and its evolution. Geobios 46:285–297, 10 fig.

Cope, J. C. W., K. L. Duff, C. F. Parsons, H. S. Torrens, W. A. Wimbledon, & J. K. Wright. 1980. A correlation of Jurassic rocks in the British Isles. Part two: Middle and Upper Jurassic. Geological Society of London, Special Report 15:109 p.

Corroy, G. 1932. Le Callovien de la bordure orientale du Bassin de Paris. Mémoires pour servir à l'explication de la Carte géologique détaillée de la France. Imprimerie Nationale. Paris. 337 p., 29 pl.

Cossmann, M. 1924. Paléoconchologie: Revue of Buckman. Revue Critique de Paléozoologie et de Paléophytologie 28:34.

Crick, G. C. 1894. On a collection of Jurassic Cephalopoda from Western Australia, obtained by Harry Page Woodward, F. G. S., Government Geologist, with descriptions of the species. Geological Magazine, London (4)1:385–392, 433–441, pl. 12–13.

Crickmay, C. H. 1930. Fossils from Harrison Lake area, British Columbia. Bulletin of the Department of Mines, Ottawa, Canada 63 (Geological Series 51):33–113, pl. 8–23.

Dietl, Gerhardt. 1978. Die heteromorphen Ammoniten des Dogger. Stuttgarter Beiträge zur Naturkunde (B) 33:97 p., 11 pl.

Dietl, Gerhardt. 1981. Über *Paracuariceras* und andere heteromorphe Ammoniten aus dem Macrocephalen-Oolith (Unter-Callovium, Dogger) des Schwäbischen Juras. Stuttgarter Beiträge zur Naturkunde (B) 76:16 p., 2 pl.

Dietze, Volker, & R. B. Chandler. 2008. *Parsemileites* n. gen., a new genus of the ammonite family Otoitidae Mascke from the Lower Bajocian (Middle Jurassic) of southern England with new information on the Otoitidae from southern England. Palaeodiversity 1:167–179, 5 fig., 1 pl.

Dietze, Volker, R. B. Chandler, Günter Schweigert, & Wolfgang Auer. 2001. New Stephanoceratids (Ammonitina) from the Lower Bajocian of Bruton (Somerset, S. England) and Achdorf (Wutach area, SW Germany). Stuttgarter Beiträge zur Naturkunde (B) 312:21 p., 9 fig.

Donovan, D. T., & Helmut Hölder. 1958. On the existence of heteromorph ammonites in the Lias.

Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1958:217–220, 1 fig.

Douvillé, Henri. 1879. Présentation de l'Atlas du IVe volume de l'explication de la Carte géologique de la France, par M. Bayle. Bulletin de la Société Géologique de France (series 3) 7:91–92.

Douvillé, Henri. 1916. Les terrains secondaires dans le massif du Moghara à l'est de l'isthme de Suez, d'après les explorations de M. Couyat-Barthoux. Paléontologie. Mémoires de l'Académie des Sciences, Paris (series 2) 54:184 p., 21 pl.

Douvillé, Robert. 1909. *Ammonites deslongchampsi, Ammonites bajocensis.* Palaeontologia Universalis. Centuria 2. Congres Géologique International. Laval. pl. 132–133.

Douvillé, Robert. 1911. Étude sur les Ammonites du Jurassique supérieur. Part 1: Cardiocératidés de Dives, Villers-sur-Mer et quelques autres gisements. Compte Rendu Sommaire des Séances de la Société Géologique de France 1911 (12, 13):130–134.

Douvillé, Robert. 1912. Études sur les Cardiocératidés de Dives, Villers-sur-Mer et quelques autres gisements. Mémoires de la Société Géologique de France, Paléontologie 45:1–77, pl. 1(VII)–5(XI).

Douvillé, Robert. 1915. Étude sur les Cosmocératidés des Collections de l'Ecole Nationale Supérieure des Mines. Mémoires pour Servir à l'Explication de la Carte Géologique Détailée de la France. Imprimerie Nationale. Paris. 75 p., 24 pl.

Efimova, A. F., V. P. Kinasov, K. V. Paraketsov, I. V. Polubotko, S. Repin, & A. S Dagys. 1968. Polevoy Atlas Yurskoy Fauny i Flory Severo-vostoka SSSR [Field Atlas of the Jurassic Fauna and Flora of North-eastern USSR]. Severo-vostochnoye Ordena Trudovogo Krasnogo Znameni, Geologicheskoye Upravleniye. Magadan Book Publishers. 383 p., 114 pl.

Eichwald, Carl Eduard von. 1830. Zoologia specialis quam expositis animalibus tum vivis, tum fossilibus potissimum Rossiae in universum, et Poloniae in specie, in usum lectionum publicarum in Universitate caesarea Vilnensi habendarum. Part II; Specialis podozoorum expositio: Josephi Zawadzki, Vilnæ. 323 p., 2 pl. Author also published under the name Eduard d' Eichwald.

Eichwald, Edouard d'. 1865–1868. Lethaea Rossica, ou Paléontologie de la Russie. Vol. 2, Période Moyenne. Schweizerbart. Stuttgart. 1304 p., 40 pl. Author also published under the name Carl Eduard von Eichwald.

Énay, Raymond. 2009. Les Faunes d'Ammonites de l'Oxfordien au Tithonien et la Biostratigraphie des Spiti-Shales (Callovien supérieure–Tithonien) de Thakkhola, Népal Central. Documents des Laboratoires de Géologie de Lyon 166:351 p., 52 pl.

Énay, Raymond, & Charles Mangold. 1996. Dimorphism dans le genre *Ermoceras* Douvillé, 1916 (Stephanoceratidae, Bajocien supérieur) et implication nomenclaturale. Comptes Rendus des Séances de l'Académie des Sciences, Paris (series 2) 322:791–798.

Favre, E. 1876. Description des fossiles du terrain oxfordien des Alpes fribourgeoises. Abhandlungen der Schweizerischen Paläontologischen Gesellschaft 3:75 p., 7 pl.

Fernandez-Lopez, S. R. 1985. El Bajociense en la Cordillera Iberica. I. Taxonomia y sistematica (Ammonoidea); II. Bioestratigrafia; III. Atlas. Master of Science Thesis, Departamento de Paleontologia, Universidad Complutense de Madrid. 940 p.

Fischer, J.-C. 1994. Révision critique de la Paléontologie Française d'Alcide d'Orbigny, vol. 1. Céphalopodes Jurassiques. Paris. xii + 340 p., 90 pl.

Fischer, P. H. 1882. Manuel de Conchyliologie et de Paléontologie Conchyliologique. Librairie F. Savy. Paris. 1369 p., 23 pl.

Frebold, Hans. 1958. Fauna, age and correlation of the Jurassic rocks of Prince Patrick Island. Bulletin of the Geological Survey of Canada 41:69 p., 18 pl.

Frebold, Hans. 1963. Ammonite faunas of the upper Middle Jurassic beds of the Fernie Group in Western Canada. Bulletin of the Geological Survey of Canada 93:33 p., 14 pl.

Frebold, Hans. 1964. The Jurassic faunas of the Canadian Arctic: Cadoceratinae. Bulletin of the Geological Survey of Canada 119:viii + 27 p., 20 pl.

Frebold, Hans, & H. W. Tipper. 1970. Status of the Jurassic in the Canadian Cordillera of British Columbia. Canadian Journal of Earth Sciences 7(1):1–21.

Galácz, András. 1990. Taxonomy, dimorphism and phylogenetic significance of the Bajocian (Middle Jurassic) ammonite *Labyrinthoceras. In* Giovanni Pallini, ed., Atti del Secondo Convegno Internazionale Fossili, Evoluzione, Ambiente, Pergola 1987:341–348, 5 fig.

Galácz, András. 1994. *Lokuticeras* nov. gen.: A new genus for a Mediterranean Bajocian (Middle Jurassic) stephanoceratid ammonite group. *In* Stefano Cresta & Giulio Pavia, eds., Proceedings 3rd International Meeting on Aalenian and Bajocian Stratigraphy. Miscellanea del Servizio Geologico National 5:161–175, 3 pl.

Gauthier, Henri. 2003. Mise au point et compléments sur la biostratigraphie et la taxonomie de la sous-famille des Garantianinae (Stephanoceratidae, Ammonoidea). Revue de Paléobiologie 22:261–267.

Gauthier, Henri, Patrick Branger, P.-Y. Boursicot, Marcel Trévisan, & Didier Marchand. 2002. La faune *d'Orthogarantiana* Bentz (Garantianinae, Stephanoceratidae, Ammonitina) de la sous-zone à Polygyralis (zone à Niortense, Bajocien supérieur) nouvellement découverte au nord de Niort (Deux-Sèvres, France). Une preuve du dimorphisme *Orthogarantiana/Strenoceras.* Géologie de la France 2002 (1):81–86, 2 pl.

Gauthier, Henri, M. Rioult, & Marcel Trévisan. 1996. Répartition biostratigraphique des ammonites dans l'Oolithe ferrugineuse de Bayeux (Bajocien) à Feuguerolles-sur-Orne (Calvados): Eléments nouveaux pour une révision des Garantianinae. Géologie de la France 1996 (2):27–67, 14 pl.

Gauthier, Henri, Marcel Trévisan, & J.-L. Joron. 2000. L'espèce *Odontolkites longidens* (Quenstedt) in Buckman (=*longidens* n. sp.) et le genre *Odontolkites* Buckman (Garantianinae, Stephanoceratidae,

Stephanoceataceae, Ammonoidea). Géologie de la France 2000 (2):17–29, 3 pl.

Gemmellaro, G. G. 1877. Sopra alcuni fossili della zona con *Posidonomya alpina* Gras di Sicilia. Giornale di Scienze Naturali ed Economiche di Palermo 12:51–81, pl. 3–4, 4bis. Also published in 1882: Sopra alcuni faune Giuresi e Liasiche della Sicilia: Studi paleontologici, p. 125–155, pl. 18–20.

Gerasimov P. A., V. V. Mitta, M. D. Kochanova, & E. M. Tesakova. 1996. Iskopayemyye Kelloveyskogo Yarusa Tsentral'noy Rossii [The Callovian Fossils of Central Russia]. Vserossiyskiy Nauchno-Issledovatel'skiy Geologicheskiy Neftyanoy Institut (VNIGNI); Moskovskaya Gorodskaya Stantsiya Yunykh Naturalistov (MosGorSYUN); Otdel Paleontologii. Moscow. 127 p., 57 pl. In Russian.

Gottsche, Carl. 1878. Über Jurassische Versteinerungen aus dere Argentinischen Cordillere.Palaeontographica Supplement 3(2):1–50, 8 pl.

Gray, John E. 1830–1835. Illustrations of Indian Zoology: Chiefly Selected from the collection of Major-General Hardwicke. 2 vol. Treuttel, Wurtz, & Richter. London. 202 pl.

Grossouvre, A. de. 1930. Notes sur le Bathonien moyen. Livre Jubilaire 1830–1930, Centenaire de la Société Géologique de France 2:361–388, pl. 39–40.

Gygi, R. A., & Didier Marchand. 1982. Les faunes de Cardioceratinae (Ammonoidea) du Callovien Terminal et de l'Oxfordien inférieure et moyen (Jurassique) de la Suisse Septentrionale. Stratigraphie, Paléoécologie, Taxonomie préliminaire. Geobios 15:517–571, 13 pl.

Hagn, Herbert. 1977. Saligrame–Gerölle von Malm-Kalken mit Ammoniten als Kultgenenstände Indiens. Mitteilingen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie 17:71–102, pl. 7–8.

Hall, R. L., & G. E. G. Westermann. 1980. Lower Bajocian (Jurassic) cephalopod faunas from western Canada and proposed assemblage zones for the Lower Bajocian of North America. Palaeontographica Americana 9(52):93 p., 16 pl.

Haug, Emil. 1887. Über die "Polymorphitidae," eine neue Ammonitenfamilie aus dem Lias. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Stuttgart 1887(2):89–163, pl. 4–5.

Healey, M. 1905. *Ammonites excavatus, Ammonites cordatus.* Palaeontologia Universalis, Centuria 1. Congres Géologique International. Laval. pl. 92, 94.

Higgins, A. K. 2010. Exploration history and place names of northern East Greenland. Geological Survey of Denmark and Greenland Bulletin 21:368 p., 90 fig., 5 maps.

Hillebrandt, Axel von. 1977. Ammoniten aus dem Bajocien (Jura) von Chile (Südamerika): Neue Arten der Gattung *Stephanoceras* und *Domkeyoceras* n. gen. (Stephanoceratidae). Mitteilingen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie 17:35–69, pl. 2–6.

Hillebrandt, Axel von, & Manfred Gröschke. 1995. Ammoniten aus dem Callovium/Oxfordium Grenzbereich von Nordchile. Berliner Geowissenschaftliche Abhandlungen A169: 40 p., 6 pl.

Hiltermann, Heinrich. 1939. Stratigraphie und Palaeontologie der Sonnnienshichten von Osnabrück und Bielefeld. Palaeontographica 90A:109–209, 7 pl.

Hörnes, Rudolf. 1884. Elemente der Palaeontologie (Palaeozoologie). 3 vol. Veit & Co. Leipzig. xvi + 594 p., 672 fig.

Howarth, M. K. 1962. The Yorkshire type ammonites and nautiloids of Young and Bird, Phillips and Martin Simpson. Palaeontology 5:93–136, pl. 13–19.

Howarth, M. K., & R. V. Melville. 1984. Interpretation of the Middle Jurassic ammonite genus *Spiroceras.* Geological Magazine 121(2):131–132.

Hyatt, Alpheus. 1867. The fossil Cephalopoda of the Museum of Comparative Zoology. Bulletin of the Museum of Comparative Zoology 5:71–102.

Hyatt, Alpheus. 1877. Genetic relations of *Stephanoceras.* Proceedings of the Boston Natural History Society 18:360–400.

Hyatt, Alpheus. 1900. Cephalopoda. *In* Karl A. von Zittel, Text-book of Palaeontology, 1st English edition, translated & edited by C. E. Eastman. MacMillan & Co. London. p. 502–604, fig. 1049–1259.

ICZN (International Commission on Zoological Nomenclature). 1954a. Opinion 235. Designation, under the Plenary Powers, of a lectotype for the nominal species *Ammonites cordatus* Sowerby (J.), 1813 (Class Cephalopoda, Order Ammonoidea). *In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 4(25):313–328, 1 pl.

ICZN (International Commission on Zoological Nomenclature). 1954b. Opinion 300. Validation, under the Plenary Powers, of the generic name *Sphaeroceras* Bayle, 1878 (Class Cephalopoda, Order Ammonoidea). *In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 8(17):237–248.

ICZN (International Commission on Zoological Nomenclature). 1954c. Opinion 303. Designation, under the Plenary Powers, of type species in harmony with current usage for the nominal genera *Kosmoceras, Perisphinctes* and *Harpoceras* (Class Cephalopoda, Order Ammonoidea) established by Waagen in 1869. *In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 8(20):273–284.

ICZN (International Commission on Zoological Nomenclature). 1954d. Opinion 309. Designation, under the Plenary Powers, of a type species in harmony with current usage for "*Normannites*" Munier-Chalmas (Class Cephalopoda, Order Ammonoidea) a genus based upon a misidentified type species. *In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 8(26):347–354.

ICZN (International Commission on Zoological Nomenclature). 1955a. Opinion 324. Addition to the *Official List of Generic Names in Zoology* of the names of twenty-one nominal genera of Ammonites (Class Cephalopoda, Order Ammonoidea) and matters incidental thereto. *In* Francis Hemming, ed., Opinions and Declarations Rendered by The

International Commission on Zoological Nomenclature 9(15):227–250.

ICZN (International Commission on Zoological Nomenclature). 1955b. Direction 14. Addition to the *Official List of Family-Group Names in Zoology* or, as the case may be, to the *Official Index of Rejected and Invalid Family-group names in Zoology* of the family group names involved in the applications relating to the names of ammonites published in volume 2 of the *Bulletin of Zoological Nomenclature. In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 10(18):463–480.

ICZN (International Commission on Zoological Nomenclature). 1957. Opinion 471. Validation under the Plenary Powers of the family-group name Mayaitidae Spath (L. F.), 1928 (Class Cephalopoda, Order Ammonoidea). *In* Francis Hemming, ed., Opinions and Declarations Rendered by The International Commission on Zoological Nomenclature 16:203–212.

ICZN (International Commission on Zoological Nomenclature). 1984. Opinion 1275. *Macrocephalites* Zittel, 1884, and *Ammonites macrocephalus* Schlotheim, 1813 (Mollusca, Cephalopoda): Placed on the Official Lists. Bulletin of Zoological Nomenclature 41:34–35.

ICZN (International Commission on Zoological Nomenclature). 1999. International Code of Zoological Nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature. London. 306 p.

ICZN (International Commission on Zoological Nomenclature). 2005. Opinion 2123. F. A. Quenstedt's trinominal nomenclature (1845–1888): Usage of the third names of ammonites stabilized and 34 important Quenstedt names placed on the Official List of Specific Names in Zoology (Cephalopoda, Ammonoidea). Bulletin of Zoological Nomenclature 62(3):158–163.

Ilovaïsky, David. 1904. L'Oxfordien et le Séquanien des gouvernements de Moscou et de Riasan. Bulletin de la Société impériale des Naturalistes de Moscou (new series) 17:222–293, pl. 8–12.

Imlay, R. W. 1948. Characteristic marine Jurassic fossils from the Western Interior of the United States. Professional Papers of the United States Geological Survey 214B:13–33, pl. 5–9.

Imlay, R. W. 1953a. Callovian (Jurassic) ammonites from the United States and Alaska. Part 1. Western Interior United States. Professional Papers of the United States Geological Survey 249A:1–39, pl. 1–24.

Imlay, R. W. 1953b. Callovian (Jurassic) ammonites from the United States and Alaska. Part 2. Alaska Peninsula and Cook Inlet regions. Professional Papers of the United States Geological Survey 249B:40–108, pl. 25–55.

Imlay, R. W. 1961. New genera and subgenera of Jurassic (Bajocian) ammonites from Alaska. Journal of Paleontology 35:467–474, pl. 63–64.

Imlay, R. W. 1962. Jurassic (Bathonian or early Callovian) ammonites from Alaska and Montana. Professional Papers of the United States Geological Survey 347C:1–32, 8 pl.

Imlay, R. W. 1964. Middle Bajocian ammonites from the Cook Inlet Region, Alaska. Professional Papers of the United States Geological Survey 418B:61 p., 29 pl.

Imlay, R. W. 1967. Twin Creek Limestone (Jurassic) in the Western Interior of the United States. Professional Papers of the United States Geological Survey 540:105 p., 16 pl.

Imlay, R. W. 1973. Middle Jurassic (Bajocian) ammonites from Eastern Oregon. Professional Papers of the United States Geological Survey 756:100 p., 47 pl.

Imlay, R. W. 1975. Stratigraphical distribution and zonation of Jurassic (Callovian) ammonites in Southern Alaska. Professional Papers of the United States Geological Survey 836:28 p., 6 pl.

Imlay, R. W. 1980. Middle Jurassic (Bathonian) ammonites from Southern Alaska. Professional Papers of the United States Geological Survey 1091:39 p., 12 pl.

Jana, S. K., S. Bardhan, & K. Halder. 2005. Eucycloceratin ammonites from the Callovian Chari Formation, Kutch, India. Palaeontology 48:883–924, 18 fig.

Jaworski, Erich. 1933. Revision der Arieten, Echioceraten und Dactylioceraten des Lias von Niederländisch-Indien. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Stuttgart, Beilage Band 70:251–334, pl. 11.

Jeannet, Alphonse. 1951. Stratigraphie und Paläontologie des oolithischen von Herznach und seiner Umgebung. Beiträge zur Geologie der Schweiz, Geotechnische (serie 13) 5:240 p., 107 pl.

Jeannet, Alphonse. 1955. Die Macrocephaliten des Callovien von Herznach (Aargau). Eclogae Geologicae Helvetiae 47:223–267, pl. 13–27.

Keyserling, A. von. 1846. Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843. Carl Kray. St. Petersburg. 465 p., 22 pl.

Kilian, Wilfred. 1910. *In* F. Frech, Lethea Geognostica. II. Mesozoicum 3(2):169–287, pl. 1–8.

Kilian, Wilfred, & P. Reboul. 1909. Les Céphalopodes Néocrétacés des Îles Seymour et Snow Hill. Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition, 1901–1903, vol. 3 (6):75 p., 20 pl.

Kiparisova, L. D., B. P. Markovski, & G. I. Radchenko, eds., 1956. Materialȳ po paleontologii: Novȳe semeĭstva i rodȳ [Materials on paleontology: new families and genera].Vsesoyuznogo Nauchno-Issledovatelskogo Geologicheskogo Instituta (VSEGEI) (new series) 12:356 p., 43 pl. In Russian.

Kiselev, D. N. 1996. Morphogenesis and systematics of the genus *Pseudocadoceras* (Ammonoidea). Paleontological Journal 30:376–388, 3 pl. Also published Paleontologicheskii Zhurnal 1996 (3):15–27, 3 pl.

Kiselev D. N., D. B. Gulyaev, & M. A. Rogov. 2003. Proiskhozhdeniye i sistematicheskoye polozheniye *Funiferites,* novogo roda Kelloveyskikh kardiotseratid (Ammonoidea) [Origin and systematic position of *Funiferites,* a new genus of the Callovian cardioceratid ammonites]. *In* N. A. Bogdanov, T. I. Vasil'eva, V. E. Verzbitsky, & others, eds., Sovremennyye Voprosy Geologii: Materialy 3-y Lektsii v Pamyati Yanshine, 26–28 Marta 2003 Goda [Modern Questions of Geology: Materials of the 3rd Lectures in Memory of

Yanshine, March 26–28, 2003]. Nauchny. Moscow. p. 220–225., 1 fig. In Russian.
Kopik, Janusz. 1967. The Middle and Upper Jurassic of the Częstochowa-Zawiercie sedimentary basin (the Cracow-Częstochowa Jura). Biuletyn Instytut Geologiczny, Warsaw 211:93–106.
Krenkel, Erich. 1915. Die Kelloway-Fauna von Popilani in Westrussland. Palaeontographica 81:191–362, pl. 19–28.
Krimholz, G. Y. 1939. Materialy po geologii Bureinskogo kamennougol'nogo basseyna. Vypusk IV: Materialy po stratigrafii morskoy yury r. Burey [Materials on the geology of the Bureya coal basin. Part 4: Contribution to the stratigraphy of the Jurassic marine strata on the Bureya River]. Trudy Tsentral'nogo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta (TsNIGRI) 117:60 p., 2 pl. In Russian; TsNIGRI is now VSEGEI.
Krimholz, G. Y. 1958. Superfamily Eoderoceratoceae. *In* Y. A. Orlov, ed., Fundamentals of Paleontology, Vol. 6. Mollusca-Cephalopoda 2. Gosudarstvennoe Nauchno-Tekhnicheskoe Izdatel'stvo Literatury po Geologii i Okhrane Nedr. Moscow. p. 67–69. In Russian.
Krishna, Jai, & G. E. G. Westermann. 1987. Faunal associations of the Middle Jurassic ammonite genus *Macrocephalites* in Kachchh, western India. Canadian Journal of Earth Sciences 24:1570–1582, 6 pl.
Kruizinga, P. 1926. Ammoniten en eenige andere Fossilien uit de jurassische afzettingen der Soela Eilanden. Jaarboek van het Mijnwezen in Nederlandsch-Oost-Indië 54:13–85, pl. 1–14.
Krystyn, Leopold. 1972. Die Oberbajocium und Bathonium Ammoniten der Klaus-Schichten des Steinbruches Neumuhle bei Wien (Osterreich). Annalen des Naturhistorisches Museums in Wien 76:195–310, 23 pl.
Leckenby, J. 1859. On the Kellaway Rock of the Yorkshire Coast. Quarterly Journal of the Geological Society 15:4–15, pl. 1–3.
Lemoine, Paul. 1910–1911. Ammonites du Jurassique supérieur du Cercle d'Analalava (Madagascar). Annales de Paléontologie 5–6(1910–1911):137–168, pl. 16–20, fig. 1–45 (1910); 45–64, pl. 6–8, fig. 46–50 (1911).
Lemoine, Paul, & M. Cossmann. 1919. Céphalopodes. Revue Critique de Paléozoologie 23 (3–4):75–79.
Lisson, C. I. 1908. Contribucion al Conocimiento Sobre Algunos Ammonites del Peru. El Peru. Lima. 26 p.
Lominadze, T. A. 1967. Callovian Macrocephalitidae of Georgia and the northern Caucasus. Meznereba. Tbilisi. 209 p., 22 pl.
Lominadze, T. A., & A. S. Sakharov. 1985. Kosmoceratidae of the Caucasus. Meznereba. Tbilisi. 62 p., 16 pl.
Madsen, Victor. 1904. On Jurassic fossils from East Greenland. Meddelelser om Grønland 29:157–210, pl. 6–10.
Makowski, Henryk. 1952. La faune callovienne de Łuków en Pologne. Palaeontologia Polonica 4:64 p., 9 pl.
Makowski, Henryk. 1963. Problems of sexual dimorphism in ammonites. Palaeontologia Polonica 12:viii + 92 p., 12 text-pl., 20 pl.
Mascke, Erich. 1907. Die *Stephanoceras*-Verwandten in den Coronatenschichten von Norddeutschland. Inaugural Dissertation. Göttingen University. 38 p.
Maubeuge, P. L. 1955. Les ammonites Aaléniennes, Bajociennes et Bathoniennes du Jura Suisse septentrional. Schweizerische Paläontologische Abhandlungen 71:1–48, pl. 1–11.
McLearn, F. H. 1927. Some Canadian Jurassic faunas. Transactions of the Royal Society of Canada (series 3) 21(section 4):61–74, pl. 1.
McLearn, F. H. 1929. Contributions to the stratigraphy and palaeontology of Skidegate Inlet, Queen Charlotte Islands, B.C. Canada Department of Mines, Bulletin 54 (geological series 49):1–27, pl. 1–16.
McLearn, F. H. 1932. Contributions to the stratigraphy and palaeontology of Skidegate Inlet, Queen Charlotte Islands, British Columbia. Part 2. Transactions of the Royal Society of Canada (series 3) 26(section 4):51–80, pl. 1–10.
McLearn, F. H. 1949. Jurassic formations of Maude Island and Alliford Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia. Bulletin of the Geological Survey of Canada 12:1–19.
Meek, F. B. 1876. A Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country. *In* F. V. Hayden, ed., Report of the United States Geological Survey of the Territories. Vol. 9. Government Printing Office. Washington, D.C. lxiv + 629 p., 45 pl.
Meek, F. B., & F. V. Hayden. 1865. Palaeontology of the Upper Missouri: A Report Upon Collections Made Principally by the Expedition Under the Command of Lieut. G. K. Warren, U.S. Top. Engrs., in 1855 and 1856. Invertebrates, Part 1. Smithsonian Institution Contributions to Knowledge 172, Vol. 14, Article 5. Collins. Philadephia. 136 p., 5 pl.
Meledina, S. V. 1967. Novyy rod sredneyurskikh arkticheskikh ammonitov [A new genus of Middle Jurassic Arctic ammonites]. *In* V. N. Saks, ed., Problemy Paleontologicheskogo Obosnovaniya Detal'noy Stratigrafii Mezozoya Sibiri i Dal'nego Vostoka SSSR [Problems of Paleontologic Substantiation of Detailed Mesozoic Stratigraphy of Siberia and the Far East of USSR]. For the 2nd International Colloquium on the Jurassic (Luxembourg, July, 1967)]. Akademiia Nauk SSSR, Sibirskoe Otdelenie, Instituta Geologii I Geofiziki. Nauka. Leningrad. p. 103–108, 1 pl. In Russian.
Meledina, S. V. 1968. Sredney yury Boreal'nyye ammonity Sibiri i ikh stratigraficheskoye znacheniye [Middle Jurassic Boreal ammonites of Siberia and their stratigraphical significance]. Trudy Geologicheskiĭ Institut, Akademiia Nauk SSSR 183(2):416–419. In Russian.
Meledina, S. V. 1973. Ammonity i zonal'naya stratigrafiya Bayosa-Bata Sibiri [Ammonites and zonal stratigraphy of the Bajocian-Bathonian of Siberia]. Trudy Instituta Geologii i Geofiziki, Akademiia Nauk SSSR, Sibirskoe Otdelenie 153:152 p., 23 pl. In Russian.

Meledina, S. V. 1977. Ammonity i zonal'naya stratigrafiya Kelloveya Sibiri [Ammonites and zonal stratigraphy of the Callovian of Siberia]. Trudy Instituta Geologii i Geofiziki, Akademiia Nauk SSSR, Sibirskoe Otdelenie 365:289 p., 47 pl. In Russian.

Mesezhnikov M. S. 1967. Novaya ammonit zona ot verkhnego Oksforda i polozheniye Oksford-Kimeridzha granitsy v Severnoy Sibiri [A new ammonite zone from the Upper Oxfordian and the position of the Oxfordian–Kimmeridgian boundary in Northern Siberia]. *In* V. N. Saks, ed., Problemy Paleontologicheskogo Obosnovaniya Detal'noy Stratigrafii Mezozoya Sibiri i na Dal'nem Vostoke SSSR [Problems of Paleontologic Substantiation of Detailed Mesozoic Stratigraphy of Siberia and the Far East of USSR. For the 2nd International Colloquium of Jurassic (Luxembourg, July, 1967)]. Akademiia Nauk SSSR, Sibirskoe Otdelenie, Instituta Geologii i Geofiziki. Nauka. Leningrad. p. 110–130, 6 pl. In Russian.

Mesezhnikov M. S., E. D. Kalacheva, & L. M. Rotkite. 1989. Opisaniye ammonitov [Descriptions of Ammonoidea]. *In* M. S. Mesezhnikov, ed., Srednіy i verkhniy Oksford Russkoy platformy [The Middle and Upper Oxfordian of the Russian Platform]. Trudy Mezhvedomstvennyy Stratigraficheskiy Komitet SSSR, Akademiya Nauk SSSR, Leningrad 19:69–108, pl. 1–26. In Russian.

Mitta, V. V. 1999. The genus *Cadochamoussetia* in the phylogeny of the Jurassic Cardoceratidae (Ammonoidea). *In* Federico Olóriz & F. J. Rodríguez-Tovar, eds., Advancing Research on Living and Fossil Cephalopods. Kluwer Academic & Plenum Publishers. New York. p. 125–136, 9 fig.

Mitta, V. V. 2009. Genus *Eckhardites* Mitta (Cardioceratidae, Ammonoidea) from the Lower Callovian of the Subboreal Jurassic. Paleontological Journal 43:50–58, pl. 6–7. Also published in Paleontologicheskii Zhurnal 2009, no. 1, p. 47–53, pl. 6–7.

Mitta, V. V., & I. A. Starodubsteva. 1998. Polevyye raboty 1998 godu i biostratigrafiya nizhnego Kelloveya Russkoy platformy [Field work in 1998 and biostratigraphy of the Lower Callovian of the Russian Platform]. Vernadsky Museum Novitates 2:20 p., 5 pl. In Russian.

Model, R., & E. Model. 1938. Die Lamberti-Schichten von Trockau in Oberfranken nebst einem Anhang: Castor-Polux-Zone und Obductus-Lager. Jahrbuch der Preußischen Geologischen Landesanstalt 58:631–665, pl. 51–53.

Morris, J. 1845. Description of some new species of the Genus *Ancyloceras.* Annals and Magazine of Natural History, London 15:31–34, 1 pl.

Munier-Chalmas, E. C. P. A. 1892. Sur la possibilité d'admettre un dimorphisme sexuel chez les Ammonitidés. Bulletin de la Société Géologique de France (3) 20:clxx–clxxiv.

Neumayr, Melichor. 1869. Die Cephalopoden der Oolithe von Balin. Verhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt, Wien (1869) 17:392–394.

Neumayr, Melichor. 1871. Die Cephalopoden-Fauna der Oolithe von Balin bei Krakau. Abhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt, Wien 5(2):19–54, pl. 9–15.

Neumayr, Melichor. 1875. Die Ammoniten der Kreide und die Systematik der Ammonitiden. Zeitschrift der Deutschen Geologischen Gesellschaft 27:854–942.

Neumayr, Melichor. 1885. Die geographische Verbreitung der Jura-formation. Denkschriften der Mathematisch-naturwissenschaftliche Klasse der Akademie der Wissenschaften, Wien 50:57–144, 1 pl.

Neumayr, Melichor, & Victor Uhlig. 1881. Über Ammonitiden aus dem Hilsbildungen Norddeutschlands. Palaeontographica 27:129–303, pl. 15–57.

Neumayr, Melichor, & Victor Uhlig. 1892. Über die von H. Abich im Kaukasus gesammelten Jura-fossilien. Denkschriften der Mathematisch-naturwissenschaftliche Klasse der Akademie der Wissenschaften, Wien 59:1–122, 6 pl.

Newton, E. T., & J. H. H. Teall. 1897. Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894–1896. Quarterly Journal of the Geological Society of London 53:477–519, pl. 37–41.

Nikitin, S. N. 1881a. Jura-Ablagerungen zwischen Rybinsk, Mologa und Myschkin an der oberen Wolga. Mémoires de l'Academie Impériale des Sciences de St.-Pétersbourg (7) 28(5):98 p., 7 pl. Also published in Materialy dlya Geologii Rossii [Materials for Geology of Russia] 10:201–331, pl. 5–11.

Nikitin, S. N. 1881b. Der Jura der Umgegend von Elatma. 1 Lieferung. Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscou (new series) 14(2):85–133, pl. VIII (I)–XIII (VI).

Nikitin, S. N. 1885. Der Jura der Umgegend von Elatma. 2 Lieferung. Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscou (new series) 15(2):43–66, pl. (VII) IX–(XI) XIII.

Ochoterena, Hector. 1963. Amonitas del Jurasico Medio y del Calloviano de Mexico. I. *Parastrenoceras* gen. nov. Paleontologia Mexicana 16:26 p., 5 pl.

Ochoterena, Hector. 1966. Amonitas del Jurasico Medio de Mexico. II. *Infrapatoceras* gen. nov. Paleontologia Mexicana 23:18 p., 3 pl.

Oppel, Albert. 1862–1863. Über jurassische Cephalopoden. Paläontologische Mittheilungen aus dem Museum des Königlichen Bayerischen Staates, Stuttgart 3:127–162, pl. 40–50 (1862); p. 163–266, pl. 51–74 (1863).

Orbigny, Alcide d'. 1842–1851. Paléontologie Française; Terrains Oolitiques ou Jurassiques. I, Céphalopodes. Masson. Paris. 642 p., 234 pl. Pages 1–80 (1842); p. 81–192 (1843); p. 193–312 (1844); p. 313–368 (1845); p. 369–432 (1846); p. 433–464 (1847); p. 465–504 (1848); p. 505–520 (1849); p. 521–632 (1850); p. 633–642 (1851).

Parnes, Abraham. 1985. Irregularly coiled Stephanoceratidae from the Upper Bajocian of Gebel Maghara, Sinai, Egypt. Geological Survey of Israel, Current Research 1983–1984:29–32, pl. 1.

Parona, C. F. 1896. Nuove osservazioni sopra la fauna e l'età degli strati con *Posidonomya alpina* nei Sette Comuni. Paleontographia Italica 1:1–42, pl. 1–2.

Parona, C. F., & G. Bonarelli. 1897. Sur la faune de Callovien inférieur (Chanasien) de Savoie. Memoires

de l'Académie des Sciences, Belles-Lettres et Arts de Savoie (series 4) 6:35–213, pl. 1–11.

Patrulius, Dan. 1996. Ammonites hétéromorphes et autres Parkinsoniidés du Bathonien–Callovien inférieur de Vadu Crişului (Monts Apuseni-Roumanie). Memoriile Institutului Geologic al României 36:13–19, 5 pl.

Patrulius, Dan, & Elena Popa. 1971. Lower and Middle Jurassic ammonite zones in the Roumanian Carpathians. Annales Instituti Geologici Publici Hungarici, Budapest 54(2):131–139, pl. 1–4.

Pavia, Giulio. 1973. Ammoniti del Baiociano inferiore di Digne (Francia SE, Dip. Alpes-Haute-Provence). Bollettino della Societa Paleontologica Italiana 10(2):75–142, pl. 13–29.

Pavia, Giulio. 1983. Ammoniti e biostratigrafia del Baiociano inferiore di Digne (Francia SE, Dip. Basses-Alpes). Museo Regionale di Scienze Naturali, Torino, Monografie II:257 p., 32 pl., 4 tables.

Pavia, Giulio. 2000. New *Subcollina* (Ammonitida) from the topmost Lower Bajocian: Their phylogenetic and paleogeographic significance. GeoResearch Forum 6:397–406.

Petitclerc, Paul. 1926. Note sur la Présence du *Nautilus julii* Baugier, dans le Bathonien des Environs de Belfort, Suivie de la Description d'Espèces Nouvelles ou Intéressantes du Callovien des Deux-Sèvres, de Maine-et-Loire, de l'Ardèche, &c.; et Enfin de l'Énumération de Certaines Ammonites Rares ou peu Connues du Crétacé des Basses-Alpes. Marcel. Vesoul. 31 p., 4 pl.

Phillips, John. 1829. Illustrations of the Geology of Yorkshire: Or, A Description of the Strata and Organic Remains of the Yorkshire Coast. Thomas Wilson. York & London. 192 p., 14 pl.

Pompeckj, J. F. 1897. Paläontologische und Stratigraphische Notizen aus Anatolien. Zeitschrift der Deutschen Geologischen Gesellschaft 49:713–828, pl. 29–31.

Potonié, R. 1929. Die ammonitischen Nebenformen des Dogger (*Apsorroceras, Spiroceras, Parapatoceras*). Jahrbuch der Preussischen Geologischen Landesanstalt 50:217–262, pl. 17–19.

Poulton, T. P. 1987. Zonation and correlation of middle boreal Bathonian to lower Callovian (Jurassic) ammonites, Salmon Cache Canyon, Porcupine River, northern Yukon. Bulletin of the Geological Survey of Canada 358:155 p., 38 pl.

Pratt, S. P. 1842. Description of some new species of *Ammonites* found in the Oxford Clay on the line of the Gt. Western Railway near Christian Malford. Annals and Magazine of Natural History 8:161–165, pl. 3–6.

Quenstedt, F. A. 1845–1849. Petrefactenkunde Deutschlands. Die Cephalopoden. Ludwig Friedrich Fues. Tübingen. 580 p., 36 pl. Pages 1–104, pl. 1–6 (1845); p. 105–184, pl. 7–14 (1846); p. 185–264, pl. 15–19 (1847); p. 265–472, pl. 20–29 (1848); p. 473–580, pl. 30–36 (1849).

Quenstedt, F. A. 1856–1858. Der Jura. H. Laupp. Tübingen. 842 p., 100 pl. Pages 1–576, pl. 1–72 (1856); p. 577–824, pl. 73–100 (1857); p. 825–842 (1858).

Quenstedt, F. A. 1882–1888. Die Ammoniten des Schwäbischen Jura. I, Der Schwarze Jura (Lias); II, Der Braune Jura; III, Der Weisse Jura. E. Schweizerbartsche. Tübingen. 1140 p., 126 pl. Part I: p. 1–48, pl. 1–6 (1882); p. 49–96, pl. 7–12 (1883); p. 97–240, pl. 13–30 (1884); p. 241–440, pl. 31–54 (1885); Part II: p. 441–672, pl. 55–78 (1886); p. 673–816, pl. 79–90 (1887); Part III: p. 817–944, pl. 91–102 (1887); p. 945–1140, pl. 103–126 (1888).

Rawson, Peter. 1982. New Arctocephalitinae (Ammonoidea) from the Middle Jurassic of Kong Karls Land, Svalbard. Geological Magazine 119:95–100, 2 pl.

Reinecke, J. C. M. 1818. Nautilos et Argonautas Vulgo Cornua Ammonis in Agro Coburgico et Vicino Reperiundos. Coburgi, ex Officina et in Commissis L. C. A. Ahlii. vi + 90 p., 13 pl.

Renz, Carl. 1913. Zur Geologie des östlichen Kaukasus. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Stuttgart, Beilage Band 36:651–703, pl. 25–29.

Repin, Y. S. 2002. New ammonites from the Upper Callovian of the Pechora region. Paleontological Journal 36:472–479, pl. 6. Also published in Paleontologicheskii Zhurnal 2002 (5):32–38, pl. 6.

Repin Y. S., A. A. Fedorova, V. V. Bystrova, N. K. Kulikova, & I. V. Polubotko. 2007. Mezozoy Barentsevomorskogo sedimentatsionnogo basseyna [Mesozoic of the Barentz sea sedimentological basin]. *In* A. I. Kirichkova & T. V. Dmitrieva, Stratigrafiya i yeye rol' v razvitii neftegazovogo kompleksa Rossii [Stratigraphy and its Role in the Development of the Oil and Gas Complex of Russia]. Vsesoiuznogo Neftianogo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta (VNIGRI). Saint-Petersburg. p. 112–161, 14 pl. In Russian.

Repin Y. S., V. A. Zakharov, S. V. Meledina, & T. I. Nalnyaeva. 2006. Atlas mollyuskov Pechorskoy Yury [Atlas of the mollusks of the Pechora Jurassic]. Vserossiyskiy Nauchno-Issledovatel'skiy Geologorazvedochnyy Neftyanoy Institut (VNIGRI) 2006 (3):262 p., 54 pl. In Russian.

Riccardi, A. C., & G. E. G. Westermann. 1991. Middle Jurassic ammonoid fauna and biochronology of the Argentine-Chilean Andes. Part III: Bajocian–Callovian Eurycephalitinae, Stephanocerataceae. Palaeontographica A216:110 p., 30 pl.

Riccardi, A. C., G. E. G. Westermann, & Serge Elmi. 1990. The Middle Jurassic Bathonian–Callovian ammonite zones of the Argentine-Chilean Andes. Geobios 22:553–597, 11 pl.

Roché, Pierre. 1939. Aalénien et Bajocien du Maconnais et des quelques régions voisines. Travaux du laboratoire de géologie, Lyon, 35 (mémoire 29):355 p., 12 fig., 13 pl.

Rollier, H. L. 1909. Phylogénie des princpaux genre d'ammonoides de l'Oolithique (Dogger) et de l'Oxfordian. Archives des Sciences Physiques et Naturelles, Genève (4)28:611–623.

Rollier, H. L. 1911. Les Faciès du Dogger ou Oolithique dans le Jura et les Régions Voisines. Mémoire publié par la Fondation Schnyder von Wartensee à Zurich. George et Cie. Zurich. 352 p.

Roman, Fredéric. 1938. Les Ammonites Jurassiques et Crétacées. Masson et Cie. Paris. 554 p., 496 fig., 53 pl.

Rouillier, Charles, & A. Vosinsky. 1849. Études progressives sur la géologie de Moscou. Cinquième étude. Bulletin de la Société Impériale des Naturalistes de Moscou 22(2):356–399, pl. K–N.

Sachs, V. N. 1976. Stratigrafiya Yurskoy Sistemy Severa SSSR [Stratigraphy of the Jurassic System of the North of the USSR]. Nauka. Moscow. 436 p., 37 pl. In Russian.

Salfeld, Hans. 1915. Monographie der Gattung *Cardioceras* Neumayr und Uhlig. Teil 1. Die Cardioceraten des oberen Oxford und Kimmeridge. Zeitschrift der Deutschen Geologischen Gesellschafte 67:149–204, pl. 16–20.

Salfeld, Hans. 1921. Kiel- und Furchenbildung auf der Schalenaußenseite der Ammonoideen in ihrer Bedeutung für die Systematik und Festlegung von Biozonen. Centralblatt für Mineralogie, Geologie und Palaeontologie 1921:343–347.

Salter, J. W., & H. F. Blanford. 1865. Palaeontology of Niti in the Northern Himalayas: Being Descriptions and Figures of the Palaeozoic and Secondary fossils Collected by Colonel Richard Strachey, R. E., 1865. Cutter, Military Orphan Press. Calcutta. 112 p., 23 pl.

Sandoval, Jose, & G. E. G. Westermann. 1986. The Bajocian (Jurassic) ammonite fauna of Oaxaca, Mexico. Journal of Paleontology 60:1220–1271, 39 fig.

Sazonov, N. T. 1957. Yurskiye otlozheniya v tsentral'nykh oblastyakh Russkoy platformy [Jurassic deposits in the central region of the Russian Platform]. Vsesoiuznyĭ Nauchno-issledovatel'skiĭ Geologorazvedochnyĭ Neftianoĭ Institut (VNIGNI). Leningrad. 155 p., 26 pl. In Russian.

Sazonov, N. T. 1965. Novyye dannyye o Kelloveyskikh,Oksfordskikh i Kimmeriyskikh ammonitakh [New data on Callovian, Oxfordian and Kimmeridgian ammonites]. *In* N. T. Sazonov & E. K. Shutskoy, eds., Fauna Mezozoya i Kaynozoya yevropeyskoy chasti SSSR i sredney Azii [Fauna of the Mesozoic and Caenozoic of the European part of the USSR and northern Asia]. Trudy Vsesoiuznogo Nauchno-Issledovatel'skogo Geologicheskogo Instituta (VSEGEI) 44:3–98, 24 pl. In Russian.

Schindewolf, O. H. 1923. Über die Ausgestaltung der Lobenlinie bei den Neoammonoidea Wedekind. Centralblatt für Mineralogie, Geologie und Palaeontologie 24:337–350, 359–370, 5 fig.

Schindewolf, O. H. 1929. Vergleichende Studien zur Phylogenie, Morphogenie und Terminologie der Ammoneenlobenlinie. Abhandlungen der Preussischen Geologischen Landesanstalt (Neue Folge) 115:102 p., 40 fig., 1 pl.

Schindewolf, O. H. 1961. Studien zur Stammesgeshichte der Ammoniten. Lieferung I. Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse, Akademie der Wissenchaften und der Literatur in Mainz 1960 (10):636–747 (1–113), pl. 1–2.

Schindewolf, O. H. 1963. *Acuariceras* und andere heteromorphe Ammoniten aus dem Oberen Dogger. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 116:119–148, pl. 6–8.

Schindewolf, O. H. 1965. Studien zur Stammesgeshichte der Ammoniten. Lieferung IV. Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse, Akademie der Wissenchaften und der Literatur in Mainz 1965 (3):137–238 (407–508).

Schindewolf, O. H. 1966. Studien zur Stammesgeshichte der Ammoniten. Lieferung V. Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse, Akademie der Wissenchaften und der Literatur in Mainz 1966 (3):324–454 (510–640).

Schirardin, Jules. 1958. Les ammonites de l'Oxfordien du Jura Alsacien de la Ferrette. Bulletin du Service de la Carte Geologique d'Alsace et de Lorraine 11:1–50, 3 pl.

Schlegelmilch, Rudolf. 1985. Die Ammoniten des Süddeutschen Doggers. Gustav Fischer. Stuttgart & New York. 284 p., 59 pl.

Schlögl, Jan, Serge Elmi, Milos Rakus, Charles Mangold, & Mohammed Ouahhabi. 2006. Specialisation and iterative evolution of some Tethyan Bathonian ammonites. Geobios 39:113–124, 9 fig.

Schlotheim, E. F. von. 1813. Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. Taschenbuch für die Gesamte Mineralogie, mit Hinsicht auf die Neuesten Entdeckungen, Herausgegeben von Dr. Carl Caesar Leonhard 7(1):3–134, pl. 1–4.

Schmidtill, Ernst, & Lothar Krumbeck. 1931. Über die Parkinsonien-Schichten Nordbayerns mit besonderer Berücksichtigun der Parkinsonien-Schichten Nordwestdeutschlands. Jahrbuch der Preussischen Geologischen Landesanstalt 51:819–894, pl. 82–91.

Schmidtill, Ernst, & Lothar Krumbeck. 1938. Die Coronaten-Schichten von Auerbach (Oberpfalz, Nordbayern). Zeitschrift der Deutschen Geologischen Gesellschaft 90:297–360, pl. 10–14.

Seebach, K. von. 1864. Der Hannoversche Jura. Verlag von Wilhelm Hertz. Bessersche Buchhandlung. Berlin. 170 p., 10 pl.

Sey, I. I., & E. D. Kalacheva. 1979. Ammonit sborka v yurskom granitse Srednego Verkhnego sloi sovetskogo Dal'nego Vostoka [An ammonite assemblage in the Middle-Upper Jurassic boundary strata of the Soviet Far East]. Akademiia Nauk SSSR; Sibirskoe Otdelenie, Novosibirsk; Geologii i Geofizki 1979 (8):34–45, 2 pl. In Russian.

Sey, I. I., & E. D. Kalacheva. 1980. Biostratigrafiya iz nizhney i sredney Yury na Dal'nem Vostoke [Biostratigraphy of the Lower and Middle Jurassic in the Far East]. Trudy Vsesoyuznogo Nauchno-Issledovatelskogo Geologicheskogo Instituta (VSEGEI), Leningrad (new series) 285:187 p., 35 pl. In Russian.

Siemradzki, Józef. 1891. Fauna Kopalna warstw oksfordzkich i kimerydzkich w okręgu krakowskim I przyleglych częściach Polskiego. Cześć I, Głowonogi. Akademja Umiejętności w Krakowie. 92 p., 5 pl. In Polish.

Smith, J. P. 1913. Cephalopoda. *In* K. A. Zittel & C. R. Eastman, Textbook of Palaeontology. Vol. 1, Invertebrata. 2nd edition. Macmillan & Co. London. p. 583–689, fig. 1098–1336.

Smorodina, N. 1929. O sistematicheskom polozhenii roda Chamoussetia Douvillé [Sur la postion systematique du genre *Chamoussetia* Douvillé].

Izvestiya Assotsiatsii Nauchno-Issledovatel'skikh Institutov pri Fiziko-Matematicheskom Fakul'tete Pervogo Moskovskogo Gosudarstvennogo Universiteta 1(3–4):417–426, 3 pl. In Russian, with French summary.

Sokolov, D. N. 1912. Zur Ammonitenfauna des Petschoraschen Jura. Mémoires du Comité Géologique (new series) 76:65 p., 3 pl.

Sokolov, M. I. 1929. Geologicheskiye issledovaniya po R. Unzha v 1925 godu [Geological investigations on the River Unzha in 1925]. Izvestiya Assotsiatsii Nauchno-Issledovatel'skikh Institutov pri Fiziko-Matematicheskom Fakul'tete Pervogo Moskovskogo Gosudarstvennogo Universiteta 2(5):5–31. In Russian.

Sowerby, James. 1813. The Mineral Conchology of Great Britain, vol. 1, parts 4–5. Meredith. London. p. 49–72, pl. 16–27.

Sowerby, James. 1814. The Mineral Conchology of Great Britain, vol. 1, part 10. Meredith. London. p. 109–124, pl. 51–56.

Sowerby, James. 1815. The Mineral Conchology of Great Britain, vol. 2, part 19. Meredith. London. p. 1–12, pl. 103–108.

Sowerby, James. 1817. The Mineral Conchology of Great Britain, vol. 2, part 32. Meredith. London. p. 179–194, pl. 181–186.

Sowerby, James. 1818. The Mineral Conchology of Great Britain, vol. 3, part 35. Meredith. London. p. 225–239, pl. 199–203.

Sowerby, James. 1819. The Mineral Conchology of Great Britain, vol. 3, part 42. Meredith. London. p. 69–80, pl. 240–245.

Sowerby, James. 1821. The Mineral Conchology of Great Britain, vol. 4, part 54. Meredith. London. p. 1–8, pl. 307–312.

Sowerby, J. de C. 1825. The Mineral Conchology of Great Britain, vol. 5, part 86. Meredith. London. p. 153–171, pl. 498–503.

Sowerby, J. de C. 1826. The Mineral Conchology of Great Britain, vol. 6, part 93. Meredith. London. p. 77–86, pl. 540–545.

Sowerby, J. de C. 1827. The Mineral Conchology of Great Britain, vol. 6, part 94. Meredith. London. p. 78–96, pl. 546–551.

Sowerby, J. de C. 1840a. Appendix: Systematic list of organic remains. *In* C. W. Grant, Memoir to illustrate a geological map of Cutch. Transactions of the Geological Society of London (series 2) 5(2):327–329, pl. 21–26.

Sowerby, J. de C. 1840b. List of fossils. *In* W. H. Sykes, A notice respecting some fossils collected in Cutch, by Capt. Walter Smee, of the Bombay Army. Transactions of the Geological Society of London (series 2) 5(3):715–719, pl. 61.

Spath, L. F. 1923. Appendix: On ammonites from New Zealand. Quarterly Journal of the Geological Society of London 79:286–312, pl. 12, 14, 17–18.

Spath, L. F. 1924. On the Blake collection of ammonites from Kachh, India. Palaeontologia Indica (new series) 9 (memoir 1):29 p.

Spath, L. F. 1925a. Ammonites and aptychi [from Somaliland]. Monograph of the Hunterian Museum, University of Glasgow 1:111–164, pl. 15–16.

Spath, L. F. 1925b. Notes on Yorkshire ammonites. III. On the *Armatus* Zone. The Naturalist, Hull 1925:167–172.

Spath, L. F. 1927–1933. Revision of the Jurassic cephalopod faunas of Katchh (Cutch), parts 1–6. Palaeontologia Indica (new series) 9 (2):945 p., 130 pl.

Spath, L. F. 1928a. Revision of the Jurassic cephalopod faunas of Katchh (Cutch), part 2. Palaeontologia Indica (new series) 9(2):73–162, pl. 8–19.

Spath, L. F. 1928b. Revision of the Jurassic cephalopod faunas of Katchh (Cutch), part 3. Palaeontologia Indica (new series) 9(2):163–278, pl. 20–47.

Spath, L. F. 1932. The invertebrate faunas of the Bathonian–Callovian deposits of Jameson Land (East Greenland). Meddelelser om Grønland 87(7):158 p., 26 pl.

Spath, L. F. 1933. Revision of the Jurassic cephalopod faunas of Katchh (Cutch), part 6. Palaeontologia Indica (new series) 9(2):i–vii, 659–945, pl. 125–130.

Spath, L. F. 1935. The Upper Jurassic invertebrate faunas of Cape Leslie, Milne Land. I. Oxfordian and Lower Kimmeridgian. Meddelelser om Grønland 99(2):82 p., 15 pl.

Spath, L. F. 1939. On Jurassic ammonites from Western Australia. Journal of the Royal Society of Western Australia 25:123–135, 2 pl.

Stehn, Edgar. 1923. Beiträge zur Kenntnis des Bathonien und Callovien in Südamerika. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Stuttgart, Beilage Band 49:52–158, 8 pl.

Stipanicic, P. N., G. E. G. Westermann, & A. C. Riccardi. 1976. The Indo-Pacific ammonite *Mayaites* in the Oxfordian of the southern Andes. Ameghiniana 12:281–305, 6 pl.

Stoll, Elisabeth. 1934. Die Brachiopoden und Mollusken der pommerschen Doggergeschiebe. Abhandlungen aus dem Geologisch-Palaeontogischen Institut der Universität Greifswald 13:62 p., 2 pl.

Stolyarova, L. R. 2007. A new genus of Cardioceratids (Ammonoidea) from the Upper Callovian–Lower Oxfordian of northern Siberia. Paleontological Journal, Moscow 41(3):241–247, pl. 3–4. Also published in Paleontologicheskii Zhurnal, 2007 (3):10–15, pl. 3–4.

Sturani, C. 1971. Ammonites and stratigraphy of the *Posidona alpina* Beds of the Venetian Alps. Memorie degli Instituti di Geologia e Mineralogia dell' Universita di Padova 28:190 p., 16 pl.

Sykes, R. M., & J. H. Callomon. 1979. *Amoeboceras* zonation of the Boreal Upper Oxfordian. Palaeontology 22:839–903, pl. 112–121.

Taylor, D. G. 1988. Middle Jurassic (Late Aalenian and Early Bajocian) ammonite biochronology of the Snowshoe Formation, Oregon. Oregon Geology 50(11–12):123–138, 4 pl.

Teisseyre, Lorenz. 1884. Ein Beitrag zur Kenntniss der Cephalopodenfauna der Ornatenthone im Gouvernment Rjäsan (Russland). Sitzungsberichte der Akademie der Wissenschaften, Wien 88:538–628, pl. 1–8.

Teisseyre, Lorenz. 1889. Über *Proplanulites* nov. gen. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Stuttgart, Beilage Band 6:148–176.

Terquem, Olry. 1857. Observation sur un fossile nouveau trouvé dans le department de la Moselle. Bulletin de la Société d'Histoire Naturelle de la Moselle 8:160–163.

Thalmann, H. 1924. *Helicoceras alpinum* nov. spec., aus dem Aalénien des Pletochbaches bei Mürren (Berner Oberland). Mitteilungen der Naturforschenden Gesallschaft in Bern 1923:xxii–xxiv.

Thierry, Jacques. 1975. Ontogenese de la ligue de suture et origine des Mayaitidae Spath 1928 (Ammonitina, Stephanoceratacеae) de l'oxfordien moyen de la province indo-malgache. Comptes Rendus des Séances de l'Académie des Sciences, Paris (D) 280:1543–1546.

Thierry, Jacques. 1976. Essai de taxionomie et de phylogénie de la famille des Macrocephalitidae (Ammonitina, Stephanoceratacеae; Jurassique moyen). *In* Quatrième Réunion Annuelle des Sciences de la Terre, Paris 13–16 Avril 1976. Maison de la Chimie. Paris. p. 375.

Thierry, Jacques. 1978. Le Genre *Macrocephalites* au Callovien Inférieur (Ammonites, Jurassic moyen). Mémoires Géologiques de l'Université de Dijon 4:xi + 491 p., 36 pl.

Tintant, Henri. 1964. Les Kosmocératidés du Callovien inférieur et moyen d'Europe Occidentale: Essai de paléontologie quantitative. Publications de l'Université de Dijon 29:500 p., 58 pl.

Tintant, Henri, & René Mouterde. 1981. Classification et Phylogenese chez les ammonites jurassiques. *In* Jordi Markell, ed., International Symposium on Concept and Method in Palaeontology; Barcelona, 5–8 May 1981. University of Barcelona. p. 85–101.

Trauth, Friedrich. 1927. Aptychenstudien I. Über die Aptychen im Allgemeinen. Annalen des Naturhistorisches Museums in Wien 41:171–259.

Trauth, Friedrich. 1930. Aptychenstudien III–V. Annalen des Naturhistorisches Museums in Wien 44: 329–411, pl. 3–5.

Turner, J. 1970. The ammonites of Bukowskii Subzone of the Oxfordian of Skye. Scottish Journal of Geology 6(14):371–378, 3 pl.

Uhlig, V. 1910. The fauna of the Spiti Shales. Palaeontologia Indica (15) 4(2):133–306, pl. 19–48A, 77–91.

Vacek, M. 1886. Über die fauna der Oolithe von Cap San Vigilio. Abhandlungen der Kaiserlich-Königlichen Geologischen Reichsanstalt, Wien 12(3):55–212, 20 pl.

Voronets. N. S. 1962. Stratigrafiya i Golovonogiye Mollyuski Yurskikh i nizhnemelovykh otlozheniy Leno-Anabarskogo Rayona [Stratigraphy and cephalopod molluscs of the Jurassic and Cretaceous deposits of the Lena-Anabar region]. Trudy Nauchno Issledovatel'skogo Instituta Geologii Arktiki 110:239 p., 61 pl. In Russian.

Waagen, W. H. 1869. Die Formenreihe des *Ammonites subradiatus* versuch einer Palaontologischen Monographie. In E. W. Benecke, Geognostisch-Paläontologische Beitrage, vol. 2, number 2. R. Oldenbourg. München. p. 179–256, pl. 16–20.

Waagen, W. H. 1875. The Jurassic fauna of Kutch: The Cephalopoda (Ammonitidae), parts 2–4. Palaeontologia Indica (9):23–247, pl. 5–60.

Weisert, Kurt. 1932. *Stephanoceras* im schwäbischen Braunen Jura Delta. Palaeontographica 76:121–191, pl. 15–19.

Westermann, G. E. G. 1954. Monographie der Otoitidae (Ammonoidea): *Otoites, Trilobiticeras, Itinsaites, Epalxites, Germanites, Masckeites* (*Pseudotoites, Polyplectites*), *Normannites.* Beihefte zum Geologischen Jahrbuch 15:364 p., 33 pl.

Westermann, G. E. G. 1956a. Phylogenie der Stephanocerataceae und Perisphinctaceae des Dogger. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 103:233–279.

Westermann, G. E. G. 1956b. Monographie de Bajocien-Gattung *Sphaeroceras* und *Chondroceras* (Ammonoidea). Beihefte zum Geologischen Jahrbuch 24:125 p., 14 pl.

Westermann, G. E. G. 1958. The significance of septa and sutures in Jurassic ammonite systematics. Geological Magazine 95 (6):441–455.

Westermann, G. E. G. 1964a. The ammonite fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula: Part I, Lower Bajocian (Aalenian). Bulletin of American Paleontology 47(216):325–497, pl. 44–76.

Westermann, G. E. G. 1964b. Sexual-dimorphismus bei Ammonoideen und seine Bedeutung für die Taxionomie der Otoitidae (Einschliesslich Sphaeroceratinae; Ammonitina, M. Jura). Palaeontographica (Abteilung A) 124:33–73, pl. 6–9.

Westermann, G. E. G. 1964c. Evolution and taxonomy of Pachyceratidae and Mayaitinae, as suggested by septal patterns (Jurassic Ammonitina). *In* B. C. Roy, ed., International Geological Congress: Report of the 22nd Session, India, 1964. Volume of Abstracts. International Geological Congress. New Dehli. p. 130.

Westermann, G. E. G. 1969. The ammonite fauna of the Kialagvik Formation at Wide Bay, Alaska Peninsula: Part II, *Sonninia sowerbyi* Zone (Bajocian). Bulletins of American Paleontology 57(255):226 p., 47 pl.

Westermann, G. E. G. 1975. *Alfeldites* nom. nov. for *Germanites* Westermann, 1954, non Schindewolf, 1929, Jurassic Ammonitina. Journal of Paleontology 49:229.

Westermann, G. E. G. 1983. The Upper Bajocian and Lower Bathonian (Jurassic) ammonite faunas of Oaxaca, Mexico and west-Tethyan affinities. Paleontologia Mexicana 46:62 p., 11 pl.

Westermann, G. E. G. 1995. Mid-Jurassic Ammonitina from the Central Ranges of Irian Jaya and the origin of the stephanoceratids. Hantkeniana 1:105–118, 181–184, pl. 14–17.

Westermann, G. E. G., & J. H. Callomon. 1988. The Macrocephalitidae and associated Bathonian and early Callovian (Jurassic) ammonoids of the Sula

Islands and New Guinea. Palaeontographica (Abteilung A) 203:1–90, 19 pl.

Westermann, G. E. G., & T. A. Getty. 1970. New Middle Jurassic Ammonitina from New Guinea. Bulletins of American Paleontology 57(256):227–321, pl. 48–62.

Westermann, G. E. G., Neville Hudson, & J. A. Grant-Mackie. 2000. Bajocian (Middle Jurassic) Ammonitina of New Zealand. New Zealand Journal of Geology & Geophysics 43:33–57, 9 fig.

Westermann, G. E. G., Neville Hudson, & J. A. Grant-Mackie. 2002. New Jurassic Ammonitina from New Zealand: Bathonian–Callovian Eurycephalitinae. New Zealand Journal of Geology and Geophysics 45(4):499–525, 10 fig.

Westermann, G. E. G., & A. C. Riccardi. 1979. Middle Jurassic ammonoid fauna and biochronology of the Argentine-Chilean Andes. Part II: Bajocian Stephanocerataceae. Palaeontographica (Abteilung A) 164:85–188, pl. 1–28.

Westermann, G. E. G., & Yi-Gang Wang. 1988. Middle Jurassic ammonites of Tibet and the age of the Lower Spiti Shales. Palaeontology 31:295–339, pl. 20–25.

Wetzel, Walter. 1911. Faunistische und stratigraphische Untersuchung der Parkinsonienschichten des Teutoburger Waldes bei Bielefeld. Palaeontographica (Abteilung A) 58:139–277, pl. 11–20.

Wetzel, Walter. 1937. Studien zur Paläontologie des nordwesteuropäischen Bathonien. Palaeontographica (Abteilung A) 87(3–6):77–157, pl. 10–15.

Wetzel, Walter. 1954. Die Bielefelder Garantianen: Geschichte einer Ammoniten Gattung. Geologisches Jahrbuch 68:547–586, pl. 11–14.

Whiteaves, J. F. 1876. Mesozoic Fossils. Volume 1, Part 1. On Some Invertebrates from the Coal-bearing Rocks of the Queen Charlotte Islands, Collected by Mr. James Richardson in 1872. Geological Survey of Canada. Montreal. 92 p., 10 pl.

Wright, J. K. 1983. The Lower Oxfordian of North Yorkshire. Proceedings of the Yorkshire Geological Society 44:249–281, pl. 18–22.

Young, G. M., & John Bird. 1822. A Geological Survey of the Yorkshire Coast: Describing the Strata and Fossils Occurring between the Humber and the Tees, from the German Ocean to the Plain of York. K. Kirby. Whitby, Yorkshire, England. 336 p., 17 pl.

Young, G. M., & John Bird. 1828. A Geological Survey of the Yorkshire Coast: Describing the Strata and Fossils occurring between the Humber and the Tees, from the German Ocean to the Plain of York, 2nd edition, enlarged. K. Kirby. Whitby, Yorkshire, England. 368 p., 17 pl.

Zieten, C. H. von. 1830–1833. Die Versteinerungen Württembergs. Privately published. Stuttgart. 102 p., 72 pl. Pages 1–16, pl. 1–12 (1830); p. 17–32, pl. 13–24 (1831); p. 33–64, pl. 25–48 (1832); p. 65–102, pl. 49–72 (1833).

Zittel, K. A. von. 1884. Handbuch der Paläontologie, vol. 1, number 2. R. Oldenbourg. Munich & Leipzig. 893 p. Cephalopods: p. 329–522.