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Psiloceratoidea, Eodoceratoidea, Hildoceratoidea

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# PART L, REVISED, VOLUME 3B, CHAPTER 4: PSILOCERATOIDEA, EODOCERATOIDEA, HILDOCERATOIDEA

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## INTRODUCTION

The revision of the original 1957 edition of Part L, Ammonoidea, of the *Treatise on Invertebrate Paleontology* had its origins in a letter from Curt TEICHERT sent on 15 February 1966, to all the original authors and contributors, enquiring whether a revision or a supplement would be preferable. The unanimous answer was that a revision would be preferred, and it was soon apparent that the size of any revision would require several volumes, divided according to geological periods. Later, in 1966, it was agreed that John CALLOMON, Raymond CASEY, Desmond DONOVAN, and Michael HOWARTH would be the authors of the revised Jurassic volume.

Work started in the 1970s, and by the mid-1980s, finished manuscripts for some groups were submitted to the *Treatise* office but were not published, because manuscript for the whole volume was not forthcoming at that time. Further efforts to complete the volume in the 1990s and later were unsuccessful for similar reasons, and eventually the lower half of the Jurassic was taken over by HOWARTH, and the upper half remained with CALLOMON. After the death of John CALLOMON in April 2010, it appeared that the project might never be completed, but, by then, HOWARTH's part was virtually complete, and manuscript left by CALLOMON was sufficiently advanced to be usable as the basis for some of his families in the upper half of the Jurassic. It is hoped to edit these groups into *Treatise* format and add the required figures. There are, however, substantial gaps in other families in the upper half of the Jurassic, especially in the later Perisphinctoidea. It is hoped to fill these

gaps with contributions from other authors and so eventually to arrive at a complete volume for the Jurassic representatives of the suborder Ammonitina.

The study of Jurassic ammonites has seen some major advances in the years since the publication of the first *Treatise* in 1957. First, sexual dimorphism, about which the original *Treatise* authors were unsure, has gained wide, though not universal, acceptance. At many horizons in the Lower Jurassic, the dimorphs, macroconchs and microconchs, can be satisfactorily associated and referred to the same species, especially where collections from accurately known stratigraphical horizons are available. But where stratigraphical information is less accurate or the horizons are condensed, dimorphs cannot always be associated with confidence and are often referred to different genera or subgenera, pending more accurate information. Second, large collections of ammonites from single beds or from single nodules sometimes show a large range of continuous morphological variation, which may embrace several traditional morphological species or morphological genera. Well-known examples are the large range of variation in a species of *Leioceras* from a single horizon in Dorset, England, described by CHANDLER and CALLOMON (2009); the huge morphological variation in single species of *Neogastropites* from nodules in the upper Albian of Montana, United States, described by REESIDE and COBBAN (1960; see also WRIGHT, 1996, p. 124); the wide variation in *Polymorphites* from single horizons in the lower Pliensbachian in Britain and at other localities in Europe; and there are examples in British Toarcian Dactyloceratidae when single bed collections were

obtained (HOWARTH, 1973). Such collections give insight into the range of variation of an ammonite so-called biospecies and can have a profound effect on the generic classification adopted. Third, study of collections from more accurately known stratigraphical horizons has led to much refinement of the generic classification in the last 50 years.

The part presented here comprises three superfamilies: Psiloceratoidea, Eoderoceratoidea, and Hildoceratoidea. These superfamilies represent all the Ammonitina from the base of the Jurassic up to approximately the middle of the Bajocian in the Middle Jurassic. All the taxonomic categories—superfamilies, families, subfamilies, genera, and subgenera—are described in an order that reflects, to some extent, their phylogenetic, biostratigraphic, and/or morphological relationships, as in the original ammonoid *Treatise* of 1957 and the Cretaceous ammonite *Treatise* revision of 1996, rather than an alphabetical order. The intention is that all generic names proposed up to the end of 2008 have been included in the text. I am indebted to Professor Desmond DONOVAN, who passed on to me his mid-1980s *Treatise* manuscript for the Psiloceratoidea and part of the Eoderoceratoidea for revision and completion.

## Order AMMONITIDA Fischer, 1882

[*nom. correct.* BASSE, 1952a, p. 555, 558, *pro order Ammonea* FISCHER, 1882, p. 328, 367]

### Suborder AMMONITINA Fischer, 1882

[*nom. correct.* ARKELL, 1950, p. 355, *pro suborder Ammonitinae* HYATT, 1884b (April), p. 260, 261, 308, 338; *nom. transl.* *ex order Ammonea* FISCHER, 1882, p. 328, 367]

Note on nomenclature. The first publication of a satisfactory name for the order Ammonitida was FISCHER's (1882, p. 328, 367) "Ordre des Ammonea," the earlier use of "Ammonoids . . . as a distinct order" by HYATT (1867, p. 71) being unacceptable because "Ammonoids" is a vernacular name, though HYATT's intention was clear. HYATT (1884a [1 February], p. 123), changed the spelling to the more correct Ammonoidea,

then introduced the suborder Ammonitinae a little later (HYATT, 1884b [April], p. 260, 261, 308, 338). Later in 1884, ZITTEL (1884, p. 392) used the term Ammonoidea as one of the suborders of the order Tetrabranchiata.

## Superfamily PSILOCERATOIDEA Hyatt, 1867

[*nom. transl.* WEDEKIND, 1918, p. 103, *ex Psiloceratidae* HYATT, 1867, p. 72] [=Ammonacea BUCKMAN, 1905b, p. 143; =Ammonitacea BUCKMAN, 1919a, p. xvii; =Psiloceratacea BUCKMAN, 1919a, p. xvii; =Arietitaceae ARKELL, 1950, p. 359]

The earliest member of the family Psiloceratidae was perhaps derived from the Triassic family Ussuritidae (of the Phylloceratoidea), but intermediate links have not been found. The Psiloceratidae retained the smooth, rounded venter of its supposed ancestors at all stages of growth, and the Schlotheimiidae developed characteristic ventral chevrons. All other families have a keel or an angular venter at some stage in ontogeny. They are probably all derived from Psiloceratidae. The great majority of Psiloceratoidea possess simple ribs only, but a few (some Schlotheimiidae, Pseudotropitinae, Oxynoticeratidae) develop secondary ribbing. Shells are predominately evolute, but some genera become involute, and the Oxynoticeratidae are oxycones.

Sutures are simple (E, L, U2, U1, I of WEDEKIND, 1916; see KULLMANN & WIEDMANN, 1970) and remarkably constant throughout the group. The only elaborations of sutural development involve the addition of extra subdivisions of U in a few of the more involute genera. In most genera, the sutural elements remain simple, with moderate indentation, but a few more involute forms (e.g., in Schlotheimiidae and Oxynoticeratidae) develop more complex sutures, especially in large individuals.

The superfamily has a worldwide range and flourished during the Hettangian and Sinemurian stages. Only *Radstockiceras*, *Hypoxynoticeras*, and the Cymbitidae survived into the Pliensbachian. In Europe, north of the alpine belt, the bisulcate forms (Arietitidae, Echioceratidae) are characteristic of, and restricted to, the Sinemurian

stage. Most genera and species have been described from Europe with stratigraphical knowledge of varying detail, but recently, rich faunas have been found in the western parts of both North and South America, with better stratigraphical data, especially from Nevada (TAYLOR, GUEX, & RAKUS, 2001). *Lower Jurassic (Hettangian–lower Pliensbachian)*.

### Family PSILOCERATIDAE Hyatt, 1867

[*Psiloceratidae* HYATT, 1867, p. 72] [=Caloceratidae BUCKMAN, 1906, p. 233]

Planulates or serpenticones, smooth or with simple ribs. No ventral ornament, except weak ventral chevrons in *Badouxia*. Sutures often asymmetrical, and saddles are phylloid in some genera. *Lower Jurassic (Hettangian)*.

#### Subfamily PSILOCERATINAE Hyatt, 1867

[*nom. transl.* LANGE, 1941b, p. 37, ex *Psiloceratidae* HYATT, 1867, p. 72] [=*Sunrisitinae* HILLEBRANDT, 2000, p. 38]

Evolute planulates or serpenticones. *Lower Jurassic (Hettangian–lower Sinemurian)*.

*Psiloceras* HYATT, 1867, p. 72 [\**Ammonites planorbis* J. DE C. SOWERBY, 1824, p. 69; SD SPATH, 1924, p. 191, ICZN Opinion 324, 1955b, proposed by ARKELL, 1951d, p. 228] [=*Psilonotoceras* QUENSTEDT, 1883 in 1882–1888, p. 10, obj.; =*Psilonotoceras* BUCKMAN, 1906, p. 232, *nom. van.*; =*Transpsiloceras* GUEX, 1980, p. 138 (type, *T. transiens*, OD); =*Primapsiloceras* REPIN in POLUBOTKO & REPIN, 1981, p. 1396 (type, *Psiloceras (Franziceras?) primulum* REPIN in EFIMOVA & others, 1968, p. 102, OD)]. Planulates, whorl section compressed, up to 6–7 whorls; smooth or with 20–30 gently sigmoidal, striate or blunt ribs per whorl, which may be irregular; sutures moderately elaborate. *Lower Jurassic (Hettangian, Planorbis Zone)*: Europe, Russia (northeast), China (Tibet), Vietnam, Indonesia (Buton, Sulawesi), Canada (British Columbia, Yukon), United States (Alaska, Nevada), Chile, Argentina, Peru, New Zealand. —FIG. 1,1a–d. \**P. planorbis* (J. DE C. SOWERBY); a, lectotype (designated herein), Watchet, Somerset, England,  $\times 1$  (new, The Natural History Museum, London, England, BMNH 43875); b–c, ribbed form, Lias a (Psilonotenbank), Bebenhausen, Tübingen, Württemberg, Germany,  $\times 1$  (Schlegelmilch, 1976, pl. 4,15); d, suture, *Psiloceras* Bed, Bristol, England,  $\times 3$  (new).

*Psilophyllites* SPATH, 1914, p. 351 [\**Ammonites hagenoui* DUNKER, 1847, p. 115; OD] [=*Hagenowiceras* LANGE, 1922, p. 470, obj.; =*Neophyllites* LANGE, 1941a, p. 137 (type, *Psilophyllites antecedens* LANGE, 1931, p. 360, OD)]. Evolute, compressed whorl

section, smooth. Similar to *Psiloceras* but with convergent whorl section and simplified sutures that have short saddles with broad, rounded terminations and ceratic lobes. *Lower Jurassic (Hettangian, Planorbis–basal Angulata Zones)*: northern Europe. —FIG. 1,2a–d. \**P. hagenoui* (DUNKER); a–b, holotype, Halberstadt, Germany,  $\times 1$  (Dunker, 1847, pl. 13,22); c–d, Exten, Rinteln, Hanover, Germany; c,  $\times 1.5$  (Lange, 1941b, pl. 2,7); d, suture,  $\times 10$  (Spath, 1924, p. 192, fig. 12d).

*Caloceras* HYATT, 1870, p. 23, 29 [\**Ammonites torus* D'ORBIGNY, 1844 in 1842–1851, p. 212; SD BUCKMAN, 1912, p. vii]. Serpenticone, up to 10 whorls; whorl section circular, umbilicus more than 60% of diameter; blunt or sharp ribs stronger than in *Psiloceras* and consistently present; suture like *Psiloceras*. *Lower Jurassic (Hettangian, Planorbis–Liasicus Zones)*: Europe, Canada (British Columbia, Yukon), United States (Alaska, Nevada), Chile, Argentina, Peru. —FIG. 2,1a–d. \**C. torus* (D'ORBIGNY); a–b, neotype, Baupre, Manche, France,  $\times 0.7$  (Fischer, 1994, pl. 12,2a–b); c–d, ?holotype of *Ammonites intermedius* PORTLOCK, Northern Ireland [possibly Gobbins Head, Island Magee],  $\times 0.7$  (new, The Natural History Museum, BMNH C.2236).

*Franziceras* BUCKMAN, 1923b, pl. 423 [\**F. ruidum*; OD] [=*Sunrisites* GUEX, 1980, p. 137 (type, *S. sunrisense*, OD)]. Whorls increase more rapidly than in *Caloceras* and umbilicus is 45–50% of diameter; whorl section rounded with slightly arched venter; ribs strong, nearly straight on whorl side; venter smooth or crossed by fine striae forming chevrons; suture like *Psiloceras*. *Lower Jurassic (Hettangian, Liasicus–Angulata Zones)*: Europe, Canada (British Columbia), United States (Alaska, Nevada, Oregon), Chile. —FIG. 1,3a–b. \**F. ruidum*, holotype, a complete adult, Corngrits, Radstock, Avon, England,  $\times 0.9$  (Buckman, 1923b, pl. 423). —FIG. 1,3c–d. *F. sunrisense* (GUEX), holotype, *Angulata* Zone, New York Canyon, Gabbs Valley Range, Nevada, United States,  $\times 1$  (Gux, 1995, pl. 27,11–12).

*Badouxia* GUEX & TAYLOR, 1976, p. 525 [\**Psiloceras canadense* FREBOLD, 1951, p. 3; OD]. Moderately involute, each whorl covering up to half of preceding whorl, umbilicus 30–45% of diameter; compressed oval whorl section; ribs strong, simple, fading on outer whorls, but largest whorls may have bullae; venter may have striae or weak secondary ribs on inner whorls, then becomes smooth; suture simple and asymmetric, with ventral lobe offset from median line. Dimorphic. More involute than *Goniptychoceras*. *Lower Jurassic (Hettangian, Angulata Zone–lower Sinemurian, Bucklandi Zone)*: Europe (eastern Alps), Russia (northeast), ?Vietnam, Canada (British Columbia, Yukon), United States (Alaska, Nevada, Oregon), Mexico, Chile, Argentina, Peru. —FIG. 2,2a–e. \**B. canadense* (FREBOLD), *Angulata* Zone, Tyughton Creek, Taseko Lakes, British Columbia, Canada; a–b, holotype, macroconch,  $\times 1$ ; c, suture,  $\times 2$ ; d–e, complete microconch,  $\times 1$  (Longridge, Smith, & Tipper, 2006, p. 803, fig. 11A, pl. 1,7–8, 17–18).

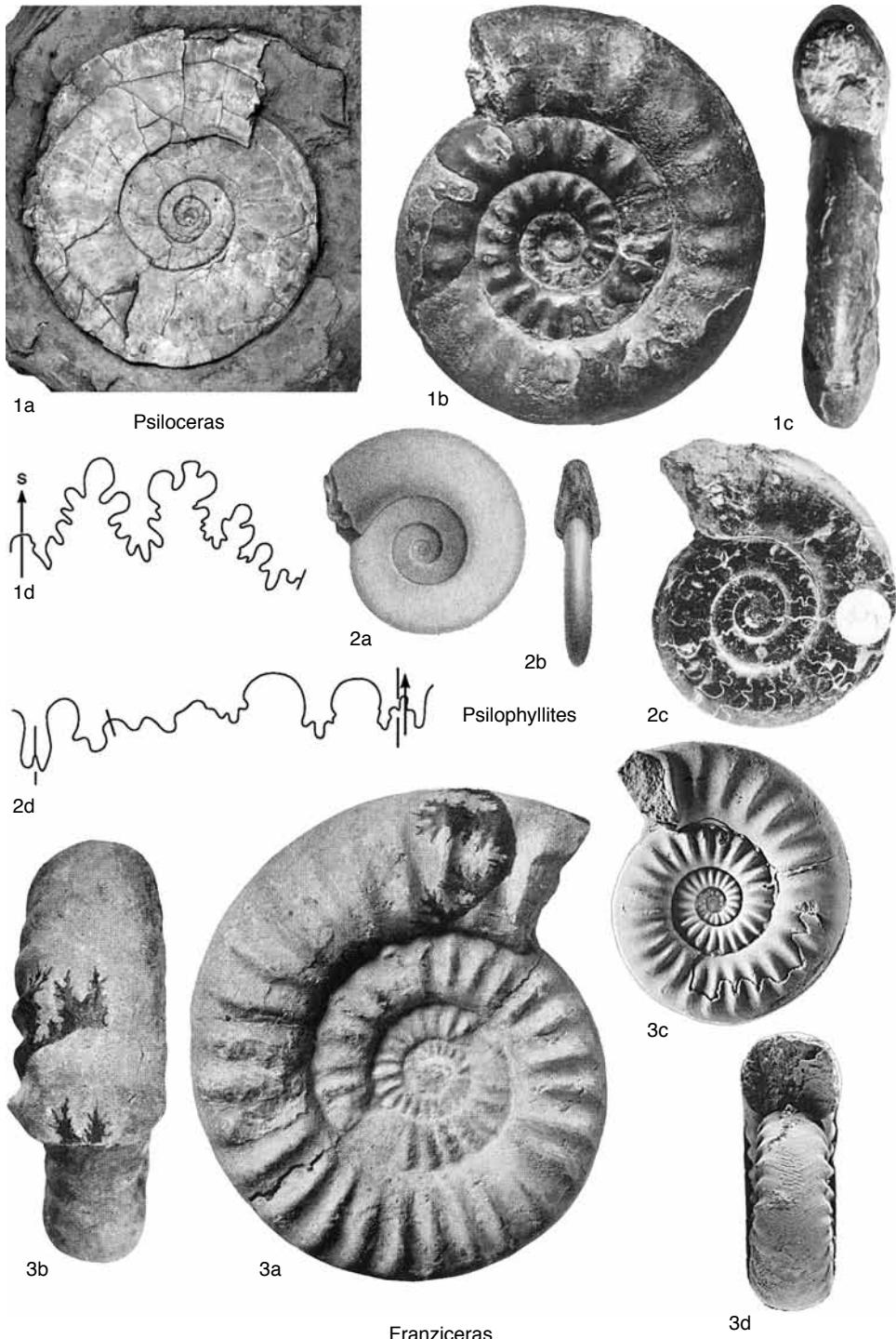


FIG. 1. Psiloceratidae (p. 3).

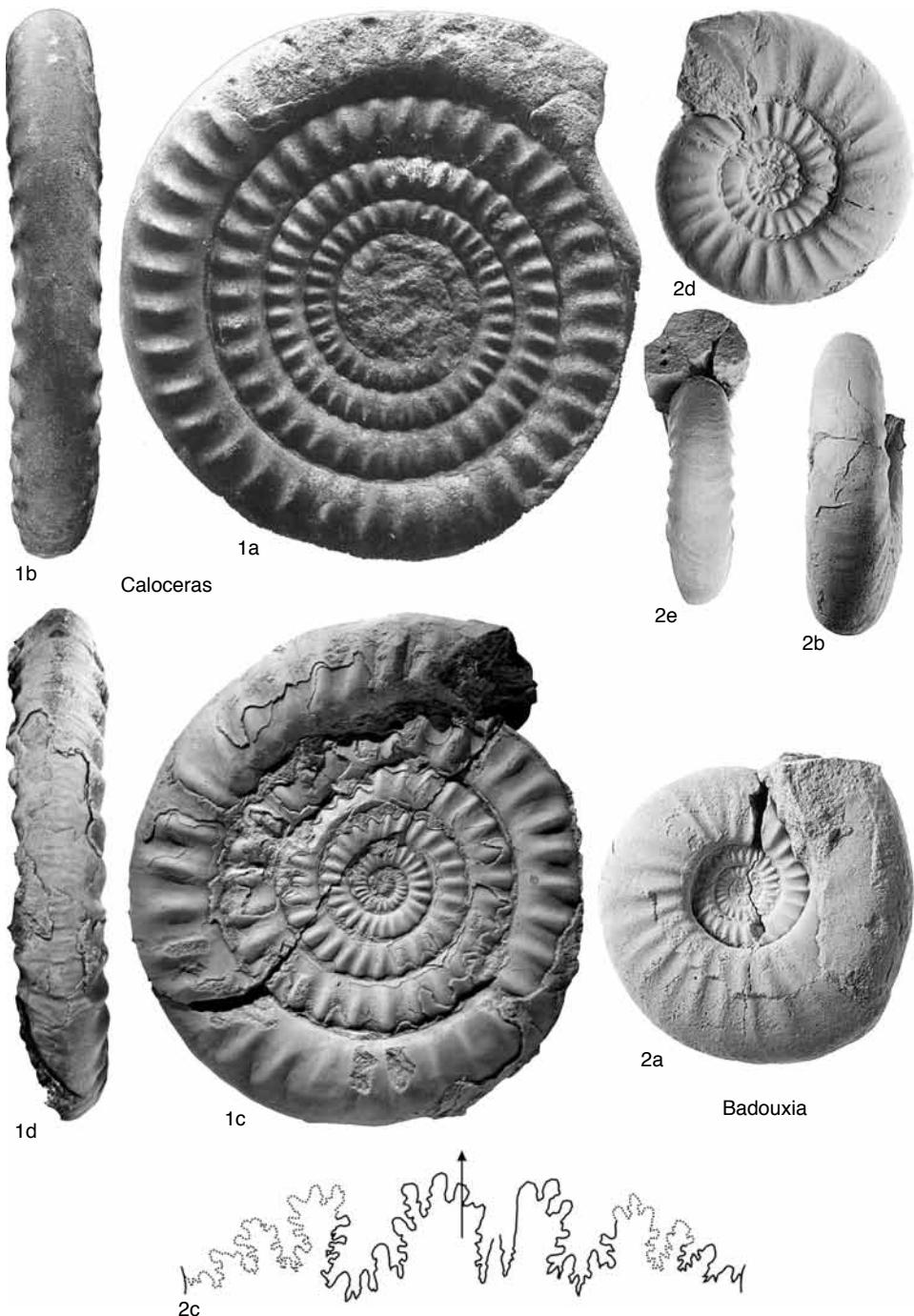


FIG. 2. *Psiloceratidae* (p. 3).

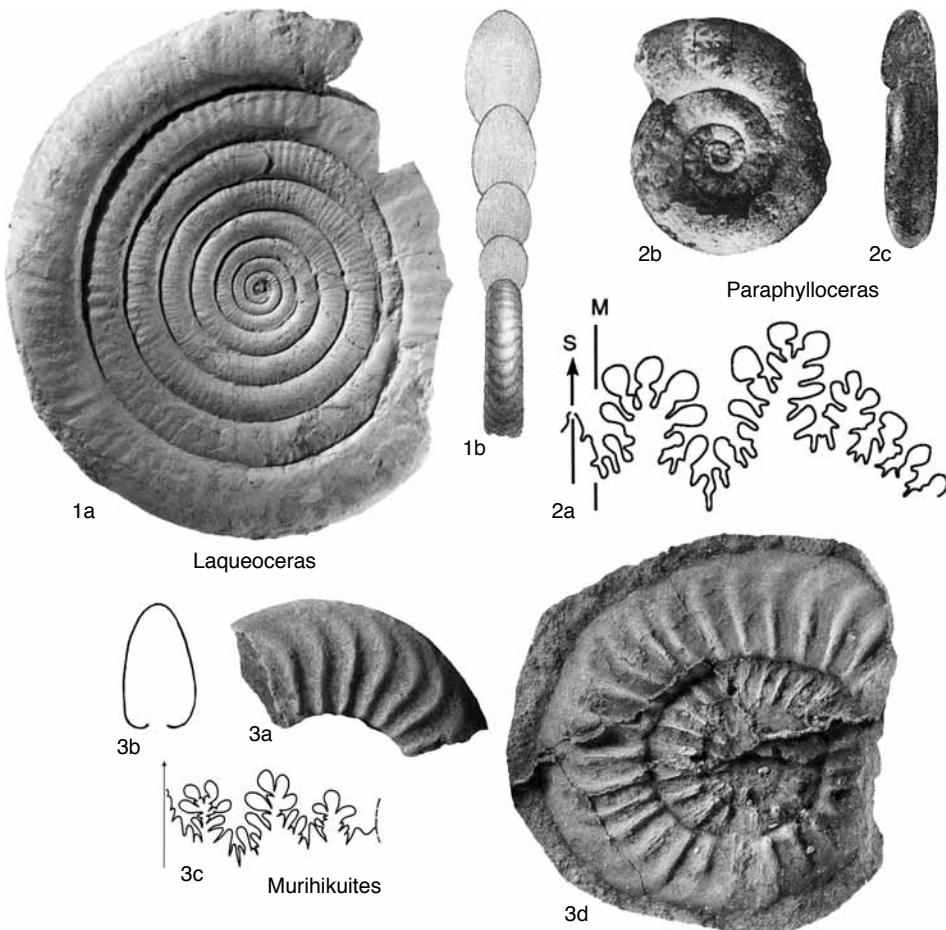


FIG. 3. Psiloceratidae (p. 6–7).

**Paraphylloceras** SALFELD, 1919, p. 459, *non* SHIMIZU, 1935, p. 173, 180 (Cretaceous, Phylloceratidae) [*\*Psiloceras calliphylum* NEUMAYR, 1879, p. 27; OD]. Large evolute planulates, up to 9 whorls and reaching 200 mm in diameter; smooth or faintly ribbed, like *Psiloceras*, but distinguished by elaborate, slightly asymmetric suture with (at comparable diameters) more divisions to the saddles. Lower Jurassic (Hettangian): southern Europe, Canada (British Columbia, Alberta).—FIG. 3,2a–c. *\*P. calliphylum* (NEUMAYR), Fonsjoch, near Jenbach, northeastern Austria; *a*, lectotype, suture, showing offset between middle of suture (*S*) and middle of venter (*M*),  $\times 2$  (Neumayr, 1879, pl. 4,5); *b–c*,  $\times 1$  (Lange, 1952, pl. 13,13a–b).

**Laqueoceras** LANGE, 1925, p. 469, 472 [*\*Aegoceras sublaqueus* WÄHNER, 1886a, p. 142; OD]. Large evolute planulates, up to 9 whorls, with a very wide umbilicus (60–72% of diameter) and compressed to circular whorl section; ribs faint, closely spaced. Lower Jurassic (Hettangian, Liasicus Zone): Europe,

New Caledonia, Canada (Alberta), United States (Alaska).—FIG. 3,1a–b. *\*L. sublaqueus* (WÄHNER), lectotype, Schreinbach, Wolfgangsee, Austria; *a*,  $\times 0.375$  (new, Palaeontologische Staatssammlung, Munich, Germany); *b*,  $\times 0.5$  (Wähner, 1886a, pl. 15 (15),1b).

**Murihikuites** STEVENS, 2004, p. 28 [*\*M. mackellari*; OD]. Evolute, compressed, rounded whorl section, with an arched, smooth, and rounded venter; ribs moderately strong, straight or slightly curved on the side of the whorl, then curving strongly forward before fading on venter; suture with phylloid saddles. [Known only from poorly preserved incomplete specimens up to approximately 100 mm in diameter. Similar to some species of *Waehneroeras* and *Kammerkarites*, but placed in Psiloceratinae because of the smooth venter throughout and the phylloid sutures.] Lower Jurassic (Hettangian, upper Planorbis–lower Liasicus Zones): New Zealand, New Caledonia.—FIG. 3,3a–d. *\*M. mackellari*,

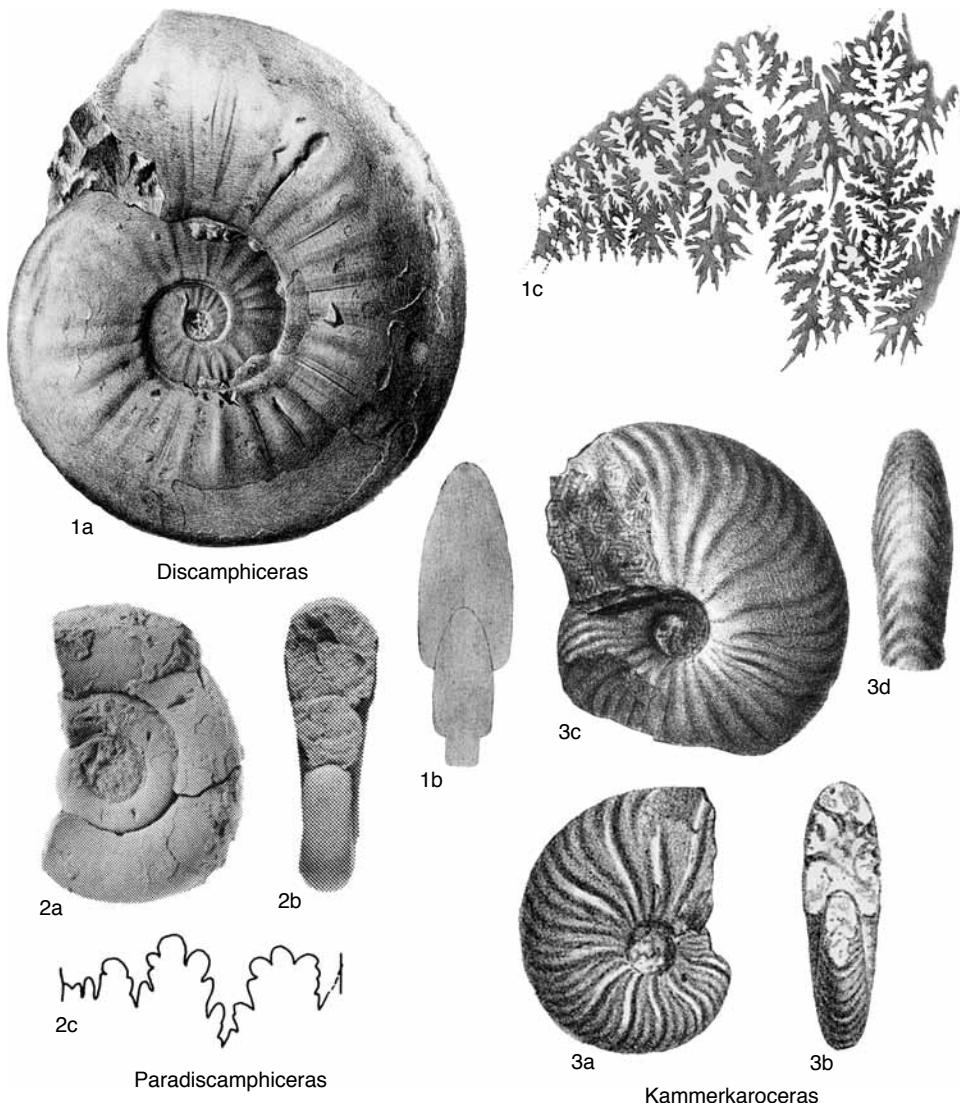


FIG. 4. Psiloceratidae (p. 7–9).

junction of Otapiri and Taylor's Streams, Hokonui Hills, Southland, South Island, New Zealand; *a–b*, holotype,  $\times 1$  (Stevens, 2004, p. 30, fig. 16, pl. 4,2); *c*, a paratype, suture,  $\times 1$  (Stevens, 2004, p. 30, fig. 17); *d*, another paratype,  $\times 1$  (Stevens, 2004, pl.4,9).

#### Subfamily DISCAMPHICERATINAE Guex & Rakus, 1991

[Discamphiceratinae GUEX & RAKUS, 1991, p. 310]

Moderately involute, compressed platycones. Suture with more subdivisions of U

lobe and more complex than in Psiloceratinae. Lower Jurassic (Hettangian, Liasicus–Angulata Zones).

**Discamphiceras** SPATH, 1923c, p. 288 [*\*Ammonites kammerkahrensis* GÜMBEL, 1861, p. 474; OD]. Shell compressed, discoidal; overlap about one-half, umbilicus 20–30% of diameter; venter narrow, rounded; smooth or with low broad ribs on whorl side; suture may be asymmetrical, with large arborescent saddles between E/L and L/U2, and about 6 umbilical lobes on external suture. Lower Jurassic

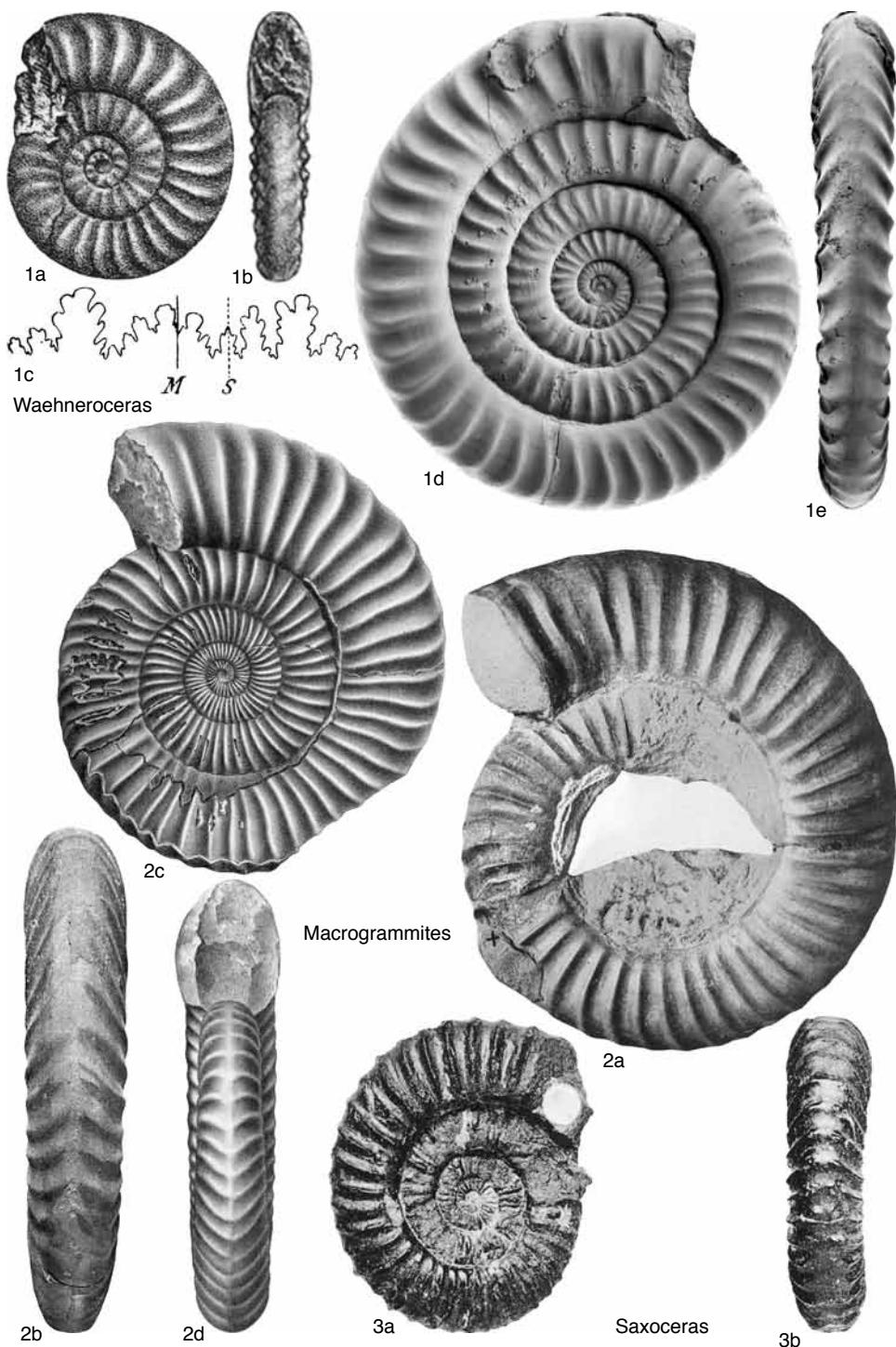


FIG. 5. Schlotheimiidae (p. 9).

(*Hettangian*, Liasicus–Angulata Zones): Austria, Italy, Canada (British Columbia), United States (Alaska, Nevada, Oregon), Chile, Argentina, Peru, New Zealand.—FIG. 4, 1a–c. \**D. kammerkahrense* (GÜMBEL), holotype, Rother Kalk with Brauneisenconcretionen, Kammerkörälpe, Lofer, northern Austria; a–b,  $\times 0.4$ ; c, suture,  $\times 8$  (Wähner, 1884, pl. 25 (13), 1a–b, 2).

**Paradiscampiceras** TAYLOR, 1988, p. 120 [\**P. dickinsoni*; OD]. Evolute with rounded whorl section; smooth or with simple ribs on inner whorls fading later. Close in morphology to *Psiloceras*, but has simple sutures with broader saddles, is derived from *Discampiceras*, and occurs near the top of the *Hettangian*. *Lower Jurassic (Hettangian, Angulata Zone)*: United States (Nevada, Oregon).—FIG. 4, 2a–c. \**P. dickinsoni*, holotype, Graylock Formation, Izee, Oregon, United States; a–b,  $\times 0.8$ ; c, suture,  $\times 3$  (Taylor, 1988, pl. 1, 1a–c).

?**Kammerkaroceras** LANGE, 1941b, p. 43 [\**Ammonites emmrichi* GÜMBEL, 1861, p. 473; OD]. Shell compressed, discoidal, involute, umbilicus 10–20% of diameter; ribs sigmoidal, joining in pairs at umbilical margin; intercalated secondary ribs on outer part of whorl side; all ribs pass over venter, forming chevrons; suture may be asymmetrical. *Lower Jurassic (Hettangian)*: Austria (eastern Alps), Italy.—FIG. 4, 3a–d. \**K. emmrichi* (GÜMBEL); a–b, ?holotype, Kammerkörälpe, Lofer, northern Austria,  $\times 1.5$  (Canavari, 1882, pl. 18 (4), 16a–b); c–d, Megastoma Horizon, Adnet, Austria,  $\times 1$  (Wähner, 1886a, pl. 26 (26), 5a–b).

## Family SCHLOTHEIMIIDAE Spath, 1923

[*nom. correct.* ICZN Direction 14, 1955d, proposed by ARKELL, 1951b, p. 204, *pro Schlotheimidae* SPATH, 1923b, p. 78] [=Angulatidae HYATT, 1874, p. 15 (rejected by ICZN Direction 14, because not formed on a nominal genus); =Schlotheimiidae H. DOUVILLE, 1916, p. 117 (rejected by ICZN Direction 14 as a vernacular name); =Waehneroceratinae RAKUS, 1975, p. 14]

Evolute to involute planululates with simple ribs that form chevrons on the venter, which may be continuous or interrupted, or with bifurcating ribs on which chevrons are weakly developed or absent. No keel. Suture with 5 lobes (E, L, U2, U1, I), which develops minor extra elements near umbilical suture (e.g., U3) during ontogeny. At larger sizes, saddles become arborescent and constricted at their bases in some. Most genera include forms more than 300 mm in diameter, which usually have smooth outer whorls with highly subdivided sutural elements. *Lower Jurassic (Hettangian–Sinemurian)*.

**Waehneroceras** HYATT, 1889, p. 125 [\**Aegoceras tenerum* NEUMAYR, 1879, p. 31; SD SPATH, 1924, p. 195] [=Teneroceras LANGE, 1951, p. 119, *nom. nud.*; LANGE, 1952, p. 97, obj.; =Tenoceras ARKELL,

1957, p. 236, *nom. null.*; =Curviceras BLIND, 1963, p. 48 (type, *Ammonites subangularis* OPPEL, 1862, p. 130, OD)]. Very evolute serpenticones, umbilicus increasing from about 45% of diameter on inner whorls to 60% on large examples; body chamber nearly one whorl in length; ribs sharp, but more rounded in the ventral chevrons, which weaken across midventral line; no change in ornament with growth; suture may be asymmetrical, indicating ancestry in Psiloceratidae. *Lower Jurassic (Hettangian)*: Europe, Russia (northeast), China (Tibet), United States (Alaska, Nevada), Chile, Argentina, Peru, New Zealand.—FIG. 5, 1a–c. \**W. tenerum* (NEUMAYR), unterste Lias, Fonsjoch, near Jensbach, northeastern Austria; a–b,  $\times 1.5$ ; c, asymmetric suture, showing offset between middle of suture (S) and middle of venter (M),  $\times 3$  (Neumayr, 1879, pl. 3, 4–5).—FIG. 5, 1d–e. *W. harpptychum* (HOLLAND), lectotype, Schwarzer Jura  $\alpha$ , Nürtingen, Stuttgart, Germany,  $\times 0.75$  (new, Staatliches Museum für Naturkunde, Stuttgart, Germany, no. 23201; also figured in Urlichs, 1977, pl. 1, 3).

**Macrogrammites** BUCKMAN, 1928, pl. 761A [\**M. grammicus*; OD] [=Storthoceras LANGE, 1941b, p. 41 (type, *Aegoceras extracostatum* WÄHNER, 1882, p. 74, OD)]. Compressed planulates of medium size, umbilicus about 50% of diameter; numerous strong radial ribs with ventral chevrons continuing to end of growth. More involute than *Waehneroceras*. *Lower Jurassic (Hettangian, Liasicus Zone)*: Europe, New Zealand.—FIG. 5, 2a–b. \**M. grammicus*, holotype, Long Itchington, Southam, Warwickshire, England,  $\times 0.6$  (Buckman, 1928, pl. 761A, B).—FIG. 5, 2c–d. *M. extracostatum* (WÄHNER), Schreinbach, Bavaria, Germany,  $\times 0.5$  (Wähner, 1882, pl. 14 (1), 1a–b).

**Saxoceras** LANGE, 1924, p. 194 [\**S. costatum*; OD]. Serpenticones, 5 or 6 whorls, whorl section circular to compressed; ribs numerous, simple, with ventral chevrons on inner whorls; venter on outer whorls smooth. *Lower Jurassic (Hettangian, Liasicus Zone)*: Europe, Vietnam, United States (Nevada), Peru, New Zealand.—FIG. 5, 3a–b. \**S. costatum*, holotype, Oldentrup, northern Germany,  $\times 1$  (Lange, 1941b, pl. 13, 3a–b).

**Kammerkarites** SPATH, 1924, p. 195 [\**Aegoceras diploptychum* WÄHNER, 1882, p. 84; OD] [=Megastomoceras LANGE, 1941b, p. 41 (LANGE, 1931, p. 354, *nom. nud.*) (type, *Ammonites megastoma* GÜMBEL, 1861, p. 474, OD)]. Compressed planulates, reaching large size, and up to 7 whorls; umbilicus usually less than 50% of diameter; inner whorls like *Macrogrammites*, outer whorls have weak ribs on whorl side and smooth venter; rib frequency increases with growth; suture complex. *Lower Jurassic (Hettangian, Liasicus Zone)*: Europe, Morocco, Russia (northeast), New Caledonia, Canada (British Columbia), United States (Nevada), New Zealand.—FIG. 6, 1a–b. \**K. diploptychum* (WÄHNER), holotype, Kammerkörälpe, Lofer, northern Austria,  $\times 0.5$  (Wähner, 1882, pl. 21 (36), 1a–b).—FIG. 6, 1c–d. *K. megastoma* (GÜMBEL), Schreinbach, Bavaria, Germany; c,  $\times 0.4$ ; d, whorl section,  $\times 0.5$  (Wähner, 1886b, pl. 18 (33), 1).

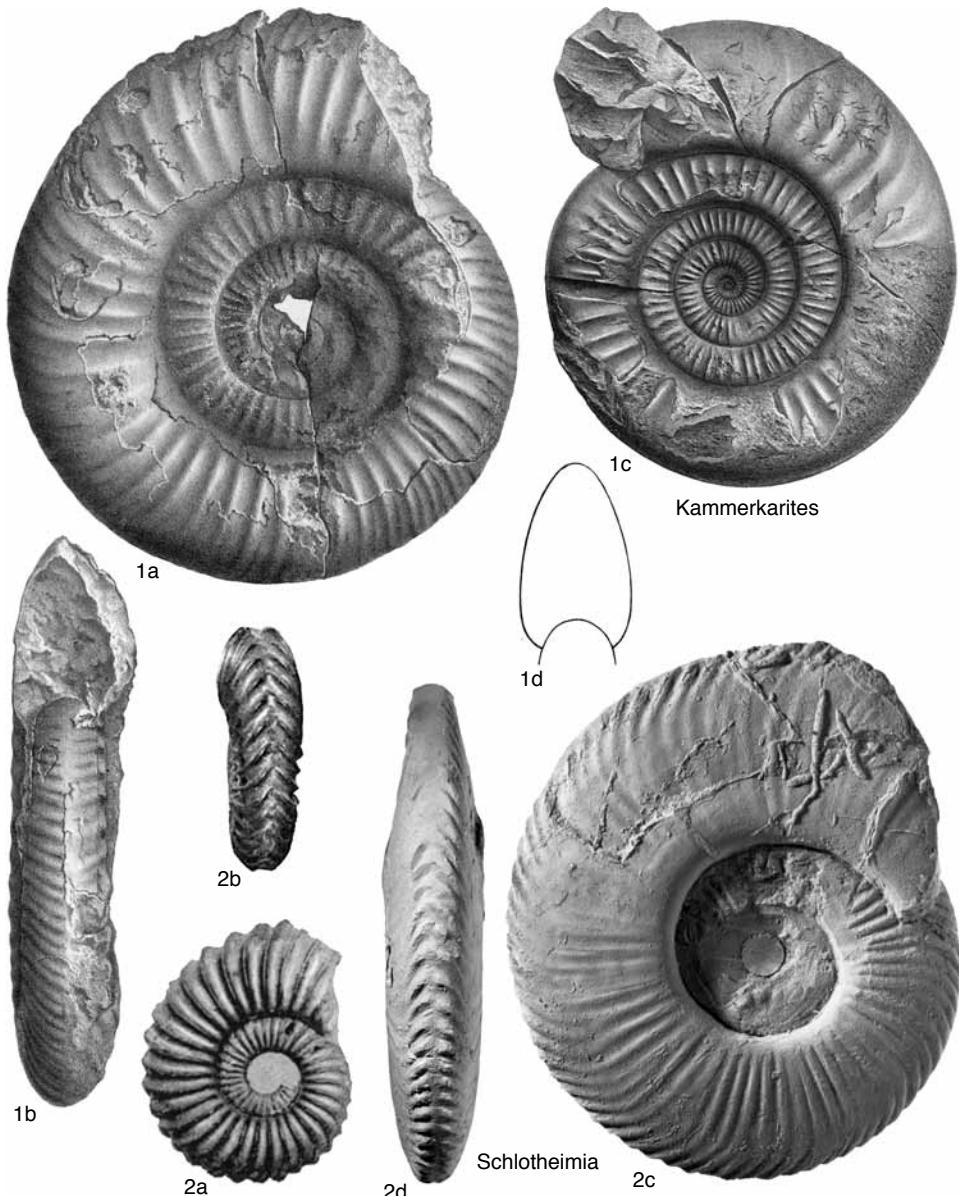


FIG. 6. Schlotheimiidae (p. 9–11).

*Schlotheimia* Bayle, 1878, pl. 65 [*\*Ammonites angulatus*

SCHLOTHEIM, 1820, p. 70; OD; *non* J. SOWERBY, 1815b, p. 9; ICZN Opinion 323, 1955a, proposed by ARKELL, 1951b, p. 204] [=*Scamnoceras* LANGE, 1924, p. 198, obj.; =*Anguliferites* LANGE, 1951, p. 52 (type, *A. gonyphora*, OD)]. Planulates, up to 7 whorls, each whorl overlapping about one-third of the preceding; whorls compressed, flat sided, sides parallel or convergent; umbilicus 35–45% of diam-

eter; attains large sizes; radial ribs numerous, simple, sharp, curving forward on venter; may join to form ventral chevrons or be interrupted by smooth band on venter; sides become smooth on outer whorls, leaving faint ribs on venter only. Lower Jurassic (Hettangian, Angulata Zone): Europe, Russia (northeast), Canada (British Columbia), United States (Alaska, Nevada, Oregon), Chile, Argentina, Peru, ?New Caledonia, New Zealand.—FIG. 6.2a–b. \*S.

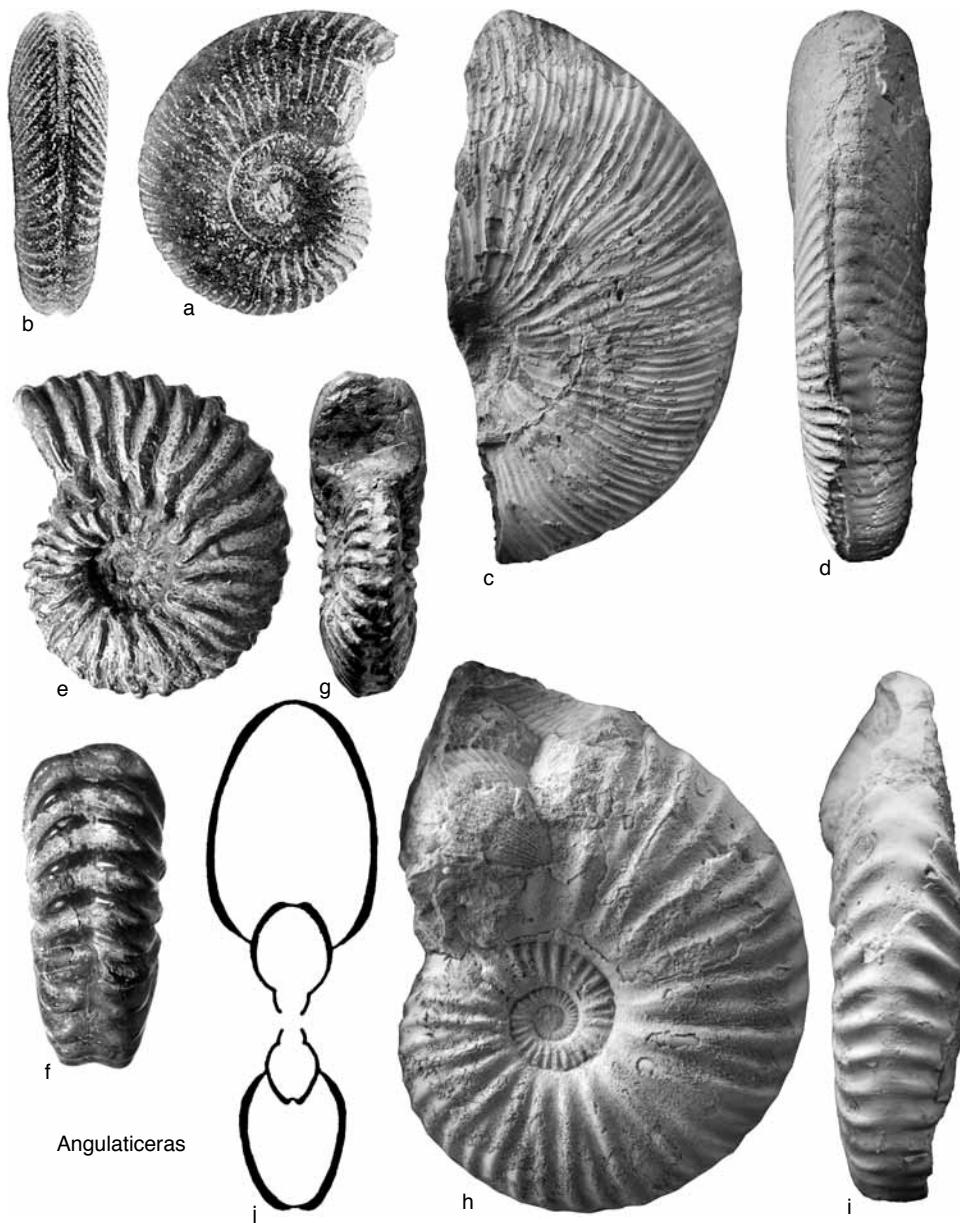


FIG. 7. Schlotheimiidae (p. 11–12).

*angulata* (SCHLOTHEIM), lectotype, Wellersen, Saxony, Germany,  $\times 1.5$  (Lange, 1951, pl. 1, 2a, 2c).—FIG. 6, 2c–d. *S. complanata* (KOENEN), holotype, Osterwald, Westphalia, Germany,  $\times 1$  (Dean, Donovan, & Howarth, 1961, pl. 64, 2a–b).

**Angulaticeras** QUENSTEDT, 1882 in 1882–1888, p. 26 [*\*Ammonites lacunatus* J. BUCKMAN, 1844, p. 105; SD LANGE, 1924, p. 203, ICZN Opinion

324, 1955b, proposed by ARKELL, 1951d, p. 226] [=*Hesperites* POMPECKJ, 1895, p. 24 (type, *H. clarae*, OD); =*Sulciferites* SPATH, 1922a, p. 30 (type, *Ammonites sulcatus* J. BUCKMAN, 1844, p. 105, pl. 11, 2, OD, non *Ammonites sulcatus* LAMARCK, 1822, p. 638, nec ZIETEN, 1830, p. 6, nec SIMPSON, 1843, p. 55–56; =*Schlotheimia sulcifera* BUCKMAN, 1911, p. 38b, OD); =*Boucaulticeras* SPATH, 1924, p. 194

(type, *Ammonites boucaultianus* D'ORBIGNY, 1844 in 1842–1851, p. 294, OD); =*Charmasseiceras* SPATH, 1924, p. 194 (type, *Ammonites charmasei* D'ORBIGNY, 1844 in 1842–1851, p. 296, OD); =*Pseudoschlotheimia* SPATH, 1924, p. 194 (type, *Schlotheimia densilobata* POMPECKJ, 1893, p. 242, OD); =*Argoceras* STEINMANN, 1925, p. 358 (type, *Ammonites boucaultianus* D'ORBIGNY, 1844 in 1842–1851, p. 294, SD DONOVAN & FORSEY, 1973, p. 4); =*Hongkongites* GRABAU, 1928, p. 774 (type, *H. hongkongensis* GRABAU, 1928, p. 774, SD ARKELL, 1957, p. 237); =*Encycloceras* BLIND, 1963, p. 80 (type, *Ammonites ventricosus* J. DE C. SOWERBY in DE LA BECHE, 1831, p. 320, OD); =*Gydanoceras* REPIN in POLUBOTKO & REPIN, 1972, p. 110 (type, *Angulaticeras kolyemicum* REPIN in EFIMOVA and others, 1968, p. 105, OD)]. Shell compressed, each whorl overlapping from about half to four-fifths of preceding whorl; umbilicus 10–35% of diameter; venter narrow to broadly rounded; many species grow to large sizes; primary ribs, which may be enlarged near umbilical margin, each giving rise to 2 or more secondary ribs, which may be straight, concave forward, or sigmoidal; secondaries may also be intercalated; venter in earliest stages is smooth, or grooved; later in ontogeny, ribs are usually continuous across the venter, on which chevrons are weak or absent; all ornament tends to disappear at large sizes (>250 mm in diameter), leaving low, irregular undulations on the side of the whorl and an evenly rounded venter; sutures become very elaborate in large, involute forms. *Lower Jurassic (upper Hettangian–Sinemurian)*: Europe, Turkey, Morocco, Tunisia, Russia (Far East, northeast), China (Tibet, Guangdong, Hong Kong), Canada (British Columbia), United States (Alaska, Nevada, Oregon), Chile, Argentina, Peru, Ecuador, New Zealand.—FIG. 7a–b. \**A. lacunatum* (J. BUCKMAN), lectotype, upper Sinemurian, Cheltenham, England, ×3 (Buckman, 1906, pl. 10, 13–14).—FIG. 7c–d. *A. boucaultianum* (D'ORBIGNY), lectotype, upper Sinemurian, *Obtusum* Zone, Champlong, Semur, Côte d'Or, France, ×0.6 (new, Museum of Comparative Zoology, Harvard, MCZ 3184; also figured in Fischer, 1994, pl. 17, 1b–c).—FIG. 7e–g. *A. sulciferum* (BUCKMAN), lectotype of *Ammonites sulcatus* J. BUCKMAN (designated by BUCKMAN, 1904b, fiche 39a), lower Sinemurian, railway cutting near Cheltenham, England, ×1.5 (new, Manchester University Museum, L.11207; also figured in Buckman, 1904b, p. 39, fig. T<sup>2</sup>, and Buckman, 1906, pl. 10, 9–10).—FIG. 7h–j. *A. charmasei* (D'ORBIGNY), lectotype, lower Sinemurian, Semur, Côte d'Or, France, ×0.8 (new, Museum of Comparative Zoology, Harvard, MCZ 3181A).

### Family ARIETITIDAE Hyatt, 1875

[nom. correct. HAUG, 1885, p. 713, pro Arietidae HYATT, 1875, p. 225, nom. conserv. ICZN Direction 14, 1955d, proposed by ARKELL, 1951a, p. 200] [=Ammonitidae BUCKMAN, 1919a, p. B, non OWEN, 1836, p. 520, suppressed by ICZN Opinion 305, 1954b, proposed by ARKELL, 1951a, p. 202]

Evolute serpenticones or planulates with simple ribs and a keel on at least the outer

whorls. Whorl section depressed, subquadrate or compressed. Rib frequency usually increases with size, but ornament may degenerate and rib frequency fall on the outer whorls of large forms. Suture comparatively simple. The Alsatitinae were chiefly a Tethyan and western North American subfamily, with only *Alsatites* itself being found in northern Europe. At the base of the Sinemurian stage, the Arietitinae spread into northern Europe and as far as Russia (northeast). Much of the later evolution of the Arietitidae and their descendants, the Echioceratidae and Oxynoticeratidae, took place in the boreal province, and some genera are restricted to it. *Lower Jurassic (Hettangian–Sinemurian)*.

#### Subfamily ALSATITINAE Spath, 1924

[nom. transl. LANGE, 1941b, p. 36, pro *Alsatiidae* SPATH, 1924, p. 200] [=Alsatiidae ROMAN, 1938, p. 85; =Proarietitinae LANGE, 1941b, p. 46]

Evolute planulates or serpenticones. Ribs simple, straight or concave forward. Venter smooth on inner whorls, with keel on outer whorls, and shallow grooves may flank the keel. Suture like that of Psiloceratidae, but developing arborescent saddles with constricted bases at larger sizes. *Lower Jurassic (Hettangian–lower Sinemurian)*.

*Alsatisites* HAUG, 1894, p. 411 [\**Ammonites liasicus* D'ORBIGNY, 1844 in 1842–1851, p. 199; OD] [=*Proarietites* LANGE, 1922, p. 461 (type, *Arietites proaries* NEUMAYR, 1879, p. 37, SD LANGE, 1924, p. 196); =*Tayloricites* GUEX, 1987, p. 466 (type, *Aegoceras crebricinctum* WÄHNER, 1886a, p. 150, OD)]. Serpentcone, whorl section compressed, circular or depressed; umbilicus more than 60% of diameter; some forms are large, with up to 9 whorls; ribs numerous and persistent, concave forward or slightly flexuous; innermost whorls may have constrictions and ventrolateral swellings; keel broad and blunt, on outer whorls only. *Lower Jurassic (Hettangian, Liassic Zone)*: Europe, Russia (northeast), Japan, Canada (British Columbia), United States (Nevada), Chile, Argentina.—FIG. 8, 1a–b. \**A. liasicus* (D'ORBIGNY), lectotype, Pouilly, Côte d'Or, France, ×0.4 (Dean, Donovan, & Howarth, 1961, pl. 63, 3).

*Goniptychoceras* LANGE, 1941b, p. 47 [\**Aegoceras goniptychum* WÄHNER, 1886a, p. 203; OD] [=*Proarnioceras* BLIND, 1963, p. 104 (type, *Arnioceras altovale*, OD); ?= *Alsatioides* GUEX, 1980, p. 130 (type, *A. coronoides*, OD)]. Evolute planulates, up to 7 whorls, umbilicus about 45% of diameter on inner whorls to 55% on outer

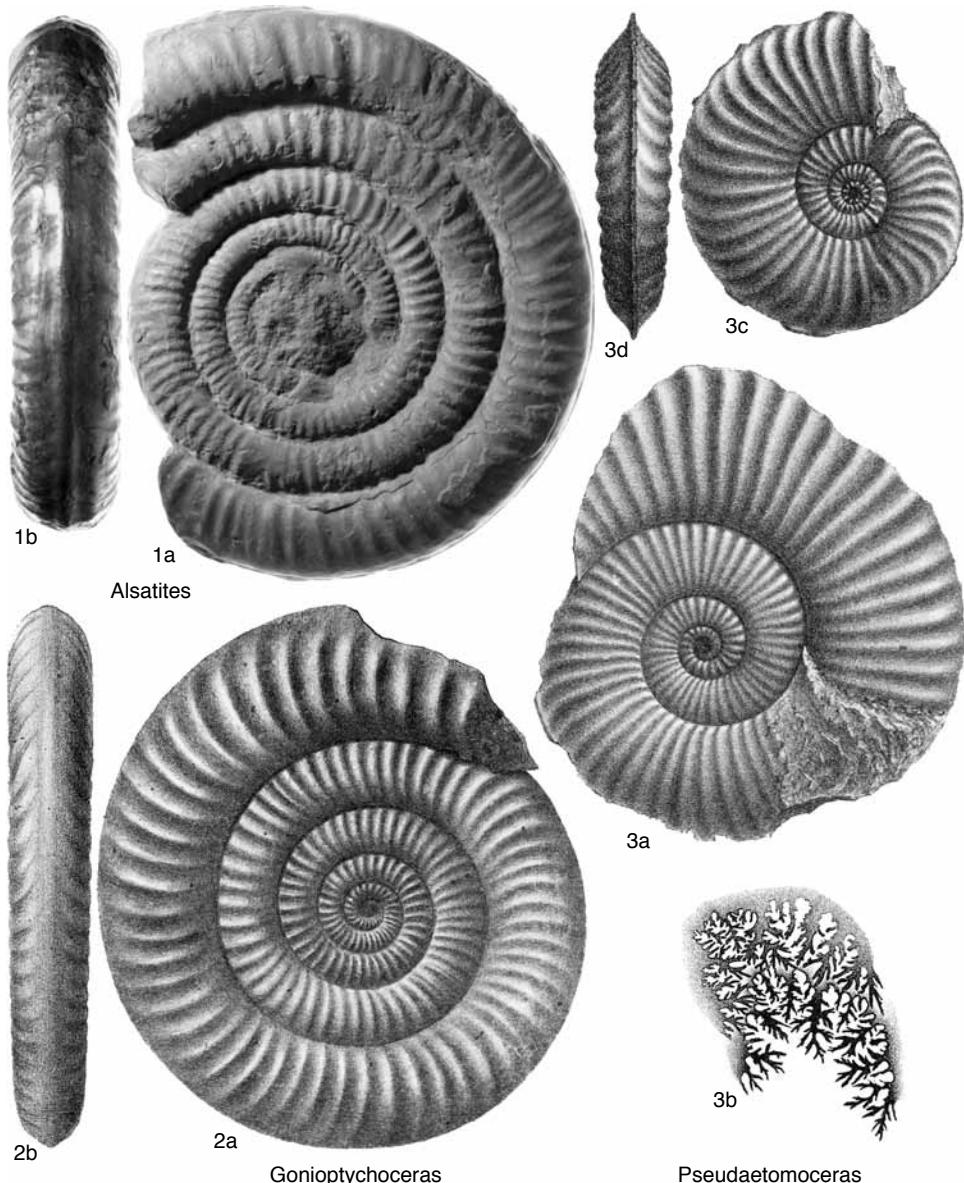


FIG. 8. Arietitidae (p. 12–14).

whorls; keel blunt; ribs strong, straight or slightly curved, swinging forward over venter; suture may be asymmetrical. More involute than *Alsatites*. Lower Jurassic (Hettangian): Austria, United States (Nevada, Oregon).—FIG. 8,2a–b. \**G. goniptychum* (WÄHNER), holotype, *Psiloceras megastoma* limestone, Schreinbach, Wolfgangsee, Austria,  $\times 0.75$  (Wähner, 1886a, pl. 27 (27),5).

*Pseudaetomoceras* SPATH, 1923b, p. 77 [\**Arietites abnormilobatus* WÄHNER, 1886b, p. 59; OD]

[= *Pseudaetomoceras* ROMAN, 1938, p. 85, nom. null., misspelling]. Planulates, with at least 7 whorls; whorls overlap by 20–33% and umbilicus 35–60% of diameter; whorl section high and compressed; keel blunt or sharp; ribs numerous, curving forward at both ends; suture develops arborescent saddles with constricted bases. Lower Jurassic (Hettangian): southern Germany, Austria, Canada (British Columbia), United States (Nevada), Chile, Argentina.—FIG. 8,3a–d. \**P.*

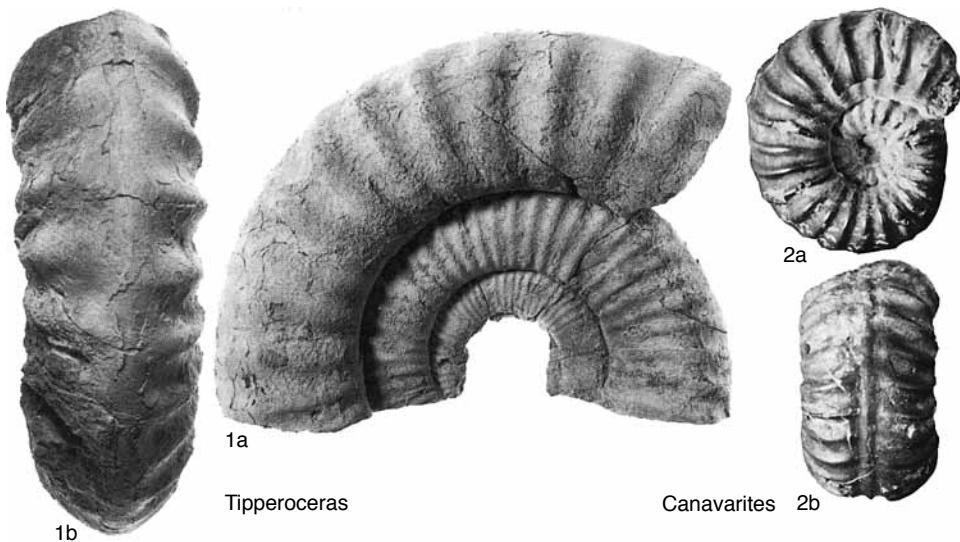


FIG. 9. Arietitidae (p. 14).

*abnormilobatus* (WÄHNER); *a–b*, lectotype (designated by SPATH, 1923b, p. 77), *Psiloceras megastoma* limestone, Breitenberg, Bavaria, Germany; *a*, side view,  $\times 1$ ; *b*, first lateral saddle of suture,  $\times 4$  (Wähner, 1886b, pl. 23 (38),*5a–b*); *c–d*, paralectotype, *Schlotheimia marmorea* horizon, Schreinbach, Wolfgangsee, Austria,  $\times 1$  (Wähner, 1886b, pl. 23 (38),*6a–b*).

**Tipperoceras** TAYLOR, 1998, p. 494 [*\*T. mullerense*; OD]. Evolute, compressed inner whorls have arched venter with keel and many straight or slightly curved ribs; outer whorl is stout and trigonal, with a slight keel and fewer, much stronger ribs. Derived from *Pseudaeatomoceras* but has straighter ribs on inner whorls and thicker, strongly ribbed outer whorl. Lower Jurassic (lower Sinemurian): United States (Nevada), ?New Zealand.—FIG. 9, *1a–b*. *\*T. mullerense*, holotype, New York Canyon,  $\times 0.33$  (Taylor, 1998, fig. 23-3, 23-4).

**Canavarites** HYATT, 1900, p. 577 [*\*C. discretum*; OD under ICZN Code (1999) Art. 11.10; =*Arietites discretus* CANAVARI, 1882, p. 182 (60), non *Ammonites discretus* J. DE C. SOWERBY IN DE LA BECHE, 1831, p. 320 (see DONOVAN & FORSEY, 1973, p. 8)]. Shell small, cadicone, with at least 6 whorls; evolute, rapidly expanding, with depressed whorl section, and umbilicus one-third to one-half of diameter; a ventral keel on outer whorls is flanked by grooves; straight ribs curve forward onto the venter. Lower Jurassic (upper Hettangian–lower Sinemurian): northern Italy, eastern Alps.—FIG. 9, *2a–b*. *\*C. discretum*, lectotype, near La Spezia, Tuscany, Italy,  $\times 2$  (new, Geological Museum, Pisa, Italy, no. i 1889; also figured in Donovan & Forsey, 1973, pl. 1, 3).

### Subfamily ARIETITINAE Hyatt, 1875

[nom. transl. et correct.. ARKELL, 1950, p. 359, ex Arietitidae HYATT, 1875, p. 225] [=Ammonitidae SPATH, 1924, p. 202, non OWEN, 1836; =Arnioceratidae SPATH, 1924, p. 205]

Arietitidae with ventral grooves flanking the keel at some stage in ontogeny; these grooves may degenerate on outer whorls of large specimens. Ribs simple, some bearing tubercles at outer ends. Lower Jurassic (Hettangian–Sinemurian).

**Vermiceras** HYATT, 1889, p. 154 [*\*Ammonites spiratissimus* QUENSTEDT, 1851, p. 355; SD SPATH, 1924, p. 202] [=Discoceras HYATT, 1867, p. 76, non BARRANDE, 1867, p. 177 (type, *Ammonites conybeari* J. SOWERBY, 1816, p. 70, SD ARKELL, 1957, p. 239); =*Protocymbites* SPATH, 1923b, p. 77 (type, *P. waehneri*, OD); =*Metaphioceras* SPATH, 1924, p. 202 (type, *Ammonites conybeari* J. SOWERBY, 1816, p. 70); =*Diplosellites* BUCKMAN, 1925a, pl. 571 (type, *D. rotarius*, OD); =*Keynshamites* BUCKMAN, 1926, pl. 653A (type, *K. keelingi*, OD); =*Dalaticeras* MEISTER, KHUC, & TRAN HUYEN, 2002, p. 456 (type, *D. flexuosum*, OD)]. Serpenticones with up to 9 whorls and umbilicus usually more than 60% of diameter. Ribbing close, frequency increasing with size. Distinguished from the slightly later genus *Coroniceras* by lack of tubercles on all whorls, except on innermost whorls of subgenus *Gyrophioceras*. Lower Jurassic (Hettangian–lower Sinemurian, Bucklandi Zone): Europe, Tunisia, Vietnam, China (Tibet), Japan, Indonesia, Canada (British Columbia), United States (Nevada, Oregon, ?California), Mexico, Chile, Argentina, Peru, New Zealand.

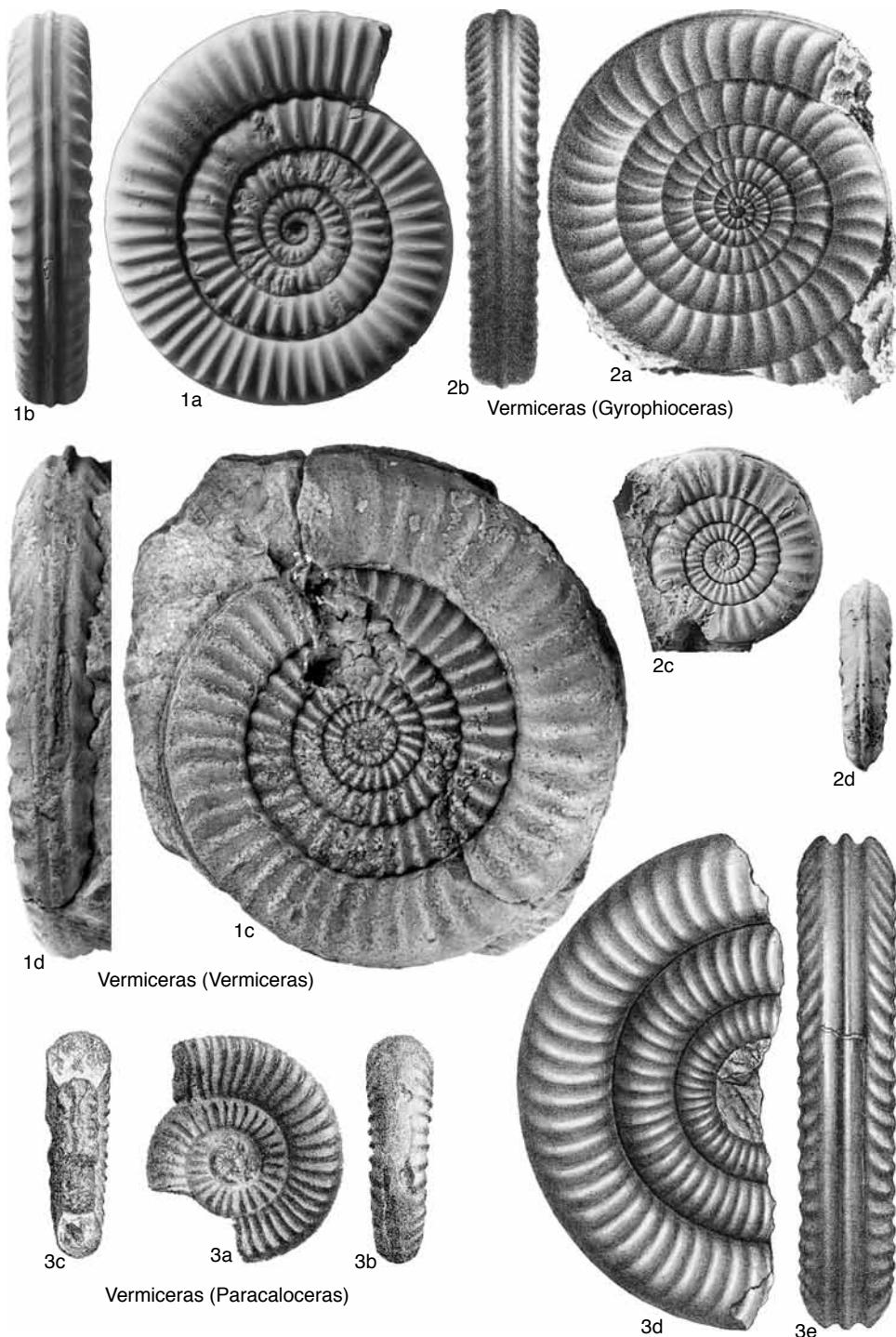


FIG. 10. Arietitidae (p. 14–16).

- V. (Vermiceras).** Serpenticones; umbilicus of adult usually more than 60% of diameter, and as much as 70% in some; adults may reach large sizes and have 7–9 whorls; venter smooth on innermost whorls, but keel appears on or before fourth whorl at about 30 mm in diameter, and shallow, rudimentary grooves flanking the keel appear later in ontogeny; ribs begin on first or second whorls and then persist throughout; ribs are straight to slightly concave forward and increase in frequency steadily, with growth to 45–70 per whorl on outer whorls. *Lower Jurassic (Hettangian–lower Sinemurian, Bucklandi Zone)*: geographic range as for genus. —FIG. 10, 1a. \**V. (V.) spiratissimum* (QUENSTEDT), neotype, Lias a, Reutlingen, Württemberg, Germany, ×1 (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5.12.7). —FIG. 10, 1b–d. *V. (V.) conybeari* (J. SOWERBY), holotype, Bath, Avon, England, ×0.7 (new, The Natural History Museum, London, BMNH 43971).
- V. (Gyrophioceras)** SPATH, 1924, p. 201 [\**Arietites praespiratissimus* WÄHNER, 1886b, p. 50; OD]. Differs from *V. (Vermiceras)* in having large, widely spaced round tubercles on innermost whorls up 5–6 mm in diameter, and ribs on larger whorls are more strongly concave forward, especially at the ventral ends. *Lower Jurassic (upper Hettangian–lower Sinemurian)*: Europe, Peru, New Zealand. —FIG. 10, 2a–d. \**V. (G.) praespiratissimus* (WÄHNER); a–b, lectotype (now lost; designated by SPATH, 1924, p. 201), Adnet, Austria, ×1 (Wähner, 1886b, pl. 21 (36), 2a–b); c–d, paralectotype, Kammerkörälpe, Lofer, northern Austria, ×1 (Bloos, 1994, pl. 3, 5a–b).
- V. (Paracaloceras)** SPATH, 1923b, p. 77 [\**Ammonites coregonensis* J. DE C. SOWERBY IN DE LA BECHE, 1831, p. 318; OD] [=*Alpinoceras* LANGE, 1941b, p. 47 (type, *Ammonites baueri* GÜMBEL, 1861, p. 473, OD); =*Centauroceras* BLIND, 1963, p. 94 (type, *Ammonites centauroides* SAVI & MENEGHINI, 1851, p. 75, OD)]. Differs from *V. (Vermiceras)* in having more strongly curved ribs throughout; the venter of innermost whorls is rounded and is crossed by ribs or chevrons of low relief, then a larger ventral keel flanked by more prominent grooves is developed on later whorls. *Lower Jurassic (upper Hettangian–lower Sinemurian)*: Europe, Indonesia (Timor, Roti), United States (Alaska, Nevada), Mexico, Chile, Argentina, Peru. —FIG. 10, 3a–e. \**V. (P.) coregonense* (J. DE C. SOWERBY); a–c, neotype (designated by DONOVAN & FORSEY, 1973, p. 7), near La Spezia, Tuscany, Italy, ×1 (Canavari, 1882, pl. 19, 15a–c); d–e, marmorea limestone, Hinter-Mandling, Austria, ×0.7 (Wähner, 1888, pl. 23 (42), 1a–b).

**Schreinbachites** BLOOS, 1994, p. 16 [\**Arietites retroversicostatus* CANAVARI, 1882, p. 177; OD]. Small serpenticones, up to approximately 60 mm in diameter in complete adults; whorl section rounded, depressed on inner whorls, becoming less depressed

in adult; venter has low rounded keel, flanked by flat areas or rudimentary sulci; bold, irregular, broad ribs on innermost whorls become more slender, rursiradiate and more frequent on middle and outer whorls, and striate to smooth near adult mouth border; suture simple and asymmetric in some. *Lower Jurassic (Hettangian, Angulata Zone)*: southern Germany, Luxemburg, Austria, Italy. —FIG. 12, 3a–b. \**S. retroversicostatus* (CANAVARI), lectotype (designated by GUÉRIN-FRANIATTE, 1990, p. 162), Campiglia, La Spezia, Italy, ×1 (Bloos, 1994, pl. 4, 8a–b).

**Coroniceras** HYATT, 1867, p. 77 [\**Ammonites kridion* ZIETEN, 1830 in 1830–1833, p. 4; SD BONARELLI, 1900, p. 58 (ICZN Opinion 324, 1955b, proposed by ARKELL, 1951d, p. 227)] [=*Paranioceras* SPATH, 1922a, p. 30 (type, *Ammonites alcinoe* REYNÉS, 1879, pl. 23, OD); =*Arnioceratooides* SPATH, 1922b, p. 176, obj.; =*Epmamonites* SPATH, 1922b, p. 173 (type, *E. latisulcatus* SPATH, OD, according to Article 11.10, ICZN Code, 1999), =*Arietites latisulcatus* SCHMIDT, 1914, p. 22, non QUENSTEDT, 1883, p. 85); =*Primarietites* BUCKMAN, 1926, pl. 678 (type, *P. primitivus*, OD); =*Saccaciaceras* VENTURI & NANNARONE, 2002, p. 151 (type, *S. pauciflexum*, OD)]. Serpenticones, with subquadrate or compressed whorl section, and keeled and bisulcate venter; reaches large sizes, and has about 9 whorls; ribs tuberculate on inner whorls, but tubercles commonly fade on outer whorls; rib frequency increases with size, but may fall on last 1 or 2 whorls. [*Saccaciaceras* is based on indeterminate inner whorls of *Coroniceras* s.l.]. *Lower Jurassic (lower Sinemurian, Bucklandi–Semicostatum Zones)*: Europe, Caucasus, Russia (northeast), China (Guangdong), Vietnam, ?Indonesia, Canada (British Columbia, Yukon), United States (Alaska, Nevada), Mexico, Chile, Argentina, Peru, Colombia, New Zealand.

**C. (Coroniceras).** Serpenticones, with up to 9 whorls, and some species reach large sizes; umbilicus increases slightly in relative size with growth and is 45–65% of diameter in adult; whorl thickness equal to or less than height; ribbing persists throughout, and ribs bear tubercles at outer ends on some or all whorls; rib frequency increases steadily with growth on earlier whorls, but may fall on last 1 or 2 whorls in some species; maximum number of ribs per whorl ranges from 30 to 60. *Lower Jurassic (lower Sinemurian, Bucklandi–Semicostatum Zones)*: geographic range as for genus. —FIG. 11, 1a–b. \**C. (C.) kridion* (ZIETEN), holotype, Lias a, Württemberg, Germany, ×1.25 (new, Bayerische Staatssammlung für Paläontologie und Geologie, Munich). —FIG. 11, 1c–d. *C. (C.) rotiforme* (J. DE C. SOWERBY), holotype, Blue Lias, Somerset, England, ×0.4 (new, The Natural History Museum, London, BMNH 43975).

**(Arietites)** WAAGEN, 1869, p. 247 [\**Ammonites bucklandi* J. SOWERBY, 1816, p. 69; OD; ICZN Opinion 305, 1954b, proposed by ARKELL,

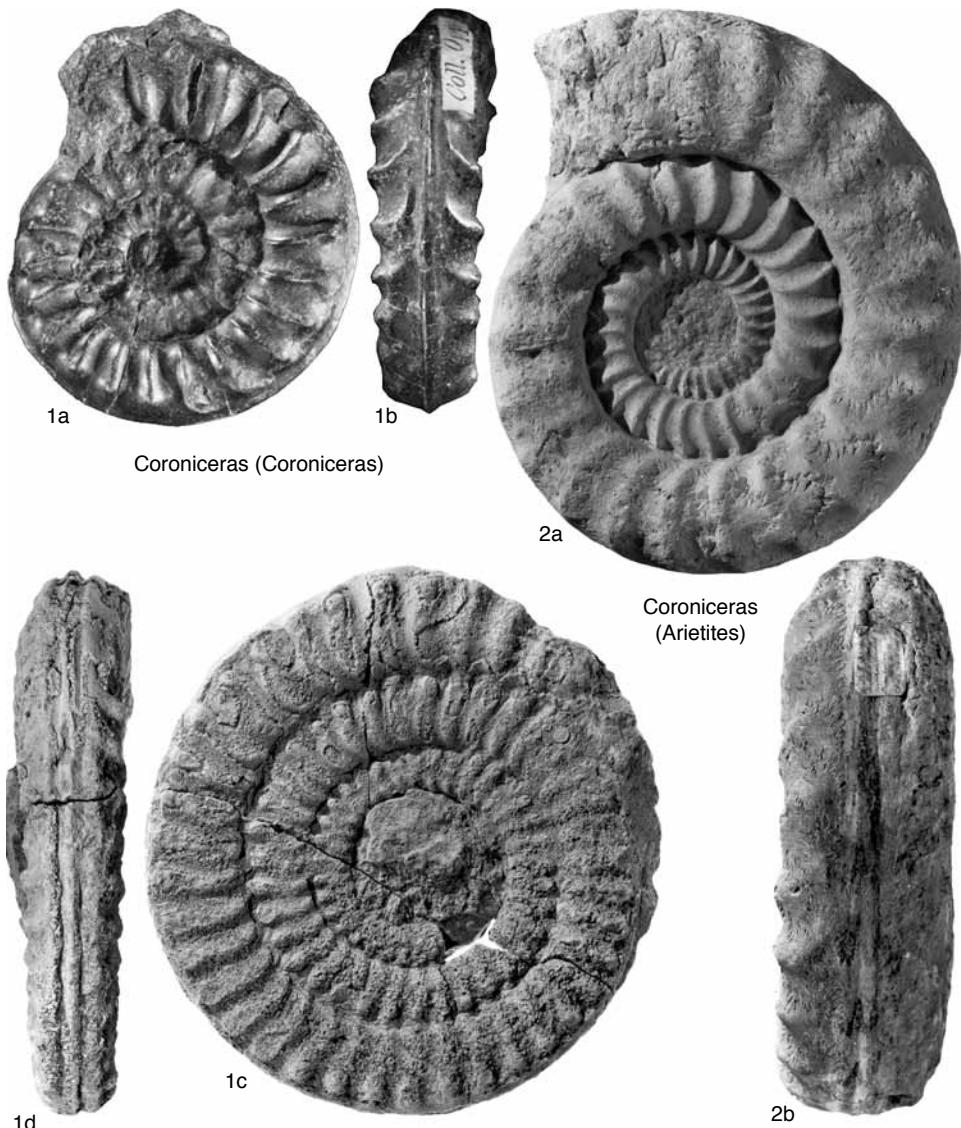


FIG. 11. Arietitidae (p. 16–17).

1951a, p. 202] [=*Arieticeras* QUENSTEDT, 1882 in 1882–1888, p. 44, obj., nom. van., non SEGUENZA, 1885, ICZN Opinion 337, 1955c, p. 111; =*Megarietites* SPATH, 1922b, p. 174 (type, *Ammonites meridionalis* REYNES, 1879, pl. 22, OD); =*Arietitites* SPATH, 1924, p. 204, nom. null., misspelling]. Large *Coroniceras* with thick subquadrate outer whorls; rib frequency decreases from 20–40 on inner whorls to 20–30 on outer whorls; tubercles weak, and absent on outer whorls. Lower Jurassic (lower Sinemurian, Bucklandi–Semicostatum Zones): Europe (north

of Alps), Russia (northeast), Vietnam, Indonesia (Timor, Roti, Buton, Sulawesi), Canada (British Columbia), United States (Alaska), Chile.—FIG. 11,2a–b. \**C. (A.) bucklandi* (J. SOWERBY), neotype, *Bucklandi* Zone, Keynsham, Avon, England, ×0.15 (new, The Natural History Museum, London, BMNH C.41796).

**C. (Eucoroniceras)** SPATH, 1922b, p. 176 [\*=*Ammonites sinemuriensis* D'ORBIGNY, 1844 in 1842–1851, p. 303; OD] [=?*Pseudasteroceras* SPATH, 1922b, p. 172 (type, *Ammonites stellaeformis* GÜMBEL, 1861, p. 474, OD)]. *Coroniceras* with

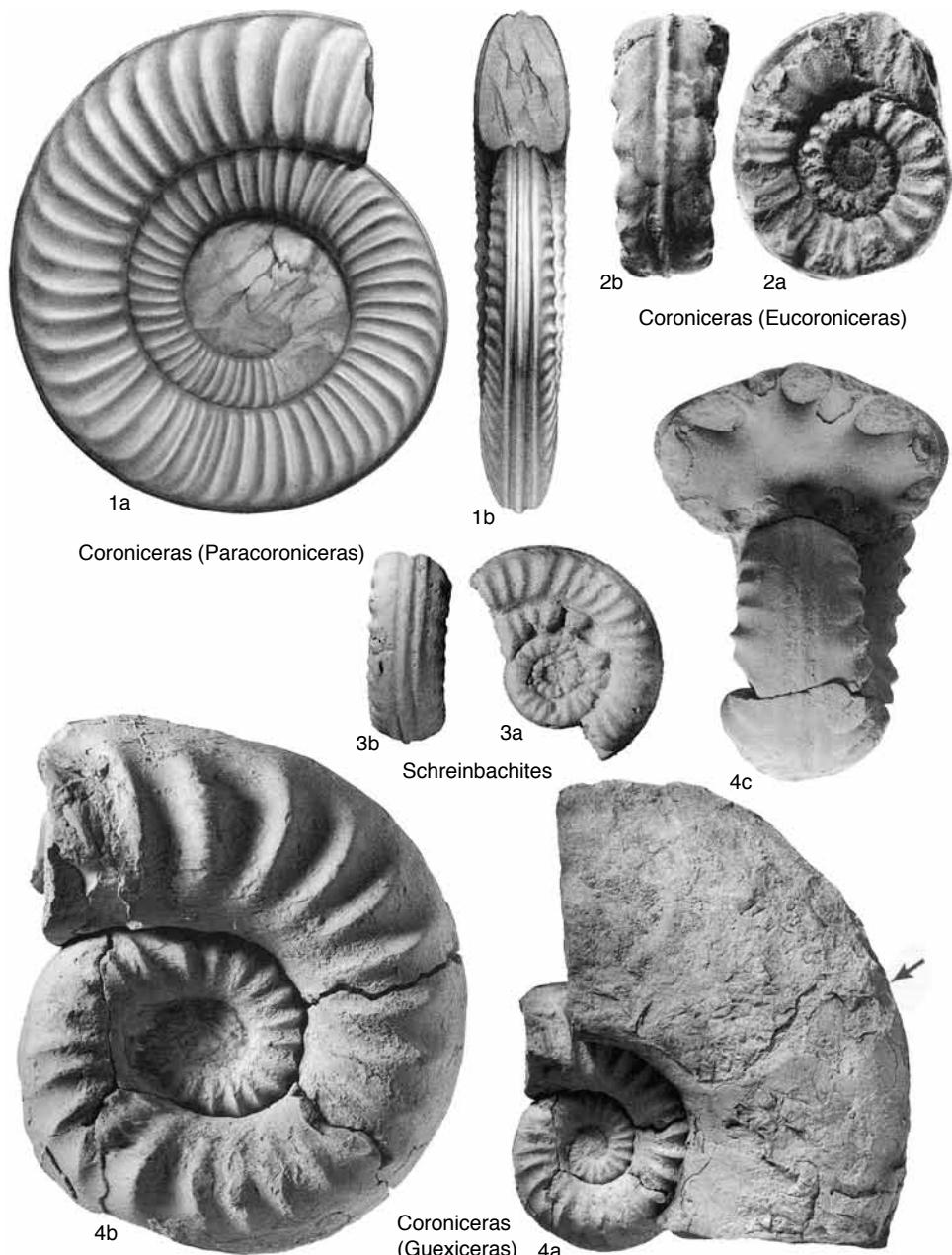


FIG. 12. Arietitidae (p. 16–20).

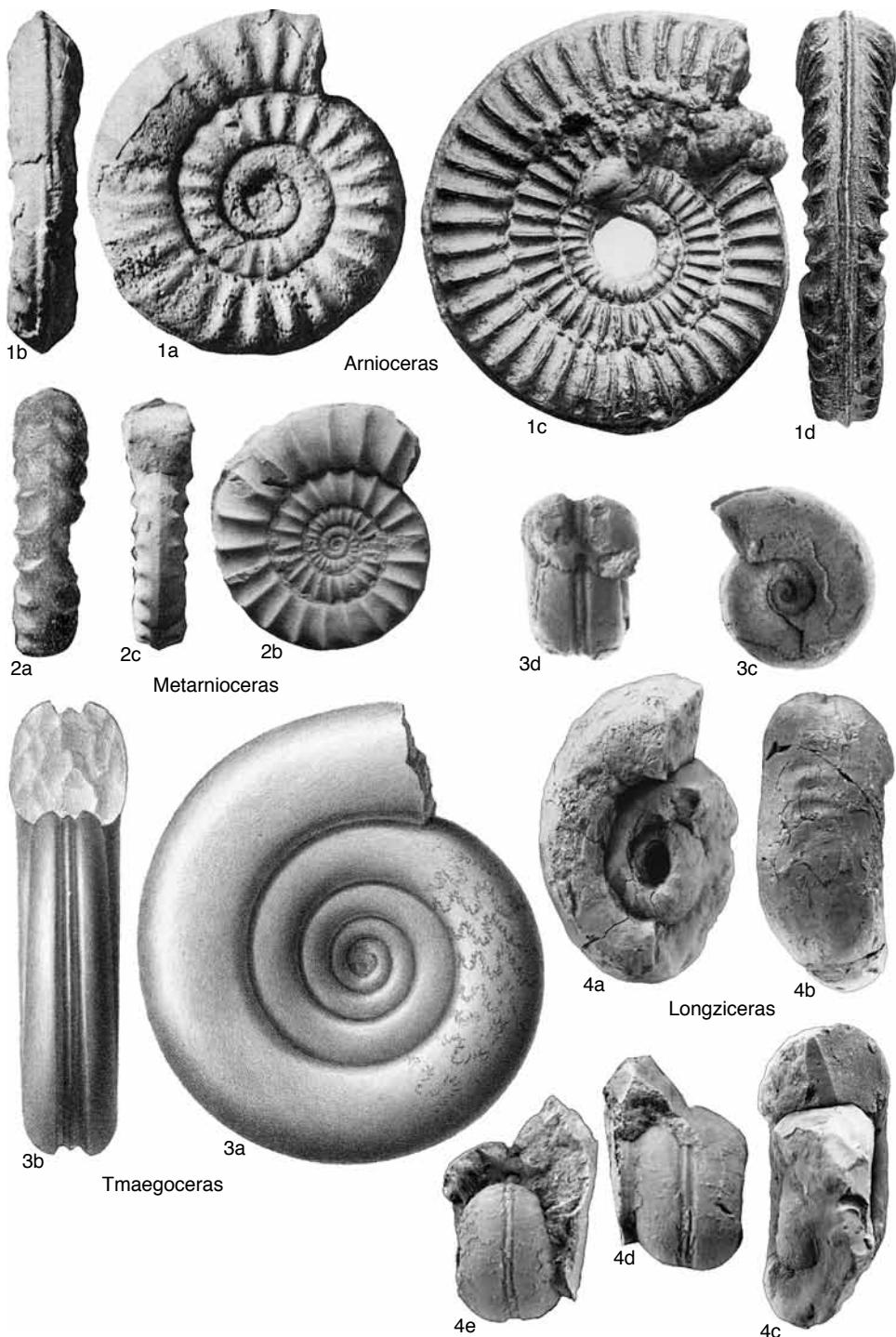


FIG. 13. Arietitidae (p. 20–21).

- paired ribs, each pair joined at ventral ends to an elongated tubercle; normal ribs may be intercalated between the pairs; the paired ribs are usually restricted to inner whorls; inner whorls quadrate in section; outer whorls indistinguishable from those of *C. (Coroniceras)*. *Lower Jurassic (lower Sinemurian, Semicostatum Zone)*: Europe, Vietnam, Peru, Colombia.—FIG. 12,2a–b. \**C. (E.) sinemuriense* (d'ORBIGNY), neotype (designated by DONOVAN & FORSEY, 1973, p. 6), St. Euphrône, Côte d'Or, France, ×1.5 (Guérin-Franiatte, 1966, pl. 74,2a–b).
- C. (Paracoroniceras)** SPATH, 1922b, p. 173 [*\*Ammonites gmuendensis* REYNÈS, 1879, pl. 16,1–2; SD LANGE, 1925, p. 470, non OPPEL, 1856, p. 80, =*P. charlesi* DONOVAN, 1955, p. 12 (see DONOVAN & FORSEY, 1973, p. 6)]. Reaches large sizes and has about 9 whorls; early whorls compressed, outer whorls tend to a trigonal cross section, with some loss of ornament; ribs straight to gently curving; rib frequency rises to 35–60 per whorl on middle whorls, then falls on outer whorls. *Lower Jurassic (lower Sinemurian, Semicostatum Zone)*: Europe, north of Alps, Russia (northeast), United States (Alaska, ?California), Argentina, Peru.—FIG. 12,1a–b. \**C. (P.) charlesi* (DONOVAN), holotype, ?Stuttgart, Württemberg, Germany, ×0.35 (Reynès, 1879, pl. 16,1–2; original specimen also figured in Guérin-Franiatte, 1966, pl. 38).
- C. (Guexiceras)** TAYLOR, 1998, p. 486 [*\*G. profundus*; OD]. Derivative of *Coroniceras* with rapidly expanding whorls, in which the middle whorls from 25–100 mm in diameter are evolute and strongly depressed, almost cadicone, and have strong forwardly curved ribs without tubercles; the outer whorl is more involute, compressed, and subtrigonal, and is nearly smooth. *Lower Jurassic (lower Sinemurian)*: United States (Nevada).—FIG. 12,4a–c. \**C. (G.) profundus*, holotype, New York Canyon; *a*, septate up to position of arrow, ×0.375; *b–c*, septate inner whorls, ×0.75 (Taylor, 1998, fig. 17.1–17.3).
- Arnioceras** HYATT, 1867, p. 73 [*\*A. cuneiforme*; SD ICZN Opinion 307, 1954c, proposed by ARKELL, 1951c, p. 219] [=*Arniotites* WHITEAVES, 1889, p. 144 (type, *Celtites ? vancouverensis* WHITEAVES, 1887, p. 110B, OD); =*Amioceras* SPATH, 1919, p. 68, nom. null., misspelling; =*Eparnioceras* SPATH, 1924, p. 190 (type, *Ammonites semicostatus* YOUNG & BIRD, 1828, p. 257, OD); ?= *Melanippites* CRICKMAY, 1928, p. 61 (type, *M. harbledownensis*, OD); =*Arniococeras* ARKELL, 1951c, p. 219, nom. null., misspelling; =*Melanippites* CRICKMAY, 1962, p. 10, nom. van.; =*Burkhardiceras* LOPEZ, 1967, p. 28 (type, *Arnioceras fallaxoides* ERBEN, 1956, p. 240, OD); =*Laevispirus* VENTURI & NANNARONE, 2002, p. 148 (type, *Arietites ambiguus* GEYER, 1886, p. 252, OD)]. Serpenticones, with up to 7 whorls; umbilicus 42–60% of diameter in small forms, always more than 50% at diameters over 5 cm; whorls compressed, thickness 70–100% of whorl height; ventral keel sharp, flanked by well-defined grooves on outer whorls of most species; innermost whorls smooth, later whorls may be smooth or ribs may appear at varying diameters; ribs straight, sharp, radial, usually prominent at umbilical edge, may become concave forward on last whorls, and outer whorls have 30–60 ribs. *Lower Jurassic (Sinemurian, Semicostatum–Obtusum Zones)*: Europe, northern Africa (Atlas Ranges), Tunisia, Caucasus, Russia (northeast), China (Tibet, Guangdong), Vietnam, Japan, Indonesia (Timor, Roti, ?New Guinea), New Zealand, New Caledonia, Canada (British Columbia, Alberta, Yukon), United States (Alaska, Nevada, California), Chile, Argentina, Peru, Ecuador, Colombia.—FIG. 13,1a–b. \**A. cuneiforme*, holotype, lower Sinemurian, Auxois region, France, ×1 (Guérin-Franiatte, 1966, pl. 135,1a–b).—FIG. 13,1c–d. *A. bodleyi* (J. BUCKMAN), Lower Lias Clay, topotype (but probably a syntype, and available for selection as lectotype), Gloucestershire, England, ×1 (Buckman, 1904b, no. 36, fig. T<sup>1</sup>, T<sup>1b</sup>).
- Metarnioceras** SPATH, 1925a, p. 359 [*\*M. sheppardi*; OD]. Small evolute serpenticones, with subquadrate whorl section; slightly arched venter has a low keel, which may bear faint chevrons, bordered by smooth or slightly subsulate bands; smooth innermost whorls followed by whorls with sharp, straight ribs; sutures have long, nearly parallel-sided lateral saddles. Differs from *Arnioceras* in having a shorter smooth stage on inner whorls and very shallow or no sulci bordering the keel. *Lower Jurassic (Sinemurian)*: England, ?Mexico.—FIG. 13,2a. \**M. sheppardi*, holotype, Glacial drift, Holderness, Yorkshire; the holotype, originally in Hull Museum, England, was destroyed, and this is the only surviving figure; ventral view, ×1 (Spath, 1925a, p. 359, fig. 11b).—FIG. 13,2b–c. *M. neera* (REYNÈS), Drift (Robin Hood's Bay), Yorkshire, England, ×1 (Getty, 1973, pl. 1,10).
- Tmaegoceras** HYATT, 1889, p. 125 [*\*Ammonites late-sulcatus* HAUER, 1856, p. 44; SD POMPECKJ, 1901, p. 158]. Serpenticone with rounded to strongly depressed whorl section; rounded venter has a deep central groove that contains a low central keel; no ribs. [See GEBHARD and SCHLATTER (1977).] *Lower Jurassic (?upper Hettangian, lower Sinemurian)*: southern England, eastern France, southern Germany, Austria, Italy, China (Tibet), United States (Nevada).—FIG. 13,3a–b. \**T. late-sulcatum* (HAUER), lectotype, lower Sinemurian, Adneth, Austria, ×0.8 (Hauer, 1856, pl. 9,1–2).—FIG. 13,3c–d. *T. crassiceps* (POMPECKJ), lower Sinemurian, Aldingen, Spaichingen, southern Germany, ×1 (Gebhard & Schlatter, 1977, pl. 1,3).
- Longiceras** WANG & HE, 1981, p. 327 [*\*L. longziense*; OD]. Cadicone inner whorls, with depressed whorl section, rounded venter and ventral groove that contains a small median keel, like *Tmaegoceras*; the keel is lost on outer whorls, which are more evolute, and have a smooth venter crossed by weak transverse folds; ribs absent throughout. *Lower Jurassic (Sinemurian)*: China (Tibet, eastern Himalayas).—FIG. 13,4a–e. \**L. longziense*, holotype, Ridang, Lhunze,

southern Xizang; *a–c*,  $\times 1$ ; *d–e*, inner whorls,  $\times 1.5$   
(Wang & He, 1981, p. 327, pl. 3, 1–5).

### Subfamily AGASSICERATINAE Spath, 1924

[*nom. transl.* ARKELL, 1957, p. 238, ex Agassiceratidae SPATH, 1924, p. 207]

Arietitidae characterized by simplification of ornament and sutures as compared with their supposed ancestors, the Arietitinae. Venter flat or fastigiate; keel reduced, although usually present, but ventral grooves usually absent. Both included genera are founded on small type species, but both also include large forms reaching at least 400 mm in diameter. Lower Jurassic (lower Sinemurian, probably restricted to Semicostatum Zone).

**Agassiceras** HYATT, 1875, p. 225 [*\*Ammonites scipionianus* d'ORBIGNY, 1844 in 1842–1851, p. 207; SD BUCKMAN, 1894, p. 362, ICZN Opinion 324, 1955b, proposed by ARKELL, 1951d, p. 226] [=Agassiceras FISCHER, 1879, p. 252, *nom. van.*; =Aetomoceras HYATT, 1900, p. 575, *obj.*; =Agassizioceras BUCKMAN, 1904b, p. 26a, *nom. null.*, misspelling]. Platycone, with at least 7 whorls; earliest whorls circular in section, becoming compressed with fastigiate venter; umbilicus 33–40% of diameter in adult; whorl thickness about two-thirds of whorl height; ribs straight, radial, occasionally joined in pairs at dorsal ends; ribbing may fade on outer whorls of large specimens; rib frequency rises on inner whorls, then becomes stable or falls slightly on outer whorls. Lower Jurassic (lower Sinemurian, Semicostatum Zone): Europe, Canada (British Columbia), ?Mexico, Chile, Argentina, Colombia.—FIG. 14, *1a–d*. *\*A. scipionianum* (d'ORBIGNY); *a–b*, lectotype, Mont-de-Lans, Isère, France,  $\times 1$  (Fischer, 1994, pl. 16, *1a, 1c*); *c–d*, Robin Hood's Bay, Whitby, Yorkshire, England,  $\times 1$  (Dean, Donovan, & Howarth, 1961, pl. 65, *3a–b*).

**Eugassiceras** SPATH, 1924, p. 208 [*\*Ammonites sauzioneanum* d'ORBIGNY, 1844 in 1842–1851, p. 304; OD] [=Paracoronites BUCKMAN, 1927b, pl. 737 (type, *P. noduliferus*, OD); =Paraconites DACQUE, 1934 in 1933–1934, p. 284, *nom. null.*, misspelling; ?=Claviceras VENTURI & NANNARONE, 2002, p. 153 (type, *C. lateclavatum*, OD); ?=Pseudagassiceras DOMMERGUES, MEISTER, & JAILLARD, 2004, p. 360 (type, *P. equadorensis*, OD, indeterminate)]. Shell evolute, with quadrate or subcircular whorl section; umbilicus 35–55% of diameter; keel weak and ventral grooves vestigial or absent; ribs straight, radial, weak on whorl side, with prominent ventral ends on quadrate-whorled species, or reduced to striae; rib frequency increases with growth on inner whorls, then becomes stable at 15–35 ribs per whorl; secondary ribs forming chevron ornament may be present on venter. Lower Jurassic (lower Sinemurian, Semicostatum Zone): Europe, Mexico, Argentina, Ecuador, Colombia.—FIG.

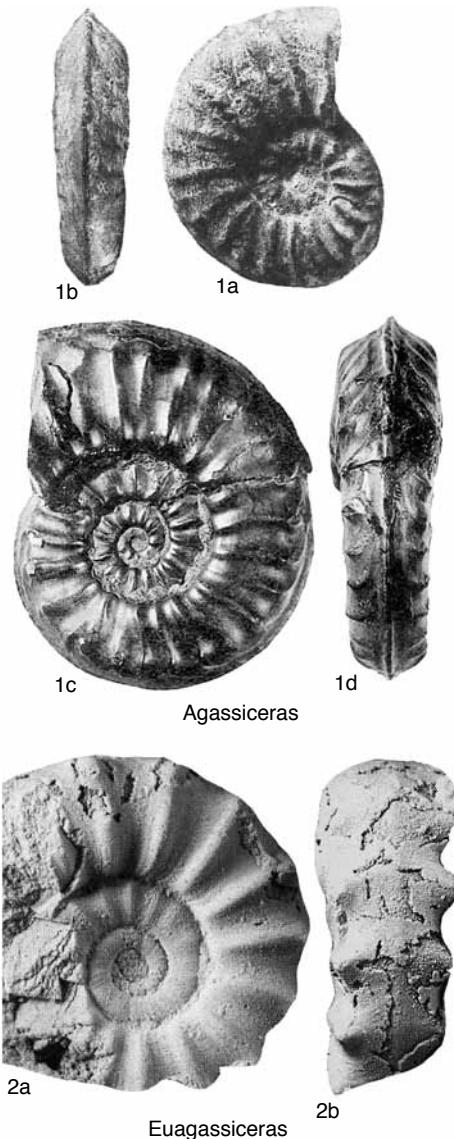


FIG. 14. Arietitidae (p. 21).

14, *2a–b*. *\*E. sauzioneanum* (d'ORBIGNY), holotype, Lias inférieur, Champlong, Semur-en-Auxois, Côte d'Or, France,  $\times 1.8$  (Fischer, 1994, pl. 16, 3).

### Subfamily PSEUDOTROPITINAE Donovan & Forsey, 1973

[*Pseudotropitinae* DONOVAN & FORSEY, 1973, p. 8]

Arietitidae with cadicone shells and tubercles at edge of umbilicus. Lower Jurassic (lower Sinemurian).

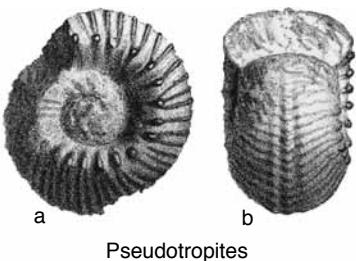


FIG. 15. Arietitidae (p. 22).

**Pseudotropites** WÄHNER, 1894, p. 24 [*\*Tropites ultratriasicus* CANAVARI, 1882, p. 184; OD]. Cadicones, with 5 or more whorls, a craterlike umbilicus and a broad arched venter; a low keel in the middle of the venter is flanked (on the last whorl) by shallow grooves; ribs on the umbilical wall end at lateral tubercles, from which issue 1, 2, or occasionally 3 prosirradiate ribs that are continuous across the venter and across the low keel and shallow grooves. Lower Jurassic (lower Sinemurian): northern Italy, Austria (eastern Alps).—FIG. 15a–b. *\*P. ultratriasicus* (CANAVARI), lectotype, La Spezia, Italy,  $\times 1$  (Canavari, 1882, pl. 21 (7), 5a–b).

#### Subfamily ASTEROERATINAE Spath, 1946

[*nom. transl.* ARKELL, 1950, p. 361, ex Asteroceratidae SPATH, 1946, p. 496]

Arietitidae with broad, rounded keel that, in some genera, is flanked by grooves. Keel and grooves commonly weak on outer whorls, and in some forms (*Aegasteroceras*, *Epophioceras*) are vestigial throughout ontogeny. Ribs sharp or blunt, either curving forward toward the venter and becoming tangential to the periphery of the shell (*Caenisites*, *Eparietites*) or making a distinct angle with the periphery. Suture has broad, often weakly indented saddles.

The subfamily comprises all the Arietitidae in the *Turneri* and *Obtusum* Zones of the Sinemurian in northwestern Europe. Lower Jurassic (Sinemurian).

**Caenisites** BUCKMAN, 1925a, pl. 572 [*\*C. caeneus*; OD; a malformed specimen of *Ammonites plotti* REYNÉS, 1879, pl. 36] [=Euasteroceras DONOVAN, 1953, p. xiii (type, *Ammonites turneri* J. DE C. SOWERBY, 1824, p. 75, OD, ICZN Opinion 482, 1957b, proposed by ARKELL & DONOVAN, 1954, p. 365)]. Evolute serpenticones to more involute forms, with each whorl covering about two-fifths of the preceding whorl; about 8 whorls and reaches large sizes; whorl section quadrate to compressed;

umbilicus 35% to more than 50% of diameter; venter keeled, bisulcate; ribs straight or concave forward, curving forward on shoulders of whorl to become tangential to ventral grooves; rib frequency increases with size, and ribs may die out on outer whorls of large specimens. [The holotype of *C. caeneus* is deformed: the ventral keel and sulci on the inner whorls end abruptly at 68 mm in diameter, then the ribs pass over a rounded venter on the final one-third of a whorl.] Lower Jurassic (lower Sinemurian, *Turneri* Zone): Europe, Morocco, Russia (northeast), Canada (British Columbia), ?Peru.—FIG. 16, 1a–d. *C. plotti* REYNÉS, holotype of *C. caeneus* BUCKMAN, Cleeve, Gloucestershire, England; a, side; b–d, venter at beginning (b), middle (c), and end (d) of final whorl,  $\times 0.9$  (BUCKMAN, 1925a, pl. 572).—FIG. 16, 1e–f. *C. turneri* (J. DE C. SOWERBY), lectotype, Quaternary (derived from Lower Lias), Wymondham Abbey, Norfolk, England,  $\times 1$  (new, The Natural History Museum, London, BMNH 43973a).

**Asteroceras** HYATT, 1867, p. 79 [*\*Ammonites stellaris* J. SOWERBY, 1815a, p. 211; SD BUCKMAN, 1911, p. v, ICZN Opinion 324, 1955b, proposed by ARKELL, 1951d, p. 227]. Evolute, up to 6 whorls, and may reach large size; umbilicus 30–42% of diameter, whorl section subquadrate or whorl sides convergent toward venter; blunt ventral keel is flanked by grooves that may die out on outer whorls; ribs are simple, straight or concave forward on side of whorl, and die out on shoulder of whorl; rib frequency increases with growth on earliest whorls and then remains at 25–40 per whorl on middle and outer whorls; surface of shell bears fine reticulate ornament. Lower Jurassic (upper Sinemurian, *Obtusum* Zone): Europe, northern Africa (Atlas Ranges), Vietnam, ?Japan, China (Guangdong), ?Indonesia (New Guinea), Canada (British Columbia, Alberta), United States (California), Chile, Argentina, Peru.—FIG. 17, 1a–b. *\*A. stellare* (J. SOWERBY), lectotype, Black Ven Marls, Charmouth, Dorset, England,  $\times 1$  (Dean, Donovan, & Howarth, 1961, pl. 67, 2).

**Parasteroceras** DOMMERGUES, FAURÉ, & PEYBERNÉS, 1986, p. 1111 [*\*P. rakusi*; OD]. Similar to *Asteroceras*, but more involute, has vertical or undercut umbilical walls, more compressed and flat inner whorls, and venter is rounded, with only a rudimentary keel throughout; ribs are flexuous, striate, and irregular on inner whorls, then stronger, mainly single and straight on the outer whorls. Dimorphic. Lower Jurassic (upper Sinemurian, *Obtusum* Zone): Morocco, Tunisia.—FIG. 17, 2a–b. *\*P. rakusi*, lectotype, designated herein, a macroconch, Oust Formation, Djebel Oust, Tunisia,  $\times 0.4$  (Dommergues, Fauré, & Peybernés, 1986, pl. 1, 1a–b).

**Euerbenites** BLAU & others, 2002, p. 411, *nom. nov. pro Erbenites* BLAU & others, 2001, p. 176, *non* PRIBIL, 1964 (trilobite) [*\*Erbenites corinnae* BLAU & others, 2001, p. 176; OD]. Similar to *Parasteroceras*, but slightly more involute (umbilicus approximately 28% of diameter), has a more

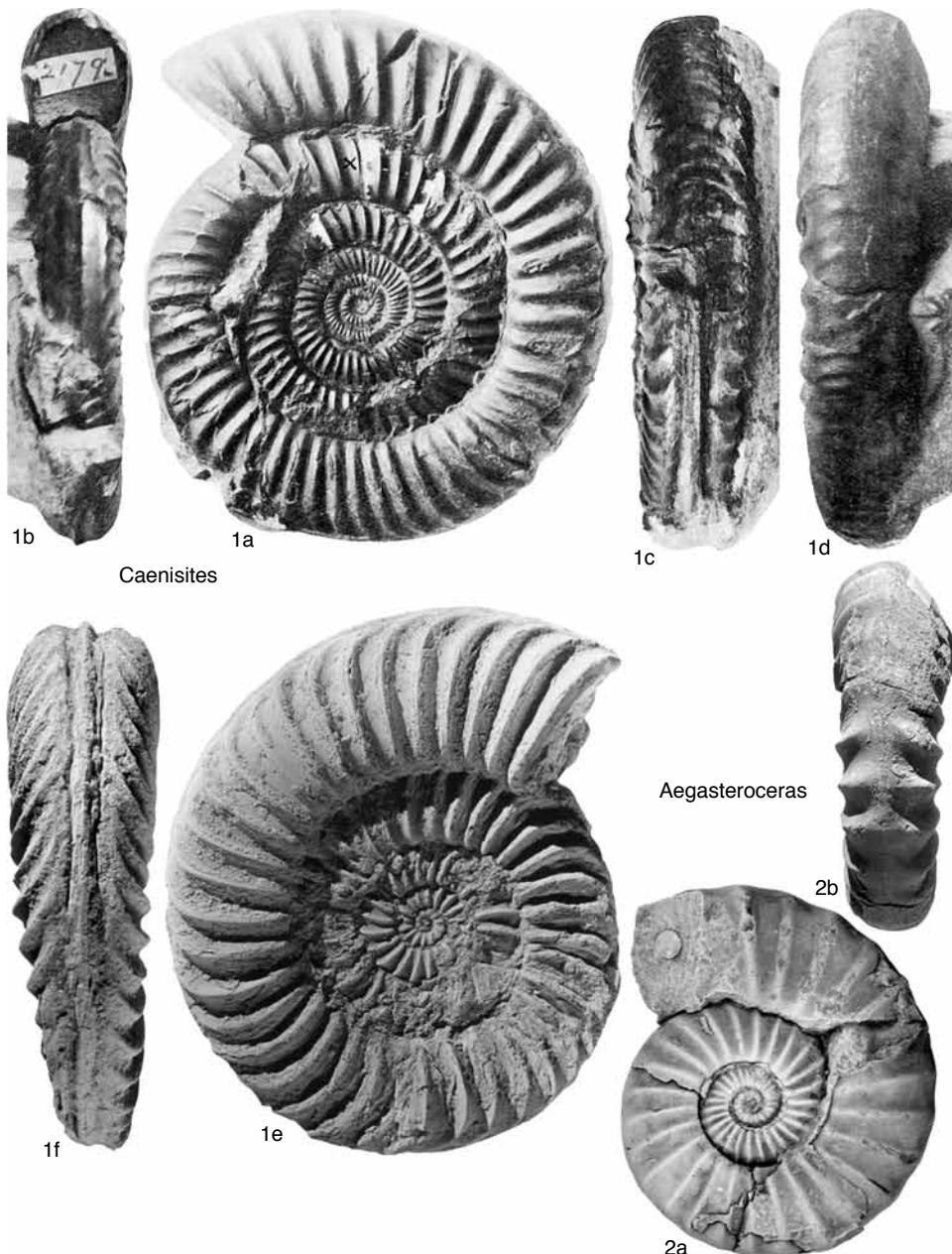


FIG. 16. Arietitidae (p. 22–24).

distinct, crenulated, ventral keel, bordered by bands and traces of striate ornament; lateral ribs divided or intercalated high on whorl and angled forward in crossing venter. *upper Lower Jurassic (upper Sinemurian, top Obtusum–Oxynotum Zones): Canada (?British Columbia), Mexico, ?Chile, Peru.*—FIG.

17,3a–b. \**E. corinnae* (BLAU & others), holotype, Despf Formation, Tenango de Doria, Sierra Madre Oriental, Mexico,  $\times 0.8$  (Blau & others, 2001, p. 179, 2a–b). *Aegasteroceras* SPATH, 1925a, p. 265 [*\*A. simile*; OD]. Evolute, umbilicus about 40% of diameter;

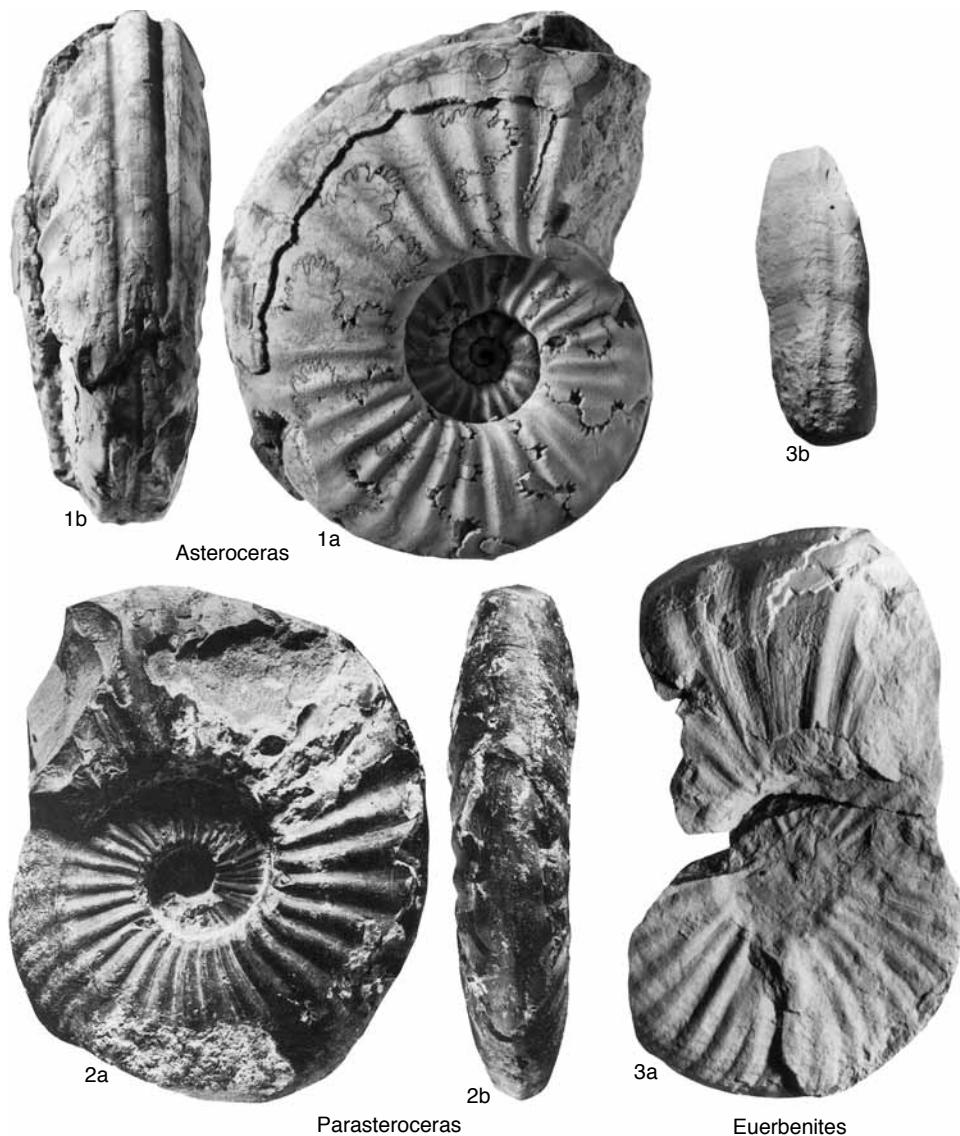


FIG. 17. Arietitidae (p. 22–23).

whorl section rounded, and rounded venter may have a weak keel; ribs bold and straight or curving slightly forward. More evolute than *Asteroceras* and has a much reduced keel. Lower Jurassic (upper Sinemurian, Obtusum Zone): Europe, Morocco, Canada (Yukon), United States (Alaska, Nevada), Mexico, Chile, Argentina, Peru.—FIG. 16, 2a–b. *\*A. simile*, holotype, Robin Hood's Bay, North Yorkshire, England,  $\times 1$  (new, The Natural History Museum, London, BMNH C.26687).

**Arcoasteroceras** FREBOLD, 1960, p. 13 (FREBOLD, 1958, p. 30, *nom. nud.*) [*\*A. jeletzkyi*; OD]. Moder-

ately involute, each whorl overlapping up to half of the preceding; umbilicus about 30% of diameter; ribs sharp, straight, curving forward at ventral ends, and faint secondary ribs may cross venter; on middle and outer whorls, ribs die out partway across side of whorl; venter flattened or slightly arched; a ventral keel may be present on inner but not on outer whorls, which have broad smooth venter distinguishing genus from others in family. Lower Jurassic (upper Sinemurian, Oxynotum Zone): United States (Alaska), Canada (British Columbia, Yukon, Northwest Territories).—FIG. 18, 1a–b.

- \**A. jeletzkyi*, holotype, Aklavik Range, Alaska, United States,  $\times 1$  (Frebold, 1960, pl. 2, 1).
- Epophioceras** SPATH, 1924, p. 204 [*\*Ammonites landrioti* D'ORBIGNY, 1849 in 1849–1850, p. 213, nom. dub.; OD; clarified by THEVENIN, 1907, p. 22]. Evolute; up to 9 whorls and reaches large sizes; whorl section subcircular with very slight overlap; umbilicus 60–70% of diameter; weak ventral keel; ribs blunt, frequency increasing steadily with size. *Lower Jurassic (upper Sinemurian, Obtusum Zone)*: Europe, Tunisia, Canada (British Columbia, Alberta), United States (Nevada), Chile, Argentina, Peru, Antarctica (Antarctic Peninsula).—FIG. 18, 2a–b. \**E. landrioti* (D'ORBIGNY), holotype, Lias inférieur, Semur, Côte d'Or, France,  $\times 0.5$  (Thevenin, 1907, pl. 7, 4–5).
- Ptycharitetes** SPATH, 1925a, p. 267 [*\*Arietites ptychogenos* POMPECKJ, 1897, p. 643; OD] [=*Pompekioceras* SPATH, 1925a, p. 268 (type, *Arietites oncocephalus* POMPECKJ, 1897, p. 654, OD)]. Inner whorls flat, compressed and smooth, with prominent ventral keel like *Eparietites*, but outer whorls have whorl section, ventral keel, and ribs like *Asteroceras* (DOMMERGUES, MEISTER, NEIGE, & ROCHA, 2004). *Lower Jurassic (upper Sinemurian, Obtusum Zone)*: Portugal.—FIG. 18, 3a–b. \**P. ptychogenos* (POMPECKJ), lectotype, Penedo da Saudade, San Pedro de Muel,  $\times 0.7$  (Pompeckj, 1897, pl. 23, 3a–b).
- Eparietites** SPATH, 1924, p. 206 [*\*Ammonites tenellus* SIMPSON, 1855, p. 97; OD]. Shell compressed, near-oxycone; whorl thickness 20–25%, umbilicus 20–30% of diameter; ventral keel sharp and high, bounded by concave shoulders and a ventrolateral angle; at least 5 whorls, and some species reach large sizes; ribs simple, straight or concave forward, curving forward onto venter (as in *Caenistes*), at least on inner whorls; outer whorls have 25–40 ribs per whorl, or ribs are lost and whorl becomes smooth at large sizes. *Lower Jurassic (upper Sinemurian, Obtusum Zone; Denotatus Subzone in Britain)*: Europe, Morocco, Algeria, Russia (northeast), China (Guangdong), Chile, Argentina, Peru.—FIG. 19, 1a. \**E. tenellus* (SIMPSON), holotype, Robin Hood's Bay, North Yorkshire, England,  $\times 1$  (Buckman, 1912, pl. 54).—FIG. 19, 1b–c. *E. denotatus* (SIMPSON), holotype, Denotatus Subzone, Robin Hood's Bay, North Yorkshire, England,  $\times 0.5$  (Buckman, 1912, pl. 67A–67B).
- Bagnolites** DONOVAN, 1998, p. 993 [*\*B. stuarti*; OD]. Inner whorls very involute, with small umbilicus and undercut umbilical wall; umbilical seam uncoils on final part of phragmocone and (possible adult) outer whorl; whorl section triangular, with narrow keeled venter; smooth on all visible whorls; sutures have shallow lateral saddles. Known from the holotype only, which has a venter like that of *Eparietites* but differs in being more involute, has undercut umbilical walls, smooth whorls and a reduced suture. *Lower Jurassic (upper Sinemurian, Obtusum Zone, Stellare Subzone)*: England (Dorset).—FIG. 18, 4a–d. \**B. stuarti*, holotype, Charmouth, Dorset, England; a–b,  $\times 0.6$ ; c, whorl cross sections,  $\times 0.6$ ; d, reconstruction of suture,  $\times 0.75$  (Donovan, 1998, fig. 2, 3A; pl. 1, 1–2).
- ?**Protechioceras** SPATH, 1925a, p. 362, non TRUEMAN & WILLIAMS, 1927; see *Palaeochioceras* SPATH, 1929, p. 29 herein [*\*Vermiceras formosum* FUCINI, 1902, p. 158 (118); OD]. Serpenticone, umbilicus 60–70% of diameter, whorl section nearly circular, with weak ventral keel and no sulci; smooth, or with faint ribs. The periodic lateral nodes on the lectotype (FUCINI, 1902, pl. 13 (16), 13) may be artifacts. Poorly preserved, but possibly a synonym of *Epophioceras* (GETTY, 1973, p. 26; see GÉCZY & SCHLATTER, 1984). *Lower Jurassic (upper Sinemurian)*: Italy, Hungary.—FIG. 19, 2a–b. \**P. formosum* (FUCINI), lectotype, Monte di Cetona, Tuscany, Italy,  $\times 1$  (FUCINI, 1902, pl. 13 (16), 13–13a).—FIG. 19, 2c–d. *P. sp. cf. formosum* (FUCINI), *Obtusum Zone*, bed 207, Lókút, Hungary,  $\times 0.6$  (new; also figured in Géczy & Schlatter, 1984, fig. 1).
- ?**Tmaegophioceras** SPATH, 1925a, p. 362 [*\*Arietites laevis* GEYER, 1886, p. 252; OD]. Serpenticone; quadrate whorl section, with small ventral keel, flanked by sulci; ribs distant and weak; may have constrictions. The poorly preserved, corroded types are lost, and affinities are uncertain (GETTY, 1973, p. 25). *Lower Jurassic (upper Sinemurian)*: Austria, ?Italy, Hungary.—FIG. 19, 3a–b. \**T. laevis* (GEYER), lectotype, Hierlatz Limestone, Hallstatt, Austria,  $\times 1$  (Geyer, 1886, pl. 3, 10a–b).

## Subfamily HYPASTEROCERATINAЕ Venturi & Nannarone, 2002

[*Hypasteroceratinae* VENTURI & NANNARONE, 2002, p. 153]

*Hypasteroceratinae* is an unsatisfactory subfamily proposed for some ammonites from Monte Cetona, central Italy. Almost all specimens referred to this subfamily are small, poorly preserved, and eroded. Characteristically, they have a tall ventral keel and smooth inner whorls. Ventral ribbing on the outer part of the whorl side may or may not be present, depending on the state of preservation. Lack of knowledge of their stratigraphical position has led to their reference to different ammonite groups in the past, but VENTURI and NANNARONE (2002) appear to have determined their age as lower Sinemurian, *Bucklandi* Zone, which is considerably older than supposed hitherto. *Cancelliceras* was proposed for some slightly better preserved specimens in which the ribbing is clearer than on the eroded types of *Hypasteroceras*, and *Oxydiscoceras* is based on small smooth inner whorls. Both are

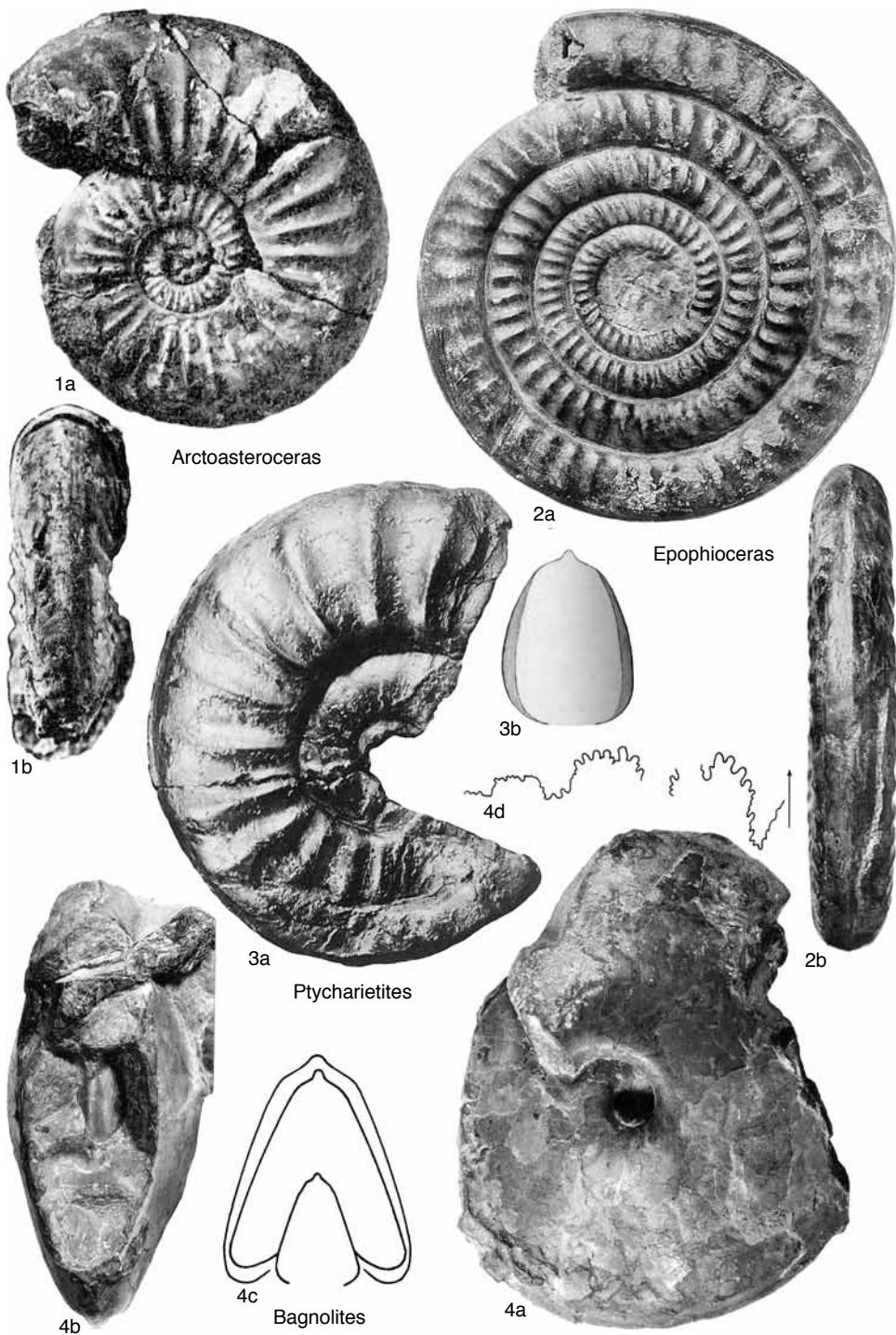


FIG. 18. Arietitidae (p. 24–25).

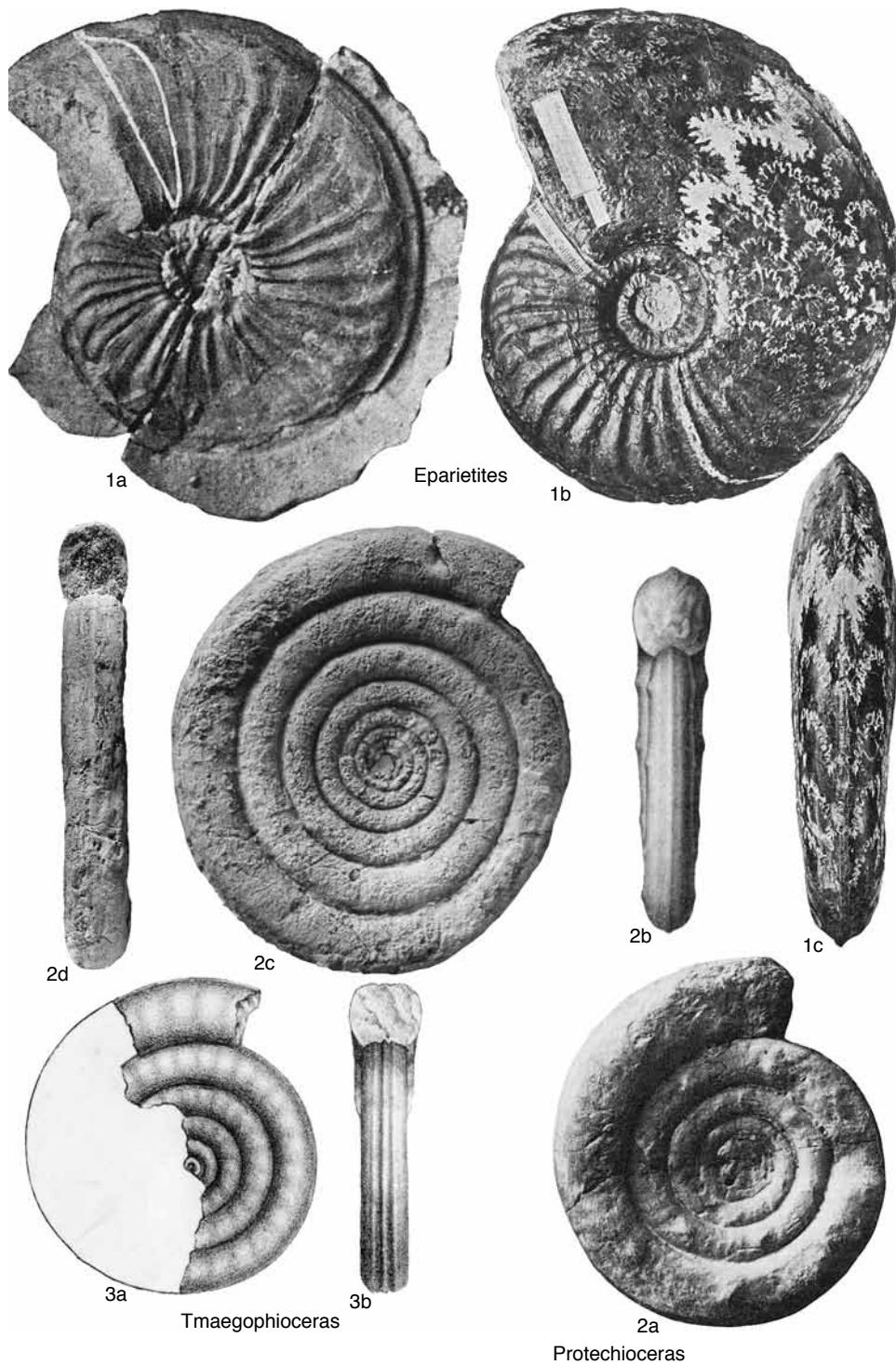


FIG. 19. Arietitidae (p. 25).

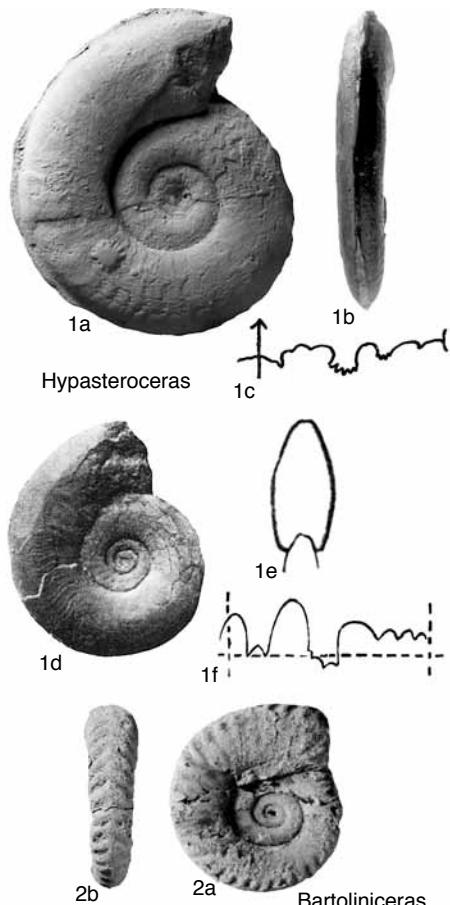


FIG. 20. Arietitidae (p. 28).

probably the same as *Hypasteroceras*, and until larger and better-preserved material is found, the subfamily and its relationships remain uncertain. Lower Jurassic (?lower Sinemurian, ?Bucklandi Zone).

?*Hypasteroceras* SPATH, 1923b, p. 84 [*Asteroceras ceratiticum* FUCINI, 1903, p. 148 (202); OD; =*Ammonites montii* MENEGHINI in DE STEFANI, 1877, p. 82 (first figured by FUCINI, 1899, p. 245 (7), pl. 20 (2), I, 1a)] [=*Asaphoceras* SPATH, 1924, p. 192 (type, *Amphiceras apenninicum* FUCINI, 1911, p. 47, OD); =*Cancelliceras* VENTURI & NANNARONE, 2002, p. 157 (type, *C. tenuicostatum*, OD); =*Oxydiscoceras* VENTURI & NANNARONE, 2003, p. 323, nom. nov. pro *Oxydiscus* VENTURI & NANNARONE, 2003, p. 156, non KOKEN, 1889, p. 390 (Devonian gastropod) (type, *O. proversus*, OD)]. Evolute and compressed, with elliptical whorl section and a high, sharp ventral keel, not bordered

by grooves; smooth on inner whorls; some outer whorls develop striate or weak ribs on upper part of whorl that curves forward on the shoulder of whorl; suture simple, ceratic (DONOVAN, 1990, p. 258; DOMMERGUES, FERRETTI, & MEISTER, 1994, p. 34). Lower Jurassic (?lower Sinemurian, ?Bucklandi Zone): Italy, Morocco.—FIG. 20, 1a-c. *H. montii* (MENEGHINI), *calcari grigi inferiori*, Monte di Cetona, Tuscany, Italy; lectotype of *Asteroceras ceratiticum* FUCINI, 1903 (designated by DONOVAN & FORSEY, 1973, p. 8); a-b,  $\times 1$ ; c, suture,  $\times 2$  (new; also figured in Fucini, 1903, pl. 23 (34), 1a-c).—FIG. 20, 1d-f. *H. apenninicum* (FUCINI), holotype, Pioraco, Central Apennines, Italy; d,  $\times 1$ ; e, whorl cross section,  $\times 1.5$ ; f, suture  $\times 2$  (Fucini, 1911, pl. 3, 4).

## INCERTAE SEDIS IN ARIETITIDAE

?*Bartoliniceras* TAYLOR, GUEX, & RAKUS, 2001, p. 401 [\**B. leslei*; OD]. Small, evolute, compressed, flat whorl sides, with low, blunt ventral keel; lower part of whorl side smooth, strong ribs on upper part of whorl side are curved forward and projected on venter, where they form small nodes. Known only up to 35 mm in diameter, and of unknown affinities, but probably within the Arietitidae. Lower Jurassic (lower Sinemurian, Turneri Zone): United States (Nevada).—FIG. 20, 2a-b. \**B. leslei*, holotype, Five Card Draw Section, New York Canyon,  $\times 1$  (Taylor, Guex, & Rakus, 2001, pl. 3, 1-2).

## Family ECHIOCERATIDAE Buckman, 1913

[Echioceratidae BUCKMAN, 1913, p. vi]

Serpenticones with circular or flat-sided whorl section, ornamented throughout with strong simple ribs, except in *Leptechioceras*, where the outer whorls become strongly compressed and smooth. A ventral keel is present in all forms, only feebly developed in some but prominent in others, and in some of the more densely ribbed, compressed forms, the keel is flanked by grooves. Tubercles are rare or absent. The initial smooth stage is very short and usually not discernible with the naked eye.

Suture simple with five principal lobes ( $U_2=U_1 < L < E=I$ ).  $U_3$  is not usually developed until a late stage and is generally small.  $U_1$  is not split, and there is a single internal saddle.  $L$  tends to be bifid, or, at least where the lobe is very broad, to possess an even number of accessories. Saddles are broad based and weakly incised, although the strength of the incisions varies considerably.

The external saddles tend to be asymmetrically divided by a deeper incision in most genera, but this may be obscured if other incisions are strongly developed. Umbilical lobes are only weakly retracted, if at all. *Lower Jurassic (Sinemurian)*.

**Palaeochioceras** SPATH, 1929, p. 271 [*\*Protechioceras spirale* TRUEMAN & WILLIAMS, 1927, p. 248; OD] [= *Protechioceras* TRUEMAN & WILLIAMS, 1927, p. 248, *non* SPATH, 1925a, p. 362, obj.; = *Hypechioceras* SPATH, 1956, p. 149 (type, *H. pierrei*, OD)]. Nucleus globose with depressed whorls, becoming evolute with circular or slightly compressed whorls, then either more compressed or depressed in later growth stages; an early smooth stage is followed on nucleus by stout prossiradiate ribs, which become straighter and sharper as whorl becomes more evolute; in compressed forms, ribs are fine and dense on outer whorl; in depressed forms, they remain strong and distant; ribs are strongly projected on venter on inner whorls, rare secondary chevrons may be intercalated, and some ribs may be paired; on outer whorls, ribs fade on venter but retain marked forward projection; compressed forms have low keel that may be flanked by feeble sulci. *Lower Jurassic (upper Sinemurian, Oxyntum Zone)*: Europe, Morocco, Chile. —FIG. 21, 1a–d. *\*P. spirale* (TRUEMAN & WILLIAMS); a–b, holotype, Gas Works, Gloucester, England, ×2 (Getty, 1973, pl. 1, 2); c–d, Stonehouse, Gloucestershire, England, ×2 (new, Sedgwick Museum, Cambridge, England, 62061).

**Gagaticeras** BUCKMAN, 1913, p. v [*\*Ammonites gagatum* YOUNG & BIRD, 1828, p. 255; OD] [= *Parechioceras* BUCKMAN, 1914, p. ix (type, *Aegoceras finitimum* BLAKE, 1876, p. 273, OD)]. Nucleus depressed, evolute, middle and outer whorls circular or slightly compressed; umbilicus 50–60% of diameter; low keel may be present on outer whorls; stout, blunt ribs on inner whorls, either densely spaced or very distant, give way to strong, usually rectiradiate, but sometimes strongly rursiradiate ribs on middle and outer whorls; ribs pass over venter without weakening, except rarely on nucleus, and may be slightly projected forward. *Lower Jurassic (upper Sinemurian, Oxyntum Zone, Simpsoni Subzone)*: northwestern Europe, ?Austria. —FIG. 21, 2a–c. *\*G. gagatum* (YOUNG & BIRD), Robin Hood's Bay, Yorkshire, England; a–b, holotype, ×1 (Buckman, 1913, pl. 78); c, suture, ×2 (Getty, 1973, p. 10, fig. 2–1c).

**Plesechioceras** TRUEMAN & WILLIAMS, 1925a, p. 706 [*\*Echioceras delicatum* BUCKMAN, 1914, pl. 96c; OD; *nom. nov. pro Ammonites tardocrescens* DUMORTIER, 1867, p. 170, pl. 31, 3–5, *non* HAUER, 1854, p. 757, ?= *P. rothpletzi* (BÖSE, 1894, p. 730)]. Whorl section oval, with blunt keel; ribs regular, concave forward and extend ventrally almost to keel; rib density high, 65–70 per whorl, at 35–45 mm in diameter. Similar

to *Paltechioceras*, but smaller, has higher rib density, and occurs in the *Densinodulum* Subzone (DOMMERGUES, 1982). *Lower Jurassic (upper Sinemurian, Raricostatum Zone, Densinodulum and ?base of Raricostatum Subzones)*: England, France, northern Africa (Atlas Ranges), Tunisia, Canada (British Columbia), United States (Alaska), Chile, Argentina. —FIG. 21, 3a–b. *\*P. delicatum* (BUCKMAN) [= *P. rothpletzi* (BÖSE)], holotype, *Densinodulum* Subzone, Nolay, Côte d'Or, France, ×1 (Getty, 1973, pl. 2, 5a–b).

**Orthechioceras** TRUEMAN & WILLIAMS, 1925a (September), p. 706 [*\*O. recticostatum*; OD] [= *Homechioceras* TRUEMAN & WILLIAMS in BUCKMAN, 1925b (December), pl. 609 (type, *H. simile*, OD)]. Inner whorls depressed, becoming subquadrate; keel blunt, flanked by grooves that are well marked in type species, but may be ill-defined in others; sharp, straight ribs, rectiradiate or slightly prossiradiate, increasing in frequency to about 38 per whorl at 80 mm in diameter. *Lower Jurassic (upper Sinemurian, Raricostatum Zone, Densinodulum and Raricostatooides Subzones)*: Britain, Canada (Yukon), United States (Alaska), Ecuador. —FIG. 22, 1a–b. *\*O. recticostatum*, holotype, Armatum Bed (derived from *Raricostatum* Zone), Radstock, Avon, England, ×1 (Trueman & Williams, 1925a, pl. 3, 1).

**Echioceras** BAYLE, 1878, pl. 77 [*\*Ammonites raricostatus* ZIETEN, 1831 in 1830–1833, p. 18; OD; ICZN Opinion 324, 1955b, proposed by ARKELL, 1951d, p. 227] [= *Ophioceras* HYATT, 1867, p. 75, obj., *non* BARRANDE, 1865, pl. 45, 97, 99; = *Pleurechioceras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *Ophioceras deciduum* HYATT, 1867, p. 76, OD); = *Pleurechioras* ROMAN, 1938, p. 92, *nom. null.*, misspelling]. Evolute; inner whorls circular or quadrate, becoming depressed; in some, outer whorls again become circular or compressed at large diameters; umbilicus 50–70% of diameter on outer whorls; venter flat or slightly arched to fastigiate, and a blunt and weakly developed keel, without sulci, appears at widely varying sizes; dense sharp ribs on nucleus, become less dense on middle whorls, and may become raricostate in some species, but rib frequency may increase slightly on outer whorls. *Lower Jurassic (upper Sinemurian, Raricostatum Zone, Raricostatum Subzone)*: Europe, Turkey, Russia (Crimea), Caucasus, Indonesia (Timor), Canada (Yukon), United States (California). —FIG. 21, 4a–c. *\*E. raricostatum* (ZIETEN); a–b, neotype, Pliensbach, Württemberg, Germany, ×1 (Getty, 1973, pl. 1, 7); c, suture, at 3.5 mm whorl height, ×9 (Getty, 1973, p. 10, fig. 2–2). —FIG. 21, 4d–f. *E. raricostatooides* (VADASZ); d, neotype (designated by Getty, 1973, p. 13), Seichamp, Nancy, Lorraine, France, ×1 (Getty, 1973, pl. 1, 12); e–f, Armatum Bed (derived from *Raricostatum* Zone), Kilmersdon Colliery Quarry, Radstock, Avon, England, (holotype of *E. sparsicostatum* TRUEMAN & WILLIAMS, 1925a, p. 713); e, side; f, whorl cross section, ×1 (TRUEMAN & WILLIAMS, 1925a, pl. 2, 8).

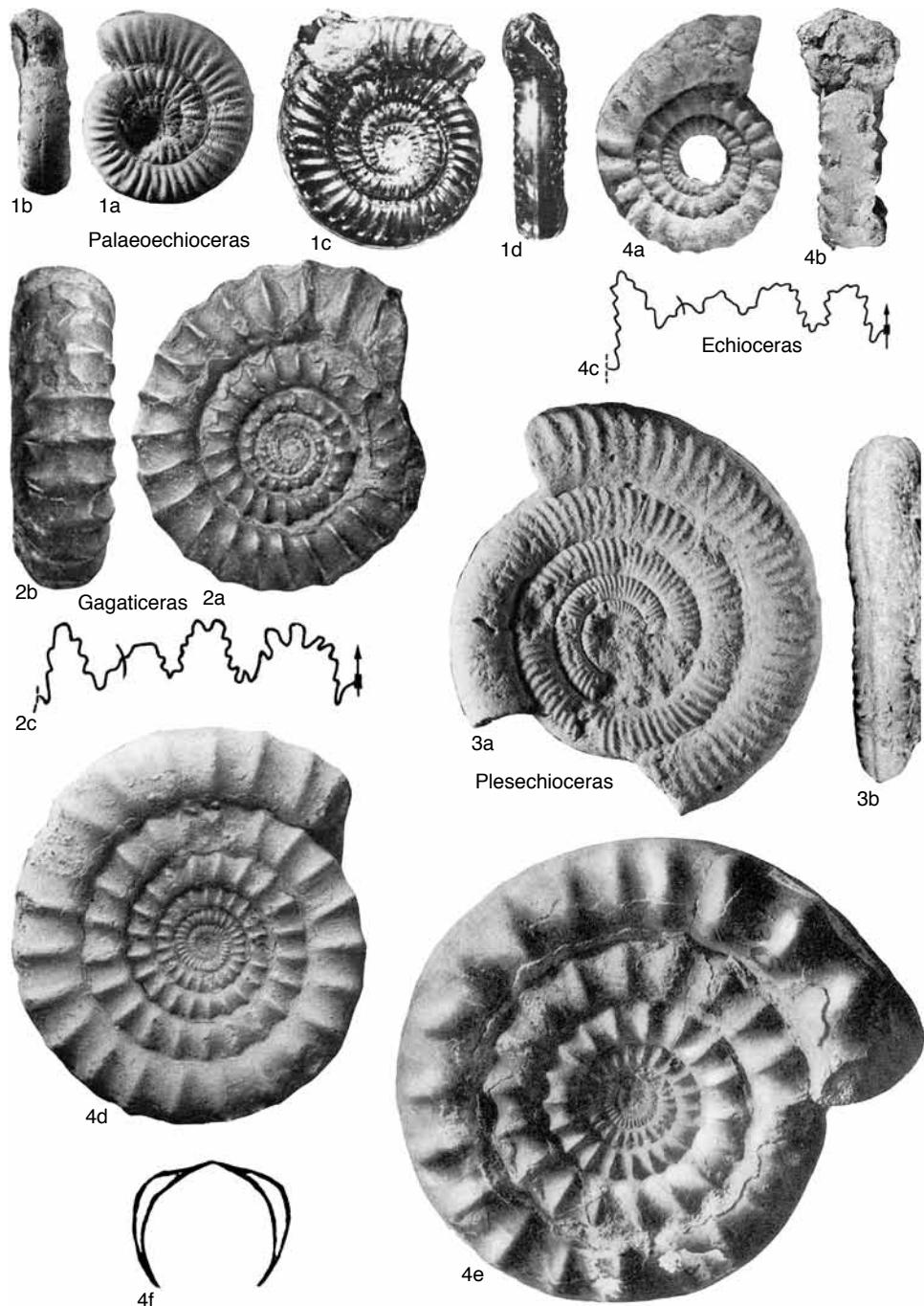


FIG. 21. Echioceratidae (p. 29).

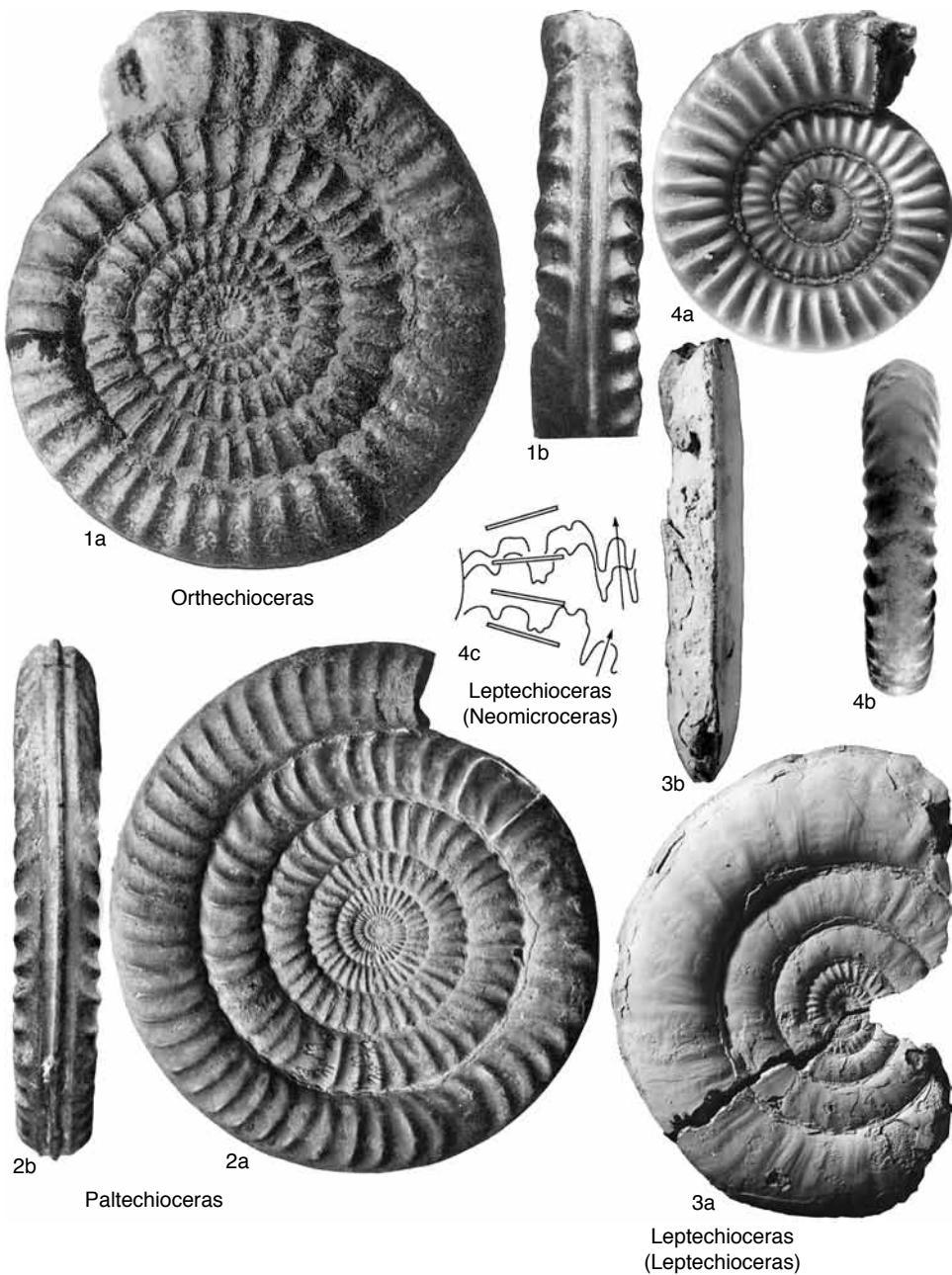


FIG. 22. *Echioceratidae* (p. 29–32).

**Paltechioceras** BUCKMAN, 1924, pl. 483 [*P. elicitum*; OD] [=*Echioceratooides* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *E. regularare*, OD); =*Epechioceras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *E. expansum*, OD); =*Euechioceras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *E. nobile*, OD); =*Kamptechioceras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *K. variabile*, OD); =*Metechioceras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *M. tardescens*, OD); =*Arietites tardescens* BLAKE, 1876, pl. 5.5, non HAUER, 1856]; =*Vobstericeras* TRUEMAN & WILLIAMS, 1925a, p. 706 (type, *V. flexicostatum*, OD); =*Stenechioceras* BUCKMAN, 1927a, pl. 697 (type, *Euechioceras angustilobatum* TRUEMAN & WILLIAMS, 1925a, p. 726, OD)]. Compressed, with carinate-bisulcate venter; ribs straight or nearly straight, increasing from 20–40 per whorl on inner whorls to higher frequencies on outer whorls, commonly more than 50 ribs at diameters of 60 mm or more. Homeomorphic with *Vermiceras* (early Arietitidae). Lower Jurassic (upper Sinemurian, Raricostatum Zone): Europe, Turkey, northern Africa (Atlas Ranges), Tunisia, Indonesia (New Guinea), Canada (British Columbia, Yukon), United States (Alaska, California), Mexico, Chile, Peru, Ecuador.—FIG. 22,2a–b. \**P. elicitum*, holotype, Armatum Bed (derived from Raricostatum Zone), Radstock, Avon, England, ×0.45 (Buckman, 1924, pl. 483).

**Leptechioceras** BUCKMAN, 1923b, pl. 443 [*Ammonites macdonnelli* PORTLOCK, 1843, p. 134; OD] [=*Psilechioceras* ERBEN, 1956, p. 317 (type, *P. glabrum*, OD)]. Inner whorls circular, becoming compressed; the fastigiate venter develops a keel at an early stage, which persists throughout growth; umbilicus about 45% of diameter at 10 mm, rising to 57% at 70 mm in diameter; after initial smooth stage, inner whorls have either dense fine ribs (as in *Echioceras*), or have strong, widely spaced ribs; middle and outer whorls become smooth or faintly plicate, and in some, blunt ribs reappear near end of adult body chamber (REID & BANCROFT, 1986). Lower Jurassic (upper Sinemurian, Raricostatum Zone, Macdonnelli Subzone): Europe, Mexico, Peru.

**L. (Leptechioceras).** Attains sizes of 100 mm in diameter or more, and has characteristic keeled, compressed, and smooth outer whorl, as in generic description. Stratigraphic and geographic range as for genus.—FIG. 22,3a–b. \**L. (L.) macdonnelli* (PORTLOCK), lectotype, Ballintoy, Antrim, Northern Ireland, ×1 (new, Ulster Museum, Belfast, Northern Ireland, BELUM K8117).

**L. (Neomicroceras)** DONOVAN, 1966, p. 312 [\**N. commune*; OD]. Micromorphic or pedomorphic development from early *Leptechioceras* in the same subzone; attains only 20 mm in diameter (the largest known phragmocones are 14 mm in diameter); whorls up to 4 mm in diameter are smooth; later whorls bear straight, radial or rursiradiate ribs that may have small spines at their ventral ends; suture simple, pseudoceratictic

(DOMMERGUES & MEISTER, 1992). Stratigraphic range as for genus: Britain, France.—FIG. 22,4a–c. \**L. (N.) commune*, holotype, Raricostatum Zone, Macdonnelli Subzone, Witney (Appley Barn) Borehole, Oxfordshire, England; a–b, ×3; c, last three sutures, ×6 (Donovan, 1966, p. 314, fig. 1a; pl. 53, 1–2).

### Family OXYNOTICERATIDAE Hyatt, 1875

[*nom. correct.* SPATH, 1926b, p. 170, *pro* Oxynotidae HYATT, 1875, p. 230, ICZN Opinion 575, 1959a]

Medium to involute oxycones and planululates, with keel usually present, but no ventral grooves; ribs are projected or falcoid, but are obsolescent in many forms; secondary ribs may be present; suture develops additional elements in umbilical region of involute forms by subdivision of umbilical lobes and saddles; in large oxycones, the suture may become highly complex with arborescent saddles. Lower Jurassic (upper Sinemurian–lower Pliensbachian).

**Oxynoticeras** HYATT, 1875, p. 230 [\**Ammonites oxynotus* QUENSTEDT, 1843, p. 161; SD BUCKMAN, 1909, p. ii, ICZN Opinion 575, 1959a] [=*Oxynotoceras* BUCKMAN, 1894, p. 361, *nom. null.*, misspelling]. Oxycones, umbilicus 20–30% of diameter; whorls cover half to three-quarters of preceding one; falcoid ribs numerous, with extra ribs intercalated on outer part of whorl, and ribs often weaken with growth; suture culminates at point of contact with previous whorl in the umbilicus (SCHINDEWOLF, 1962, fig. 91), and extra sutural elements are added near umbilical margin during ontogeny. Lower Jurassic (upper Sinemurian, Oxynotum Zone): Europe, Morocco, Turkey, Russia (Far East), Vietnam, Indonesia (Timor), Canada (British Columbia, Yukon), United States (Alaska, Nevada), Mexico, Chile, Argentina, Peru.—FIG. 23,1a–b. \**O. oxynotum* (QUENSTEDT), holotype, Lias b, Schömberg, Württemberg, Germany, ×1 (new; also figured in Dean, Donovan, & Howarth, 1961, pl. 66,5).

**Cheltonia** BUCKMAN, 1904b, p. 27a [\**Ammonites accipitris* J. BUCKMAN, 1844, p. 102; OD]. Small compressed platycones, umbilicus 30–40% of diameter; last whorl eccentrically coiled and has aperture with ventral rostrum that may be preceded by 3 to 5 corrugations on venter; ribs weak, falcoid; suture as in young *Oxynoticeras*. May be the microconch of *Oxynoticeras*. Lower Jurassic (upper Sinemurian): Europe, Morocco, Tunisia, Chile, Argentina, Peru.—FIG. 23,2a–d. \**C. accipitris* (J. BUCKMAN), Lower Lias Clay, near Cheltenham, Gloucestershire, England; a–b, lectotype, ×1; c–d, paralectotype, ×1 (Buckman, 1904b, p. 27, fig. T<sup>1</sup>, T<sup>1a</sup> T<sup>1b</sup>, T<sup>2</sup>).

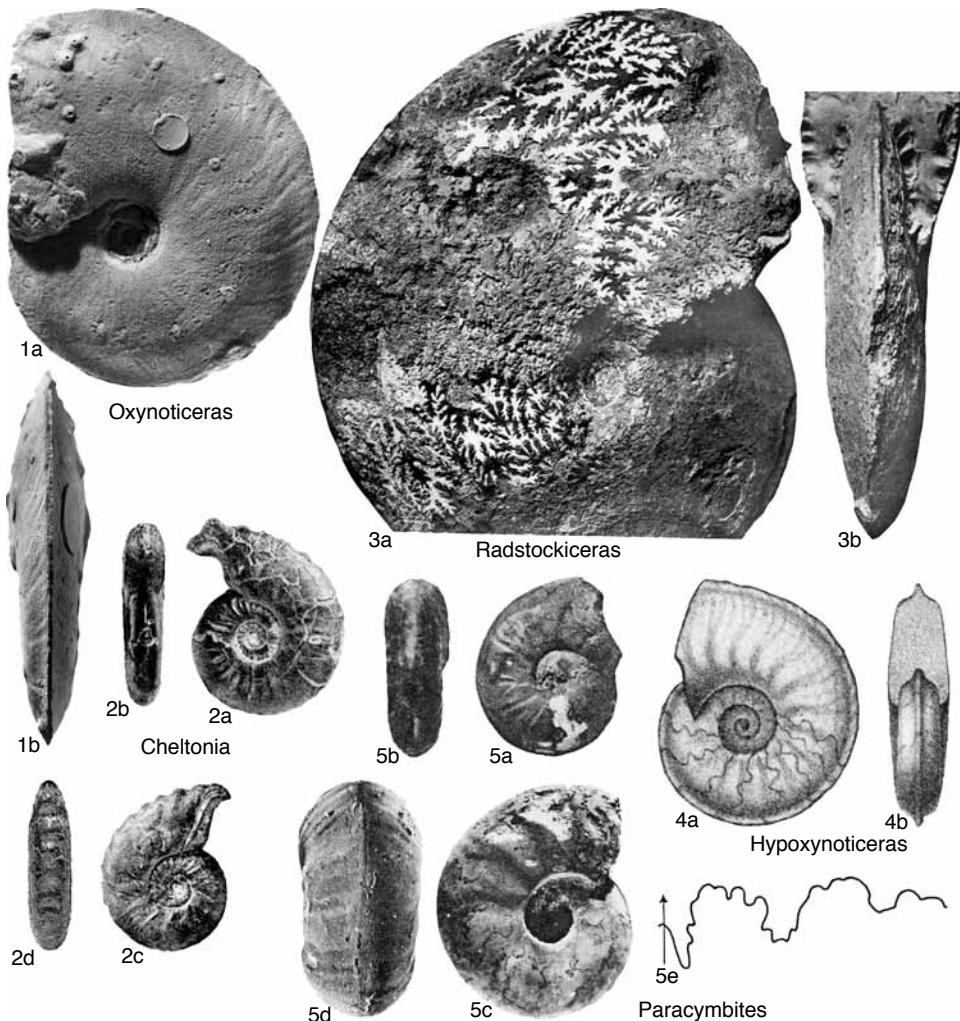


FIG. 23. Oxynoticeratidae (p. 32–35).

*Gleviceras* BUCKMAN, 1918b, p. 269, 289 [\**G. glevense*; OD; =*Oxynoticeras subguibalianum* PIA, 1914, p. 11] [=*Guibaliceras* BUCKMAN, 1918b, p. 293 (type, *Ammonites guibalianus* D'ORBIGNY, 1844 in 1842–1851, p. 259, OD); =*Tutchericeras* BUCKMAN, 1919b, pl. 137 (type, *T. perfoliatum*, OD); =*Victoriceras* BUCKMAN, 1918b, p. 293 (type, *Ammonites victoris* DUMORTIER, 1867, p. 136, OD); =*Glevumites* BUCKMAN, 1924, pl. 527 (type, *Oxynoticeras subguibalianum* PIA, 1914, p. 11, OD); =*Glevumites* LANG, 1926, p. 156, nom. null, misspelling; =*Riparioceras* SCHINDEWOLF, 1962, p. 490 (type, *Ammonites riparius* OPPEL, 1862, p. 132, OD)]. Earliest whorls quadrate with widely spaced ribs, about 10 per whorl, ending in ventrolateral clavi that may be joined by sharp ridge; venter with acute chevrons and small, well-defined keel;

umbilical margin may be pentagonal rather than spiral. This stage (*Riparioceras*) is succeeded after about two whorls (approximately 15 mm) by oxycone shell form with umbilicus 12–25%, and whorl thickness 20–25% of diameter; keel sharp and ribs falcold with intercalated secondaries. On later whorls, ribs become faint or intermittently developed (*Guibaliceras*). Species may reach large sizes (450 mm in diameter), and body chamber may become smooth with rounded venter and eccentric coiling. Suture like *Oxynoticeras*, but without umbilical culmination, becoming elaborate on large examples. Lower Jurassic (upper Sinemurian): Europe, Morocco, Canada (British Columbia, Alberta, Yukon), United States (Alaska), Mexico, Peru.—FIG. 24a–e. \**G. subguibalianum* (PIA); a–b, holotype of *Gleviceras glevense*, *Raricostatum*

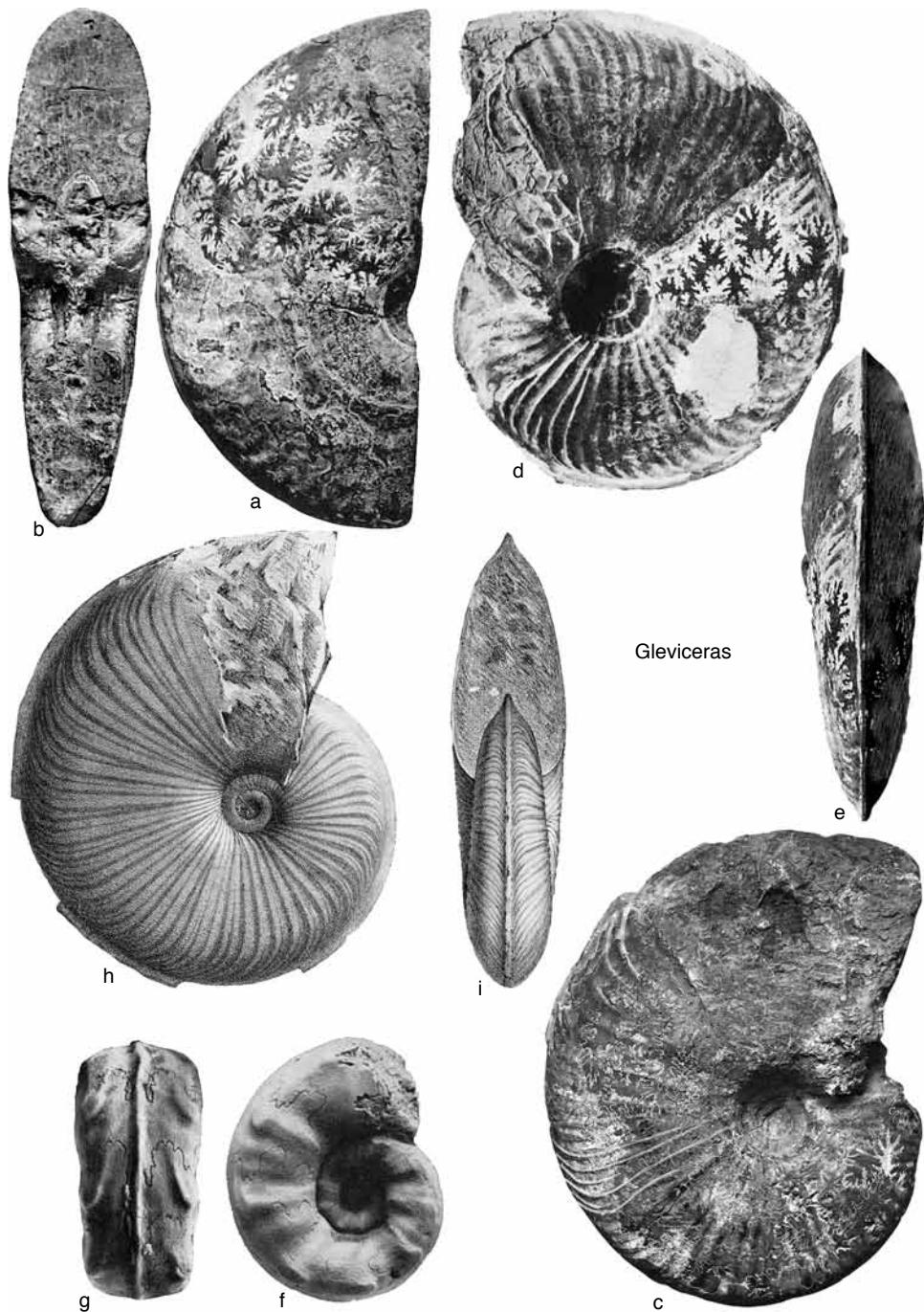


FIG. 24. Oxynoticeratidae (p. 33–35).

Zone, Folly Lane Brickyard, Cheltenham, Gloucestershire, England,  $\times 0.4$  (*a*, Buckman, 1918b, pl. 28, *1*; *b*, Buckman, 1918b, pl. 27, *2*); *c*, paratype of *G. glevense*, Lower Lias Shales, Cheltenham, Gloucestershire, England,  $\times 0.67$  (new; also figured in Buckman, 1918b, pl. 27, *2*, and Buckman, 1924, pl. 526); *d–e*, Lansdown, Cheltenham, Gloucestershire, England,  $\times 0.67$  (Buckman, 1924, pl. 527).—FIG. 24*f–g*. *G. riparium* (OPPEL), holotype, Balingen, Württemberg, Germany,  $\times 4$  (Schindewolf, 1962, pl. 3, *2*).—FIG. 24*h–i*. *G. victoris* (DUMORTIER), lectotype, Nolay, Côte d'Or, France,  $\times 0.67$  (Dumortier, 1867, pl. 42, *1–2*).

**Radstockiceras** BUCKMAN, 1918b, p. 269, 287  
[*\*R. complicatum*; OD] [=Fastigeras BUCKMAN, 1919b, pl. 144 (type, *F. clausus*, OD); =Retenticeras BUCKMAN, 1920, pl. 166 (type, *Ammonites retentus* SIMPSON, 1855, p. 84, OD); =Metoxynoticeras SPATH, 1922c, p. 550 (type, *Ammonites oppeli* SCHLOENBACH, 1863, p. 515, OD); =Phylloxynoticeras BUCKMAN, 1924, pl. 465 (type, *P. phyllinus*, OD); =Homoxynoticeras BUCKMAN, 1925a, pl. 575 (type, *H. homoeum*, OD); =Kleistoxynoticeras BUCKMAN, 1925a, pl. 576 (type, *K. columellatum*, OD); =Carixiceras SPATH, 1925a, p. 112 (type, *Amaltheus wiltshirei* WRIGHT, 1881, pl. 48, OD); =Radstokiceras ROMAN, 1938, p. 98, nom. null., misspelling; =Oxynoticeroides DOMMERGUES, FAURÉ, & PEYBERNÉS, 1986, p. 1112 (type, *O. simplicatum*, OD)]. Involute oxycones, umbilicus 0–12% of diameter on outer whorls; venter sharp on inner whorls, rounded on outer whorls; attains large sizes; ribs falcold, faint or absent; suture complex like *Oxynoticeras* but without culmination at umbilical margin. Lower Jurassic (upper Sinemurian, Oxynotum–Raricostatum Zones–lower Pliensbachian): Europe, Morocco, Tunisia, Turkey.—FIG. 23, *3a–b*. *\*R. complicatum*, holotype, Jamesoni Zone, Radstock, Avon, England,  $\times 0.35$  (Buckman, 1918b, pl. 27, *1*).

**Hypoxynoticeras** SPATH, 1925a, p. 111 [*\*Ammonites spheronotus* MONKE, 1888, p. 228; OD]. Small platycones; umbilicus 25–30% of diameter; prominent ventrolateral shoulders and strong keel on venter; weak ribs are falcold and bifurcating; simple suture. Might be microconch or juvenile of *Radstockiceras*. Lower Jurassic (lower Pliensbachian, Jamesoni Zone): England, western Scotland, northern Germany.—FIG. 23, *4a–b*. *\*H. spheronotum* (MONKE), lectotype, Caprarius-schichten, Herford, Westphalia, Germany,  $\times 1.5$  (Monke, 1888, pl. 3, *14*, *14a*).

**Paracymbites** TRUEMAN & WILLIAMS, 1927, p. 247 [*\*P. obsoletus*; OD; =*Ammonites dennyi* SIMPSON, 1843, p. 9]. Shell small, involute; umbilicus about 25% of diameter, but last whorl may be eccentric; whorl section semicircular, becoming parallel sided; venter rounded or fastigiate with very faint keel; aperture with ventral rostrum; body chamber about three-quarters of a whorl; smooth or faintly plicate (DONOVAN, 1966). Lower

Jurassic (upper Sinemurian, Raricostatum Zone): Britain, Morocco, Tunisia.—FIG. 23, *5a–e*. *\*P. dennyi* (SIMPSON); *a–b*, lectotype, Robin Hood's Bay, North Yorkshire, England,  $\times 2$  (Buckman, 1909, pl. 7, *1*); *c–d*, holotype of *Paracymbites obsoletus* TRUEMAN & WILLIAMS, Stanton Fields railway cutting, Cheltenham, Gloucestershire, England,  $\times 4$  (Donovan, 1966, pl. 53, *6–7*); *e*, Folly Lane brick pit, Cheltenham, Gloucestershire, England, suture,  $\times 8$  (Donovan, 1966, p. 316, fig. 2c).

**Paraoxynotericeras** PIA, 1914, p. 18 [*\*Ammonites salisburgensis* HAUER, 1856, p. 47; SD SPATH, 1924, p. 206] [=Paraoxynotericeras ARKELL, 1957, p. 243, nom. null., misspelling]. Platycones with compressed whorls and attains large sizes; umbilicus small on inner whorls, increasing with growth, and last whorl eccentrically coiled; venter sharp or rounded on inner whorls, rounded on outer whorls; ornament on inner whorls like *Oxynoticeras*, changing on later whorls to straight, blunt, simple ribs, which may bear midlateral tubercles; suture as in *Oxynoticeras*. Lower Jurassic (upper Sinemurian): England, Europe, Morocco, Tunisia.—FIG. 25, *1a–b*. *\*P. salisburgense* (HAUER), lectotype, red cephalopod limestone, Adnet, Austria,  $\times 0.7$  (Hauer, 1856, pl. 13, *1–2*).—FIG. 25, *1c–d*, Adnet, Austria; *c*, side,  $\times 0.5$  (PIA, 1914, pl. 1, *2f*); *d*, cross section of outer whorl,  $\times 0.5$  (PIA, 1914, p. 20, *1a*).

**Slatterites** SPATH, 1923b, p. 87 [*\*Aegoceras slatteri* WRIGHT, 1882, p. 374; OD]. Small size; oxycone inner whorls with sharp venter passing rapidly into more evolute, thicker, oval whorls with rounded venter; last whorl has blunt ribs, straight or curving backward; ribs may alternate on opposite sides of shell; suture has broad, simple elements like those of *Eparietites*. Lower Jurassic (upper Sinemurian, ?Oxynotum Zone): England.—FIG. 25, *2a–c*. *\*S. slatteri* (WRIGHT), holotype, Lower Lias Clay, Pershore, Worcestershire,  $\times 1$  (Wright, 1882, pl. 50, *1–3*).

### Family CYMBITIDAE Buckman, 1919

[Cymbitidae BUCKMAN, 1919a, p. B]

Diagnosis as for *Cymbites*. [This is a long-ranging genus showing little change with time. Its origin is obscure. The suture resembles those of the Psiloceratidae and early Arietitidae; Cymbitidae are probably derived from Arietitidae in view of the low keel present in some examples.] Lower Jurassic (Sinemurian–Pliensbachian).

**Cymbites** NEUMAYR, 1878, p. 64 [*\*Ammonites globosus* ZIETEN, 1832 in 1830–1833, p. 37; OD] [=Metacymbites SPATH, 1923b, p. 76 (type, *Ammonites centriglobus* OPPEL, 1862, p. 140, OD)]. Inner whorls involute, sphaeroconic; last whorl strongly eccentric and becoming evolute,

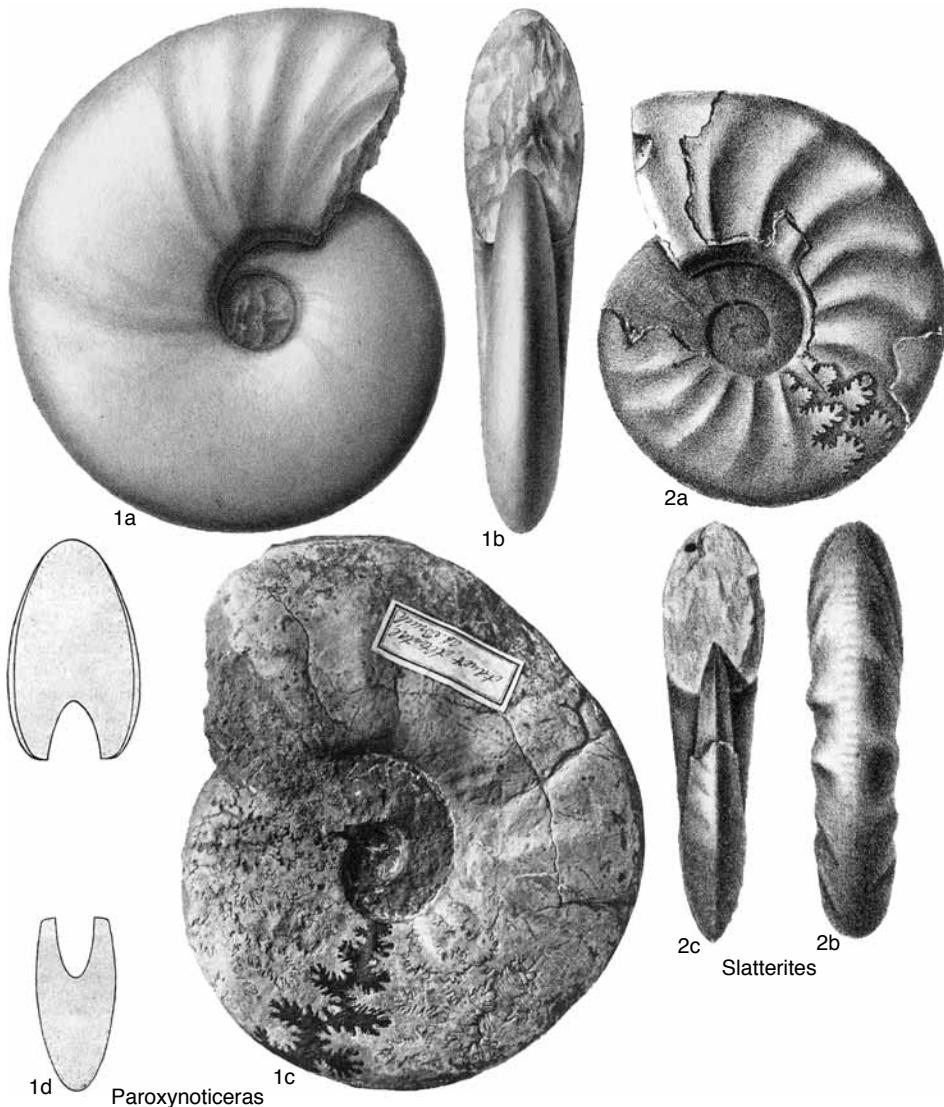


FIG. 25. Oxynoticeratidae (p. 35).

umbilicus opening out from less than 20% to 35–40% of the diameter; small size, usually less than 20 mm, and has about four whorls; venter smooth, rounded or fastigiate; aperture constricted and has ventral rostrum; shell smooth or plicate, rarely with lateral tubercles, giving cadicone appearance to inner whorls; suture simple, with constricted saddles in some specimens. Lower Jurassic (*Sinemurian*–*Pliensbachian*): northern Europe, Tunisia, United States (Oregon).—FIG. 26, 1a–c. *\*C. globosus* (ZIETEN), neotype, *Sinemurian*, Fulbach, near Dürnau, Württemberg, Germany; a–b,  $\times 3$ ; c,

suture,  $\times 7$  (Schindewolf, 1961, pl. 29, 1; p. 203, fig. 1).—FIG. 26, 1d–f. *C. centriglobus* (OPPEL), ?lectotype, upper Pliensbachian, Dürnau, Württemberg, Germany; d–e,  $\times 3$ ; f, suture  $\times 6$  (Schindewolf, 1961, pl. 31, 1; p. 219, fig. 22). ?*Hyerifalchia* FUCINI, 1907, p. 648 [*H. solitaria*; OD] [=*Hierifalchia* FUCINI, 1907, p. 654, nom. null., misspelling]. Small (7 mm in diameter), smooth sphaerocone with closed umbilicus, and depressed inner whorls that become more compressed; ventral keel well defined; suture has 3 nearly equal saddles. Known from a single specimen; probably a synonym of *Cymbites* (DONOVAN, 1990, p.

258). Lower Jurassic (?Sinemurian): Italy.—FIG. 26, 2a–b. \**H. solitaria*, holotype, Gerfalco, La Spezia, Tuscany,  $\times 2$  (Fucini, 1907, pl. 11, 28, 30).

## Superfamily EODEROCERATOIDEA Spath, 1929

[nom. correct. VENTURI, NANNARONE, & BIOLLA, 2004, p. 367, pro Eoderocerataceae ARKELL, 1950, p. 361, nom. transl. ex Eoderoceratidae SPATH, 1929, p. 270] [=Deroceratacea BUCKMAN, 1919a, p. xvi, and Deroceratida SPATH, 1926a, p. 140, both nom. transl. ex Deroceratidae HYATT, 1867, p. 81, invalid based on junior homonymy; =Xiphoceratidae SPATH, 1929, p. 270, nom. transl. ex Xiphoceratidae SPATH, 1925a, p. 305; =Coelocerataceae WIEDENMAYER, 1977, p. 73, nom. transl. ex Coeloceratidae HAUG, 1910, p. 932]

The basic shell form is an evolute septenticone, present from the earliest member (Eoderoceratidae) to the latest (Dactylioceratidae). Involute shells occur in Liparoceratidae and Amaltheidae, although both of these families also include septenticone genera, and *Pseudoamaltheus* is an oxycone. The venter is typically rounded, but some Polymorphitidae have a fastigiate venter, developing into a keel in *Tropidoceras*, and Amaltheidae have a ventral keel. Simple radial ribs are present on the side of the whorl in most genera. The ribs typically bear tubercles or spines at their outer ends and sometimes at or near their inner ends as well. Normally the number of outer and inner spines is the same, but in *L. (Liparoceras)*, there are more outer spines than inner ones. Some genera bear striae, fine ribs, or secondary ribs that may pass over the venter. Longitudinal (spiral) ornament is present in some Liparoceratidae and their derivatives Amaltheidae. The majority of genera show little change of ornament with growth, but there are notable exceptions, such as *Androgynoceras* (see diagnosis for Liparoceratidae), *Epideroceras*, and *Phricodoceras*, in which strong modifications of the outer whorls may occur. Adult sizes range from a diameter of only 20–30 mm in some genera, to up to 500 mm in the giant genera *Apoderoceras*, *Epideroceras*, and *Liparoceras*.

The suture is very similar to that of Psiloceratoidea, except that in the interpretation of SCHINDEWOLF (1962), it lacks the minor umbilical element U4. Many genera have sutures with highly subdivided, arborescent saddles, and a few have simplified sutures.

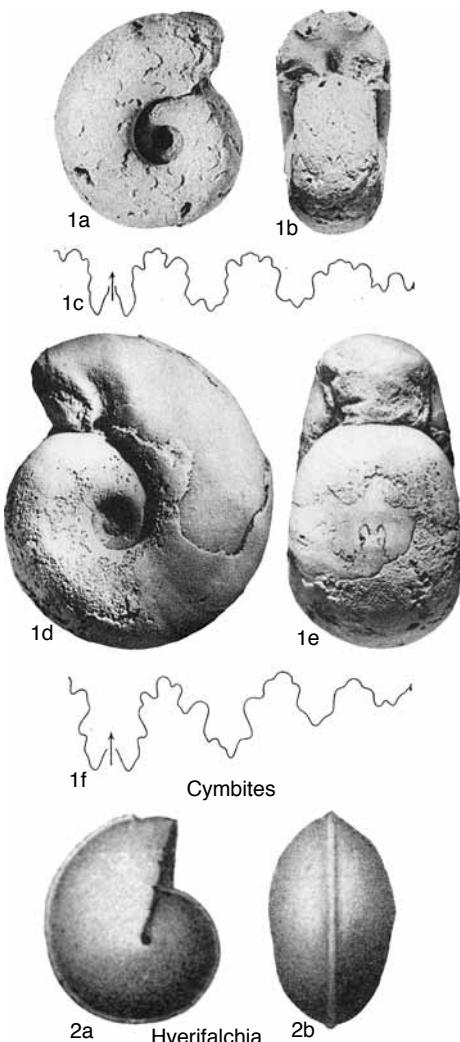


FIG. 26. Cymbitidae (p. 35–37).

The earliest genus is *Microderoceras* from the *Semicostatum* Zone of Germany; its immediate ancestors are unknown. The origin of the superfamily may be found in such Tethyan genera as *Etocentrites*, which is among the earliest Lytoceratoidea, but SCHINDEWOLF (1962) suggested derivation from the Psiloceratoidea, on the basis of suture comparisons. The latest members of the superfamily are the Dactylioceratidae genera *Catacoeloceras* and *Collina* in the upper Toarcian, *Variabilis* Zone.

Geographical range is worldwide. In Europe, the greatest variety of genera occur in countries to the north of the alpine belt, and some genera are largely or wholly restricted to this area (DOMMERGUES & MEISTER, 1999). [The family-group names based on the genus *Eoderoceras* have a complicated nomenclatural history that has been summarized by EDMUNDS (2009, p. 22–23). Despite the inclusion in the superfamily Eoderoceratoidea of many family names that have date priority (including three dating from HYATT, 1867), Eoderoceratoidea SPATH, 1929, is retained here as the name of this superfamily under the provisions of Article 35.5, ICZN Code (1999), because of its long-established usage in major works on classification, e.g., ARKELL (1950, p. 361; 1957, p. 245), BASSE (1952b, p. 616), KRIMHOLZ (1958, p. 67) and DONOVAN, CALLOMON, and HOWARTH (1981, p. 109, 138), among others. For similar reasons of long-established usage, the family and subfamily names Eoderoceratidae SPATH, 1929, and Eoderoceratinæ SPATH, 1929, are also retained, despite the existence of earlier family and subfamily names that have date priority but have never gained wide acceptance.] Lower Jurassic (*Sinemurian*–upper *Toarcian*).

### Family EODEROERATIDAE Spath, 1929

[Eoderoceratidae SPATH, 1929, p. 270, retained under the provisions of Article 35.5, ICZN Code (1999), because of long-established usage] [=Deroceratidae HYATT, 1867, p. 81, invalid based on junior homonym; =Xipheroceratidae SPATH, 1925a, p. 305; =Microceratidae SPATH, 1926b, p. 176, invalid based on junior homonym; =Hemimicroceratidae SPATH, 1929, p. 270, replacement for Microceratidae; =Dubariceratidae DOMMERGUES & MEISTER, 1999, p. 281]

Shells evolve and platycone in the subfamily Eoderoceratinæ, but involute oxycones develop in the subfamily Fanninoceratinæ. Ribs and tubercles present in most genera, but oxycones become smooth. Fanninoceratinæ are probably derived from *Dubariceras* or *Metaderoceras*. Lower Jurassic (*Sinemurian*–lower *Toarcian*).

### Subfamily EODEROERATINÆ Spath, 1929

[*nom. transl.* ARKELL, 1950, p. 361, *ex* Eoderoceratidae SPATH, 1929, p. 270, retained under the provisions of Article 35.5, ICZN Code (1999), because of long-established usage] [=Xipheroceratinæ SPATH, 1925a, p. 305, *nom. transl.* ARKELL, 1950, p. 361; =Hemimicroceratinæ SPATH, 1929, p. 270, *nom. transl.* ARKELL, 1950, p. 361; =Paramicroderoceratinæ VENTURI, NANNARONE, & BILOTTA, 2004, p. 367]

Shells evolve with little change of form during growth. Early smooth stage may be prolonged, followed by simple ribs, which at some stage of growth bear spines at their ventral ends, and at their umbilical ends as well in some genera (*Microderoceras*, *Bifericeras*). Venter smooth, or with blunt ribs (*Promicroceras*) or weak secondary ribs. Keel absent. Lower Jurassic (*Sinemurian*–lower *Pliensbachian*).

**Microderoceras** HYATT, 1871, p. 23 [*\*Ammonites birchi* J. SOWERBY, 1820, p. 121; SD SPATH, 1926b, p. 171]. Evolute, with very slight overlap of whorls; whorl section subcircular or subquadrate; seven or more whorls that may reach large size; innermost whorls smooth, ribs appearing on about third or fourth whorl and becoming bituberculate on outer whorls; venter smooth or with faint, close ribbing. Lower Jurassic (*lower Sinemurian*, *Semicostatum*–*Turneri* Zones): Europe, Morocco, Tunisia, Indonesia (Timor, Roti), Canada (Yukon), USA (Alaska), Mexico, Chile, Argentina, Peru.—FIG. 27, *1a–b*. *\*M. birchi* (J. SOWERBY), lectotype (designated by DONOVAN & FORSEY, 1973, p. 10), *Turneri* Zone, Dorset, England,  $\times 0.7$  (new, The Natural History Museum, London, BMNH 43923).

**Xipheroceras** BUCKMAN, 1911, p. *iv* [*\*X. planicosta*; OD; Article 11.10, ICZN Code (1999); =*Ammonites ziphus* ZIETEN, 1830 in 1830–1833, p. 6] [=Praederoceras DIETZ, 1916, p. 199; DIETZ, 1923, p. 407, obj.; =Postderoceras SCHINDEWOLF, 1923, p. 368, *nom. nud.*]. Evolute, with very slight overlap of adjacent whorls; whorl section subcircular, becoming more compressed on outer whorls; 7 to 8 whorls, reaching large size; innermost whorls smooth, all later whorls bear straight ribs; periodic ribs are enlarged on middle whorls and bear strong ventral tubercles or spines; this stage is preceded and followed by ordinary ribs, which may bear ventrolateral tubercles. Lower Jurassic (*upper Sinemurian*, *Obtusum* Zone): Europe, Vietnam, Indonesia (Borneo).—FIG. 27, *2a–d*. *\*X. ziphus* (ZIETEN); *a–b*, holotype, Boll, Württemberg, Germany,  $\times 1$  (new, The Natural History Museum, London, BMNH 62590); *c–d*, *Obtusum* Zone, Dorset, England, holotype of *X. planicosta* BUCKMAN,  $\times 0.4$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 25033).

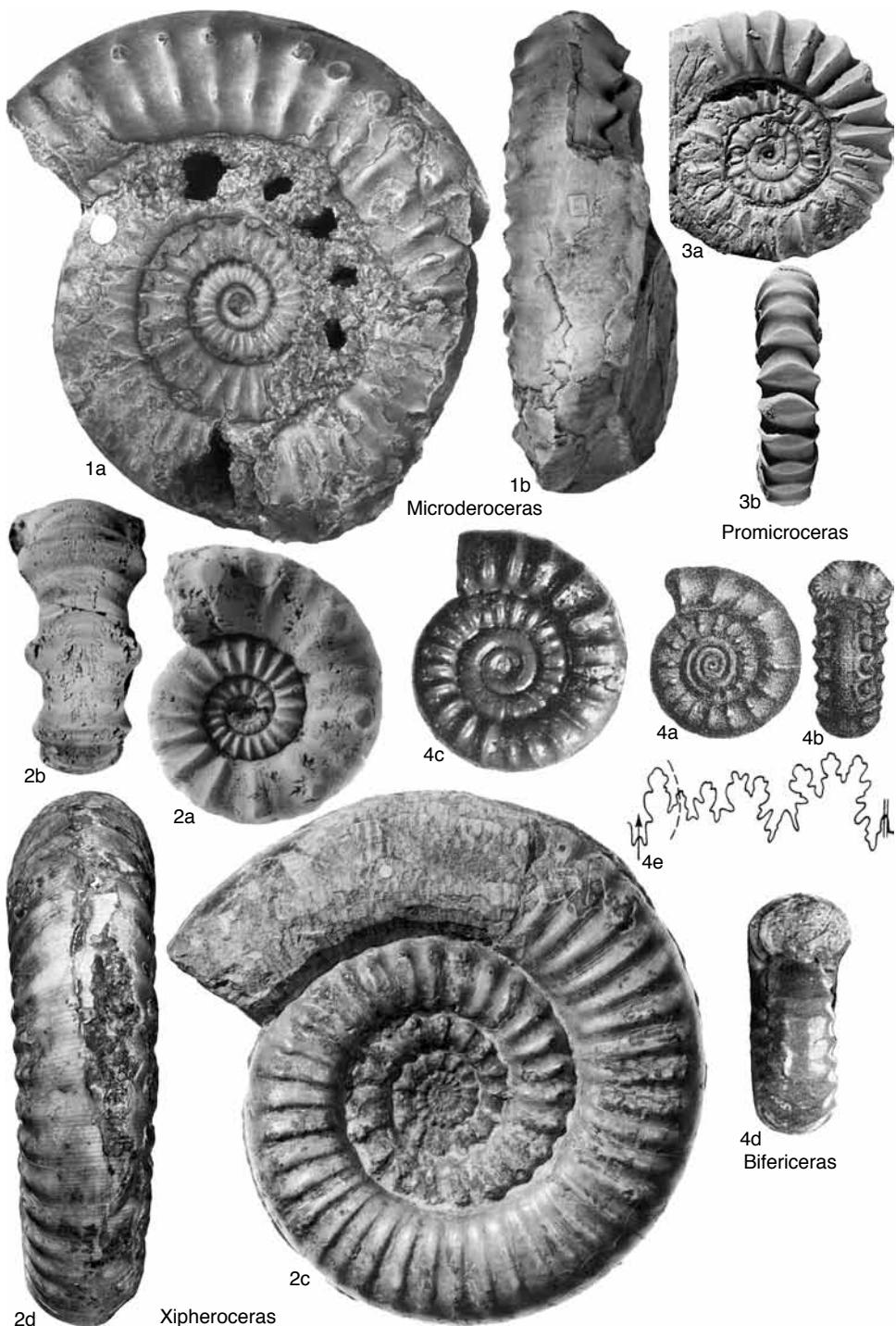


FIG. 27. Eoderoceratidae (p. 38–40).

**Promicroceras** SPATH, 1925a, p. 304 [*\*Ammonites planicosta* J. SOWERBY, 1814, p. 167; OD]. Evolute, slight overlap of whorls, compressed whorl section; small in size and attains about 5 whorls; inner whorls smooth, outer whorls bear straight, sharp ribs that become broad and flattened as they pass over venter. May be the microconch of *Microderoceras* or *Xiphoceroceras*. *Lower Jurassic (Sinemurian, Turneri–Obtusum Zones)*: Europe.—FIG. 27,3a–b. \**P. planicosta* (J. SOWERBY), neotype, *Obtusum Zone*, Dorset, England,  $\times 1.5$  (new, The Natural History Museum, London, C.2235b).

**Bifericeras** BUCKMAN, 1913, p. iii [*\*Ammonites bifer* QUENSTEDT, 1843, p. 160; OD] [= *Microceras* HYATT, 1867, p. 80, non HALL, 1845, p. 294 (type, *Ammonites confusus* QUENSTEDT, 1856 in 1856–1858, p. 127, SD BUCKMAN, 1924, p. 24); = *Hemiceroceras* SPATH, 1925a, p. 140 (type, *H. thompsoni*, OD); ?= *Ophideroceras* SPATH, 1925a, p. 137 (type, *O. zippoides*, OD)]. Evolute, small size and up to 6 whorls; only slight overlap of whorls; whorl section subcircular or depressed; umbilicus 50–60% of diameter; inner whorls smooth, outer whorls develop bold straight ribs that bear umbilical and ventrolateral spines in some species (including the type species), but ribs are poorly developed in other species; venter smooth or crossed by low ribs. *Lower Jurassic (upper Sinemurian)*: Europe.—FIG. 27,4a–e. \**B. bifer* (QUENSTEDT), Balingen, Württemberg, Germany; a–b, holotype,  $\times 1$  (Quenstedt, 1846 in 1845–1849, pl. 14,4); c–d,  $\times 2$  (Söll, 1957, pl. 19,4); e, suture,  $\times 4$  (Söll, 1957, p. 404, fig. 32).

**Eoderoceras** SPATH, 1925a, p. 363 [*\*Deroceras bispinigerum* BUCKMAN, 1918b, p. 302; OD] [= *Paramicroderoceras* DOMMERGUES, FERRETTI, & MEISTER, 1994, p. 36 (type, *Microderoceras birchiades* ROSENBERG, 1909, p. 262, OD); = *Paraderoceras* VENTURI, NANNARONE, & BIOLLA, 2007, p. 10 (type, *S. spirale*, OD)]. Evolute serpenticones; whorl section subcircular to coronate; umbilicus about 50% of diameter; innermost whorls smooth; later whorls become ribbed; prominent ventrolateral tubercles or spines and smaller umbilical edge tubercles occur on the ribs; minor ribs or striae develop between the spinose ribs and pass over the venter; suture has arborescent saddles. *Lower Jurassic (upper Sinemurian, Oxynotum Zone–lower Pliensbachian, lowest part of Jamesoni Zone)*: Europe, Turkey, Morocco, Tunisia, Japan, Indonesia (Timor), Canada (British Columbia, Alberta), USA (Nevada), Mexico, Chile, Argentina.—FIG. 28,1a–b. \**E. bispinigerum* (BUCKMAN), neotype (designated by EDMUND, 2009, p. 32), *Raricostatum Zone*, *Densinodulum Subzone*, Stonebarrow Cliff, Charmouth, Dorset, England,  $\times 0.5$  (Edmunds, 2009, pl. 8,3).

**Eteoderoceras** EDMUND, 2009, p. 36 [*\*Ammonites armatus* J. SOWERBY, 1815a, p. 215; OD] [= *Deroceras* HYATT, 1867, p. 81, non RAFINESQUE, 1820, p. 10 (type, *Ammonites armatus* J. SOWERBY, 1815a, p. 215, SD BUCKMAN, 1898b, p. 460)]. Differs from *Eoderoceras* in the absence of spines at the umbilical ends of the ribs at all growth stages;

also has much longer smooth (so-called tubeliform) innermost whorls than *Eoderoceras*. *Lower Jurassic (upper Sinemurian, Raricostatum Zone)*: Britain, France, Luxembourg, Germany, Austria, less common in southeastern Europe.—FIG. 28,2a–b. \**E. armatum* (J. SOWERBY), neotype (designated by HOWARTH, 2002, p. 133), Robin Hood's Bay, Yorkshire,  $\times 0.5$  (Howarth, 2002, pl. 5,9).

**Crucilobiceras** BUCKMAN, 1920, pl. 178 [*\*C. crucilobatum*; OD]. Shell evolute, up to 8 whorls, with slight whorl overlap; umbilicus 50–60% of diameter in adult; inner whorls smooth, later whorls have straight, somewhat rursiradiate ribs, that bear ventrolateral and sometimes inner spines near umbilical edge; fine striae may occur between ribs; venter smooth or finely ribbed; suture has arborescent saddles. *Lower Jurassic (upper Sinemurian)*: Europe, Canada (British Columbia, Alberta), USA (Alaska, California), Mexico.—FIG. 28,3a–b. \**C. crucilobatum*, holotype, *?Raricostatum Zone*, Cheltenham, Gloucestershire, England,  $\times 0.9$  (Buckman, 1920, pl. 178,1–2).

**Metaderoceras** SPATH, 1925a, p. 363 [*\*Ammonites muticum* D'ORBIGNY, 1844 in 1842–1851, p. 274; OD] [= *Spiniclaviceras* VENTURI, NANNARONE, & BIOLLA, 2007, p. 10 (type, *S. spirale*, OD)]. Evolute serpenticones like *Eoderoceras*, but whorl section becomes higher, more compressed, and more closely ribbed; ribs end in prominent ventrolateral tubercles or spines, and minor ribs or striae occur between the tuberculate ribs; venter smooth or striate; suture with arborescent saddles. *Spiniclaviceras* is poorly known and poorly preserved. *Lower Jurassic (lower Pliensbachian, Jamesoni and Ibex Zones)*: Europe, Tunisia, Turkey, Canada (British Columbia), USA (Alaska, Nevada, Oregon), Mexico.—FIG. 29,1a–c. \**M. muticum* (D'ORBIGNY), Saint-Amand-Montrond, Cher, France; a, lectotype,  $\times 0.8$  (J. C. Fischer, 1994, pl. 22,12); b–c, D'ORBIGNY's original reconstructed figure based on the lectotype,  $\times 0.8$  (d'Orbigny, 1844 in 1842–1851, pl. 80).

**Dubariceras** DOMMERGUES, MOUTERDE, & RIVAS, 1984, p. 833 [*\*D. dubari*; OD] [= *Farinacites* FARAONI & others, 1997, p. 98 (type, *F. clavatus*, OD)]. Similar to *Metaderoceras*, but whorl section higher and more compressed, has low, rounded venter, and many more ribs; inner whorls almost smooth, then with closely spaced, weakly sigmoidal ribs that do not change with growth; ventrolateral spines small, sharp, joined across venter by weak ribs with slight forward curve; suture similar to *Metaderoceras*. *Lower Jurassic (lower Pliensbachian, mainly Ibex Zone)*: Italy, Hungary, southeastern Spain, ?Turkey, Morocco, Canada (British Columbia), USA (Alaska, Nevada, Oregon), Mexico, Chile, Argentina.—FIG. 29,2a–b. \**D. dubari*, holotype, Caravaca, Murcia, Spain,  $\times 1$  (new, Palaeontology Department, Granada University, Spain, no. G2-1; also figured in Dommergues, Mouterde, & Rivas, 1984, pl. 1,10–11).

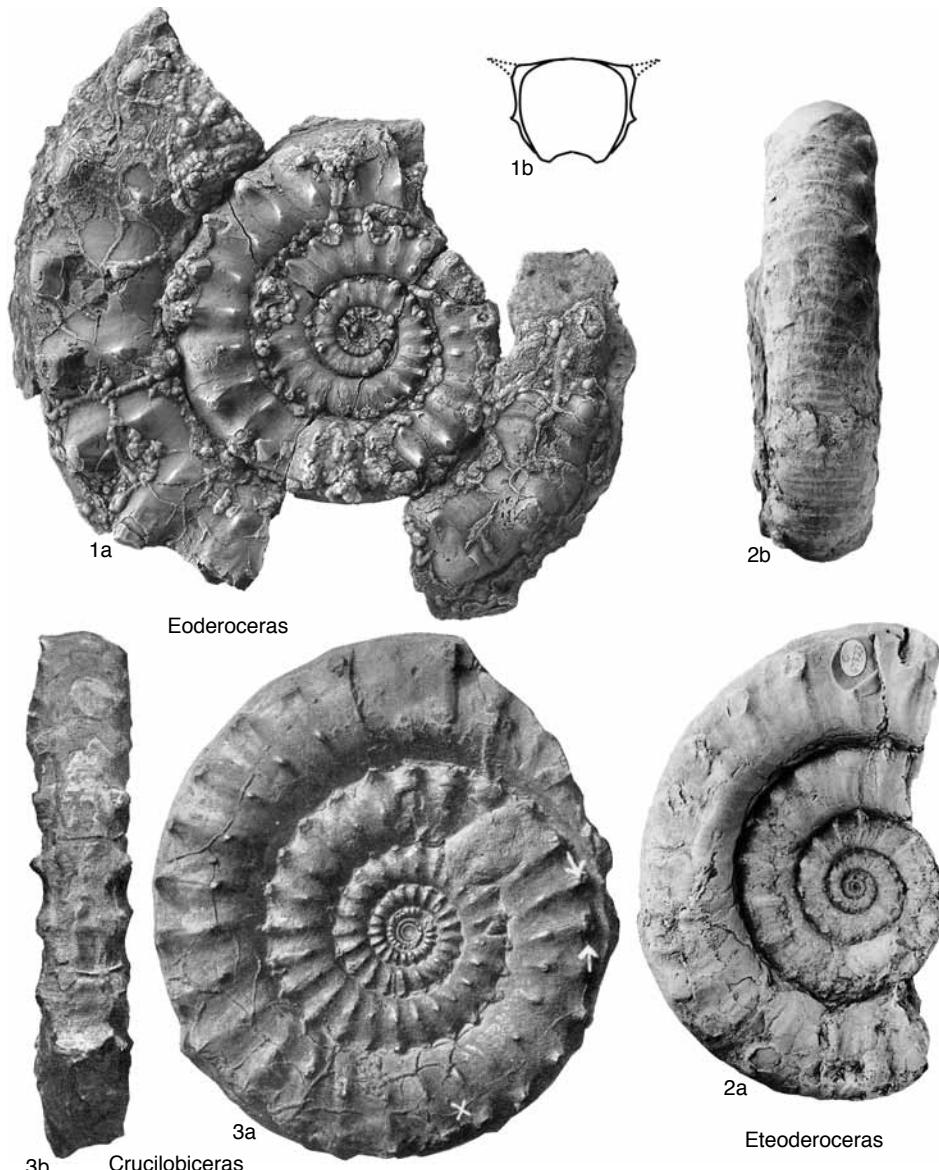


FIG. 28. Eoderoceratidae (p. 40).

**Hyperderoceras** SPATH, 1926a, p. 47, footnote 1  
[\**Ammonites armatus ruga* QUENSTEDT, 1884 in 1882–1888, p. 206; OD; =*Ammonites retusus* SIMPSON, 1855, p. 62]. Evolute, strongly ribbed eoderoceratids, in which some ribs, at irregular intervals (about 5 to 12 per whorl), are flared and bear ventrolateral tubercles; the tuberculate ribs bifurcate, others cross venter without loss of strength, giving it a corrugated appearance. Lower Jurassic (lower Pliensbachian, Jamesoni

Zone): England, southern Germany.—FIG. 29, 3a–b. *H. retusum* (SIMPSON), paralectotype of *Ammonites armatus ruga* QUENSTEDT (1884 in 1882–1888, pl. 25, 10) (the lectotype [QUENSTEDT, 1884 in 1882–1888, pl. 25, 9] is lost), Gomaringen-Hinterweiler, Tübingen, Germany, ×1 (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5/25/10; also figured in Schlegelmilch, 1976, pl. 26, 4).

**Parahyperderoceras** SCHLATTER, 1980, p. 62 [*\*Ammonites planarmatus* QUENSTEDT, 1856 in 1856–1858, p. 153; OD]. Shells fairly evolute with strong, straight, primary ribs that cross venter, separated by concave spaces in which there may be fine striate ribs; some slightly weaker secondary ribs are intercalated, and this ornament shows little change with growth. *Lower Jurassic (lower Pliensbachian, Jamesoni Zone)*: southern Germany.—FIG. 29, 4a–b. *\*P. planarmatum* (QUENSTEDT), ?holotype, Pliensbach, Göppingen, Württemberg,  $\times 0.67$  (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5/27/1; also figured in Schlegelmilch, 1976, pl. 27,2).

### Subfamily FANNINOCERATINAE Dommergues & Meister, 1999

[*Fanninoceratinae* DOMMERGUES & MEISTER, 1999, p. 282]

Involute oxycones, with sharp, fastigiated, or keeled venter; ribs at least on inner whorls, and ventrolateral tubercles in some; outer whorls becoming smooth in some. [*Fanninoceras* has usually been placed in the Oxynoticeratidae because of its resemblance to the genus *Radstockiceras* (DONOVAN, CALLOMON, & HOWARTH, 1981; SMITH & TIPPER, 1996); but in the lower Pliensbachian of South America, an evolutionary series can be demonstrated from *Eoamaltheus* in the *Ibex* Zone through intermediates (e.g., HILLEBRANDT, 1990, fig. 4–4; HILLEBRANDT & others, 1992, pl. 11,6, into *Andidiscus* and *Fanninoceras*, which then ranges up into the lowest Toarcian (HILLEBRANDT, 1987, 2006; HILLEBRANDT & others, 1992). *Eoamaltheus* may be derived from *Dubariceras* or *Metaderoceras*, and the subfamily Fanninoceratinae is placed here in the Eoderoceratidae (Dubariceratidae of DOMMERGUES & MEISTER, 1999, p. 282); however, an alternative placement of Fanninoceratinae is in the Polymorphitidae, from the resemblance of the ancestral *Eoamaltheus* to some species of *Polymorphites*, e.g., some of the more costate specimens of *P. polymorphus* (HILLEBRANDT & SCHMIDT-EFFING, 1981; SMITH & TIPPER, 1996)]. *Lower Jurassic (Pliensbachian–lowest Toarcian)*: western North and South America.

*Eoamaltheus* HILLEBRANDT, 1981, p. 510 [*\*E. meridianus*; OD]. Inner whorls evolute, with ventral keel; sigmoidal ribs are projected well forward

on venter and bear medium to large ventrolateral tubercles; larger whorls more compressed, with some bifurcating or intercalated ribs, and tubercles are gradually lost. *Lower Jurassic (lower Pliensbachian, Meridianus Zone [=top Ibex Zone–lower Davoei Zone])*: Chile, Argentina.—FIG. 30, 1a–d. *\*E. meridianus*, Quebrada Amolanas, southeast of Copiapo, Atacama, Chile; a–b, holotype, microconch,  $\times 2$ ; c–d, macroconch,  $\times 1$  (Hillebrandt, 2006, pl. 27, 18a–b, 19a–b).

*Andidiscus* HILLEBRANDT, 2006, p. 167 [*\*A. volkheimeri*; OD]. Early whorls moderately evolute, with sharp, straight to gently sinuous ribs curving forward to join the midventral keel; middle and outer whorls become more involute and compressed with an angled umbilical edge, vertical or undercut umbilical wall, and a more acute venter. Appears to be dimorphic: macroconchs attain 200 mm in diameter with fading ribs at large sizes in some species; microconchs are much smaller and strongly ribbed to the end of growth. Intermediate in morphology and age between *Eoamaltheus* and *Fanninoceras*. *Lower Jurassic (lower Pliensbachian, Behrendseni Zone [=mid–upper Davoei Zone])*: Argentina, Chile.—FIG. 30, 2a–b. *\*A. volkheimeri*; holotype, macroconch, Puesto Araya, Rio Atuel, Mendoza, Argentina,  $\times 1$  (Hillebrandt, 2006, pl. 39, 12a–b).

*Fanninoceras* MCLEARN, 1930, p. 4 [*\*F. fannini*; OD] [*Astromorphites* LEANZA & BLASCO, 1990, p. 164 (type, *"Amaltheus spinatus* BURCKHARDT, 1900," p. 22, non *Ammonites spinatus* BRUGUIÈRE, 1789 in 1789–1792, =*Oxynoticeras behrendseni* JAWORSKI, 1926, p. 233)]. Early whorls moderately evolute and depressed, with rounded venter and variable ribbing; then whorls quickly become involute, compressed oxycones, with sharp venter, angled umbilical edge, undercut umbilical wall, and ribbing that gradually disappears; attains sizes of at least 200 mm in diameter. *Lower Jurassic (upper Pliensbachian–base of Toarcian)*.

**F. (Fanninoceras).** Inner whorls have rounded venter without a keel, and single, undivided ribs; large whorls are highly involute, compressed oxycones, and are smooth. *Lower Jurassic (upper lower Pliensbachian–base of Toarcian)*: Canada (British Columbia), USA (Alaska, Nevada, Oregon), Mexico, Chile, Argentina, Peru.—FIG. 30, 3a–b. *\*F. (F.) fannini*, holotype, Kunae Zone, upper Pliensbachian, Fannin Bay, Maude Island, Queen Charlotte Islands, Canada,  $\times 1$  (Smith & Tipper, 1996, pl. 3,2).

**F. (Charlotticeras)** SMITH & TIPPER, 1996, p. 32 [*\*F. (C.) carteri*; OD]. Inner whorls have incipient ventral keel and ribs that bifurcate irregularly with some intercalated secondaries; ribs are projected on venter; known only up to 26 mm in diameter; oxycone stage unknown. *Lower Jurassic (upper Pliensbachian, Kunae Zone)*: Canada (British Columbia).—FIG. 30, 4a–b. *\*F. (C.) carteri*; holotype, Fannin Bay, Maude Island, Queen Charlotte Islands,  $\times 1.5$  (Smith & Tipper, 1996, pl. 6,1).

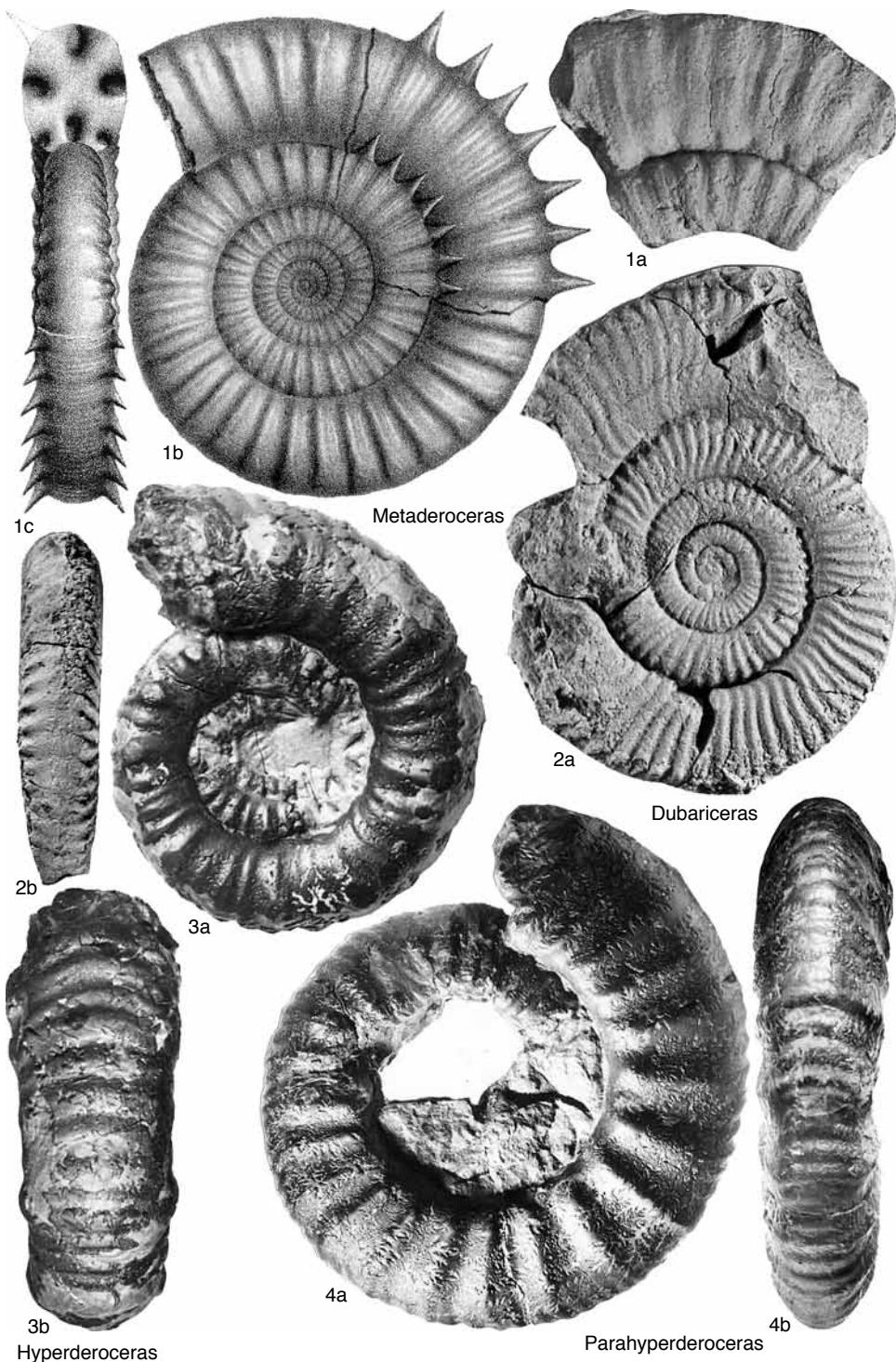


FIG. 29. *Eoderoceratidae* (p. 40–41).

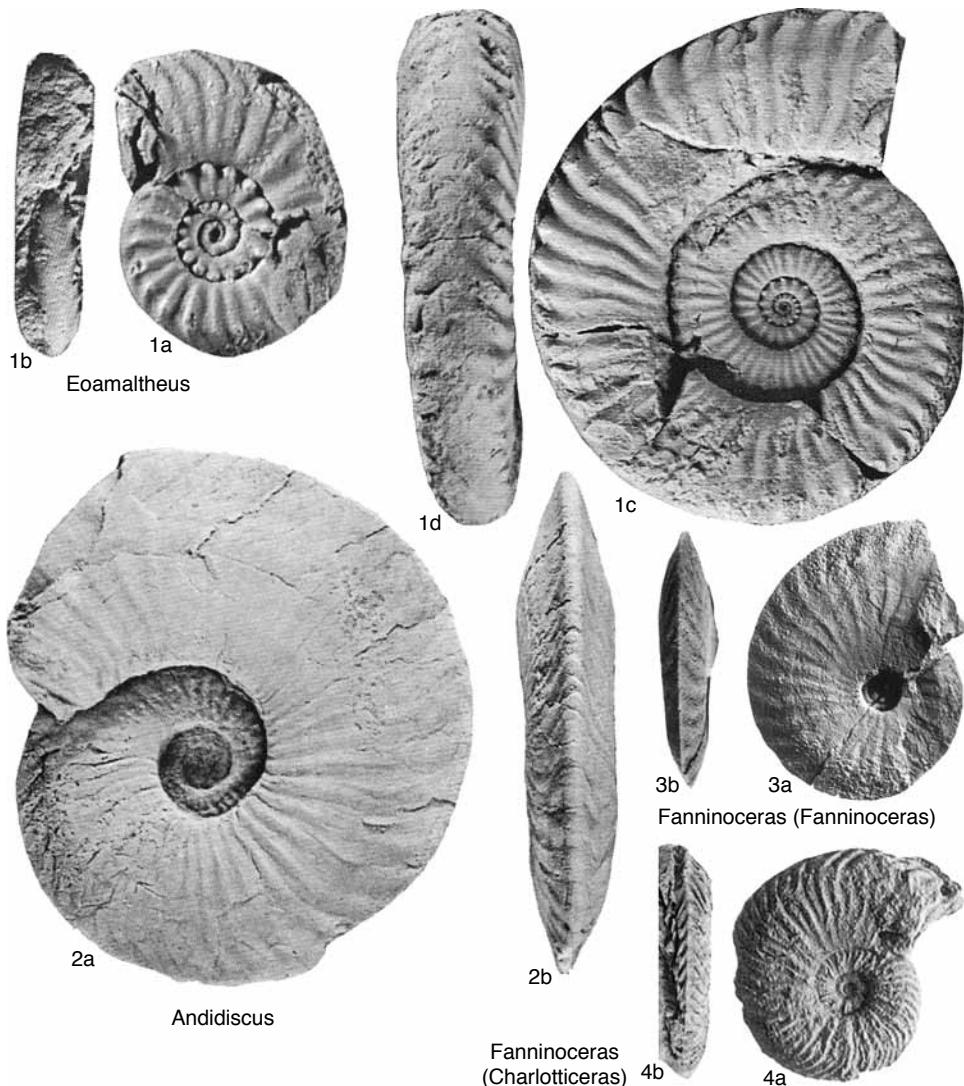


FIG. 30. Eoderoceratidae (p. 42).

**Family COELOCERATIDAE**  
Haug, 1910

[Coeloceratidae HAUG, 1910, p. 932] [=Pimelitinae WIEDENMAYER, 1977, p. 74]

Inner whorls depressed, coronate, with strong primary ribs. Tuberles at outer ends of primaries give rise to fine secondary ribs. On middle and outer whorls of large forms (*Apoderoceras*, *Pseudoskirroceras*, *Tetraspidoceras*), the coronate shell form is lost and the shell becomes evolute with subcircular

or subquadrate whorl section; the middle whorls of these large forms are ribbed and have moderate or large ventrolateral or lateral tubercles, while the ribbing may be lost on the outer whorls. Suture very elaborate, with large saddle between lobes E and L. [The presence of coronate inner whorls in *Tetraspidoceras* is uncertain, and this genus is included in the family on the basis of its resemblance to *Apoderoceras*]. Lower Jurassic (upper Sinemurian—lower Pliensbachian).

**Coeloceras** HYATT, 1867, p. 87 [*\*Ammonites pettos*; QUENSTEDT, 1843, p. 178; SD BUCKMAN, 1898b, p. 454]. Shell coronate, with possibly 7 whorls, each whorl overlapping about one-third of previous one; primary ribs end at ventrolateral angle in tubercles that give rise to secondary ribs; body chamber unknown. *Lower Jurassic (lower Pliensbachian)*: Europe, Turkey, Tunisia.—FIG. 31, 1a–c. *\*C. pettos* (QUENSTEDT), lectotype, Lias α, Pliensbach, Württemberg, Germany; *a*, *b*,  $\times 1$  (Schlatter, 1977, pl. 2, 5a–b; also figured in DONOVAN & FORSEY, 1973, p. 10, pl. 2, 2); *c*, suture, Kirchheim,  $\times 1.5$  (Schindewolf, 1962, p. 522, fig. 112e).

**Andicoeloceras** HILLEBRANDT, 2006, p. 80 [*\*A. jensei*; OD]. Evolute and cadicone, with coronate inner whorls and attains large sizes; depressed whorl section with greatest width at ventrolateral angle; broad arched venter; straight ribs up to large ventrolateral tubercles give rise to 2 or more secondary ribs curving gently forward across venter; dimorphism unknown. With larger and more massive whorls and tubercles and coarser ribs than *Coeloceras*. *Lower Jurassic (lower Pliensbachian, lower Externum Zone [=upper Jamesoni-lower Ibex Zones])*: Chile, Argentina.—FIG. 31, 2a–b. *\*A. jensei*, Hacienda Manflas Region, Atacama, Chile; *a*, holotype (Hillebrandt, 1981, pl. 4, 2a); *b*, holotype,  $\times 0.8$  (Hillebrandt, 2006, pl. 16, 7b).

**Pimelites** FUCINI, 1896a, p. 124 [*\*P. populonius*; OD]. Small involute cadicones, inner whorls smooth or weakly ornamented, later whorls develop ornament like *Coeloceras*; last whorl becomes abruptly contracted and more evolute; suture has large external saddle. Probably a microconch. *Lower Jurassic (lower Pliensbachian, probably Ibex Zone)*: Italy, ?Turkey.—FIG. 31, 3a–c. *\*P. populonius*, lectotype, Monte Calvi, Tuscany, Italy; *a*–*b*,  $\times 2$ ; *c*, suture,  $\times 3$  (Fucini, 1896b, pl. 25(2), 16).

**Praesphaeroceras** LEVI, 1896, p. 275 (15th September 1896) [*\*P. campiliense*; OD] [= *Diaphorites* FUCINI, 1896a, p. 124 (before 22nd December 1896) (type, *D. vetulonius*, OD)]. Inner whorls involute, sphaerocone, or cadicone, with strong ribs on umbilical slope; later whorls become compressed, and final whorl is eccentrically coiled; small size (less than 20 mm in diameter); aperture plain, hooded; blunt primary ribs on middle whorls are continuous across venter; secondary ribs appear on final whorls; suture has large external saddle, like that of *Pimelites*. Probably a microconch. *Lower Jurassic (lower Pliensbachian, ?Ibex Zone)*: Italy.—FIG. 31, 4a. *\*P. campiliense*, lectotype (designated by DONOVAN & FORSEY, 1973, p. 11), beds with *'Terebratula' aspasia*, near Cetona, Tuscany,  $\times 1.5$  (Levi, 1896, pl. 8, 13).—FIG. 31, 4b–d. *P. vetulonium* (FUCINI), lectotype (designated by DONOVAN & FORSEY, 1973, p. 10), Monte Calvi, Tuscany; *b*–*c*,  $\times 3$ ; *d*, suture,  $\times 8$  (Fucini, 1896b, pl. 25(2), 1e, 1c, 9).

**Miltoceras** WIEDENMAYER, 1980, p. 172 [*Aegoceras sellae* GEMMELLARO, 1884, p. 179; OD]. Planulites,

with closely spaced ribs and small ventrolateral tubercles that give rise to numerous secondary ribs on venter. Ornament somewhat like middle whorls of *Apoderoceras*, but shows little change with growth and lacks cadicone inner whorls of that genus. *Lower Jurassic (lower Pliensbachian)*: Austria, southern Europe, Tunisia, Canada (British Columbia), Chile, Argentina.—FIG. 31, 5a–b. *\*M. sellae* (GEMMELLARO), lectotype (designated by HOWARTH, herein), Strati a *'Terebratula' aspasia*, Galati, Province Messina, Sicily,  $\times 1$  (Gemmellaro, 1884, pl. 3, 1–2).

**Meridiceras** HILLEBRANDT, 2006, p. 60 [*\*M. externum*; OD]. Evolute whorls, only slightly overlapping; quadrate whorl section, with flat whorl sides and arched venter; straight or slightly curved ribs on inner whorls with small ventrolateral tubercles angled strongly forward on venter to form a raised and corded midventral pseudokeel. Dimorphic: microconchs are adult at about 33 mm in diameter, and retain ribs and pseudokeel to the end of growth; macroconchs reach 145 mm in diameter, and ribs, tubercles, and keel diminish on whorls larger than 50 mm in diameter. Differs from *Miltoceras* in its arched venter with corded pseudokeel on inner and middle whorls. *Lower Jurassic (lower Pliensbachian, Externum Zone [=upper Jamesoni and Ibex Zones])*: Chile, Argentina, Peru.—FIG. 32, 1a–d. *\*M. externum*, Quebrada Dona Ines Chica, northeast of El Salvador, northern Chile; *a*–*b*, holotype, complete macroconch,  $\times 0.5$  (Hillebrandt, 2006, pl. 8, 1a, 1d); *c*–*d*, paratype, complete microconch,  $\times 1$  (Hillebrandt, 2006, pl. 7, 16a–b).

**Pseudoskirroceras** WIEDENMAYER, 1980, p. 172 [*\*Coeloceras mastodon* FUCINI, 1935, p. 90 (166); OD]. Very evolute, has many whorls, and attains sizes up to 480 mm in diameter. Differs from *Miltoceras* in having depressed, cadicone inner whorls, more widely spaced primary ribs that end in tubercles that are lower on the whorl side, and fewer, coarser secondary ribs on the venter. *Lower Jurassic (lower Pliensbachian)*: southern Europe, Tunisia, Morocco, Canada (British Columbia), USA (Oregon), Mexico, Chile, Argentina.—FIG. 32, 2. *\*P. mastodon* (FUCINI), lectotype (designated by HOWARTH, herein), Serra Francese, Taormina, Sicily,  $\times 0.15$  (Fucini, 1935, pl. 10(40), 3).

**Zamaiceras** RAKUS & GUEX, 2002, p. 115 [*\*Z. mangoldi*; OD]. Evolute, with depressed, cadicone inner whorls, becoming more compressed on outer whorls; fine, slightly sigmoidal ribs are continuous, though diminished, across venter; small ventrolateral tubercles. Small, known only up to 15 mm in diameter, and apparently are adult microconchs at this size. Corresponding macroconchs are not known; possible macroconchs are *Pseudoskirroceras* or *Coeloceras*, but these are older in age, i.e., occur in the Jamesoni Zone, not Ibex Zone. Differs from *Polymorphites* (Polymorphitinae) in having cadicone inner whorls. *Lower Jurassic (lower Pliensbachian, Ibex Zone)*: Tunisia.—FIG. 32, 3a–c. *\*Z. mangoldi*, holotype, bed 5, Jebel Staa mines, Massif de Zaghouan; *a*, side view; *b*, venter; *c*, whorl

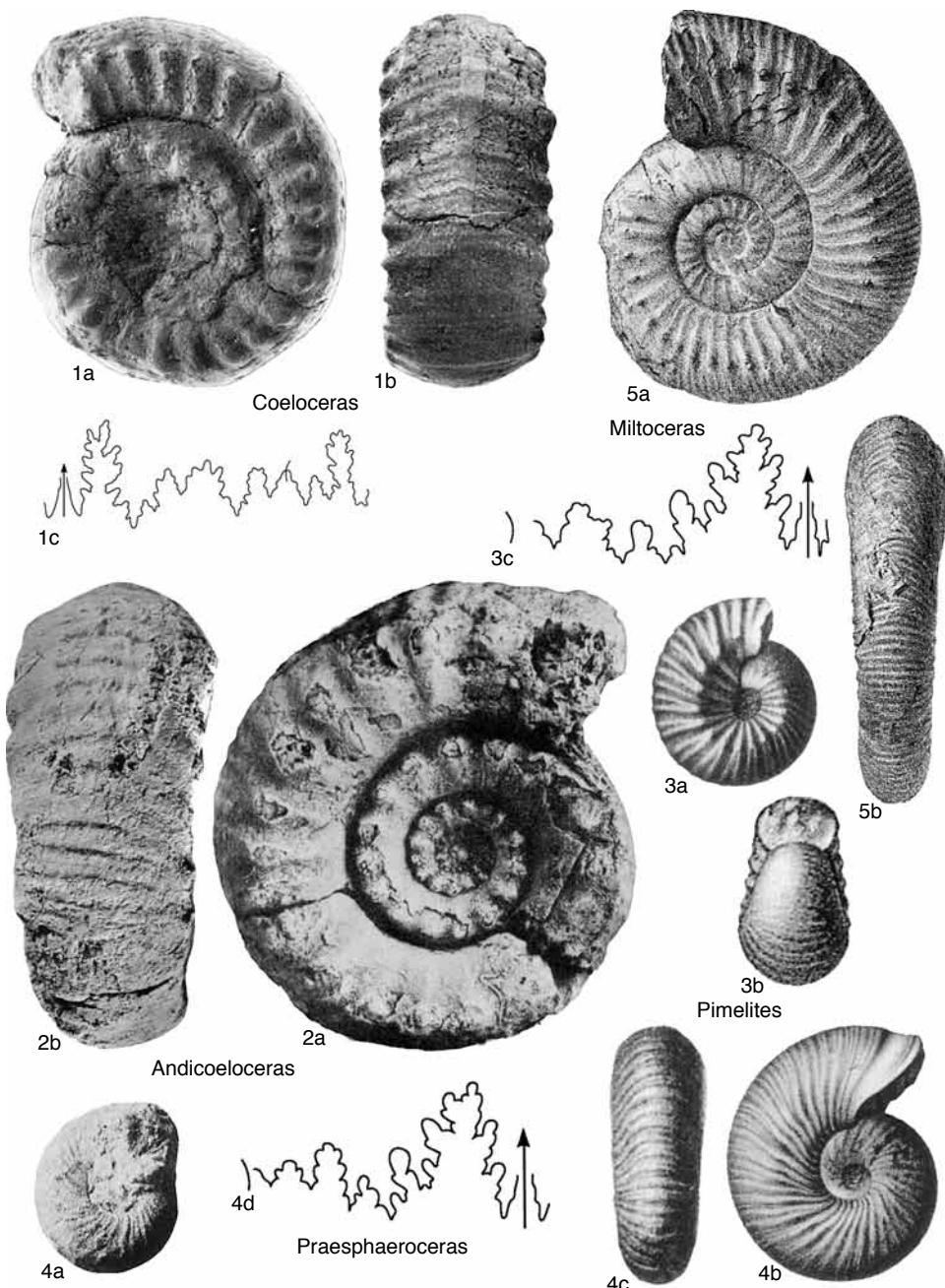


FIG. 31. Coeloceratidae (p. 45).

section,  $\times 2$  (Rakus & Guex, 2002, pl. 32, 13; p. 117, fig. 92a, 92c).

**Apoderoceras** BUCKMAN, 1921, pl. 235 [*\*A. lobulatum*; OD]. Evolute with about 8 whorls having slight overlap; innermost whorls coronate, like *Coelo-*

*ceras*, then becoming serpenticonic with subquadrate whorl section that has ventrally divergent whorl sides; attains large sizes; moderately strong, straight ribs on inner whorls become weaker or striate on middle and outer whorls; moderate to

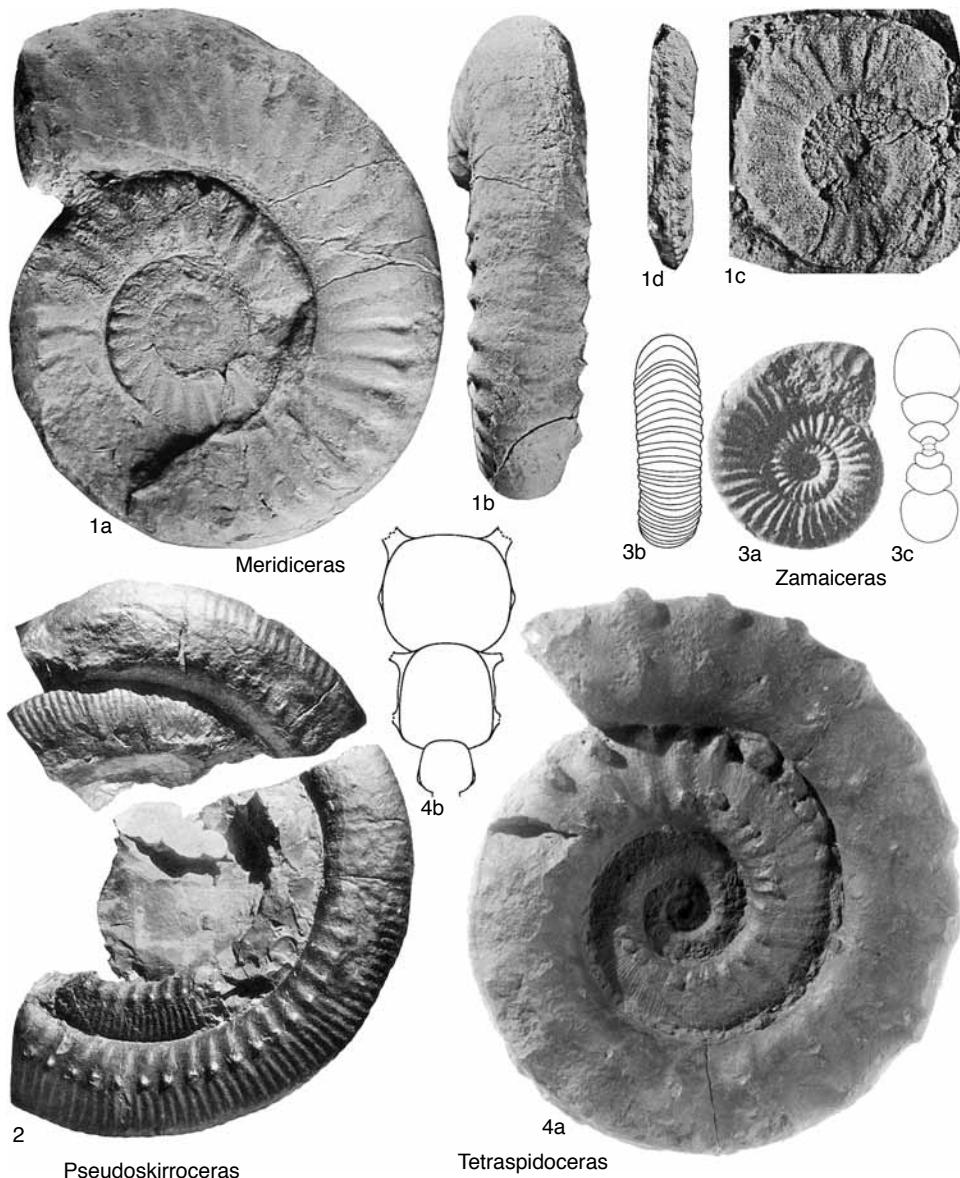


FIG. 32. Coeloceratidae (p. 45–48).

strong ventrolateral tubercles throughout but may weaken on large outer whorls; suture has strongly dissected arborescent saddles. Lower Jurassic (lower Pliensbachian, Jamesoni Zone): Europe, USA (Alaska), Argentina.—FIG. 33, 1a–b. *\*A. lobulatum*, holotype, Armatum Bed, Jamesoni Zone, Radstock, Avon, England,  $\times 0.4$  (Buckman, 1921, pl. 235).—FIG. 33, 1c–d. *A. aculeatum* (SIMPSON), holotype of *A. triornatum* BUCKMAN, 1928, pl. 783A–B, Armatum Bed, Radstock, Avon, England,

$\times 0.3$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 49353).

**Tetraspidoceras** SPATH, 1926a, p. 47 [*\*Ammonites quadrarmatus* DUMORTIER, 1869, p. 60; OD]. Planulate, becoming serpenticone; whorl section compressed, becoming subquadrate; umbilicus increases proportionately with growth to nearly 60% of diameter in adult; attains large sizes; inner and middle whorls have closely spaced ribs or striae, continuous over venter, with periodic

stronger, bituberculate ribs; final whorl smooth with distant pairs of tubercles only. *Lower Jurassic (upper Sinemurian, Raricostatum Zone–lower Pliensbachian, Jamesoni Zone)*: Europe, Morocco, Tunisia, ?Indonesia.—FIG. 32, 4a–b. \**T. quadrarmatum* (DUMORTIER), lectotype (designated by EDMUNDS, 2009, p. 60; original of DUMORTIER, 1869, pl. 9), “Zone of *Belemnites clavatus*” (?Jamesoni Zone), St-Fortunat-au-Mont d’Or, France, ×0.25 (Dumortier, 1869, pl. 9, pl. 11, I).

*Bakonyceras* MEISTER & GÉCZY in GÉCZY & MEISTER, 2007, p. 206 [\**Tetraspidoceras quadrarmatum evolutum* GÉCZY, 1976, p. 49; OD]. Highly evolute serpenticones attaining large sizes, with quadrate whorl section, large, wide umbilicus and flat venter; straight, single ribs bear moderate to large tubercles or spines near umbilical edge and end at larger ventrolateral spines; 3–4 low secondary ribs cross venter between each primary rib. More evolute than *Tetraspidoceras*. *Lower Jurassic (lower Pliensbachian, basal Jamesoni Zone)*: Hungary.—FIG. 33, 2a–c. \**B. evolutum* (GÉCZY), Kávástető, Bakony Mountains, Hungary; a, holotype, side, ×0.3; b, paratype, venter, ×0.5 (Géczy, 1976, pl. 7, 1, holotype; pl. 9, 1a, paratype); c, venter of a topotype, ×0.3 (Géczy & Meister, 2007, pl. 34, 1).

## Family PHRICODOCERATIDAE Spath, 1938

[nom. transl. ARKELL, 1950, p. 361, ex Phricodoceratinae SPATH, 1938, p. 16] [=Villiinae ARKELL, 1957, p. 196; =Epideroceratidae DOMMERGUES & MEISTER, 1999, p. 277]

Inner whorls strongly ribbed, bituberculate, with secondary ribs on venter. Large forms develop compressed outer whorls, with loss of ornament, so that there is a strong contrast between inner and outer whorls. Suture very complex. *Lower Jurassic (upper Sinemurian–lower Pliensbachian)*.

*Phricodoceras* HYATT, 1900, p. 587 [\**Ammonites taylori* J. DE C. SOWERBY, 1826, p. 23; OD] [=Hemipariodiceras GÉCZY, 1959, p. 143 (type, *H. urkuticum*, OD)]. Can attain large sizes, and large individuals have contrasting inner and outer whorls; earliest whorls are evolute, becoming platycone, each whorl overlapping up to one-third of preceding whorl; middle whorls have strong ribs that are continuous over venter and have large lateral and ventrolateral spines; outer whorls become rapidly expanding and compressed, with trapezoidal whorl section, close ribs and spines much reduced or absent; suture has arborescent saddles in large examples. Small individuals with body chambers may be microconchs. *Lower Jurassic (lower Pliensbachian)*: Europe, Turkey, Indonesia (Timor, Roti), Canada (British Columbia), USA (Oregon).—FIG. 34, 1a–b. \**P. taylori* (J. DE C. SOWERBY), Jamesoni Zone, Robin Hood’s Bay, Yorkshire, England (holotype is lost), ×1 (new, The Natural History Museum, London, BMNH C.17981;

also figured in Dean, Donovan, & Howarth, 1961, pl. 68, 5).—FIG. 34, 1c–d. *P. lamellosum* (D’ORBIGNY), Jamesoni Zone, Jamesoni Limestone, Radstock, Avon, England, ×0.67 (new, The Natural History Museum, London, BMNH C.41767; also figured in Buckman, 1920, pl. 149D).

*Pseudophricodoceras* MOUTERDE, DOMMERGUES, & ROCHA, 1983, p. 196 [\**P. capriforme*; OD]. Moderately evolute platycones, umbilicus 35–45% of diameter; whorl section subquadrate, compressed, becoming oval, and convergent on outer whorls; ribs curve slightly forward, and pass over venter without loss of strength on all whorls; ribs are bituberculate, but tubercles may be lost on outer whorls. *Lower Jurassic (lower Pliensbachian, Jamesoni Zone)*: Portugal, northern Germany.—FIG. 34, 2a–b. \**P. capriforme*, holotype, Taylori Subzone, Quiaios, Vale das Fontes, Portugal, ×1 (Mouterde, Dommergues, & Rocha, 1983, pl. 1, 2a–b).

*Villania* TILL, 1909, p. 194; TILL, 1911, p. 45 [\**Perisphinctes* (*Villania*) *densilobata*; OD] [=Epideroceras SPATH, 1923a, p. 10 (type, *Ammonites roberti* HAUER, 1854, p. 748; OD); =Coeloderoceras SPATH, 1923a, p. 11 (type, *Coeloceras ponticum* PIA, 1913, p. 353, OD); ?=Omoderoceras VENTURI, NANNARONE, & BILOTTA, 2004, p. 367 (type, *O. cantianense*, OD)]. Shell planulate, reaching large sizes, with 6–7 whorls; inner whorls subcircular in section, becoming more compressed; umbilicus 30–40% of diameter on inner whorls, 40–55% on outer whorls; primary ribs bituberculate on inner whorls, with secondary ribs crossing venter; tubercles and secondaries fade with growth, but primary ribs may fade or persist; rib frequency increases with size; suture has complex arborescent saddles. *Omoderoceras* is poorly known. [The TILL (1909) publication date has not been recorded before, and the TILL (1911) date is much better known.] *Lower Jurassic (upper Sinemurian, Raricostatum Zone–lower Pliensbachian, Jamesoni–?Ibex Zones)*: southern England, France, Switzerland, Austria, Hungary, Romania, Turkey.—FIG. 35, 1a–b. \**V. densilobata*, holotype, wholly septate at 222 mm in diameter, lower Pliensbachian, Villány, Hungary, ×0.35 (new, Geological Institute, Budapest, Hungary).—FIG. 35, 1c–d. *V. steinmanni* (HUG), condensed fossil bed, Langeneckgrat, Canton Bern, Switzerland, half a whorl of body chamber; c, side; d, whorl section, ×0.3 (Donovan, 1958, pl. 7, 1).—FIG. 35, 1e–f. *V. ponticum* (PIA), holotype, lower Pliensbachian, Akdaglı, Amasya, Turkey, ×1 (PIA, 1913, pl. 15, 2).

*Foetterleiceras* RAKUS & GUEX, 2002, p. 103 [\**Ammonites foetterlei* HAUER, 1856, p. 61; OD]. Moderately evolute platycones, with compressed, oval whorl section; slightly prosiradiate ribs issue in bundles of 3 or 4 from prominent tubercles at umbilical edge and pass over venter without interruption; ribs and umbilical tubercles may fade on outer whorl, but tubercles usually persist longer than ribbing. Differs from *Villania* in the absence of a bituberculate stage, and strong umbilical tubercles that persist onto early part of final whorl. *Lower Jurassic (lower*

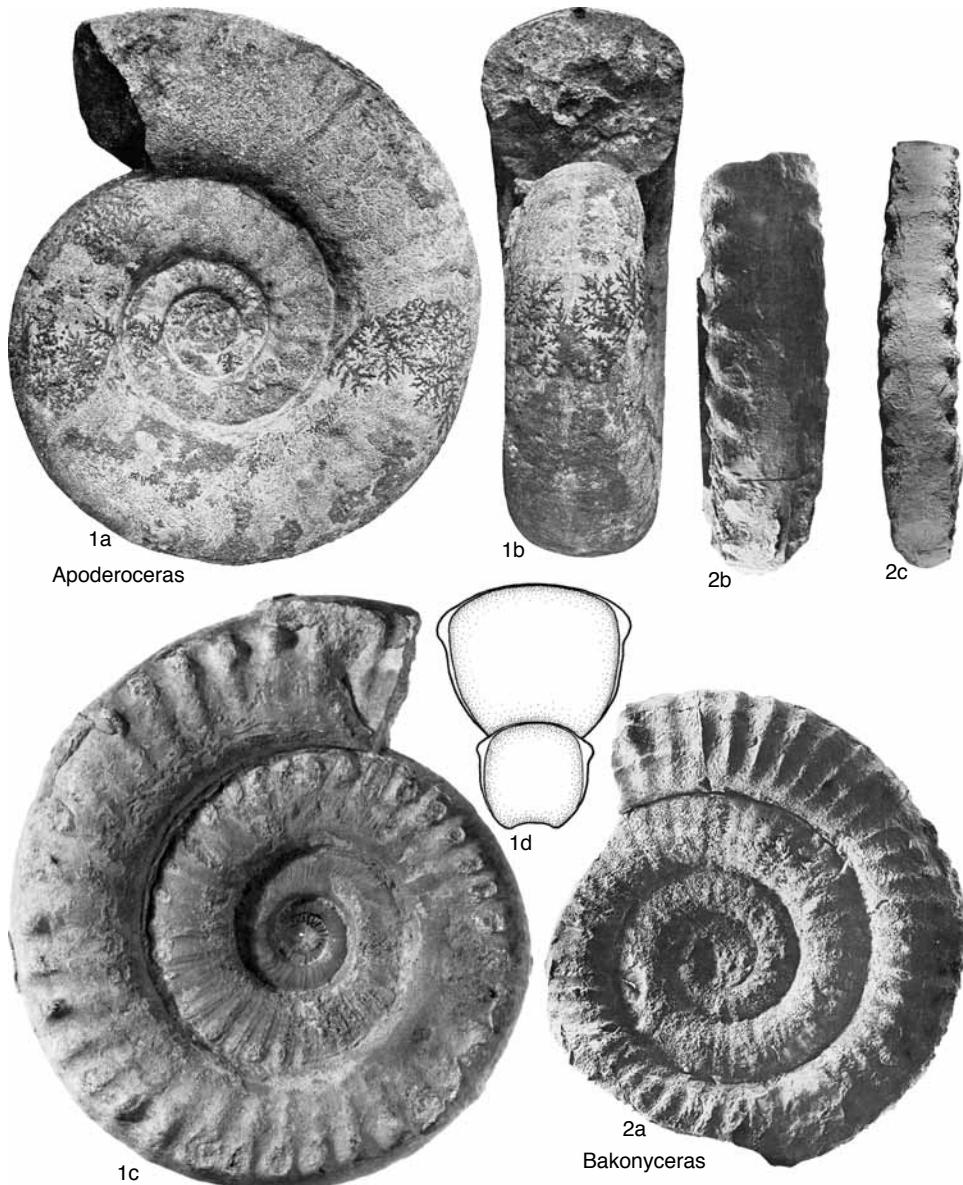


FIG. 33. Coeloceratidae (p. 46–48).

*Pliensbachian, ?Jamesoni Zone): Austria, eastern France, southwestern Germany, Turkey, Tunisia.*—FIG. 34,3a–b. *\*F. foetterlei* (HAUER), ?holotype, Adneth, Austria,  $\times 0.7$  (Hauer, 1856, pl. 19,4–5).

**Pseuduptonia** BREMER, 1965, p. 162 [*\*Uptonia micromphala* PIA, 1913, p. 345; OD]. Inner whorls evolute, depressed, becoming subcircular in section; outer whorls compressed, each whorl overlapping one half or more of the preceding one. Has 5–6 whorls and adult at 50–100 mm in diameter; strong,

straight primary ribs give rise to secondary ribs that continue over venter; rib density can increase or decrease with growth, and outer whorls have 25–40 ribs per whorl; ventrolateral tubercles usually absent, but rarely are present on inner whorls. *Lower Jurassic (?upper Sinemurian, lower Pliensbachian): Turkey.*—FIG. 34,4a–b. *\*P. micromphala* (PIA), lectotype (designated by DONOVAN & FORSEY, 1973, p. 11), lower Pliensbachian, Akdag, Amasya,  $\times 1$  (PIA, 1913, pl. 14,4d).

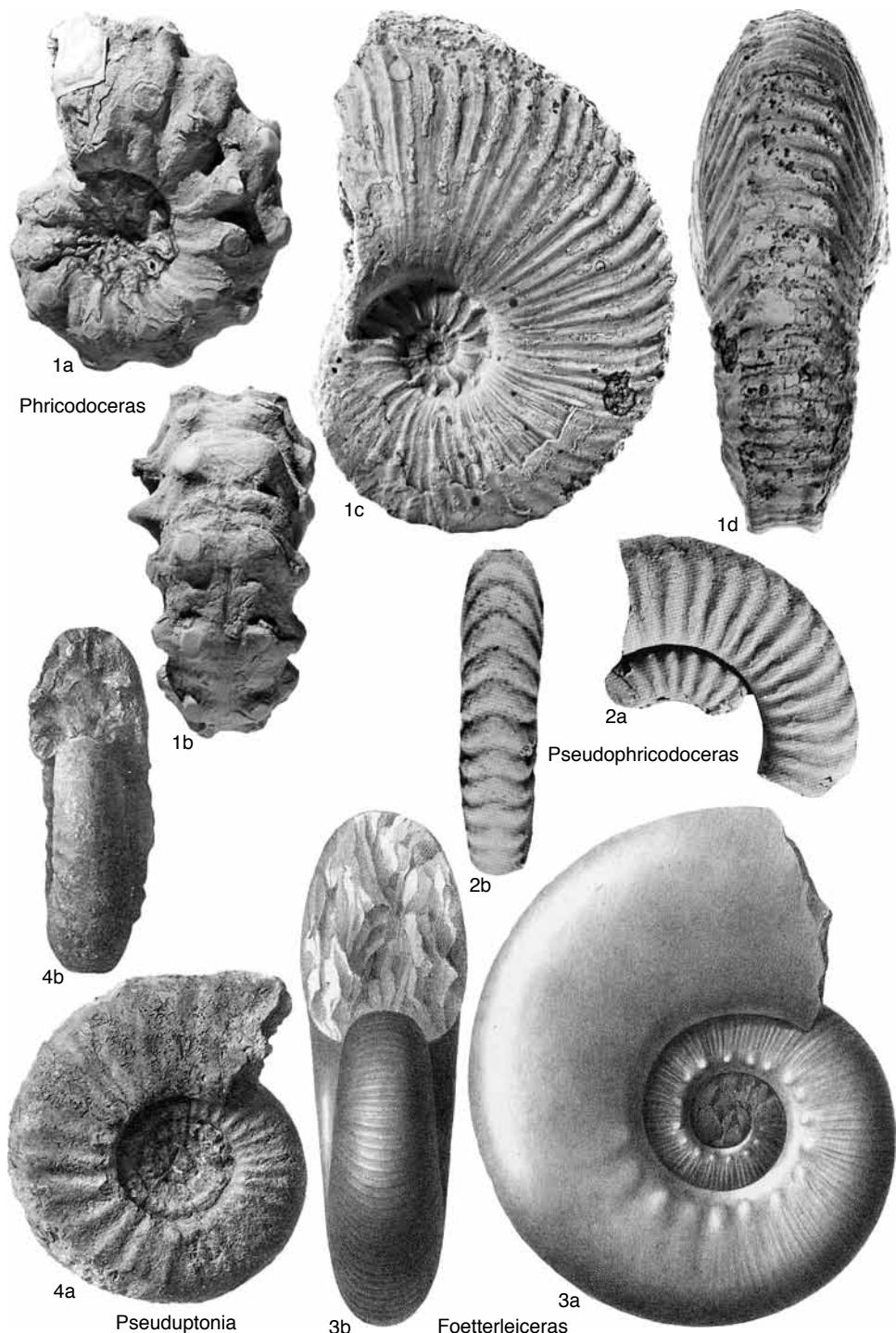


FIG. 34. Phricodoceratidae (p. 48–49).

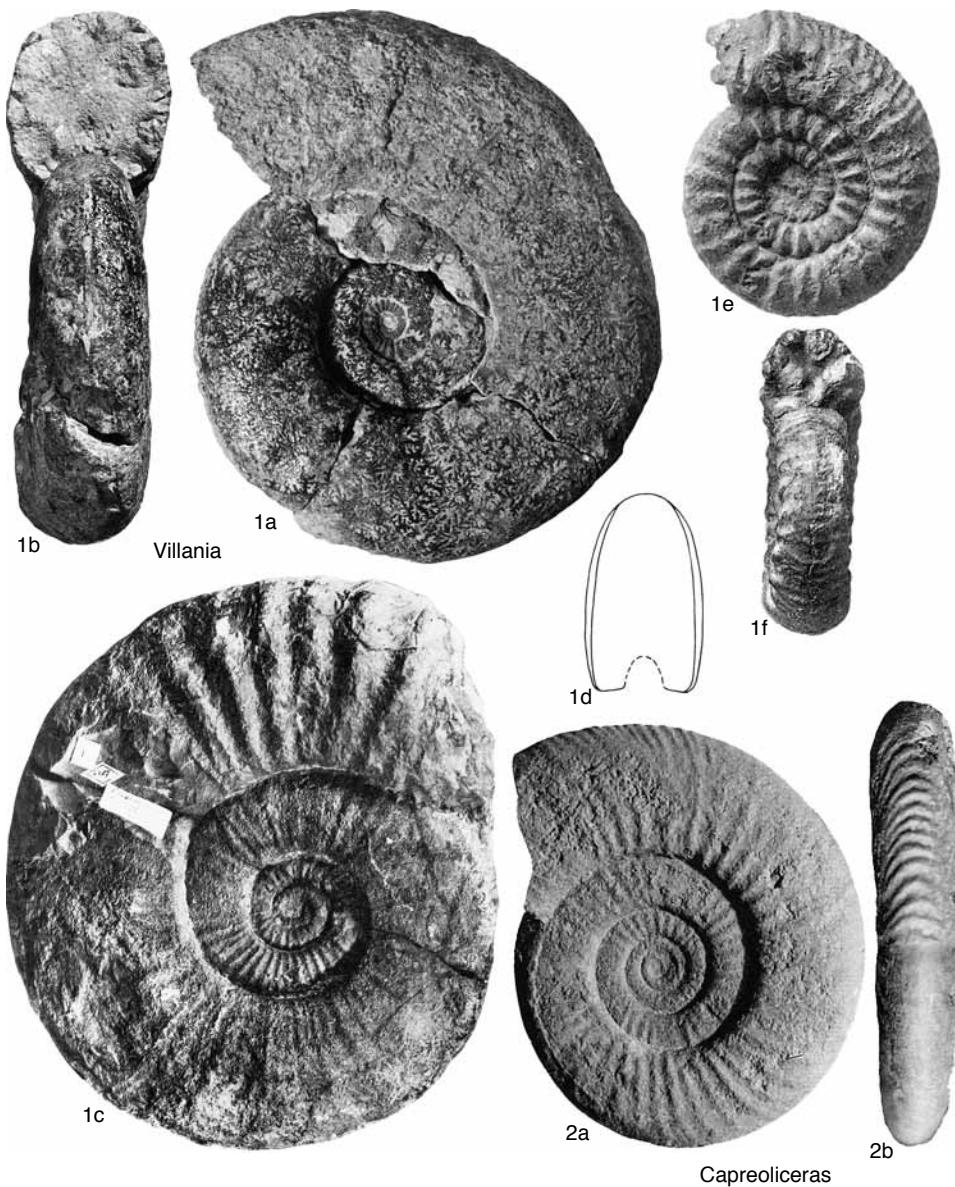


FIG. 35. Phricodoceratidae (p. 48–51).

**Capreoliceras** ALKAYA & MEISTER, 1995, p. 153  
[\**C. asagiense*; OD]. Evolute platycones, with compressed whorls and narrow, rounded venter; slightly prosiradiate primary ribs are angled further forward in passing over unkeeled venter; on larger whorls, primary ribs bifurcate at ventrolateral edge or secondaries are intercalated; no tubercles. Similar to *Pseuduptonia* but more compressed and more evolute. Lower Jurassic (lower Pliensbachian, ?Jamesoni Zone): Italy, Turkey.—FIG. 35,2a–b.

\**C. asagiense*, holotype, Asagi, Gümüşhane, Turkey,  
×1 (Alkaya & Meister, 1995, pl. 7, 16b–c).

#### Family POLYMORPHITIDAE Haug, 1887

[nom. correct. ARKELL, 1950, p. 361, pro Polymorphidae HAUG, 1887, p. 89; ICZN Opinion 575, 1959a, p. 135]

Evolute ammonites with compressed whorls; venter rounded, fastigiated, or with

small keel (*Tropidoceras*); smooth or ribbed, ribs usually forming ventral chevrons at some stage in growth; secondary ribs on outer whorls of some forms (*Acanthopleuroceras*, *Tropidoceras*); ribs may be plain or bear ventrolateral tubercles or both ventrolateral and umbilical tubercles during part of ontogeny. Usually distinguishable from Eoderoceratidae by fastigiate venter or ventral chevrons or both. *Lower Jurassic* (upper Sinemurian–lower Pliensbachian).

*Kondiloceras* FUCINI (1901b, p. 14 [14]; type, *K. manciatti*, OD) was included in the family Polymorphitidae in the first edition of the ammonoid Treatise (ARKELL, 1957, p. 249, fig. 275,4), on account of the alleged Sinemurian or Pliensbachian age of the holotype, the only known specimen, at Monte Cetona, Italy. Though best treated as a *nomen dubium* owing to its poor preservation, it is probably a junior synonym of the Cretaceous genus *Barroisiceras* of Turonian or Coniacian age, and it was included as such in the revised volume of the Cretaceous ammonite Treatise (WRIGHT, 1996, p. 187).

### Subfamily POLYMORPHITINAE Haug, 1887

[*nom. correct.* ARKELL, 1950, p. 361, *pro* Polymorphinae J. P. SMITH, 1913, p. 657, *nom. transl.* ex Polymorphidae HAUG, 1887, p. 89] [=Furlitinæ VENTURI, NANNARONE, & BILOTTA, 2007, p. 15; =Parinodiceratidae EDMUNDS, 2009, p. 72]

Venter rounded, crossed by ribs that usually curve forward or form chevrons. As the family name implies, some genera, especially *Polymorphites*, show a great amount of variation in morphological features in a single species at a single horizon, and further division of such collections serves little purpose. *Lower Jurassic* (upper Sinemurian, Raricostatum Zone–lower Pliensbachian, Jamesoni Zone).

*Polymorphites* HAUG, 1887, p. 107 [\**Ammonites polymorphus* QUENSTEDT, 1845 in 1845–1849, p. 86; SD BUCKMAN, 1892, p. 267, ICZN Opinion 575, 1959a, p. 134] [=Gorgheiceras VENTURI & FERRI, 2001, p. 136 (type, *G. gorghense*, OD); =Caleites VENTURI & FERRI, 2001, p. 137 (type, *C. calensis*, OD); =Paramorphites VENTURI, NANNARONE, & BILOTTA, 2007, p. 13 (type, *P. acutiventris*, OD)]. Shell small, commonly up to about 30 mm in diameter, evolute, with quadrate or compressed whorl section; ribbing

highly variable from striate to ribbed, and ribs or striae may be continuous over venter, forming chevrons, but venter may be only weakly striate or smooth; lateral or ventrolateral tubercles may be present. Large variation in ornament (from striate to ribbed and sometimes tuberculate) may occur in an individual specimen (e.g., as on the questionable lectotype figured here). The specimen figured here is undoubtedly the original of QUENSTEDT (1884 in 1882–1889, pl. 30,32), from Hinterweiler; it might also be the lectotype, the original of QUENSTEDT (1845 in 1845–1849, pl. 4,9a–d), as designated by DONOVAN and FORSEY (1973, p. 12). *Lower Jurassic* (lower Pliensbachian, Jamesoni Zone): Europe, Russia (northeast), Canada (British Columbia).—FIG. 36,1a–d. \**P. polymorphus* (QUENSTEDT); a–b, ?lectotype, Hinterweiler, Tübingen, Germany, ×2 (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5/30/32); c–d, Gomaringen-Hinterweiler, Tübingen, Germany, ×2 (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5/30/9).

*Gemmellaroceras* HYATT, 1900, p. 574 [\**Aegoceras aenigmaticum* GEMMELLARO, 1884, p. 189; OD] [=*Tubellites* BUCKMAN, 1924, pl. 491 (type, *Ammonites tubellus* SIMPSON, 1855, p. 42, OD); =*Leptnotoceras* SPATH, 1925a, p. 170 (type, *Ammonites abnormis* HAUER, 1854, p. 757, OD); =*Furlites* VENTURI & FERRI, 2001, p. 134 (type, *F. involutus*, OD); =*Pelingoceras* VENTURI, NANNARONE, & BILOTTA, 2005, p. 109 (type, *P. pseudocarinatum*, OD)]. Shell small, evolute, with circular, oval or compressed whorl section; smooth throughout, or smooth at first, then developing numerous, sharp, straight or sigmoidal ribs, which may be irregularly spaced, giving rise to fine secondary ribs that form chevrons on venter; suture may be asymmetrical. *Lower Jurassic* (upper Sinemurian, Raricostatum Zone–lower Pliensbachian, Jamesoni Zone): Europe, Morocco, Tunisia, Canada (British Columbia).—FIG. 36,2a–b. \**G. aenigmaticum* (GEMMELLARO), holotype, Strati a 'Terebratula' aspasia Galati, Messina province, Sicily, ×1.3 (Gemmellaro, 1884, pl. 3,12,14).—FIG. 36,2c–d. *G. tubellus* (SIMPSON), holotype, probably Robin Hood's Bay, North Yorkshire, England, ×3 (Buckman, 1924, pl. 491).

*Parinodiceras* TRUEMAN, 1918, p. 66 [\**Ammonites striatus parinodus* QUENSTEDT, 1884 in 1882–1888, p. 226; OD] [=*Platynoticeras* SPATH, 1938, p. 17, 86 (type, *Ammonites alter* OPPEL, 1862, p. 133, OD)]. Inner whorls fairly evolute, rather like *Polymorphites*, but whorl then expands rapidly, reaching diameter of more than 100 mm; flat whorl side bears primary ribs with small umbilical and ventrolateral tubercles, and fine secondary ribs cross venter; ornament varies between feeble and strong. *Lower Jurassic* (lower Pliensbachian, Jamesoni Zone): Europe, ?Indonesia.—FIG. 36,3a–c. \**P. parinodus* (QUENSTEDT), lectotype, Ofterdingen, Württemberg, Germany, ×0.8 (new, Geologisches-Palaeontologisches Institute, Tübingen University, Germany, Ce 5/28/16).

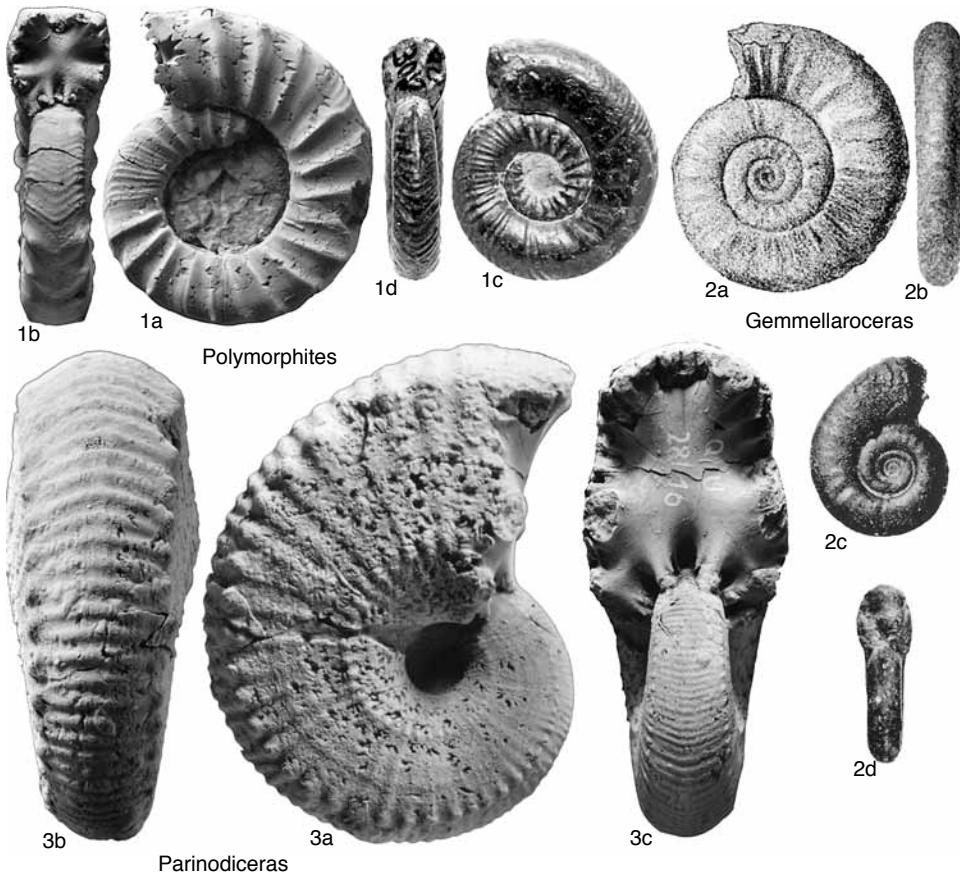


FIG. 36. Polymorphitidae (p. 52).

**Uptonia** BUCKMAN, 1898b, p. 453 [*\*Ammonites jamesoni* J. DE C. SOWERBY, 1827, p. 105; OD]. Evolute planulates, with compressed, flat-sided whorls, each overlapping up to one-quarter of preceding one; up to 8 whorls and reaches large sizes; ribs on inner whorls form ventral chevrons, and ventro-lateral tubercles may occur; tubercles are lost on larger whorls and ribs become thicker and tend to curve forward over venter. Inner whorls like those in some species of *Polymorphites*, except lacking irregularity of ornament. Lower Jurassic (lower Pliensbachian, Jamesoni Zone): Europe, Russia, Indonesia (Roti, ?Timor), ?Hong Kong, eastern Greenland, Canada (British Columbia), USA (Alaska), Chile, Argentina, Peru.—FIG. 37,1a–b. *\*U. jamesoni* (J. DE C. SOWERBY), neotype, Pabay Beds, Pabay, Scotland,  $\times 0.5$  (new, The Natural History Museum, London, BMNH C.40426; also figured in Donovan & Forsey, 1973, pl. 4,3).—FIG. 37,1c–d. *U. lata* (QUENSTEDT), Cheltenham, Gloucestershire, England,  $\times 1$  (new, The Natural History Museum, London, BMNH C.2209).

**Platyplesuroceras** HYATT, 1867, p. 92 [*\*Ammonites brevispina* J. DE C. SOWERBY, 1827, p. 106; OD]. Platycone, more than 6 whorls; umbilicus 50–60% of diameter, whorl sides flat; venter smooth on inner whorls, crossed by ribs on outer whorls; ribs strong, and typically 20–30 ribs per whorl; bituberculate, inner tubercles appearing later than, and may fade earlier than, outer ones. Lower Jurassic (lower Pliensbachian, Jamesoni Zone): Europe, ?Morocco.—FIG. 37,2a–d. *\*P. brevispina* (J. DE C. SOWERBY); a–b, holotype, Pabay, Scotland,  $\times 1$  (new, The Natural History Museum, London, BMNH 43915); c–d, Radstock, Somerset, England,  $\times 0.9$  (new, The Natural History Museum, London, BMNH C.48955).

**Jamesonites** BUCKMAN, 1923a, pl. 407 [*\*J. reticulatus*; OD]. Evolute planulates, attains large sizes and has about 7 whorls; closely spaced, weak ribs may give rise to secondaries that pass over venter; this ornament does not change with growth; suture complex with arborescent saddles. Lower Jurassic (Pliensbachian, Jamesoni Zone): southern

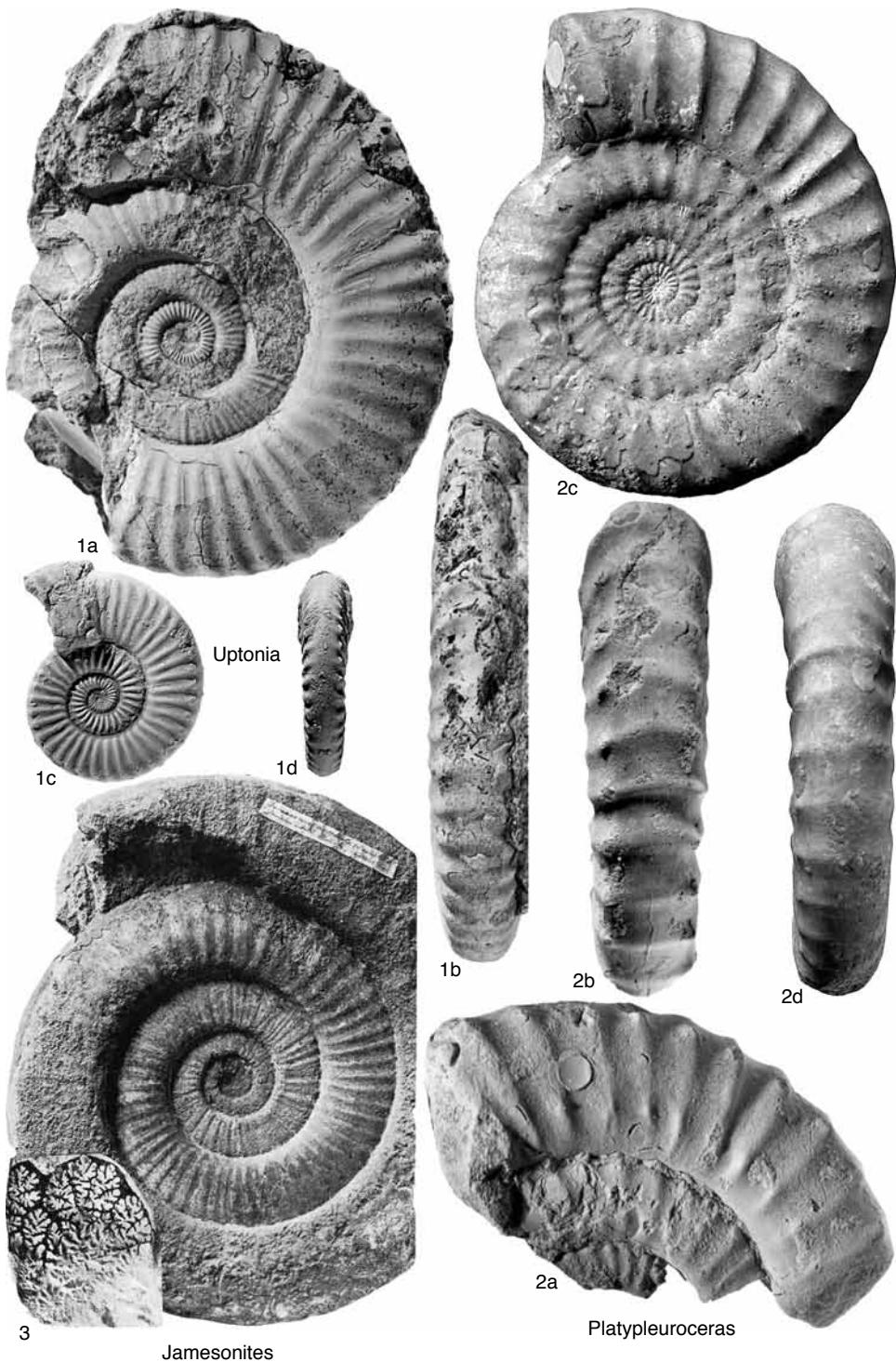


FIG. 37. Polymorphitidae (p. 53–55).

England, southern Germany, Tunisia.—FIG. 37,3. *J. reticulatus*, holotype, Jamesoni Limestone, Radstock, Avon, England,  $\times 0.3$  (Buckman, 1923a, pl. 407).

### Subfamily TROPIDOCERATINAE Hyatt, 1900

[*nom. transl.* HOWARTH, herein, *ex* Tropidoceratidae HYATT, 1900, p. 578] [=Acanthopleuroceratinae ARKELL, 1950, p. 361, *pro* Cycloceratidae HYATT, 1867, p. 91, based on *Cycloceras* HYATT, 1867, p. 93, *non* MC'COY, 1844, p. 10]

Platycones, with fastigiate or keeled venter. Lower Jurassic (lower Pliensbachian—lowest upper Pliensbachian).

*Acanthopleuroceras* HYATT, 1900, p. 578 [*\*Ammonites valdani* D'ORBIGNY, 1844 in 1842–1851, p. 255; SD ICZN Opinion 996, 1973, proposed by HOWARTH, 1971, p. 8, amending GETTY, 1970, p. 105] [= *Cycloceras* HYATT, 1867, p. 92, *non* MC'COY, 1844, p. 10, obj.]. Platycone with about 7 whorls; umbilicus about 50% of diameter; venter fastigiate, becoming rounded on outer whorls; whorl section compressed with flat sides; earliest 2–3 whorls are coronate and smooth; larger whorls bear bituberculate ribs that tend to be rursicostate, and weak secondary ribs cross venter to form chevrons. Lower Jurassic (lower Pliensbachian, Ibex Zone): Europe, Tunisia, Canada (British Columbia), USA (Alaska, Nevada), Argentina.—FIG. 38,1a–b. *\*A. valdani* (D'ORBIGNY), lectotype, Saint-Amand-Montrond, Cher, France,  $\times 1$  (Fischer, 1994, pl. 23,3a, 3c).

*Tropidoceras* HYATT, 1867, p. 93 [*\*Ammonites masseanus* D'ORBIGNY, 1844 in 1842–1851, p. 225; SD HAUG, 1885, p. 606] [= *Eremiticeras* FARAONI & others, 2002, p. 223 (type, *E. evolutum*, OD)]. Platycone, with about 6 whorls, each whorl overlapping about one-third of preceding one; umbilicus 35–45% of diameter; venter angular on inner whorls but with strong keel on outer whorls; straight or sigmoidal bituberculate primary ribs give rise to fine secondary ribs that are angled forward over ventrolateral shoulder on outer whorls. Lower Jurassic (lower Pliensbachian, Jamesoni–Ibex Zones): Europe, Morocco, Tunisia, Turkey, ?Caucasus, Indonesia (New Guinea, Timor), Canada (British Columbia), USA (Alaska), Chile, Argentina, Peru.—FIG. 38,2a–b. *\*T. masseanum* (D'ORBIGNY), holotype, Saint-Amand-Montrond, Cher, France,  $\times 1$  (new, IMP-R.1397, Institut de Paléontologie, Muséum d'Histoire naturelle, Paris, France; also figured in Dean, Donovan, & Howarth, 1961, pl. 69,2).

*Catriceras* VENTURI, 1978, p. 100, 111 [*\*C. catriense*; OD]. Platycones with whorls overlapping one-fifth to one-quarter of previous whorl; umbilicus 40–50% of diameter; venter with low, blunt keel; ribs sigmoidal and rursiradiate, bearing small umbilical tubercles and larger ventrolateral tubercles or nodes. Lower Jurassic (lower Pliensbachian): Europe.—FIG. 38,3a–b. *\*C. catriense*, holotype, Corniola, Monte Catria,

Appennino Marchigiano, Italy,  $\times 1$  (Venturi, 1978, pl. 1,3).

*Dayiceras* SPATH, 1920, p. 538 [*\*D. polymorphoides*; OD]. Platycones with up to 6 whorls; umbilicus about 50% of diameter in adult; compressed, oval whorl section; dense, faintly biconcave, ribs throughout increase to about 100 per whorl on outer whorls; ribs terminate ventrally in small, elongated tubercles; midventral tubercles correspond to spacing of ribs; outer whorls may become smooth. Lower Jurassic (lower Pliensbachian—lowest upper Pliensbachian): southwestern England, Portugal, Italy, Canada (British Columbia), USA (Nevada, Oregon).—FIG. 38,4a–b. *\*D. polymorphoides*, holotype, Ibex Zone, Charmouth, Dorset, England,  $\times 1$  (new, The Natural History Museum, London, C.22102).

*Paratropidoceras* DOMMERGUES, MEISTER, SOUSSI, & ABDALLAH, 2004, p. 470 [*\*P. numidianum*; OD] [= *Tunisiceras* DOMMERGUES, MEISTER, SOUSSI, & ABDALLAH, 2004, p. 466 (type, *T. insolitus*, OD)]. Large sub-oxycones with compressed, high whorls, and umbilicus about 25% of diameter; dense, sinuous ribs bend strongly forward near venter to join strong keel; a few ribs branch, or secondary ribs are intercalated. More involute and has more ribs than *Tropidoceras*, and more involute, but generally less densely ribbed than *Dayiceras*. Lower Jurassic (lower Pliensbachian, upper Jamesoni–lower Ibex Zones): Tunisia.—FIG. 38,5a–b. *\*P. numidianum*, holotype, lower Ibex Zone, Jebel Stah,  $\times 0.6$  (Dommergues, Meister, Soussi, & Abdallah, 2004, pl. 1,1a–b).

### Family LIPAROCERATIDAE Hyatt, 1867

[Liparoceratidae HYATT, 1867, p. 80] [=Aegoceratidae NEUMAYR, 1875, p. 878]

The family includes two extreme morphological types: inflated sphaerocones (*Liparoceras*) and evolute serpenticons or so-called capricorns (*Aegoceras*). They are united in one family because ammonites occur in the Ibex and Davoei Zones, have inner whorls indistinguishable from contemporary *Aegoceras*, and body chambers indistinguishable from *Liparoceras*. These intermediate forms (*Androgynoceras*), variously referred to as hybrids or variocostates (and dimorphs by SPATH, 1938), occur in association with the capricorns but are always more rare. The capricorns and hybrids show parallel evolutionary changes in size and ornament. For this reason, the capricorns and sphaerocones are regarded as being closely related.

The sphaerocones have two rows of tubercles on the whorl side, which may be equal

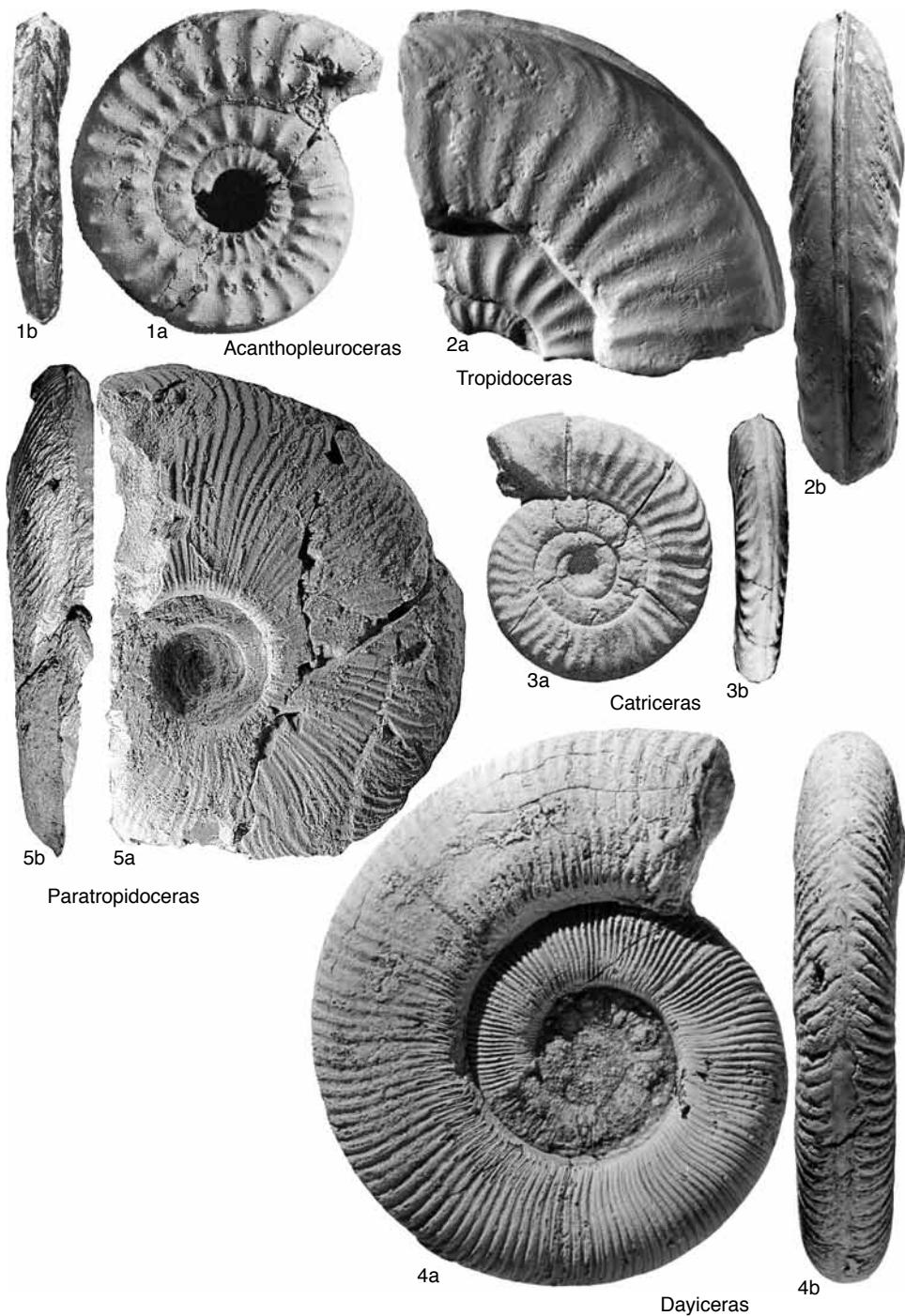


FIG. 38. Polymorphitidae (p. 55).

in number (parinode), or there may be more tubercles in the outer row than the inner (imparinode). In imparinode forms, some inner tubercles are joined to two outer ones by ribs forming a V. The venter is crossed by blunt ribs that show much variation, from fine to coarse, in a single species. The inner row of tubercles is usually on or close to the umbilical edge. The sphaerocones have long body chambers and apertures with plain margins. The capricorns bear strong, simple ribs that pass over the venter, where they may be projected forward, and their apertures may have a ventral rostrum. Most capricorns are smaller than most sphaerocones.

The coexistence of the three morphological forms, capricorns, hybrids, and sphaerocones, and the persistence of sphaerocones [*Liparoceras* (*Becheiceras*)] well into the *Margaritatus* Zone after all capricorns [*Aegoceras* (*Oistoceras*)] had disappeared at the top of the *Davoei* Zone, precludes the identification of dimorphism in Liparoceratidae at the present time. Liparoceratidae were probably derived either from *Jamesoni* Zone *Parinodiceras* (Polymorphitidae) or from *Raricostatum* Zone *Tetraspidoceras* (Coeloceratidae) (SPATH, 1938, p. 17). Lower Jurassic (*Pliensbachian*).

**Vicinodiceras** TRUEMAN, 1919, p. 264 [*\*V. simplicicosta*; OD] [= *Vicinodiceras* ROMAN, 1938, p. 81, nom. null., misspelling]. Sphaerocones, attaining large sizes; with broad, rounded venter, and whorl thickness usually greater than whorl height; narrow umbilicus opens out on body chamber; numerous blunt ribs pass right around whorl, including umbilical wall and venter; pairs of small spines occur on every 2nd, 3rd, or 4th rib on middle part of whorl side; inner and outer rows of spines closer together than in later *Liparoceras* and always parinode; on body chamber, ribs may fade between rows of spines. Lower Jurassic (*lower Pliensbachian*, *Jamesoni* Zone, *Taylori* Subzone): Britain, Portugal, Austria.—FIG. 39, 1a–b. *\*V. simplicicosta*, holotype, Jamesoni Limestone, Radstock, Avon, England, ×0.75 (new, The Natural History Museum, London, C.38329).

**Liparoceras** HYATT, 1867, p. 83 [*\*L. bronni* SPATH, 1938, p. 43; SD ICZN Opinion 308, 1954d]. Sphaerocones; can attain large size; umbilicus 10–30% of diameter; whorl thickness ranges from slightly to much greater than whorl height; inner whorls smooth, becoming ribbed and bitubercu-

late, with more outer tubercles than inner (imparinode), thus differing from *Vicinodiceras*; on body chamber, ornament differentiated into three zones: umbilical slope striate or with fine ribs; middle of whorl side with tubercles and irregular ribs, some joining inner and outer tubercles; and venter crossed by strong, blunt ribs, some of which arise from tubercles. Lower Jurassic (*Pliensbachian*, *Ibex–Margaritatus* Zones).

**L. (Liparoceras).** Ornament strong, coarse to very coarse. Lower Jurassic (*lower Pliensbachian*, *Ibex–Davoei* Zones): northern and central Europe, Morocco, Indonesia (Timor, Roti), Canada (British Columbia), USA (California), Chile.—FIG. 39, 2a–b. *(L.) bronni* SPATH, holotype, Bettlingen, Württemberg, Germany, ×1 (new, The Natural History Museum, London, BMNH 22118).

**L. (Becheiceras)** TRUEMAN, 1918, p. 66 [*Ammonites bechei* J. SOWERBY, 1821, p. 143; OD] [= *Anisoloboceras* TRUEMAN, 1918, p. 66 (type, *Ammonites nautiliformis* J. BUCKMAN, 1844, p. 105, OD); = *Becheoceras* DACQUÉ, 1934 in 1933–1934, p. 292, nom. null.]. Reaches large sizes of more than 300 mm in diameter; umbilicus small (about 10%) on inner whorls; ribs much finer and tubercles smaller than in *Liparoceras*. Lower Jurassic (*Pliensbachian*, *Ibex–Margaritatus* Zones): Europe, Morocco, Tunisia, Canada (British Columbia), USA (Oregon).—FIG. 39, 3a–b. *(B.) bechei* (J. SOWERBY), neotype (designated by DONOVAN & FORSEY, 1973, p. 13), *Davoei* Zone, *Capricornus* Subzone, The Red Band, Charmouth, Dorset, England, ×0.8 (new, The Natural History Museum, BMNH 39731; also figured in DONOVAN & FORSEY, 1973, pl. 2, 4).

**Androgynoceras** HYATT, 1867, p. 83 [*\*Ammonites hybrida* D'ORBIGNY, 1844 in 1842–1851, p. 285; SD BUCKMAN, 1911, p. iii; = *A. subhybridum* SPATH (1938, p. 122, pl. 9, I)]. Variocostate: inner whorls capricorn, similar to *Aegoceras*; middle and outer whorls expand more rapidly and body chambers resemble *Liparoceras*, though not so markedly sphaeroconic in form; body chambers reach about 300 mm in diameter; bold, single ribs of inner capricorn whorls become blunt and broad as they cross venter, forming chevrons in some species; ribs on middle and outer whorls are sharp, radial, or proxsiradiate, and there are some secondary ribs; primary ribs may bear pairs of tubercles or spines, which may become imparinode. [There is no satisfactory type specimen for *Ammonites hybrida* D'ORBIGNY (FISCHER, 1994, p. 74), so pending the designation of a suitable neotype, the holotype of its junior synonym, *A. subhybridum* SPATH (1938, p. 122, pl. 9, I), is figured here.] Lower Jurassic (*lower Pliensbachian*, *Ibex–Davoei* Zones): Europe, Russia, eastern Greenland, Peru.—FIG. 39, 4a–b. *\*A. hybrida* (D'ORBIGNY); holotype of *A. subhybridum* SPATH, Green Ammonite Beds, near Charmouth, Dorset, England, ×0.5 (new, The Natural History Museum, London, C.36924).

**Aegoceras** WAAGEN, 1869, p. 247 [\**Ammonites capricornus* SCHLOTHEIM, 1820, p. 71; SD HAUG, 1900, p. 82] [=*Amblyoceras* HYATT, 1900, p. 578, obj. (type, *Ammonites capricornus* SCHLOTHEIM, 1820, p. 71, M); =*Defossiceras* BUCKMAN, 1913, p. vi (type, *Ammonites defossus* SIMPSON, 1843, p. 15, ICZN Opinion No. 1088, 1977, p. 42)]. Inner whorls coronate, becoming capricorn, reaching 150 mm in diameter on some body chambers; ribs single, strong, passing over venter with or without forward projection; ribs bituberculate in some; adult aperture with ventral rostrum. *Lower Jurassic (lower Pliensbachian, Ibex-Davoei Zones)*: Europe, eastern Greenland.

A. (*Aegoceras*). Ribs bold and prominent on venter, without chevrons. *Lower Jurassic (lower Pliensbachian, Davoei Zone, Maculatum-Capricornus Subzones)*: Europe, eastern Greenland.—FIG. 40, 1a–b. \*A. (A.) *capricornus* (SCHLOTHEIM), lectotype, Amberg, Bavaria, Germany, ×1 (new, Geological-Palaeontological Museum, Berlin University, Germany).

A. (*Beaniceras*) BUCKMAN, 1913, p. iii [\**Ammonites luridus* SIMPSON, 1855, p. 46; OD]. Usually smaller than 50 mm in diameter; aperture of body chamber with ventral rostrum; inner whorls coronate; ribs on venter usually weak, often projected. Smaller than *A. (Aegoceras)* or *A. (Oistoceras)*. Possibly microconchs. *Lower Jurassic (lower Pliensbachian, Ibex Zone)*: Europe.—FIG. 40, 2a–b. \*A. (B.) *luridum* (SIMPSON), holotype, Robin Hood's Bay, Yorkshire, England, ×1 (new, Sedgwick Museum, Cambridge, J.3274).—FIG. 40, 2c–d. A. (B.) *senile* (BUCKMAN), holotype, questionable adult with contracting whorl thickness, Hewlets Road, Cheltenham, Gloucestershire, England, ×2 (Buckman, 1918a, pl. 126).

A. (*Oistoceras*) BUCKMAN, 1911, p. iv [\**Ammonites figulinus* SIMPSON, 1855, p. 47; OD]. Differs from *A. (Aegoceras)* by ribs forming well-marked chevrons on venter, ribs usually finer on inner whorls, and ribs may be bituberculate throughout in later species. *Lower Jurassic (lower Pliensbachian, Davoei Zone, Figulinum Subzone)*: Europe.—FIG. 40, 3a–d. \*A. (O.) *figulinum* (SIMPSON); a–b, holotype, Robin Hood's Bay, Yorkshire, England, ×1 (Buckman, 1911, pl. 26); c–d, near adult with body chamber 0.8 whorls long, Charmouth, Lyme Regis, Dorset, England, ×0.75 (Spath, 1938, pl. 21, 8a–b).

### Family AMALTHEIDAE Hyatt, 1867

[nom. correct. FISCHER, 1882, p. 387, pro Amaltheidae HYATT, 1867, p. 89, validated by ICZN Opinion 575, 1959a] [=Paltopleuroceratidae SPATH, 1926a, p. 140]

Discoidal oxycones evolving into quadrate-whorled planulates. Oxycones ribbed, striate, tuberculate, or smooth;

planulates strongly ribbed, sometimes with ventrolateral tubercles or spines. Strong, crenulated keel is characteristic, but is secondarily lost in *Pseudoamaltheus* and *Amauroceras*. Dimorphic: microconchs of *Pleuroceras* are known from southern Germany, but are not yet described; dimorphism is almost certainly present in *Amaltheus*, but paired dimorphs have yet to be associated. Derived from *Aegoceras (Oistoceras)* (Liparoceratidae) at the base of the upper Pliensbachian (HOWARTH, 1959, p. xxviii) and became extinct at top of the upper Pliensbachian, leaving no successors. The apparent polymorphism in Amaltheidae has led to major descriptions of the family in which normal zoological nomenclature was abandoned in favor of a nomenclature based on tri- and quadrinomial names for morphological growth stages. These were of collections from Germany (FRENTZEN, 1937) and France (MATTEI, 1985), which were dominated by small pyritized specimens. Other descriptions by HOWARTH (1959) and DAGIS (1976) on rich collections from Britain and Russia (northeast) have shown that it is possible to use conventional zoological nomenclature, especially when stratigraphical relationships are known within the collections. *Lower Jurassic (upper Pliensbachian)*: northern hemisphere, Boreal Province (common), Tethyan Province (rare).

**Amaltheus** DE MONTFORT, 1808, p. 90–91 [\**A. margaritatus*; M] [=*Proamaltheus* LANGE, 1932, p. 235, 238 (type, *P. wertheri*, OD); =*Nordamaltheus* REPIN in EFIMOVA & others, 1968, p. 111 (type, *Acanthopleuroceras vilgaensis* TUCHKOV, 1954, p. 109, OD)]. Oxycones with moderately open umbilicus or evolute platycones; ribs straight or gently sigmoidal, usually bifurcating, projected forward near venter, forming crenulations on keel or angled venter; striate ornament or ventrolateral tubercles in some forms; aperture with ventral rostrum. Forms (e.g., *Nordamaltheus*) transitional to *Amauroceras* are smooth on the venter at some stage. *Lower Jurassic (upper Pliensbachian, Margaritatus-Spinatum Zones)*: Europe, northern Africa (Atlas Ranges), Tunisia, Caucasus, Russia (eastern Transbaikalia, Far East, northeast), Japan, Canada (British Columbia, Alberta, Yukon), USA (Alaska), ?Honduras.

A. (*Amaltheus*). Description as for genus; striate ornament occurs on dorsal shell only. *Lower*

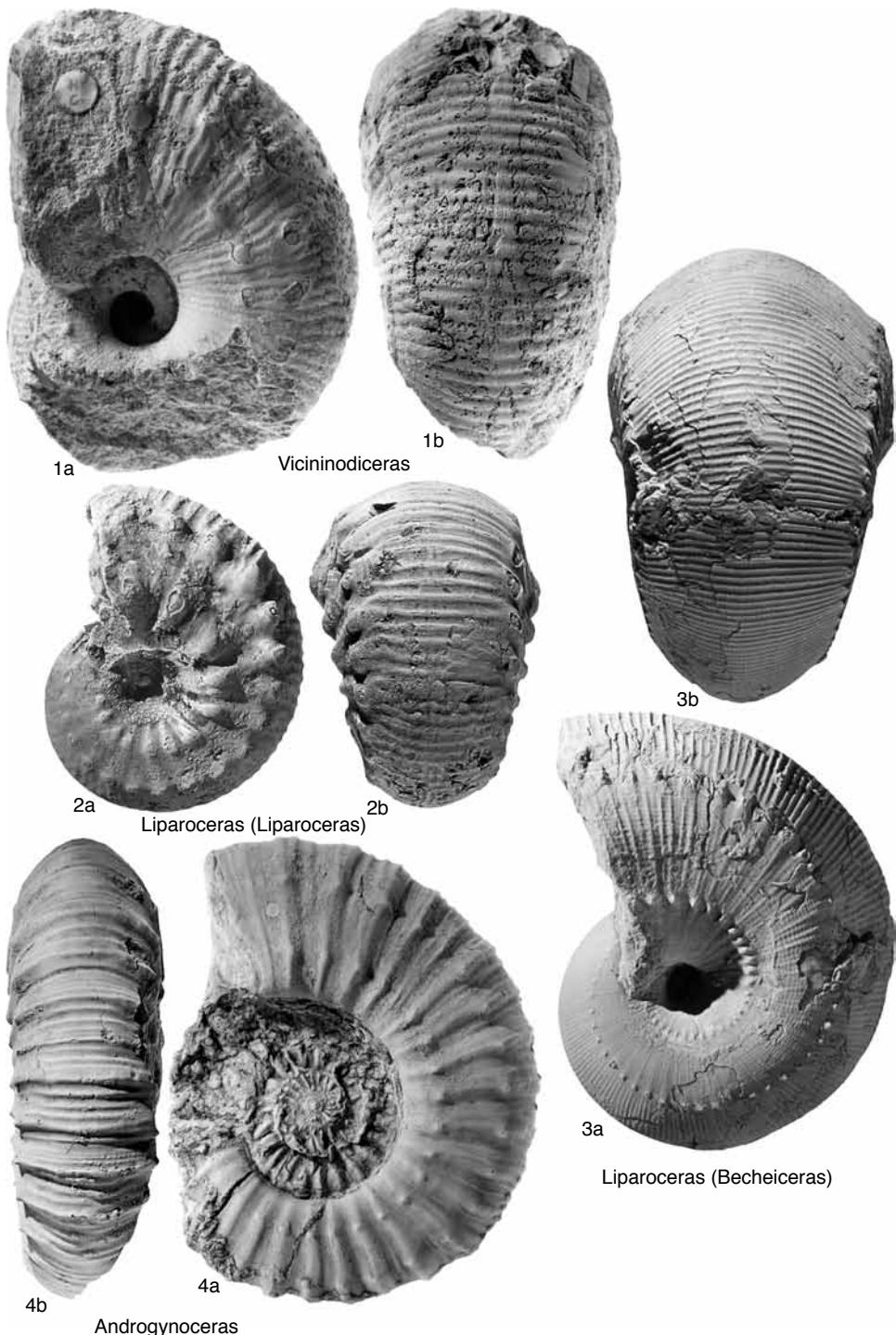


FIG. 39. *Liparoceratidae* (p. 57).

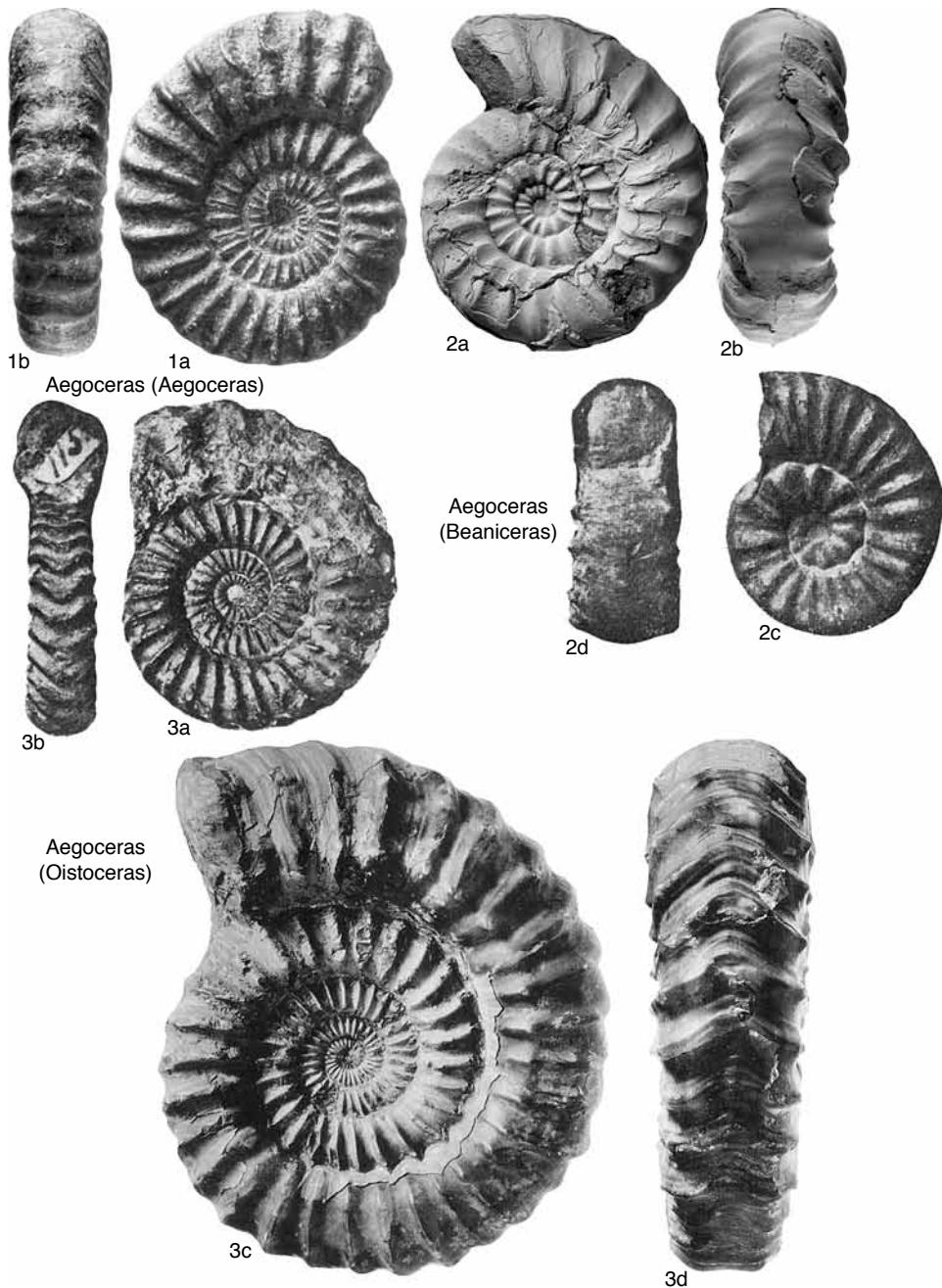


FIG. 40. Liparoceratidae (p. 58).

- Jurassic (upper Pliensbachian, Margaritatus Zone–Spinatum Zone):* geographic range as for genus.—FIG. 41, 1a–b. \**A. (A.) margaritatus*, neotype, *Spinatum* Zone, Croisilles Calvados, France; a, ×0.5 (Fischer, 1994, pl. 27, I); b, ×0.5 (new, The Natural History Museum, London, BMNH 37039).—FIG. 41, 1c–d. *A. (A.) subnodosus* (YOUNG & BIRD), possible adult microconch, *Margaritatus* Zone, Hawsker Bottoms, Robin Hood's Bay, Whitby, North Yorkshire, England, ×1 (Dean, Donovan, & Howarth, 1961, pl. 71, 3a–b).—FIG. 41, 1e–f. *A. (A.) bifurcus* HOWARTH, inner whorls showing resemblance to ancestral *Oistoceras*, basal *Margaritatus* Zone, Seatown, Lyme Regis, Dorset, England, ×1.5 (Howarth, 1958, pl. 1, 8a–b).
- A.** (*Pseudoamaltheus*) FREBOLD, 1922, p. 3, 4, 13 [\**Ammonites engelhardtii* D'ORBIGNY, 1844 in 1842–1851, p. 245; SD FRENTZEN 1937, p. 24]. Late derivative of *A. (Amaltheus)*, with coarse striate ornament on whole shell dominant over radial ribs; venter angled and keel and crenulations lost. *Lower Jurassic (upper Pliensbachian, Margaritatus Zone, Gibbosus Subzone–Spinatum Zone):* Europe, USA (Alaska).—FIG. 41, 2a–b. \**A. (P.) engelhardtii* (D'ORBIGNY), holotype, Seltzbrunner, Bas Rhin, France; a, ×0.42 (Fischer, 1994, pl. 26, 2); b, ×0.42 (Howarth, 1958, p. 22, fig. 11).
- Amauroceras* BUCKMAN, 1913, p. vii [\**Ammonites ferrugineus* SIMPSON, 1855, p. 79; OD]. Involute oxycones, venter rounded or sharp, no keel; smooth or with striate or rudimentary ribs; suture with prominent saddle in middle of first lateral lobe. Development from *Amaltheus*. *Lower Jurassic (upper Pliensbachian, Margaritatus–Spinatum Zones):* Europe, Canada (?Alberta).—FIG. 41, 3a–b. \**A. ferrugineum* (SIMPSON), lectotype, *Spinatum* Zone, Hawsker Bottoms, Whitby, Yorkshire, England, ×2 (Buckman, 1919b, pl. 142).—FIG. 41, 3c–d. *A. lenticulare* (YOUNG & BIRD), holotype, *Spinatum* Zone, near Whitby, Yorkshire, England, ×1 (Buckman, 1910a, pl. 20).
- Pleuroceras* HYATT, 1867, p. 89 [\**Ammonites spinatus* BRUGUIÈRE, 1789 in 1789–1792, p. 40; SD FISCHER, 1882, p. 388] [= *Paltopleuroceras* BUCKMAN, 1898b, p. 453, obj.]. Planululates with quadrate whorl section; tabulate venter has a strong, crenulated keel; ribs strong, straight, projected forward on venter in some, ending at high ventrolateral tubercles or spines in others. Complete adult microconchs occur where favorable preservation conditions existed (e.g., southwestern Germany). Derived from *Amaltheus*. *Lower Jurassic (upper Pliensbachian, Spinatum Zone):* Europe, northern Africa (Atlas Ranges), Canada (?British Columbia, ?Yukon).—FIG. 42a–b. \**P. spinatum* (BRUGUIÈRE), neotype, complete macroconch, South Petherton, Somerset, England, ×0.4 (new, Sedgwick Museum, Cambridge, England, SM J.35923).—FIG. 42c–d. *P. hawskerense* (YOUNG & BIRD), Kettleness, Whitby, North Yorkshire, England, ×1 (Howarth, 1959, pl. 9, 5a–b).—FIG. 42e–f. *P. solare* (PHILLIPS), Marlstone Rock Bed, Thorncombe Beacon, Dorset coast, England, ×1 (Howarth, 1959, pl. 5, 9a–b).—FIG. 42g–h. *P. transiens* (FRENTZEN), coastal cliff 1 km northeast of Dun Caan, Isle of Raasay, western Scotland, ×1 (Howarth, 1958, pl. 4, 16a–b).
- Family DACTYLIOCERATIDAE**  
Hyatt, 1867
- [*nom. correct.* ICZN Opinion 576, 1959b, *pro* Dactyloidae HYATT, 1867, p. 87, 94]
- Evolute, serpenticone to cadicone, ribbed, tuberculate and keel-less forms. Homeomorphic with some Bajocian stephanoceratids and Oxfordian perisphinctids, but unique shell structure, with double shells and flat-topped ribs on the inner shell, seen in some favorable modes of preservation, is distinctive of Dactylioceratidae (HOWARTH, 1975). Divided into two subfamilies on suture differences: earlier Reynoldscoeloceratinæ has two major secondary lobes in dorsal side of external saddle; in Dactylioceratinæ, external saddle is not so divided, and lateral lobe is deeply trifid. Reynoldscoeloceratinæ, the earliest subfamily, was derived from *Metaderoceras* (Eoderoceratidae) at the bottom of the *Luridum* Subzone, *Ibex* Zone (BUCKMAN, 1911, p. iv; SPATH, 1936a, p. 443; DOMMERGUES, 1986, p. 9), and not from Lytoceratidae, as has sometimes been suggested. *Lower Jurassic (lower Pliensbachian, Ibex Zone–upper Toarcian, Variabilis Zone):* worldwide.
- Subfamily**  
**REYNESOCOEOLOCERATINAE**  
Dommergues, 1986
- [Reynesocoeloceratinæ DOMMERGUES, 1986, p. 23]
- The earliest subfamily, consisting of depressed, cadicone, tuberculate forms, as well as some evolute, serpenticone, fine-ribbed forms; single ribs are common in some genera; some species are size dimorphic; characterized by major subdivisions in dorsal side of external saddle. *Lower Jurassic (Pliensbachian, Ibex–Spinatum Zones):* Europe, northern Africa, North America, South America.

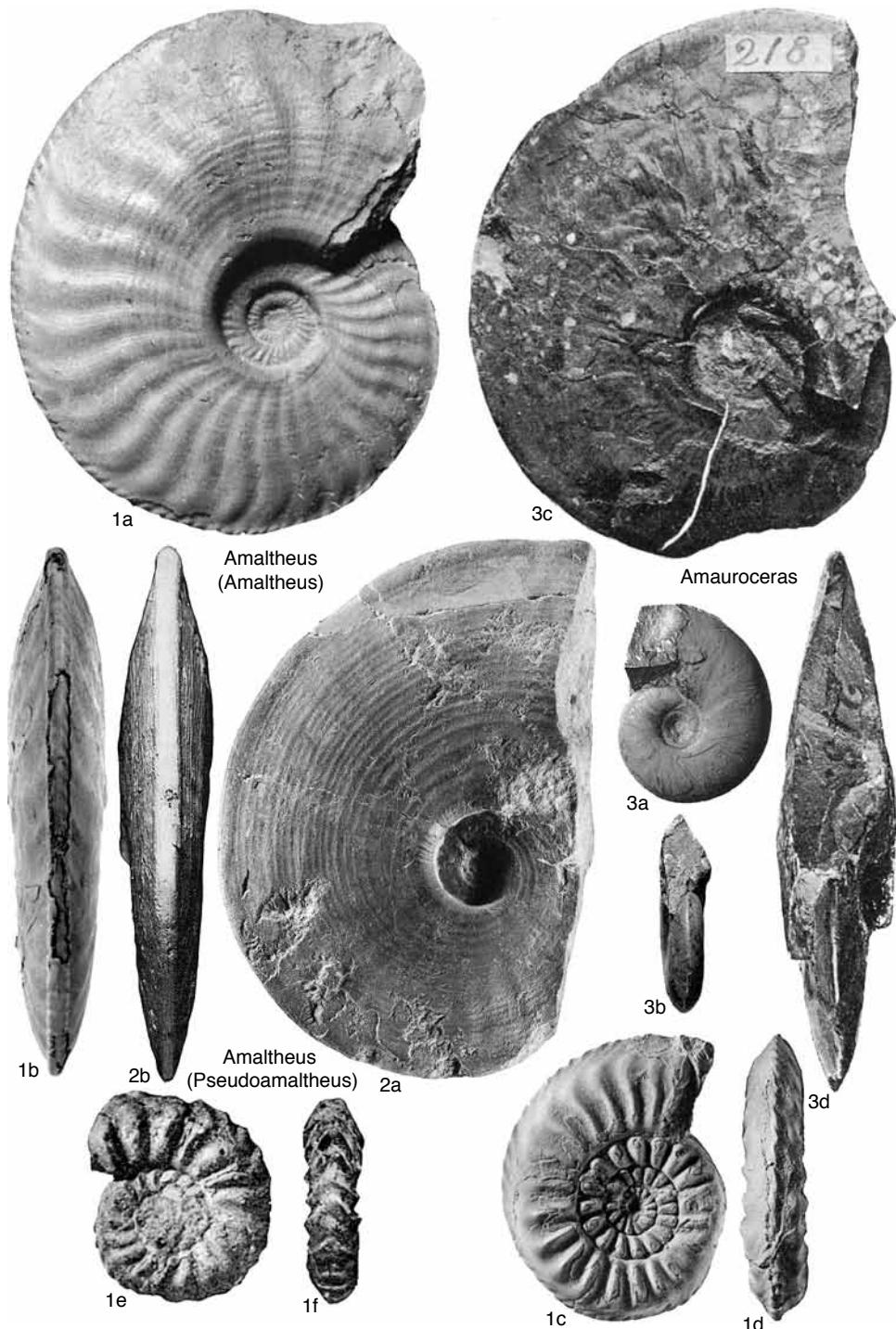


FIG. 41. Amaltheidae (p. 58–61).

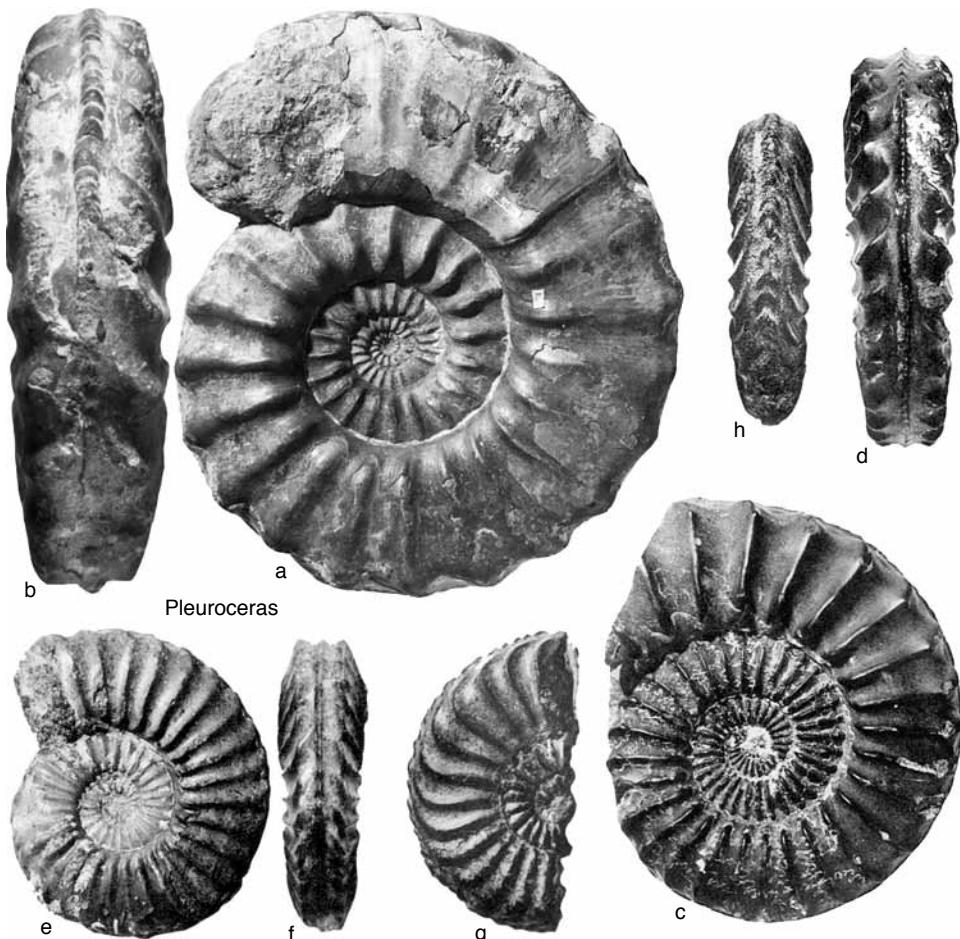


FIG. 42. Amaltheidae (p. 60).

*Reynesocoeloceras* GÉCZY, 1976, p. 123 [*Ammoneites (Stephanoceras) crassus* YOUNG & BIRD, 1828, p. 253, var. *indunense* MENEGHINI, 1874 in 1867–1881, p. 72; OD] [=*Indunoceras*] WIEDENMAYER, 1977, p. 75, obj.]. Evolute cadicones with depressed whorls and a flat venter; ribs are mostly single, but some bifurcation occurs at small to large tubercles at ventrolateral edge. Lower Jurassic (Lower Pliensbachian, Ibex–Davoei Zones): Switzerland, Italy, Portugal, Spain, France, Morocco, Canada (British Columbia, Alberta), USA (Oregon), Argentina.—FIG. 43,1a–b. *\*R. indunense* (MENEGHINI); a, neotype, Ibex Zone, Breggia Gorge, Switzerland,  $\times 1$  (Pinna, 1969, pl. 5,1); b, Monte di Cetona, Tuscany, Italy,  $\times 1$  (Fischer, 1971, pl. 2,3).—FIG. 43,1c–d. *R. levicosta* (FUCINI), lectotype (designated by HOWARTH, herein), venters of outer and inner whorls, Monte di Cetona, Tuscany, Italy,  $\times 1$  (Fucini, 1905, pl. 9 (49), 16b, 16e).

*Bettoniceras* WIEDENMAYER, 1977, p. 80 [*\*Coeloceras italicum* FUCINI, 1900, p. 55 (FUCINI, 1901a, p. 72 (98)); OD]. Evolute serpenticone planulates, with round whorl section and very fine, mainly single ribs; no tubercles. Differs from *Prodactylioceras* only in lacking all tubercles. Derived from *Reynesocoeloceras*. Lower Jurassic (Pliensbachian, Davoei Zone–Margaritatus Zone): Portugal, Switzerland, Italy, Hungary, Morocco, Chile.—FIG. 43,2a–b. *\*B. italicum* (FUCINI), holotype, Margaritatus Zone, Marconessa, Appennino Centrale, Italy,  $\times 1$  (Fucini, 1901a, pl. 13 (13),4).  
*Prodactylioceras* SPATH, 1923a, p. 10 [*\*Ammonites davoei* J. SOWERBY, 1822, p. 71; OD] [=*Paralytoceras* FREBOLD, 1922, p. 15, non FRECH, 1902, p. 83 (Upper Devonian goniatite) (type, *Ammonites davoei* J. SOWERBY, 1822, p. 71, SD HOWARTH herein); =*Praedactylioceras* FRENTZEN, 1937, p. 19, obj., nom. null., misspelling]. Evolute, circular to slightly depressed whorls; ribs fine,

often prorsiradiate, single or bifurcating, with sporadic ribs bearing ventrolateral tubercles in compressed forms, but ribs coarser and swollen, and ventrolateral tubercles larger in depressed forms. Derived from *Reynesocoeloceras*, possibly via *Bettoniceras* (DOMMERGUES, 1986). *Lower Jurasic* (*Pliensbachian*, *Davoei Zone*–*Margaritatus Zone*): Europe, Turkey, Japan, China (Guangdong), Canada (British Columbia), USA (Alaska, Nevada, Oregon).—FIG. 43,3a–b. \**P. davoei* (J. SOWERBY), topotype (holotype, figured by SOWERBY, 1822, pl. 350, is lost), *Davoei Zone*, Charmouth, Dorset, England,  $\times 0.75$  (new, The Natural History Museum, London, BMNH 39892).

**Cetoniceras** WIEDENMAYER, 1977, p. 79 [\**Coeloceras psiloceroides* FUCINI, 1905, p. 118 (290); OD] [= *Seccianoceras* VENTURI in FARAOXI & others, 1995, p. 254 (type, *S. secchianense*, OD)]. Early whorls depressed, becoming rounded and more compressed later; strong primary ribs mostly bifurcate ventrolaterally, and ventrolateral tubercles on inner whorls diminish at larger sizes; differs from *Reynesocoeloceras* in having bifurcating ribs. *Lower Jurassic* (*upper Pliensbachian*, *Margaritatus*–*Spinatum* Zones): Portugal, Spain, France, Italy.—FIG. 43,4a–b. \**C. psiloceroides* (FUCINI), lectotype (designated by HOWARTH, herein), *Margaritatus Zone*, Monte Cetona, Apennines, Italy,  $\times 1$  (Fucini, 1905, pl. 7 (47), 6, 9b).

### Subfamily DACTYLIOCERATINAE Hyatt, 1867

[nom. correct. J. P. SMITH, 1913, p. 661, pro *Dactylioidae* HYATT, 1867, p. 87, 94; ICBN Opinion 576, 1959b] [= *Kedoceratinæ* DAGIS, 1968, p. 56; = *Mesodactylioceratinæ* PINNA & LEVI-SETTI, 1971, p. 80; = *Reyneseratinæ* WIEDENMAYER, 1977, p. 82; = *Nodicoceratinæ* VENTURI & FERRI, 2001, p. 114]

Ribs that bifurcate at ventrolateral edge predominate over single ribs throughout subfamily; presence or absence of ventrolateral tubercles is especially variable; adults have simple, contracted final apertures, and dimorphism on size alone is widespread (LEHMANN, 1968; GUEX, 1973b). Complete graduations between compressed serpenticons and depressed cadicones occur at many horizons, and specific or generic separation of depressed forms is arbitrary. In many cases, depressed forms are clearly related to compressed forms they accompany, as can be seen on final adult whorl that reverts to that of compressed forms, and depressed forms do not belong to a separate evolving lineage of cadicones. Although fibulation (primary ribs looped in pairs to

ventrolateral tubercles) may occur in any of the tuberculate cadicone forms, regular fibulation in compressed forms first appears in *Peronoceras* at the base of the *Fibulatum Subzone*, and the family is divided naturally at this point. Derived from *Reynesocoeloceratinae* in the *Margaritatus Zone* and died out near the top of the *Variabilis Zone*, leaving no successors. *Lower Jurassic* (*upper Pliensbachian*, *Margaritatus Zone*–*upper Toarcian*, *Variabilis Zone*): worldwide.

**Reynesoceras** SPATH, 1936a, p. 444 [\**Ammonites ragazzonii* HAUER, 1861, p. 415; OD] [= *Aeyroniceras* PINNA & LEVI-SETTI, 1971, p. 62 (type, *Ammonites acanthoides* REYNÈS, 1868, p. 91, OD)]. Depressed whorls; coarse, single ribs cross venter without bifurcation; no tubercles. Size dimorphic (*Aeyroniceras*, macroconch; *Reynesoceras*, microconch). Derived from *Prodactylioceras* or *Cetoniceras*. *Lower Jurassic* (*upper Pliensbachian*): France, Italy, Tunisia, Pakistan, Canada (British Columbia, Alberta), USA (Alaska, Nevada, Oregon, California), Argentina.—FIG. 44,1a–b. \**R. ragazzonii* (HAUER), holotype, Medolo, Val Trompia, Brescia, Italy,  $\times 1$  (Hauer, 1861, pl. 1, 16–17).

**Dactylioceras** HYATT, 1867, p. 95 [\**Ammonites communis* J. SOWERBY, 1815b, p. 10; SD ICBN Opinion 576, 1959b] [= *Arcidactylites* BUCKMAN, 1926, pl. 657 (type, *A. arcus*, OD); = *Microdactylites* BUCKMAN, 1926, pl. 655 (type, *Ammonites attenuatus* SIMPSON, 1855, p. 54, OD); = *Anguidactylites* BUCKMAN, 1926, p. 41 (type, *A. anguiformis*, OD); = *Leptodactylites* BUCKMAN, 1926, p. 42 (type, *L. leptum*, OD); = *Peridactylites* BUCKMAN, 1926, p. 42 (type, *P. consimilis*, OD); = *Toxodactylites* BUCKMAN, 1926, p. 42 (type, *T. toxophorus*, OD); = *Vermidactylites* BUCKMAN, 1926, p. 42 (type, *Ammonites vermis* SIMPSON, 1855, p. 51, OD); = *Xeinodactylites* BUCKMAN, 1926, p. 41 (type, *Dactylioceras helianthoides* YOKOYAMA, 1904b, p. 16, OD); = *Athlodactylites* BUCKMAN, 1927a, p. 43 (type, *Ammonites athleticus* SIMPSON, 1855, p. 102, OD); = *Curvidactylites* BUCKMAN, 1927a, p. 43 (type, *C. curvicosta*, OD); = *Kainodactylites* BUCKMAN, 1927a, p. 43, obj.; = *Nomodactylites* BUCKMAN, 1927a, p. 43 (type, *N. temperatus*, OD); = *Parvidactylites* BUCKMAN, 1927a, p. 43 (type, *P. parvus*, OD); = *Simplidactylites* BUCKMAN, 1927a, p. 43 (type, *S. simplicicosta*, OD); = *Rakusites* GUEX, 1971, p. 232 (type, *R. prudeni*, OD); = *Eodactylites* SCHMIDT-EFFING, 1972, p. 55 (type, *Dactylioceras pseudocommune* FUCINI, 1935, p. 86 (162), OD); = *Planicoeloceras* VENTURI & FERRI, 2001, p. 151 (type, *P. simplex*, OD)]. Evolute planulites or serpenticons, with compressed to equidimensional, flat-sided whorls; inner whorls are depressed cadicones in some species; adults have simple, contracted final apertures and are size dimorphic; ribs numerous, straight, single

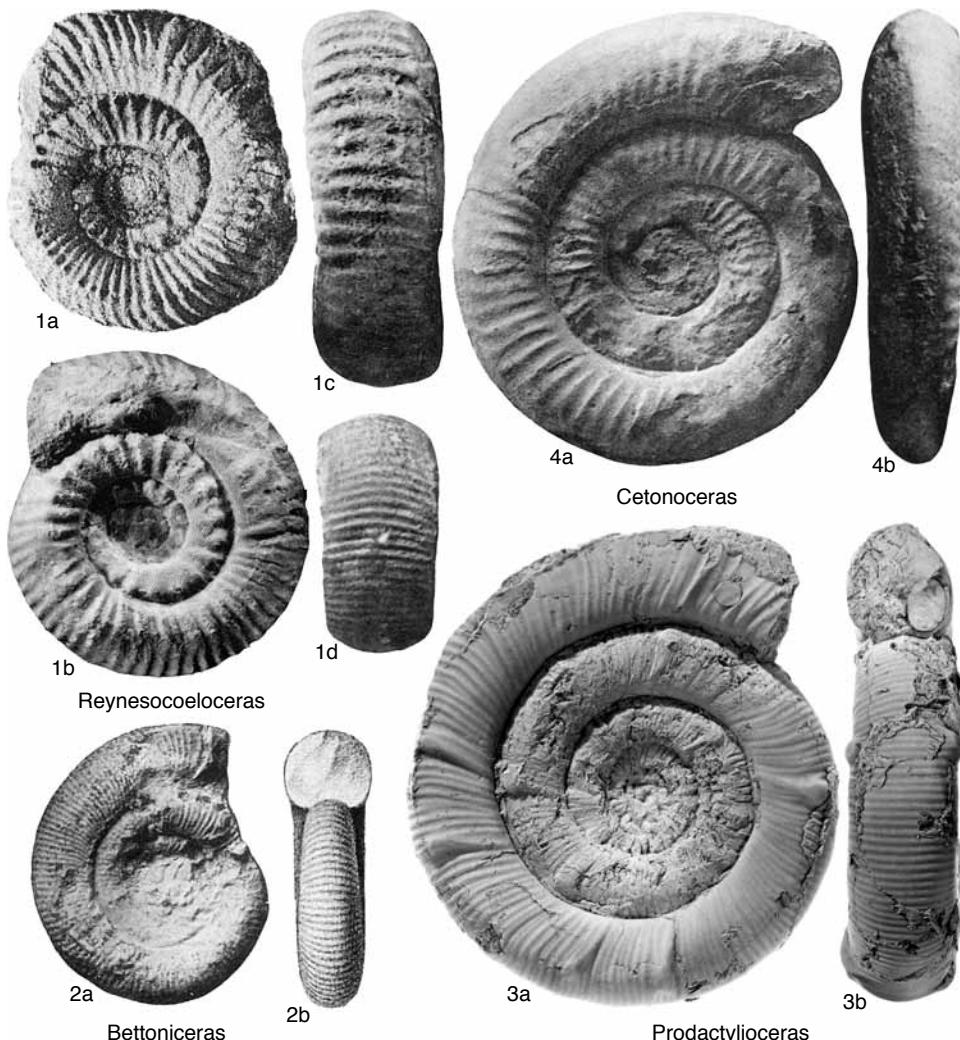


FIG. 43. Dactylioceratidae (p. 63–64).

or bifurcating at ventrolateral edge and usually continuous across venter; ventrolateral tubercles small or absent; occasional fibulate ribs and sporadic ventrolateral spines occur in some species. Lower Jurassic (?Upper Pliensbachian, Spinatum Zone–lower Toarcian, Tenuicostatum Zone–Bifrons Zone, Commune Subzone).

**D. (Dactylioceras).** Ribs typically distant, though dense in some, and usually projected forward on venter; few or no single ribs. Lower Jurassic (?Upper Pliensbachian, Spinatum Zone–lower Toarcian, Tenuicostatum Zone–Bifrons Zone, Commune Subzone): Europe, northern Africa (Atlas Ranges), Russia (Transbaikal, Far East, northeast), Iran, Pakistan, Japan, Vietnam, western Borneo, Indonesia (Roti), Spitzbergen,

Greenland, Canada (British Columbia, Alberta, Yukon), USA (Alaska, Oregon), Chile, Argentina, Peru, New Zealand.—FIG. 44, 2a–b.

\**D. (D.) commune* (J. SOWERBY), lectotype (a so-called snake stone, with a roughly carved snake's head in the matrix at the aperture), Bifrons Zone, Commune Subzone, Whitby, Yorkshire, England,  $\times 1$  (new, The Natural History Museum, London, BMNH 43895a).

**D. (Orthodactylites)** BUCKMAN, 1926, pl. 654 [\**O. directum*; OD] [= *Kryptodactylites* BUCKMAN, 1926, p. 41 (type, *Ammonites semicelatus* SIMPSON, 1843, p. 22, OD); = *Tenuidactylites* BUCKMAN, 1926, p. 41 (type, *Ammonites tenuicostatus* YOUNG & BIRD, 1822, p. 247, OD); = *Kedonoceras* DAGIS, 1968, p. 56 (type,

*K. asperum*, OD)]. Evolute, round-whorled serpenticones, but inner whorls highly variable and include depressed cadicones with broad flat venters and ventrolateral spines; ribs typically annular and dense, rectiradiate or prorsiradiate, but some are distantly ribbed; single ribs occur, as well as bifurcating or trifurcating ribs, especially on inner whorls; tubercles or spines may occur at ventrolateral edge and ribs may be fibulate; final adult whorl may be totally different from cadicone inner whorls, reverting to round-whorled serpentcone, with fine, annular ribs, no tubercles, and whorl breadth less than that of previous whorl (HOWARTH, 1973). *Lower Jurassic (lower Toarcian, Tenuicostatum–Falciferum Zone, Exaratum Subzone)*: Europe, northern Africa (Atlas Ranges), Russia (northeast), Canada (British Columbia), USA (Alaska), Chile, Argentina.—FIG. 44,3a–b. \**D. (O.) directum* (BUCKMAN), holotype, *Tenuicostatum* Zone, Middleton Cheney, Northamptonshire, England, ×1 (Buckman, 1926, pl. 654).—FIG. 44,3c–e. *D. (O.) clevelandicum* HOWARTH, paratype, *Tenuicostatum* Zone, *Clevelandicum* Subzone, Holmsgrove Sand, Whitby, North Yorkshire, England, ×0.9 (new, The Natural History Museum, London, England, BMNH C.50419; also figured in Howarth, 1973, pl. 4,2).—FIG. 44,3f–g. *D. (O.) asperum* (DAGIS), holotype, Omolon area, Brodny, northeastern Russia, ×1 (Dagis, 1968, pl. 11,7).

**D. (Iranodactylites)** REPIN, 2000, p. 39 [\**I. ketevenae*; OD]. Similar to *Orthodactylites*, with fine, single, and bifurcating, prorsiradiate ribs, but with higher whorls and considerably more involute, especially on inner whorls; whorls oval and compressed; umbilicus 39–42% of diameter, whorl height 30–36%; no tubercles; some specimens possibly adult at about 70 mm in diameter. *Lower Jurassic (lower Toarcian, Bifrons Zone)*: Iran.—FIG. 44,4. \**D. (I.) ketevenae*, holotype, Shakhmirzad, 30 km north of Semnan, Elburz Mountains, northern Iran, ×1 (Repin, 2000, p. 40, fig. 3-1a).

**Nodicoeloceras** BUCKMAN, 1926, p. 42 [\**Ammonites crassoides* SIMPSON, 1855, p. 55; OD] [= *Crassicoeloceras* BUCKMAN, 1926, p. 42 (type, *C. pingue*, OD); = *Lobodactylites* BUCKMAN, 1926, p. 42 (type, *L. lobatum*, OD); = *Multicoeloceras* BUCKMAN, 1926, p. 42 (type, *M. multum*, OD); = *Spinicoeloceras* BUCKMAN, 1926, p. 42 (type, *S. spicatum*, OD); = *Mesodactylites* PINNA & LEVI-SETTI, 1971, p. 91 (type, *Coeloceras annulatiforme* BONARELLI, 1899, p. 212, OD); = *Fibulocoeloceras* VENTURI & FERRI, 2001, p. 150 (type, *F. concavum*, OD)]. Depressed cadicones, which accompany *Dactylioceras* s.s.; ribs distant, fibulate in tuberculate forms, bifurcating at ventrolateral edge; ventrolateral tubercles or spines usually present, at least on inner whorls. *Lower Jurassic (lower Toarcian, Falciferum Zone, Exaratum Subzone–Bifrons Zone, Commune Subzone)*: Europe, northern Africa (Atlas Ranges), Pakistan, Indonesia, USA (Nevada), Chile, Argen-

tina.—FIG. 45,1a–b. \**N. crassoides* (SIMPSON), holotype, *Exaratum* Subzone, Whitby, Yorkshire, England, ×1 (Buckman, 1913, pl. 89).

**Peronoceras** HYATT, 1867, p. 85 [\**Ammonites fibulatus* J. DE C. SOWERBY, 1823a, p. 147; SD BUCKMAN, 1911, p. v.]. Gradational from compressed ellipsocones to depressed cadicones; whorls quadrangular, with flat sides and venter; ribs fine to distant, always fibulate, except on inner whorls of fine-ribbed forms; ventrolateral tubercles present. *Lower Jurassic (lower Toarcian, Bifrons Zone, Fibulatum Subzone only)*: Europe, northern Africa (Atlas Ranges), Caucasus, Vietnam, Japan, Canada (British Columbia, Alberta, Yukon), USA (Alaska), Chile, Argentina, Peru.—FIG. 45,2a–b. \**P. fibulatum* (J. DE C. SOWERBY), lectotype (designated by HOWARTH, 1978, p. 260), Whitby, North Yorkshire, England, ×1 (new, The Natural History Museum, London, BMNH 43911).

**Zugodactylites** BUCKMAN, 1926, pl. 658 [\**Ammonites braunianus* D'ORBIGNY, 1845 in 1849–1851, p. 327; OD] [= *Omolonoceras* DAGIS, 1967, p. 48 (type, *O. manifestum*, OD); = *Gabillites* GUEX, 1971, p. 234 (type, *G. larbussensis*, OD)]. Compressed, equidimensional or depressed whorls; adult whorl has collar and constriction at final aperture; fine, dense ribs bifurcate at sharp, pointed ventrolateral tubercles or spines; no fibulate ribs. Size dimorphic (*Gabillites*, microconch). Derived from fine-ribbed *Peronoceras*. *Lower Jurassic (lower Toarcian, Bifrons Zone, Fibulatum Subzone only)*: Europe, Russia (eastern Transbaikalia, Far East, northeast), Canada (Alberta, Yukon).—FIG. 45,3a–d. \**Z. braunianus* (D'ORBIGNY); a–b, lectotype, Le Clapier, Aveyron, France, ×1 (Fischer, 1994, pl. 29,5a, 5c); c–d, Northampton, England, ×1 (new, The Natural History Museum, London, England, BMNH C.67521; also figured in Howarth, 1978, pl. 6,4).—FIG. 45,3e–f. *Z. manifestum* (DAGIS), holotype, Omolon area, Tokur-Yuryakh, northeastern Russia, ×1 (Dagis, 1967, pl. 1,5).

**Poropoceras** BUCKMAN, 1911, p. v [\**Ammonites vortex* SIMPSON, 1855, p. 60; OD] [= *Telodactylites* PINNA & LEVI-SETTI, 1971, p. 114 (type, *Ammonites desplaceti* D'ORBIGNY, 1845 in 1842–1851, p. 334, OD); = *Platytrypites* LEVI-SETTI & PINNA, 1971, p. 476 (type, *P. latus*, OD)]. Whorl shape varies from rounded-quadrangular to depressed; ribs bearing ventrolateral tubercles tend to alternate with nontuberculate ribs, and only some of the tuberculate ribs are fibulate. Occurs with *Peronoceras*, but does not have compressed whorls and lacks its regular fibulation; *Catacoeloceras* has regular ventrolateral tubercles and no fibulation. *Lower Jurassic (lower Toarcian, Bifrons Zone, Fibulatum Subzone only)*: Europe, Caucasus, Pakistan, Russia (Far East, northeast), Canada (British Columbia, Yukon), Chile, Argentina.—FIG. 46,1a–b. \**P. vortex* (SIMPSON), holotype, Ravenscar, Whitby, North Yorkshire, England, ×0.8 (Buckman, 1911, pl. 29A).

**Septimaniceras** FAURÉ, 2002, p. 711 [\**Ammonites zitteli* OPPEL, 1862, p. 139; OD]. Small (30 mm maximum diameter), very evolute, early whorls cadicone, later whorls quadrate in section; inner whorls have widely spaced, bold ribs bearing prominent ventrolateral tubercles and fine striate ribs

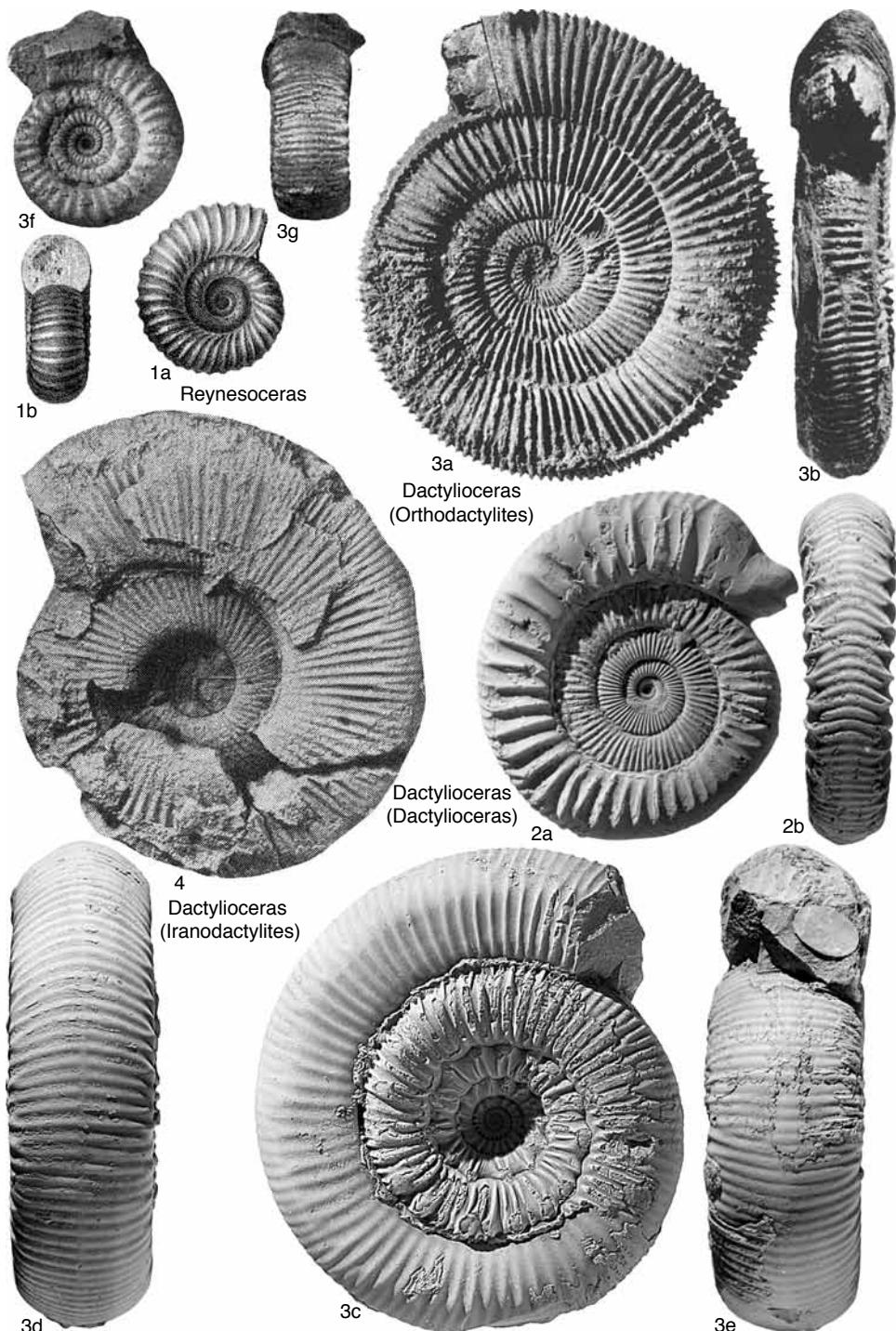


FIG. 44. *Dactylioceratidae* (p. 64–66).

between; later whorls have alternating single and looped ribs with ventrolateral tubercles on looped ribs. Dimorphic: microconchs adult at 10–12 mm in diameter, macroconchs at approximately 30 mm in diameter. Lower Jurassic (lower Toarcian, upper Bifrons Zone): France.—FIG. 46,2a–f. \**S. zitteli* (OPPEL); a–b, lectotype (designated by HOWARTH, herein), microconch, Milhau, Aveyron,  $\times 4$  (Oppel, 1862, pl. 42a–b); c–f, Saint-Paul-de-Font, Aveyron; c–d, macroconch; e–f, microconch,  $\times 1.5$  (Fauré, 2002, pl. 9,27–28).

**Catacoeloceras** BUCKMAN, 1923a, pl. 413 [*\*C. confectum*; OD] [= *Transicoeloceras* PINNA, 1966, p. 124 (type, *T. angustum*, OD)]. Cadicones, with depressed rounded whorls, some extreme forms (*Transicoeloceras*) almost sphaerocones; ribs simple or bifurcating, and regular ventrolateral tubercles present in most forms; venter may become flat and smooth between tubercles on adult body chamber, which contracts toward mouth border. Size dimorphic. Lower Jurassic (lower Toarcian, Bifrons Zone, Crassum Subzone—upper Toarcian, Variabilis Zone): Europe, northern Africa (Atlas Ranges), Turkey, Caucasus, Russia (Crimea, northeast), Indonesia, Greenland, Canada (British Columbia, Yukon), Chile, Argentina, Peru, Bolivia.—FIG. 46,3a–b. \**C. confectum*, holotype, Variabilis Zone, North Nibley, Gloucestershire, England,  $\times 1.5$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 47198).—FIG. 46,3c–d. *C. dumortieri* (DE BRUN), ?Variabilis Zone, Ilminster, Somerset, England,  $\times 1$  (new, The Natural History Museum, London, BMNH C.67678).

**Collina** BONARELLI, 1893, p. 205, 207 [*\*C. gemma*; SD BUCKMAN, 1927a, p. 44] [= *Mucroductylites* BUCKMAN, 1927a, p. 43 (type, *Ammonites mucronatus* D'ORBIGNY, 1845 in 1842–1851, p. 328, OD); = *Collinites* ATROPS, 1972, p. 1598 (type, *Collina meneghinii* BONARELLI, 1899, p. 210, OD)]. Whorls angular, quadrate whorl section; ribs distant, bifurcating or trifurcating at a high ventrolateral tubercle; secondary ribs projected strongly forward and raised in middle of venter. Size dimorphic. Lower Jurassic (lower Toarcian, Brauniarius Subzone—upper Toarcian, Variabilis Zone): Europe, Russia (eastern Transbaikalia, northeast), Canada (British Columbia, Yukon), Chile, Argentina, Peru.—FIG. 45,4a–b. \**C. gemma*, holotype, Valdoria, Umbria, Italy,  $\times 1$  (Gallitelli-Wendt, 1970, pl. 6,3).

## Superfamily HILDOCERATOIDEA Hyatt, 1867

[*nom. correct.* HILLEBRANDT, 2006, p. 229, *pro* Hildocerataceae ARKELL, 1957, p. 254, *nom. transl.* ex Hildoceratidae HYATT, 1867, p. 99] [suborder Harpoceracea WEDEKIND, 1918, p. 103; =Hammatocerataceae SCHINDEWOLF, 1964, p. 366]

Evolute planulates to involute oxycones, usually keeled with a compressed whorl

section; straight to falcoid or falcate ribs; tubercles present in a few genera. Size dimorphism is widespread in this superfamily, adult macroconchs being several times larger than adult microconchs, and the earliest occurrence of lappets in the adult mouth borders of the microconchs is also found here. Aptychi with plicated shiny surface (*Cornaptichus*) or smooth surface (*Laevicornaptichus*) are known in some genera. Lower Jurassic (lower Pliensbachian, Jamesoni Zone)—Middle Jurassic (lower Bajocian, ?upper Bajocian): worldwide.

## Family HILDOCERATIDAE Hyatt, 1867

[Hildoceratidae HYATT, 1867, p. 99]

Typical Hildoceratoidea, derived from Polymorphitidae in the Jamesoni Zone. Lower Jurassic (lower Pliensbachian, Jamesoni Zone)—Middle Jurassic (lower Bajocian, Laeviuscula Zone): worldwide.

### Subfamily PROTOGRAMMOCERATINAE Mattei, 1974

[Protogrammoceratinae MATTEI, 1974, p. 553, 557]

Variable from involute planulates, with quadrate whorl sections, to involute oxycones with compressed whorls; all have keels and sigmoidal to falcate ribs; dimorphism probably widespread but is poorly documented. Some forms are very similar to various genera of Harpoceratinæ. Includes the earliest forms and is the root stock for all the other subfamilies. Lower Jurassic (lower Pliensbachian, Jamesoni Zone—lower Toarcian, Tenuicostatum Zone): worldwide.

**Protogrammoceras** SPATH, 1913, p. 547 [*\*Grammoceras bassanii* FUCINI, 1901a, p. 46 (72); SD SPATH, 1919, p. 174] [= *Wrightia* GEMMELLARO, 1886b, p. 190, *non* AGASSIZ, 1862 (Coelenterata) (type, *Harpoceras (Wrightia) alternans*, M); = *Paltarpites* BUCKMAN, 1922, pl. 362A (type, *P. paltus*, OD); = *Argutarpites* BUCKMAN, 1923a, pl. 363 (type, *A. argutus*, OD); = *Bassaniceras* FUCINI, 1929, p. 63 (87), obj.; = *Eoprotogrammoceras* CANTALUPPI, 1970, p. 42 (type, *Protogrammoceras mellahense* DUBAR, 1961, p. 253, OD); = *Neoprotogrammoceras* CANTALUPPI, 1970, p. 42 (type, *Harpoceras meneghinii* BONARELLI, 1899,

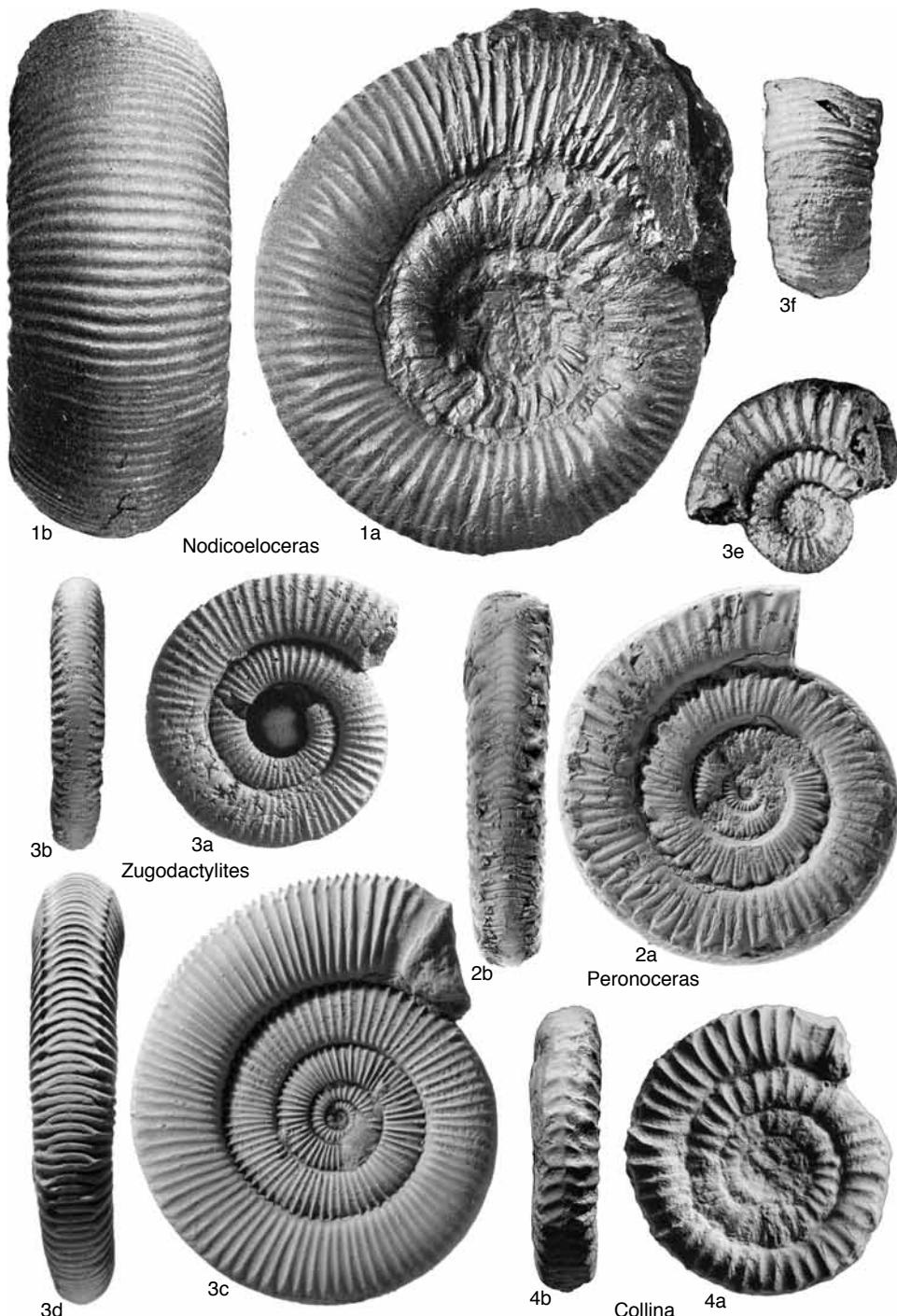


FIG. 45. Dactylioceratidae (p. 66–68).

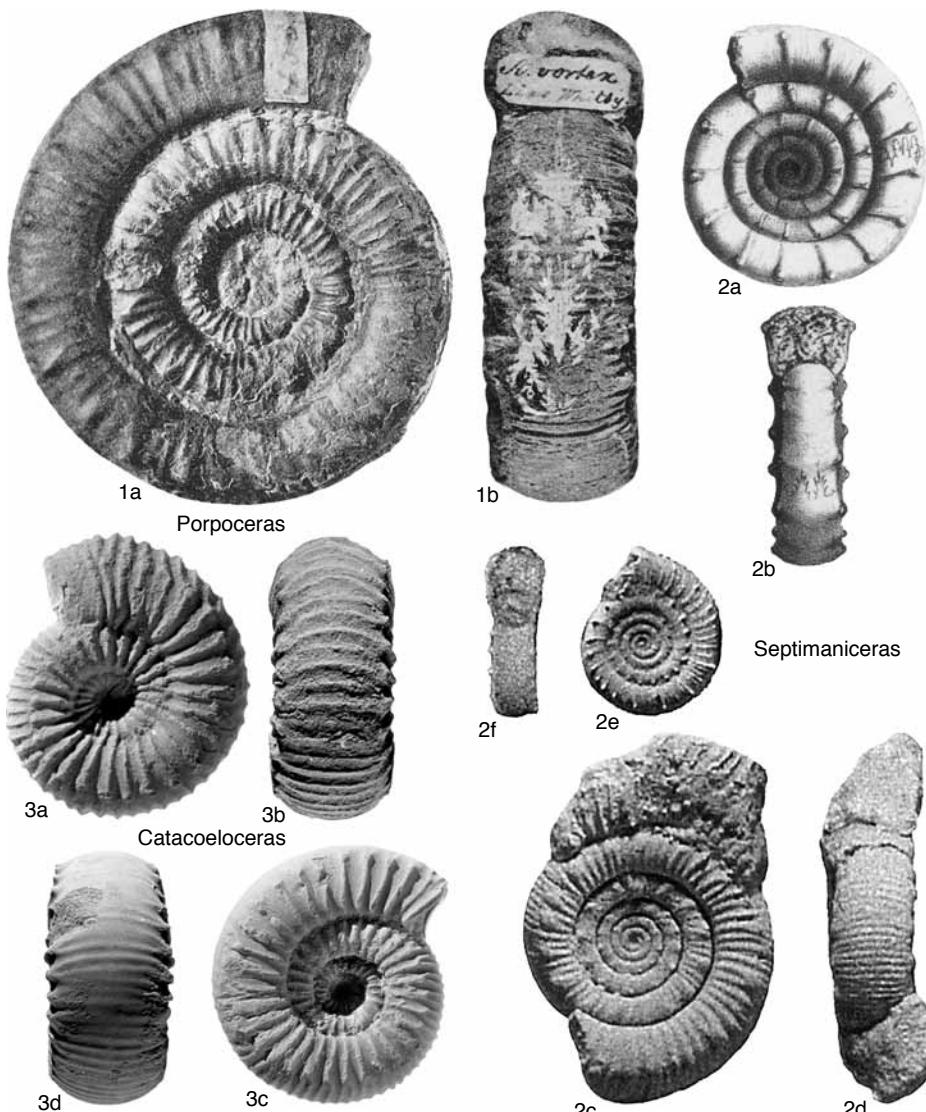


FIG. 46. Dactylioceratidae (p. 66–68).

p. 203, OD)]. Planulates, with moderately wide umbilicus, flat whorl sides, and venter acute or flat with keel and sulci; ribs straight, sinuous or falcoid, fine and dense to coarse and distant, sometimes broad and flat topped, usually strongly projected forward on venter; some forms develop strong, distant, rursiradiate ribs on outer half of whorl, ending in a ventrolateral tubercle. Derived from Polymorphitidae in *Jamesoni* Zone. Lower Jurassic (lower Pliensbachian, *Jamesoni* Zone–lower *Toarcian*, *Tenuicostatum* Zone): Europe, northern Africa (Atlas Ranges), Madagascar, Somalia, Saudi

Arabia, Russia (Far East), Pakistan, Vietnam, Japan, Canada (British Columbia, Alberta), USA (Alaska, Nevada, Oregon), Chile, Argentina.

**P. (Protogrammoceras).** *Protogrammoceras* with sinuous to falcoid ribs that are strongly projected forward on approaching venter. Age and geographic range as for genus.—FIG. 47, 1a–b. \**P. (P.) basanii* (FUCINI), lectotype, upper Pliensbachian, Pian de' Giugoli, Central Apennines, Italy; a, lectotype,  $\times 0.8$  (Fucini, 1901a, pl. 10 (10), 6a); b, lectotype,  $\times 0.8$  (Cantaluppi, 1972, pl. 15, 2c).—FIG.

- 47,1c-d. *P. (P.) paltum* (BUCKMAN), holotype, lower Toarcian, *Tenuicostatum* Zone, Junction Bed, Thorncome Beacon, Dorset, England,  $\times 0.75$  (Howarth, 1992a, pl. 2,2).
- P. (Matteiceras)** WIEDENMAYER, 1980, p. 124 [*\*Ammonites nitescens* YOUNG & BIRD, 1828, p. 257; OD] [=*Procanavaria* MATTEI, 1974, p. 551, 555, 557, *nom. nud.*]. *Protogrammoceras* with moderate to coarse, straight to rursiradiate ribs, ending in small or medium ventrolateral tubercles, from which ribs may be projected strongly forward on venter. *Lower Jurassic (upper Pliensbachian, Margaritatus Zone, Stokesi Subzone):* England, France, Germany, Portugal, Spain. —FIG. 47,2a-b. \**P. (M.) nitescens* (YOUNG & BIRD), holotype, Hawsker Bottoms, Whitby, Yorkshire, England,  $\times 0.75$  (Howarth, 1992a, pl. 4,4).
- P. (Fieldingiceras)** WIEDENMAYER, 1980, p. 128, *nom. nov. pro Fieldingia* CANTALUPPI, 1970, p. 41, *non* KENT, 1870 (sponge) [*\*Ammonites fieldingi* REYNÈS, 1868, p. 97; OD]. Small, adult at 25–35 mm in diameter; evolute, compressed, with ventral keel; inner whorls smooth to a variable size, then single, gently sigmoidal ribs appear, which may be irregular and widely spaced. Possibly a microconch accompanying much larger *P. (Protogrammoceras)*, e.g., *P. (P.) depressum* (QUENSTEDT) (DOMMERGUES, 1987, p. 217; MEISTER, 1989, p. 40). *Lower Jurassic (upper Pliensbachian, Margaritatus Zone, top Stokesi Subzone–basal Subnodosus Subzone):* France, Spain, Italy, Canada (British Columbia). —FIG. 47,3a-c. \**P. (F.) fieldingi* (REYNÈS); a–b, lectotype, Rivière, Milhau, Aveyron, France,  $\times 1$  (Reynès, 1868, pl. 4,1a–b); c, Le Samonta, Aveyron,  $\times 1.5$  (Monestier, 1934, pl. 4,29).
- Fuciniceras** HAAS, 1913, p. 75 [*\*Harpoceras lavinianum* FUCINI, 1901a, p. 52 (78); OD] [=*Eofuciniceras* CANTALUPPI, 1970, p. 41 (type, *Fuciniceras dubari* CANTALUPPI in CANTALUPPI & MONTANARI, 1969, p. 75, OD); =*Neofuciniceras* CANTALUPPI, 1970, p. 41 (type, *Harpoceras? ambiguum* FUCINI, 1901a, p. 24 (50), OD)]. Similar to *Protogrammoceras*, but some species are more evolute; differs in having ribs that are more rursiradiate on outer half of whorl, and ending abruptly at ventrolateral edge with no forward projection. Possibly derived independently from *Tropidoceras* (Polymorphitidae). *Lower Jurassic (lower Pliensbachian, Ibex Zone–upper Pliensbachian, Spinatum Zone):* Europe, northern Africa (Atlas Ranges), Tunisia, Caucasus, Pakistan, Japan, Indonesia (Sulawesi, Buton), Canada (British Columbia), USA (Alaska, Oregon), Chile, Argentina. —FIG. 48,1a–b. \**F. lavinianum* (FUCINI), lectotype (designated by BRAGA, 1983, p. 136), Canfaito, Central Apennines, Italy,  $\times 0.8$  (Fucini, 1901a, pl. 11 (11),6). —FIG. 48,1c. *F. suejense* MONESTIER, upper Pliensbachian, Margaritatus Zone, Rivière, Aveyron, France,  $\times 1$  (Monestier, 1934, pl. 2,11).
- Lioceratooides** SPATH, 1919, p. 174 [*\*Lioceras grecoi* FUCINI, 1901a, p. 65 (91); OD] [=*Platyharpites* BUCKMAN, 1927a, pl. 698 (type, *P. platyleurus*, OD); =*Praeleioceras* FUCINI, 1929, p. 71 (95) (type, *P. aradasi*, SD HOWARTH, 1992a, p. 68); =*Nagatoceras* MATSUMOTO, 1947, p. 28 (type, *Harpoceras (Nagatoceras) toyoranum*, M); =*Neoliceratooides* CANTALUPPI, 1970, p. 40 (type, *Hildoceras (Lillia) hoffmanni* GEMMELLARO, 1886a, p. 122, OD)]. More involute than *Protogrammoceras*, and compressed with tall ventral keel; falcoïd ribs vary from coarse to fine and are sometimes almost striate or smooth; at small sizes, ribs may bifurcate, but at larger sizes, most are single, and may be broad and flat topped, with narrower sulci between; some species are homeomorphic with the much later *Cleviceras* and *Harpoceras*. *Lower Jurassic (upper Pliensbachian):* Europe, Morocco, Japan, Canada (British Columbia), USA (Nevada, Oregon, California). —FIG. 48,2a–b. \**L. grecoi* (FUCINI), lectotype (designated herein), Monte Nerone, Central Apennines, Italy,  $\times 1$  (Fucini, 1901a, pl. 11 (11),4). —FIG. 48,2c. *L. praexaratum* (FUCINI), upper Pliensbachian, *Spinatum* Zone, Fontanelle, Taormina, Sicily,  $\times 0.8$  (new, The Natural History Museum, London, BMNH C.50911).
- ### Subfamily HARPOCERATINAE
- #### Neumayr, 1875
- [*nom. correct.* ZITTEL, 1884, p. 458, *pro* Harpoceratinen NEUMAYR, 1875, p. 905, invalid vernacular name, ICZN Direction 14, 1955d] [=Polyplectiniae VENTURI, 1981b, p. 584]
- Involute and compressed, with strong keel and moderate to fine, single or bifurcating, sigmoidal to falcate ribs, or occasionally smooth; tubercles rare. Dimorphism widespread: macroconchs are 4× to 6× larger than microconchs, and adult size variation within each dimorph usually at least 2:1 and can be 3:1; adult mouth borders of dimorphs similar, any difference only reflecting greater curvature of ribs at the smaller size of the microconchs; no true lappets. *Lower Jurassic (upper Pliensbachian, Spinatum Zone)–Middle Jurassic (lower Bajocian, Laeviuscula Zone):* worldwide.
- Tiltoniceras** BUCKMAN, 1913, p. viii [\**T. costatum*; OD; =*Harpoceras antiquum* WRIGHT, 1883, p. 431] [=*Pacificeras* REPIN, 1970, p. 41 (type, *Schloenbachia propinqua* WHITEAVES, 1884, p. 247, OD)]. Moderately to very involute, compressed, nearly flat whorl sides, rounded umbilical edge, strong keel on venter but no sulci; ribs moderately strong to fine, striate or smooth, straight, or gently sigmoidal, and strongly projected forward on venter. Size dimorphic. *Lower Jurassic (upper Pliensbachian, Spinatum Zone–lower Toarcian, Tenuicostatum Zone):* England, Germany, Russia (northeast), Canada (British Columbia), USA (Nevada, California). —

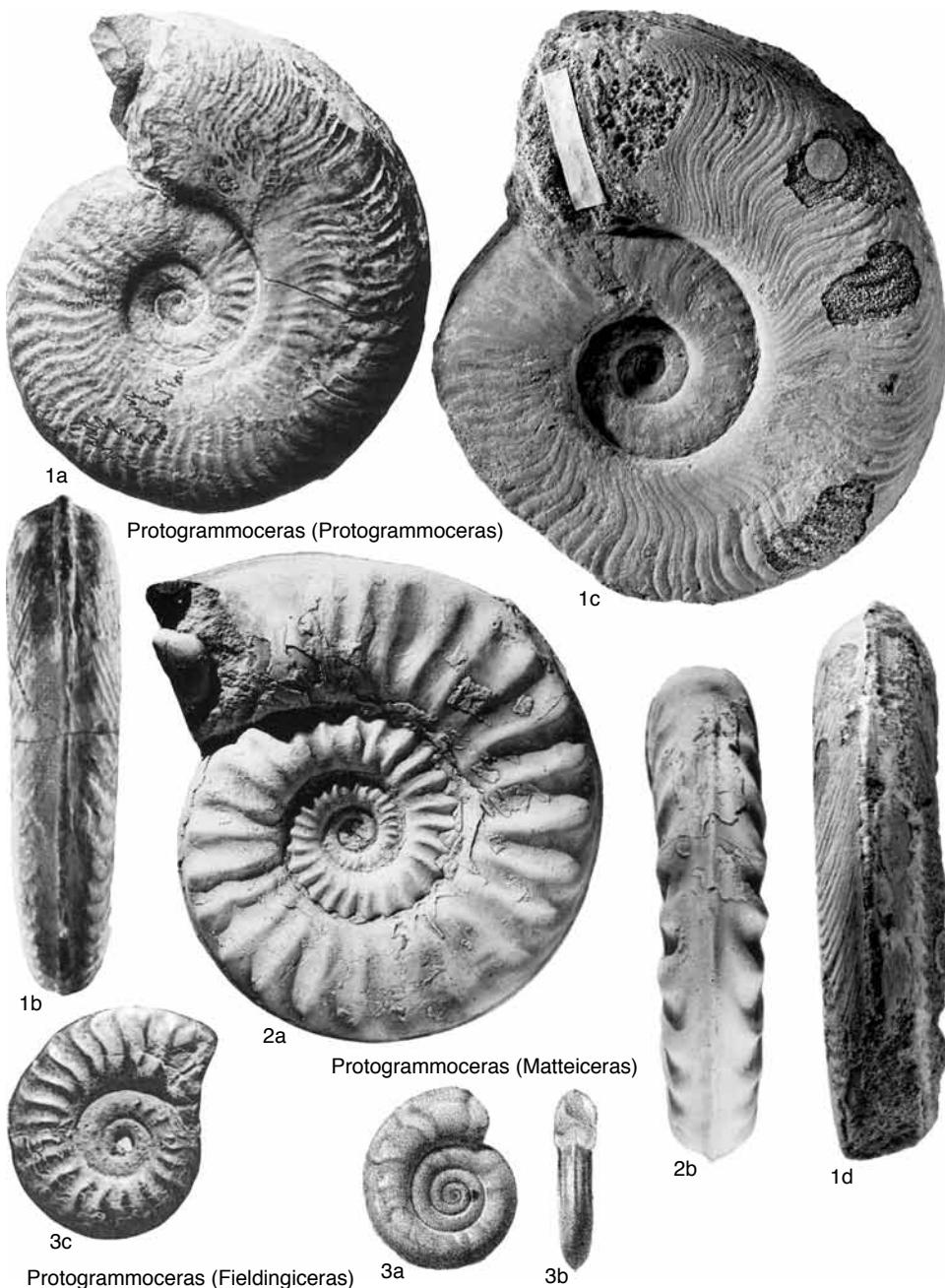


FIG. 47. Hildoceratidae (p. 68–71).

FIG. 49, 1a–b. \**T. antiquum* (WRIGHT), holotype of originally designated type *T. costatum*, Tilton, Leicestershire, England,  $\times 1.5$  (new, Manchester University Museum L.11431).—FIG. 49, 1c–d. *T. propinquum* (WHITEAVES), paratype, *Carlottense*

Zone (=*Spinatum* Zone), Fannin Bay, Queen Charlotte Islands, western Canada,  $\times 1$  (Smith & others, 1988, p. 1516, pl. 5, 3–4).

*Eleganticeras* BUCKMAN, 1913, p. viii [*\*E. pseudoelégans*; OD; =*Ammonites elegantulus* YOUNG & BIRD,

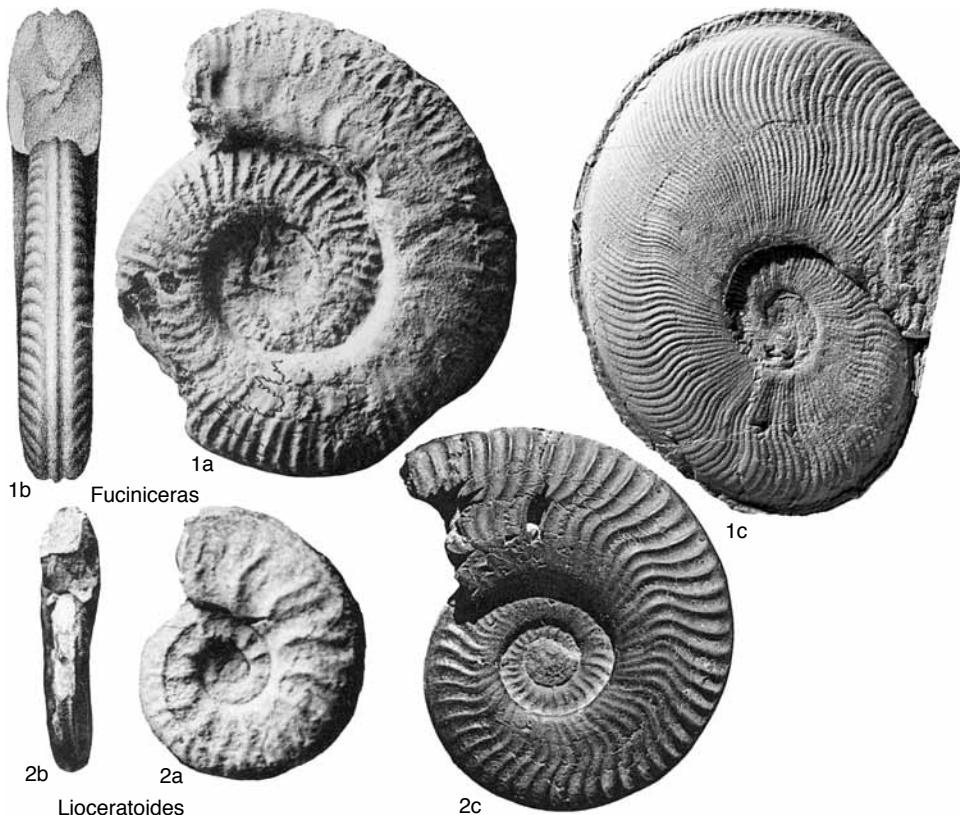


FIG. 48. Hildoceratidae (p. 71).

1828, p. 267] [= *Elegantuliceras* BUCKMAN, 1913, p. viii (type, *Ammonites elegantulus* YOUNG & BIRD, 1828, p. 267, OD); = *Ochotoceras* REPIN, 1970, p. 43 (type, *Harpoceratooides alajaensis* REPIN in POLUBOTKO & REPIN, 1966, p. 44, OD); = *Leptarites* REPIN, 1970, p. 41, 44 (type, *Harpoceratooides planus* REPIN in EFIMOVA & others, 1968, p. 117, OD)]. Derived from *Tiltoniceras*, differing in having an angled umbilical edge, flat, sloping, or vertical umbilical wall, and falcoid ribs becoming striate or smooth at large sizes. Dimorphic: macroconchs 60–195 mm in diameter, striate or smooth; microconchs 9–40 mm, with blunt single ribs on body chamber. Lower Jurassic (lower Toarcian, Falciferum Zone, Exaratum Subzone [lower part only]): England, Germany, Russia (eastern Transbaikalia, northeast), Canada (British Columbia), USA (Alaska).—FIG. 49, 2a–f. \**E. elegantulum* (YOUNG & BIRD), Whitby, Yorkshire, England; a–b, holotype, immature macroconch,  $\times 1$  (Howarth, 1992a, pl. 7, 5); c–d, macroconch (holotype of *E. pseudoellegans* BUCKMAN),  $\times 0.8$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 47090); e–f, adult microconch,  $\times 1.5$  (Howarth, 1992a, pl. 8, 7).

*Cleviceras* HOWARTH, 1992a, p. 89 [\**Ammonites exaratus* YOUNG & BIRD, 1828, p. 266; OD]. Moderately involute, compressed, flat whorl sides, sloping, vertical, or undercut umbilical walls, strong, floored ventral keel; ribs falcoid, bifurcating at small sizes, single at larger sizes, broad and flat on outer part of whorl, becoming striate on adults; no tubercles. Abnormal specimens of *Cleviceras* and *Harpoceras* with no ventral keel occur occasionally; they have often been referred to “*Monestieria*,” but the type specimen of *Monestieria* is a similarly abnormal specimen of *Pseudogrammoceras* (see below). Dimorphic: macroconchs 85–200 mm in diameter; microconchs 16–62 mm, with strong bifurcating ribs. *Harpoceras* attains a larger adult size in both dimorphs, is more evolute, and has falcate, rather than falcoid, ribbing, with a midlateral groove or series of undulations in many specimens. Lower Jurassic (lower Toarcian, Falciferum Zone, middle–upper Exaratum Subzone): England, France, Germany, Switzerland, Russia (northeast), Canada (British Columbia).—FIG. 50, 1a–f. \**C. exaratum* (YOUNG & BIRD); a–b, holotype, Whitby, Yorkshire, England,  $\times 0.75$  (Howarth, 1992a, pl. 10, 1); c–d, complete adult macroconch, with a

complete adult microconch attached near aperture, Whitby, Yorkshire, England,  $\times 0.75$  (Howarth, 1992a, pl. 10,2); *e–f*, complete adult microconch, Hawsker Bottoms, Whitby, Yorkshire, England,  $\times 1.5$  (Howarth, 1992a, pl. 11,17).

**Harpoceras** WAAGEN, 1869, p. 245 [*\*Ammonites falcifer* J. SOWERBY, 1820, p. 99; SD ICZN Opinion 303, 1954a] [=*Lioceras* BAYLE, 1878, explanation of pl. 87–88 (type, *Ammonites subplanatus* OPPEL, 1856 in 1856–1858, p. 244, SD HOWARTH, 1992b, p. 107); =*Harpoceratoides* BUCKMAN, 1909, p. ii (type, *Ammonites alternatus* SIMPSON, 1843, p. 43, OD); =*Maconiceras* BUCKMAN, 1926, pl. 684 (type, *M. vigorensis*, OD); =*Glyptarpites* BUCKMAN, 1927b, p. 8 (type, *G. glyptus*, OD); =*Tardarpoceras* BUCKMAN, 1927b, pl. 741 (type, *T. tardum*, OD); =*Phaularpites* BUCKMAN, 1928, p. 13 (type, *P. exiguum*, OD); =*Falcifericeras* BREISTROFFER, 1949, p. 100, obj.; =*Falciferites* ARKELL, 1957, p. 255, misspelling of *Falcifericeras* BREISTROFFER, 1949, p. 100; =*Kolymeroceras* DAGIS, 1970, p. 863 (type, *Osperveloceras viluense* KRIMHOLZ, 1963, p. 216, OD); =*Gallitellia* VENTURI & FERRI, 2001, p. 182 (type, *G. costostriata*, OD)]. Moderately evolute to involute, compressed, flat whorl sides, sloping, vertical, or undercut umbilical walls, strong keel on venter; ribs biconcave, falcoid or falcate, strong and projected, and sometimes broad and flat topped on outer half of whorl; striate on inner half in some forms; midlateral groove, or series of undulating depressions on inner half of whorl in some species. Dimorphic: macroconchs large (115–430 mm), ribs as above, gently sinuous mouth border; microconchs 24–51 mm, ribs strong, falcoid and bifurcating; mouth border follows falcate rib shape. *Lower Jurassic (lower Toarcian, Falciferum Zone–Bifrons Zone, Commune Subzone)*: Europe, northern Africa (Atlas Ranges), Russia (eastern Transbaikalia, northeast), Japan, western Borneo, New Zealand, Canada (British Columbia, Alberta, Yukon), USA (Alaska, Nevada, Oregon), Chile, Argentina, Peru. —FIG. 50,2a–d. \**H. falciferum* (J. SOWERBY), *Falciferum* Subzone; *a–b*, holotype, macroconch, Thorncome Beacon, Dorset, England,  $\times 1$  (Howarth, 1992b, pl. 19,2); *c–d*, microconch (holotype of *Phaularpites exiguum* BUCKMAN), Moolham, Ilminster, Somerset, England,  $\times 1$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 49349; also figured in Buckman, 1928, pl. 775A).

**Ovaticeras** BUCKMAN, 1918a, p. xi [*\*Ammonites ovatus* YOUNG & BIRD, 1822, p. 251; OD]. Moderately involute, compressed, narrow venter with keel, and characteristic elliptical (“oval”) whorl section; rounded umbilical edge, sloping umbilical wall; ribs sinuous or falcoid, moderate or weak on inner whorls, striate or smooth on outer whorl. Complete adults 120–250 mm in diameter; dimorphism unknown. *Lower Jurassic (lower Toarcian, top Falciferum Subzone only)*: England, ?Vietnam, ?Canada (British Columbia, Yukon). —FIG. 50,3a–b. \**O. ovatum* (YOUNG & BIRD), holotype, Whitby, Yorkshire, England,  $\times 1$  (Howarth, 1992b, pl. 24,4).

**Taffertia** GUEX, 1973a, p. 503 [*\*T. taffertensis*; OD].

Similar to *Pseudolioceras*, but more evolute, and with bold, regularly bifurcating ribs. *Lower Jurassic (lower Toarcian, Falciferum Zone, ?Exaratum Subzone)*: Morocco, Canada (British Columbia). —FIG. 51,1a–b. \**T. taffertensis*, holotype, Taffert, Moyen Atlas, Morocco; *a*,  $\times 1$ ; *b*, cross section of whorl,  $\times 1$  (Guex, 1973a, pl. 2,6, pl. 14,7).

**Pseudolioceras** BUCKMAN, 1889a, p. 81 [*\*Ammonites compactilis* SIMPSON, 1855, p. 74; OD; =*Ammonites boulbiensis* YOUNG & BIRD, 1822, p. 252] [=*Praehaploceras* MONESTIER, 1930, p. 28–29; MONESTIER, 1931, p. 69 (type, *P. zwieselei*, M); =*Pseudowalkericeras* MAUBEUGE, 1949b, p. 151 (type, *P. hussignyense*, M); =*Buckmanites* GUEX, 1973d, p. 470 (type, *Oxynoticeras buckmani* MONESTIER, 1921, p. 39, OD)]. More involute than *Harpoceras*, with vertical, sloping, or undercut umbilical walls, compressed whorl section narrowing toward venter; tall, hollow, floored ventral keel, no ventral sulci; ribs single and falcoid or falcate, weak or striate on inner half of whorl, stronger, nearly straight and rursiradiate on outer half of whorl, and suddenly projected forward near venter in some. Dimorphic: macroconchs more than 150 mm in diameter, microconchs adult at 35–50 mm in diameter. The type specimen of *Praehaploceras* is an abnormal (malformed) *Pseudolioceras* without a keel. *Lower Jurassic (lower Toarcian, Bifrons Zone–Middle Jurassic (lower Bajocian, Laeviuscula Zone))*: Europe, northern Africa (Atlas Ranges), Turkey, Russia (Transbaikalia, Bureya Basin, Far East, northeast), Thailand, Japan, Spitzbergen, Greenland, Canada (British Columbia, Yukon), USA (Alaska).

**P. (Pseudolioceras).** Ribs falcoid, and weak to smooth on inner half of whorl. *Lower Jurassic (lower Toarcian, Bifrons Zone–Middle Jurassic (Aalenian, Opalinum Zone))*: age and geographic range as for genus. —FIG. 51,2a–b. \**P. (P.) boulbiense* (YOUNG & BIRD), holotype of *Ammonites compactilis* SIMPSON, upper Toarcian, *Thouarsense* Zone, *Striatulum* Subzone, Ravenscar, Whitby, Yorkshire, England,  $\times 1$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 24914). —FIG. 51,2c–d. *P. (P.) lythense* (YOUNG & BIRD), lower Toarcian, *Bifrons* Zone, Whitby, Yorkshire,  $\times 1$  (Howarth, 1992b, pl. 26,5).

**P. (Tugurites)** KALACHEVA & SEY, 1970, p. 450 [*\*Ammonites (Amaltheus) whiteavesi* WHITE, 1889, p. 69; OD]. Ribs falcate, stronger on inner half of whorl and more strongly angled backward at falcate bend than in *P. (Pseudolioceras)*; umbilical edge may have a raised rim, which has a ropelike pattern where crossed by ribs (SEY, KALACHEVA, & WESTERMANN, 1986). *Middle Jurassic (Aalenian–lower Bajocian, Laeviuscula Zone)*: Russia (Far East, northeast), Japan, Spitzbergen, USA (Alaska). —FIG. 51,3a–b. \**P. (T.) whiteavesi* (WHITE), lectotype, Aalenian, *Howelli* Zone, Wide Bay, Alaska Peninsula,  $\times 0.75$  (Westermann, 1964, pl. 69,1).

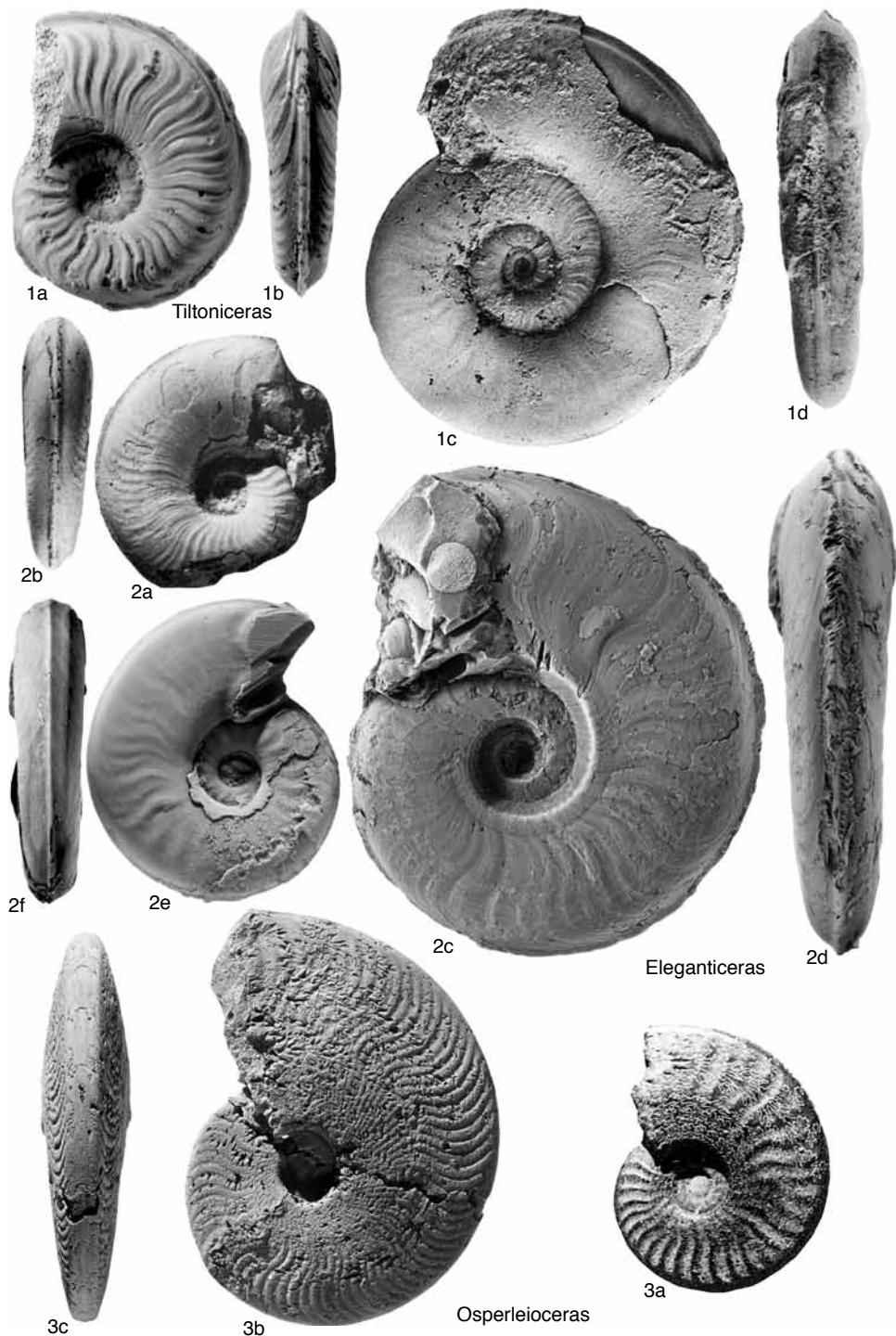


FIG. 49. *Hildoceratidae* (p. 71-76).

**Osperleioceras** KRIMHOLZ in KRIMHOLZ & TAZIKHIN, 1957, p. 130 [*Pseudolioceras beaulizense* MONESTIER, 1921, p. 30; OD] [=*Pseudopolyplectus* MATTEI, 1969, p. 15 (type, *Ammonites bicarinatus* ZIETEN, 1831 in 1830–1833, p. 21, OD); =*Osperleioceras* GUEX, 1972, p. 639, *nom. null.*, misspelling]. Similar to *Harpoceras*, but more involute and has a more triangular whorl section, with greatest width near umbilicus, and flat whorl sides converging toward a narrow, flat venter; venter tends to be tricarinate, with strong central keel and weaker lateral keels; ribs falcoïd, strongly projected forward near venter; suture highly incised and ornate, with many auxiliary saddles. *Lower Jurassic* (*lower Toarcian*, *Bifrons Zone*, *Crassum Subzone*—*upper Toarcian*, *Levesquei Zone*, *Dispansum Subzone*): England, France, Germany, Italy, Greece, Chile.—FIG. 49,3a. \**O. beaulizense* (MONESTIER), lectotype (designated herein), upper Toarcian, *Thouarsense Zone*, *Cornus*, Aveyron, France, ×1 (Monestier, 1921, pl. 1, I).—FIG. 49,3b–c. *O. bicarinatum* (ZIETEN); upper Toarcian, ?*Variabilis Zone*, Milhau, Aveyron, France, ×1 (new, The Natural History Museum, London, BMNH C.75300).

**Polyplectus** BUCKMAN, 1890, p. 214 [*Ammonites discooides* ZIETEN, 1831 in 1830–1833, p. 21; M] [=*Micropolyplectus* GUEX, 1973d, p. 470 (type, *Oxynoticeras meunieri* MONESTIER, 1921, p. 38, OD); =*Praeopolyplectus* VENTURI, 1981b, p. 588 (type, *P. forzanensis*, OD)]. Oxycone, with very small umbilicus; more involute than *Cleviceras*, *Harpoceras*, or *Osperleioceras*; venter acutely angled, but without a differentiated keel; whorl section triangular and sides only slightly rounded; ribs single, falcoïd, projected strongly forward on ventral half of whorl; suture highly incised and ornate, and has 4 or more auxiliary saddles. Probably dimorphic. *Lower Jurassic* (*lower Toarcian*, *Falciferum Zone*, *Falciferum Subzone*—*upper Toarcian*, *Levesquei Zone*, *Dispansum Subzone*): Europe, Morocco, Algeria, Pakistan, Japan, Canada (British Columbia, Alberta), USA (Oregon), Chile, Argentina.—FIG. 51,4a–b. \**P. discooides* (ZIETEN), holotype, Heiningen, Württemburg, Germany, ×1 (new, The Natural History Museum, London, BMNH 62568).

**Sphenarpites** SPATH, 1936b, p. 643 [\**S. hawkinsi*; OD]. Single known specimen. Involute oxycone, very small umbilicus, smoothly rounded umbilical wall; apparently smooth; suture much reduced, but has many elements, including about 10 auxiliary saddles in external suture and 1 or 2 adventitious saddles. *Lower Jurassic* (*Toarcian*): Pakistan.—FIG. 51,5a–c. \**S. hawkinsi*, holotype, Kelat, Baluchistan; a–b, ×1; c, suture, ×2 (new, The Natural History Museum, London, C.40703).

### Subfamily HILDOCERATINAE Hyatt, 1867

[*nom. transl.* BUCKMAN, 1887, p. 15, 16, 21, *ex Hildoceratidae* HYATT, 1867, p. 99] [=*Mercaticeratiniae* GUEX, 1973d, p. 472]

Evolute planulites with quadrate or elliptical whorl section and keeled or tricarinate-

bisulcate venter; ribs vary from fine to strong, and straight to falcate or strongly angled, and they may be interrupted by a midlateral spiral groove; some forms are smooth, but strongly ribbed forms may have ventrolateral tubercles. Some genera are dimorphic: microconchs have short lateral lappets reflecting forward projection of growth lines in midlateral spiral groove. The earliest form (*Hildaites*) was probably derived from an evolute form of *Protogrammoceras* in the upper Pliensbachian, *Spinatum Zone*. *Lower Jurassic* (?*upper Pliensbachian*, *Spinatum Zone*—*upper Toarcian*, *Variabilis Zone*): worldwide.

**Hildaites** BUCKMAN, 1921, pl. 217 [\**H. subserpentinus*; OD] [=*Murleyiceras* BUCKMAN, 1921, pl. 216 (type, *Ammonites murleyi* MOXON, 1841, pl. 24, 6, OD); =*Hildoceratooides* BUCKMAN, 1921, pl. 218 (type *H. propeserpentinus*, OD); =*Harpohildoceras* REPIN, 1970, p. 44 (type, *Hildaites grandis* REPIN in POLUBOTKO & REPIN, 1966, p. 47, OD); =*Praemercaticeras* VENTURI, 1981b, p. 592 (type, *P. forzanense*, OD); =*Petranoceras* VENTURI in FARAONI & others, 1995, p. 256 (type, *P. rinaldinii*, OD); =*Neotaffertia* VENTURI & FERRI, 2001, p. 186 (type, *N. alternans*, OD); =*Cingolites* SASSAROLI & VENTURI, 2010, p. 105 (type, *C. clavatus*, OD)]. Moderately evolute; whorl section elliptical, rounded, or quadrate, umbilical walls vertical or sloping; strong ventral keel bordered by sulci or flat areas; ribs fine to coarse, single or bifurcating, sinuous, projected on venter; inner part of whorl may be striate or smooth; coarse-ribbed species may have ventrolateral swellings or tubercles. Dimorphic: both dimorphs have similar plain mouth borders. *Lower Jurassic* (*upper Pliensbachian*, *Spinatum Zone*—*lower Toarcian*, *Falciferum Zone*): Europe, Morocco, Turkey, Saudi Arabia, Somalia, Madagascar, Russia (northeast), Canada (British Columbia, Alberta, Yukon), USA (Nevada), Chile, Argentina.

**H. (Hildaites)**. Whorls typically evolute with quadrate or rounded whorl section; ribs mostly bifurcate, but some single ribs may also be present. Age and geographic range as for genus.—FIG. 52,1a–b. \**H. (H.) subserpentinus*, holotype, *Falciferum Zone*, *Falciferum Subzone*, Ilminster, Somerset, England, ×0.75 (new, Manchester University Museum, England, L.11544).—FIG. 52,1c–d. *H. murleyi* (MOXON), holotype, *Falciferum Zone*, *Exaratum Subzone*, Dumbleton Hill, Gloucestershire, England, ×1 (new, British Geological Survey, Keyworth, Nottingham, England, GSM 32049).

**H. (Mantanites)** VENTURI, 1997, p. 324 [\**Mantanites prorsiradiatus*; OD]. More involute than most *Hildaites* with higher whorls and a

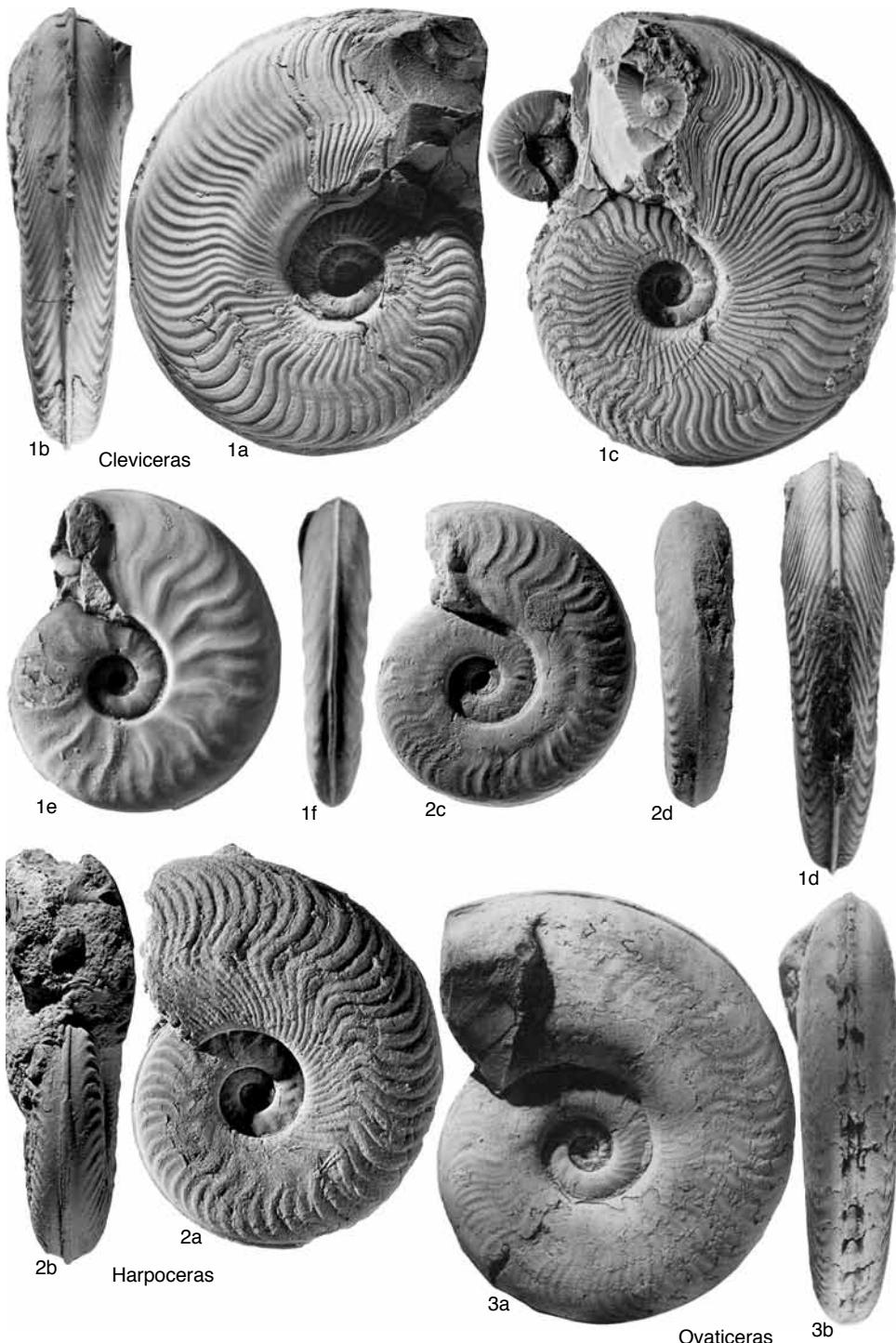


FIG. 50. Hildoceratidae (p. 73–74).

more rounded and compressed whorl section; falcoid ribs are single throughout growth and are bold from the umbilical edge. *Lower Jurassic (lower Toarcian, Falciferum Zone, Falciferum Subzone)*: England, Italy, Greece, Algeria.—FIG. 52,2a–b. \**H. (M.) prorsiradiatus*, holotype, Cima Panco, Monti Martani, Umbria, Italy, ×1 (Venturi, 1997, pl. 1,1).

**Orthildaites** BUCKMAN, 1923b, pl. 444 [\**O. orthus*; OD; =*Harpoceras douvillei* HAUG, 1884, p. 353]. Evolute; quadrate whorl section; broad venter with strong central keel, bordered by sulci and moderately strong ventrolateral keels; ribs strong, almost straight, and curving slightly forward at ventrolateral edge. *Lower Jurassic (lower Toarcian, Falciferum Subzone)*: England, France, Germany, Italy, Portugal, Spain, Greece, Algeria.—FIG. 52,3a–c. \**O. douvillei* (HAUG); a, holotype of *O. orthus* BUCKMAN, Down Cliff, Chideock, Lyme Regis, Dorset, England, ×0.5 (Buckman, 1923b, pl. 444); b–c, holotype of *O. douvillei* (HAUG), St-Jacques, Thouars, Deux-Sèvres, France, ×1 (Gabilly, 1976, pl. 19,1,3).

**Hildoceras** HYATT, 1867, p. 99 [\**Ammonites bifrons* BRUGUIÈRE, 1789 in 1789–1792, p. 40; SD BUCKMAN, 1889a, p. 111] [=*Goniohildoceras* SEGUENZA, 1886, p. 1383 (type, *G. bipartitum*, M); =*Urkutites* GÉCZY, 1967, p. 124 (type, *U. boeckhi*, OD)]. Evolute, with quadrate whorl section; differs from *Hildaites* in its more marked tricarinate-bisulcate venter, and midlateral spiral groove that develops in later species; ribs vary from weak or striate to strong, and from nearly straight to falcate or highly arcuate, and are projected strongly forward in spiral groove when that feature is present; dorsal part of whorl may be smooth. Dimorphic: macroconchs are 80–250 mm in diameter, microconchs are 24–65 mm in diameter when adult and have constricted mouth borders with short lateral lappets. *Lower Jurassic (lower Toarcian, Falciferum Zone, Falciferum Subzone–upper Toarcian, Variabilis Zone)*: Europe, northern Africa (Atlas ranges), Turkey, Iran, Japan, Russia (northeast).—FIG. 53,1a–d. \**H. bifrons* (BRUGUIÈRE); a–b, holotype, *Bifrons* Zone, Whitby, Yorkshire, England, macroconch, ×0.9 (new, The Natural History Museum, London, C.55840); c–d, microconch, Northampton, England, ×1 (new, The Natural History Museum, London, C.68821).

**Parahildaites** BLAISON, 1967, p. 104–105 [\**Hildaites sanderi* ARKELL, 1952, p. 265; OD]. Differs from *Hildoceras* and *Hildaites* in being entirely smooth, at least at sizes more than 40 mm in diameter, though fine sigmoidal ribs or striae may occur on smaller whorls; no spiral groove; venter has strong keel, bordered by flat areas or slight sulci. *Lower Jurassic (lower Toarcian, Bifrons Zone)*: central Saudi Arabia, Madagascar.—FIG. 53,2a–b. \**P. sanderi* (ARKELL), holotype, Jafair Trail, Jebel Tuwaiq, Saudi Arabia, ×0.6 (new, Sedgwick Museum, Cambridge, England, F.10682).

**Mercaticeras** BUCKMAN, 1913, p. vii [\**Ammonites mercati* HAUER, 1856, p. 43; OD]. Evolute,

depressed; whorl section broad, with rounded ventrolateral shoulders converging to a narrowly tricarinate-bisulcate venter; ventral sulci may be lost at large sizes; ribs strong, straight to sinuous, projected forward on ventrolateral shoulders. *Lower Jurassic (lower Toarcian, Mercati Zone (=Bifrons Zone))*: southern and eastern Europe, northern Africa (Atlas ranges), Canada (British Columbia).—FIG. 53,3a–b. \**M. mercati* (HAUER), lectotype, Erba, Italy, ×1 (Hauer, 1856, pl. 23,6–7).

**Hildaitoides** HILLEBRANDT, 1987, p. 125 [\**H. retrocostatus*; OD]. Evolute, whorl section round or elliptical, and rounded umbilical edge; venter has single keel, with no sulci; ribs strong, sinuous, and rursiradiate, fading at large sizes. *Lower Jurassic (lower Toarcian, Chilensis Zone (=top Bifrons Zone–upper Toarcian, Variabilis Zone))*: Chile.—FIG. 53,4a–b. \**H. retrocostatus*, holotype, Quebrada El Bolito, Atacama, Chile, ×0.6 (Hillebrandt, 1987, pl. 9,1a, p. 123, fig. 1c).

**Atacamiceras** HILLEBRANDT, 1987, p. 123 [\**A. glabrum*; OD]. Evolute, whorl section elliptical, slightly compressed; venter has single keel, with no sulci; smooth or has very weak simple ribs; suture simplified. *Lower Jurassic (lower Toarcian, Chilensis Zone (=top Bifrons Zone–upper Toarcian, Variabilis Zone))*: Chile.—FIG. 53,5a–b. \**H. glabrum*, holotype, Rio Manflas, Atacama, ×0.75 (Hillebrandt, 1987, pl. 8,13, p. 123, fig. 1a).

## Subfamily BOULEICERATINAE Arkell, 1950

[Bouleiceratinae ARKELL, 1950, p. 361] [=Paroniceratidae SCHINDEWOLF, 1964, p. 366]

Aberrant forms with reduced and simplified sutures, which are ceratitic in some genera. *Bouleiceras* is an evolute planulate, with strong ribs and tubercles, but most others are much more involute, varying from sphaerocones with a rounded venter to oxycones with a sharp or keeled venter. Dimorphism known in some genera. The earliest genus, *Bouleiceras*, was probably derived from the Arieticeratinae (*Canavaria* or *Tauromeniceras*) at the top of the upper Pliensbachian; younger genera may form a phylogeny that extends nearly to the top of the Toarcian, though an alternative view has placed the sphaeroconic genera (*Frechiella*, *Paroniceras*, *Jacobella*) in a subfamily, Paroniceratinae, that was derived separately from the Hildoceratinae (RULLEAU, BÉCAUD, & NEIGE, 2003); THEVENIN, 1908; RENZ, 1925a, 1927; ARKELL, 1952; COLIGNON, 1958; GALLITELLI-WENDT, 1963; WENDT, 1966; BLAISON, 1968; HILLEBRANDT, 1973; REPIN, 1991. *Lower Jurassic (lower*

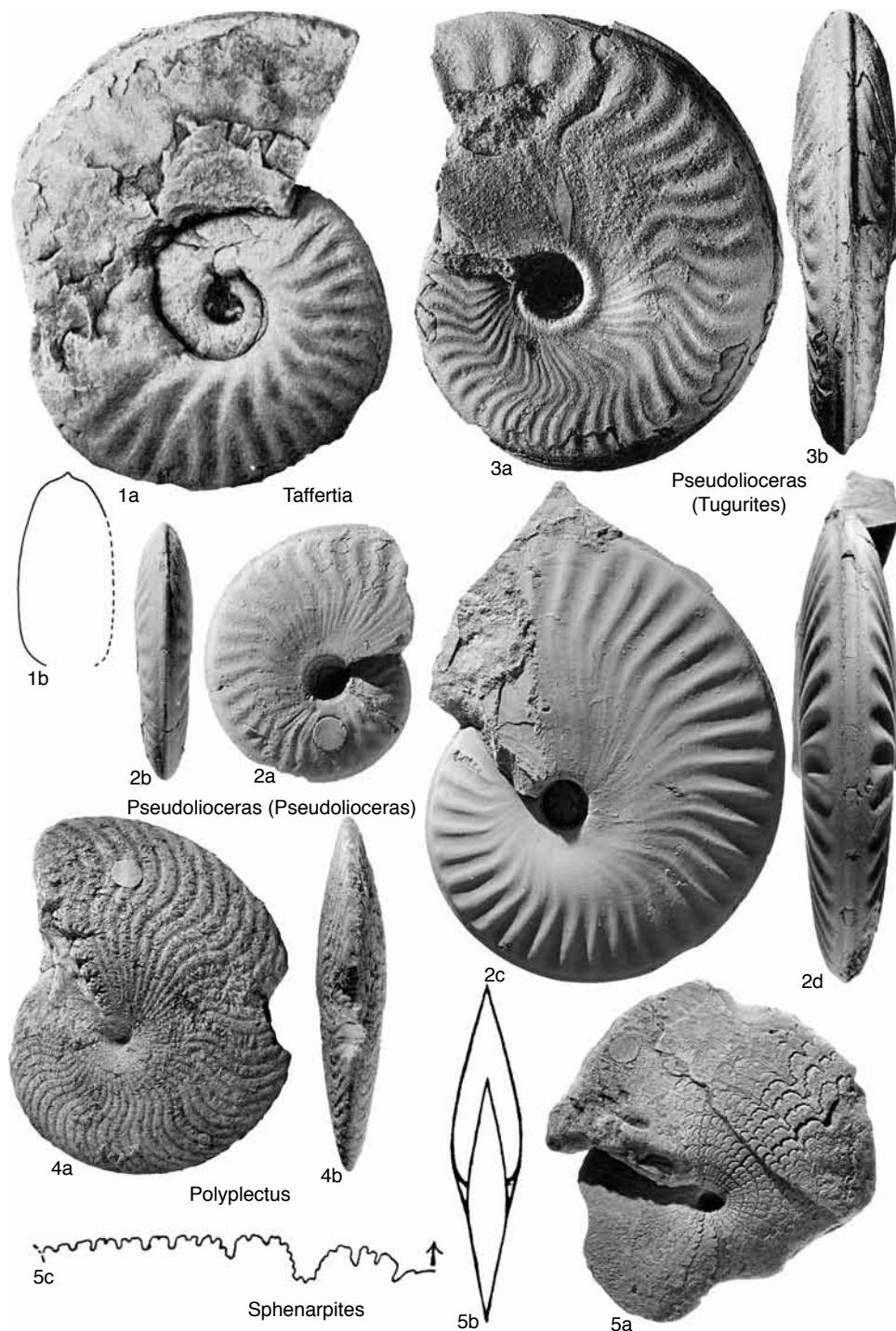


FIG. 51. *Hildoceratidae* (p. 74–76).

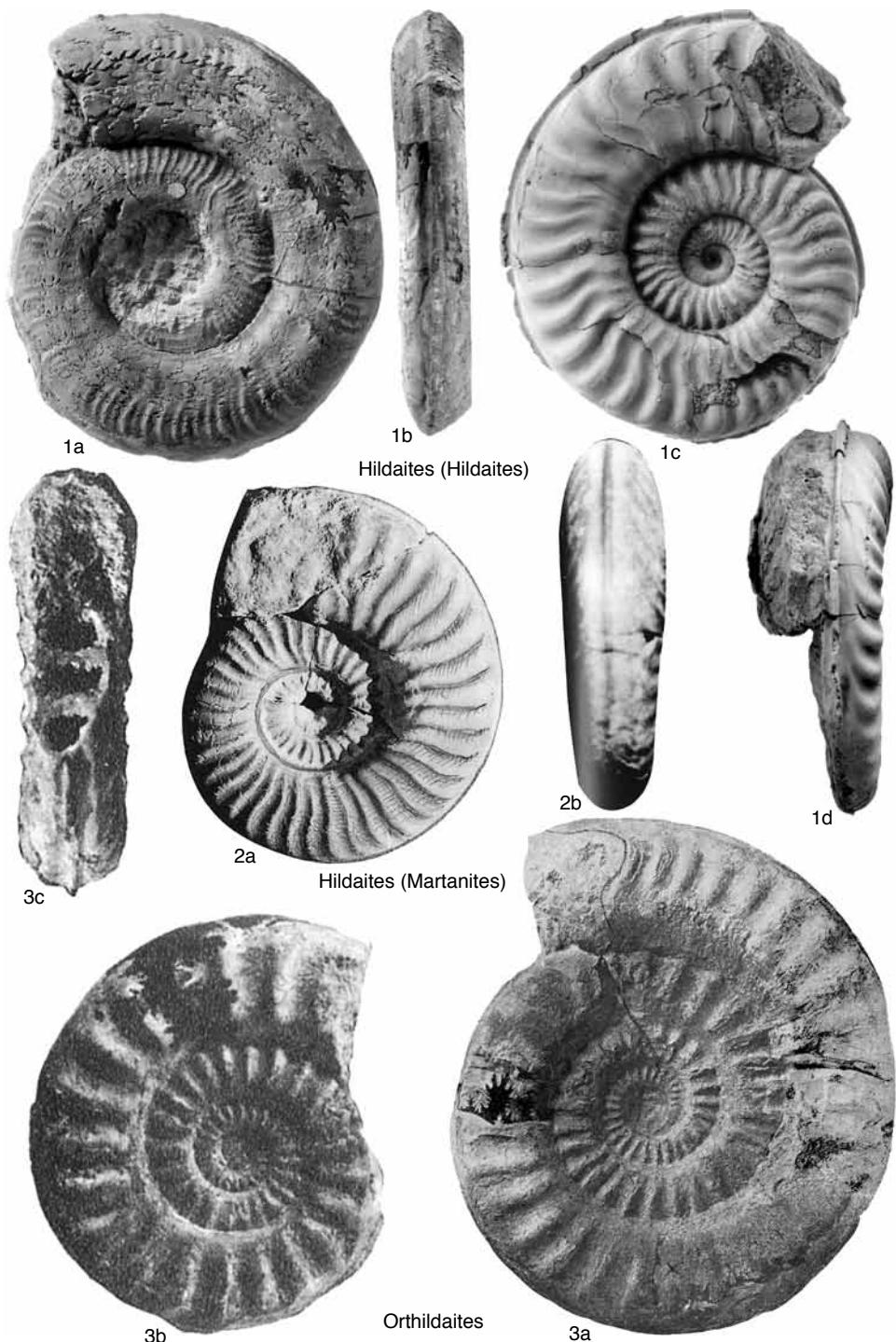


FIG. 52. Hildoceratidae (p. 76-78).

*Toarcian*, *Tenuicostatum Zone*—*upper Toarcian*, *Levesquei Zone*): Europe (especially Tethys), northern Africa, eastern Africa, Canada, South America.

**Bouleceras** THEVENIN, 1906, p. 171 [*\*B. nitescens*; M] [=Colcanapites COLLIGNON, 1958, pl. 1,7 (type, *Bouleceras (Colcanapites) colcanapi*, M)]. Evolute, coronate inner whorls, becoming more involute, planulate, and compressed on outer whorls; strong ventral keel throughout; innermost whorls are smooth, followed by a uni- or bituberculate stage, with or without ribs, then a stage with strongly rursiradiate, straight or sinuous ribs that bifurcate from umbilical tubercles, and finally a flat-sided smooth adult stage; sutures ceratitic, with wide entire saddles, and a deep digitate first lateral lobe. *Lower Jurassic (lower Toarcian, Tenuicostatum–Falciferum Zones)*: Portugal, Spain, Morocco, Somalia, northeastern Kenya, Madagascar, Saudi Arabia, Pakistan, Chile, Argentina. —FIG. 54, 1a–c. *\*B. nitescens*, lectotype, Bekoratsaky, Maevatanaana, Madagascar; a–b,  $\times 1$ ; c, suture,  $\times 2$  (Thevenin, 1908, pl. 2,6).

**Kohaticeras** FATMI & HÖLDER, 1975, p. 36 [*K. razai*; OD]. Moderately involute, subquadrate whorl section, venter with narrow central sulcus bordered by two weak keels; ribs prorsiradiate, sinuous; moderate to large midlateral bullae and moderate to large ventrolateral clavi; sutures ceratitic with almost entire saddles. *Lower Jurassic (lower Toarcian)*: Pakistan. —FIG. 54, 2a–c. *\*K. razai*, holotype, Saramela, Kohat Tribal Belt; a–b,  $\times 0.75$ ; c, suture,  $\times 1.5$  (Fatmi & Hölder, 1975, pl. 5, 1,4, p. 38, fig. 1).

**Nejdia** ARKELL, 1952, p. 266 [*\*N. bramkampi*; OD]. Involute, whorl section lanceolate, with vertical or undercurl umbilical wall, rounded umbilical edge, and ventral keel; smooth; sutures subceratitic, highly variable (GUEX, 1973c). *Lower Jurassic (lower Toarcian, Falciferum–Bifrons Zones)*: Italy, Spain, Morocco, central Saudi Arabia, Madagascar. —FIG. 54, 3a–c. *\*N. bramkampi*, holotype, Jebel Tuwaiq, Saudi Arabia; a–b,  $\times 0.7$ ; c, suture,  $\times 1.5$  (Arkell, 1952, pl. 17,5).

**Frechiella** PRINZ, 1904, p. 31 [*Nautilus subcarinatus* YOUNG & BIRD, 1822, p. 255; OD] [=Achilleia RENZ, 1913, p. 595 (type, *Frechiella (Achilleia) achillei*, M)]. Involute to moderately evolute, swollen whorls, with characteristic narrowly tricarinate-bisulcate venter, fading on outer whorl; smooth, or with low distant primary ribs that fade or divide into obscure secondaries in middle of whorl side; sutures simplified, both saddles and lobes digitate or ceratitic. *Lower Jurassic (lower Toarcian, Bifrons Zone [=Mercati Zone])*: England, France, Germany, Spain, Portugal, Switzerland, Austria, Italy, Hungary, Greece, Chile, Argentina. —FIG. 55, 1a–c. *\*F. subcarinata* (YOUNG & BIRD), holotype, Whitby, Yorkshire, England; a–b,  $\times 0.7$  (Howarth, 1992b, pl. 29,7); c, suture,  $\times 1.5$  (Howarth, 1992b, p. 159, fig. 39A).

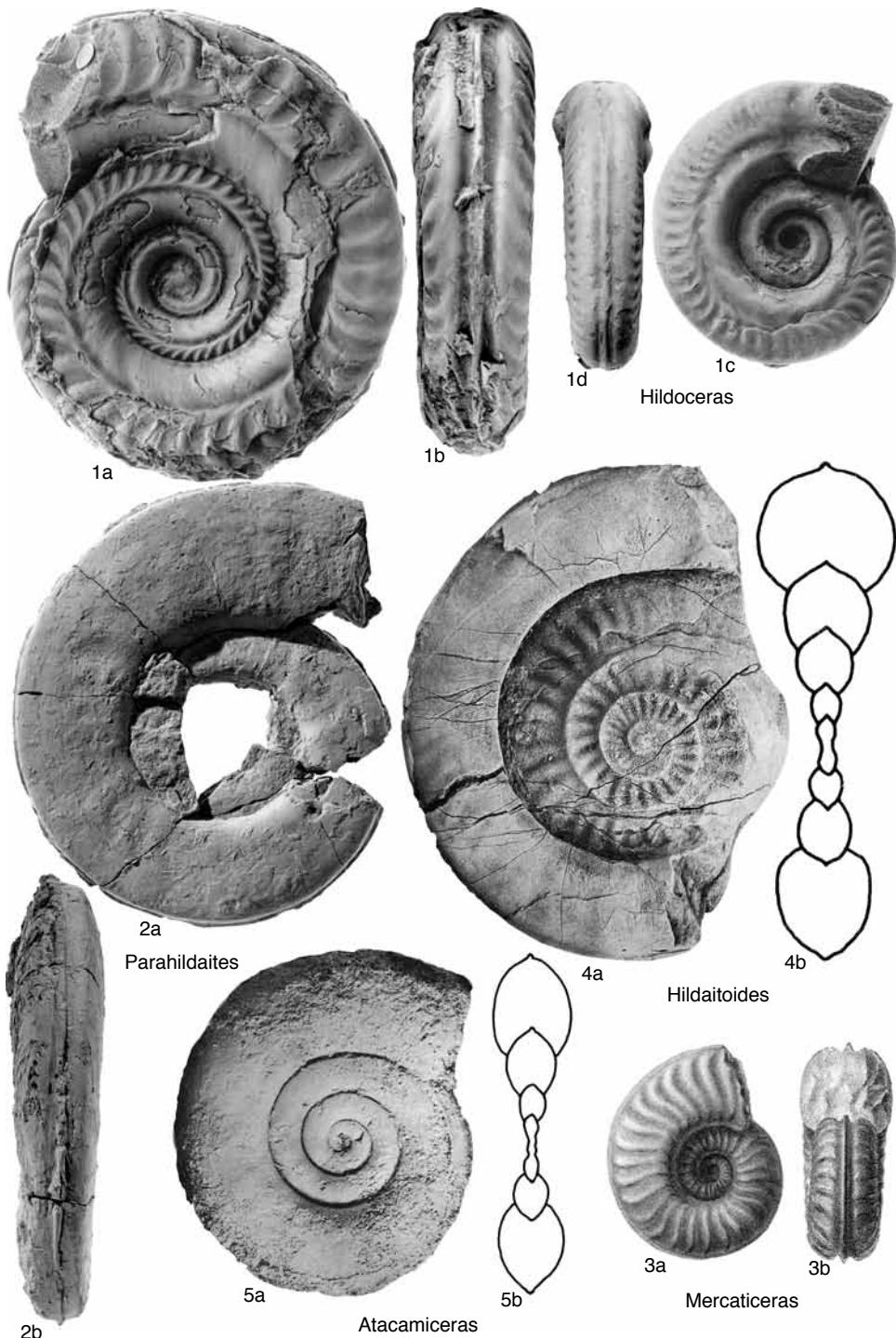
**Paroniceras** BONARELLI, 1893, p. 202 [*Ammonites sternalis* D'ORBIGNY, 1845 in 1842–1851, p. 345; M]. Involute sphaerocones, with swollen whorls, a small umbilicus and a smoothly rounded venter that is not tricarinate-bisulcate; smooth or with low ribs on inner whorls; sutures simplified, with digitate lobes and saddles. Probably dimorphic. *Lower Jurassic (upper Toarcian, Variabilis–Levesquei Zones)*: France, Germany, Switzerland, Austria, Hungary, Italy, Portugal, Spain, Greece, Morocco, Algeria, Canada (British Columbia). —FIG. 55, 2a–f. *\*P. sternale* (D'ORBIGNY); a–b, lectotype, France,  $\times 0.75$  (d'Orbigny, 1845 in 1842–1851, pl. 111, 1–2); c–d, possible adult microconch, Fonte Calderalle, Cesi, Terni, Italy,  $\times 1$  (Renzi, 1923, pl. 12, 1–2); e–f, macroconch, with uncoiling body chamber, *Variabilis* Zone, Carrière Lafarge, Belmont, Gers, France,  $\times 1$  (Rulleau, Bécaud, & Neige, 2003, p. 337, fig. 15-1a, 15-1c).

**Jacobella** JEANNET, 1908, p. 205 [*\*J. lugeoni*; M] [=Oxyparoniceras GUEX, 1974, p. 429 (type, *Paroniceras telemachi* RENZ, 1913, p. 603, OD); =Neoparoniceras RULLEAU, BÉCAUD, & NEIGE, 2003, p. 341 (type, *Paroniceras undulosum* MONESTIER, 1921, p. 8, OD)]. Similar to *Paroniceras*, but more compressed, and venter becomes angled, keeled, or lanceolate; obscure ribs on inner whorls, smooth outer whorls; simplified sutures. Dimorphic: microconchs (synonym *Neoparoniceras*) are adult at a diameter of approximately 15–25 mm and have a rounded venter, because their maximum size is less than the size at which an angled or keeled venter was developed in the larger macroconchs (synonym *Oxyparoniceras*). [*Jacobella* is not a *nomen oblitum* as claimed by RULLEAU, BÉCAUD, and NEIGE (2003, p. 336), because its usage does not conform to the requirements of Articles 23.9.1 and 23.9.2 of the ICZN Code of Nomenclature (1999) for a *nomen oblitum*.] *Lower Jurassic (upper Toarcian, Thouarsense Zone–Levesquei Zone, Dispansum Subzone)*: England, France, Germany, Spain, Italy, Greece, Morocco. —FIG. 55, 3a–c. *\*J. lugeoni*, holotype, Pontarlier, Doubs, France; a–b,  $\times 1$ ; c, suture,  $\times 2.5$  (Jeannet, 1908, pl. 9, 1,3, p. 210, fig. 4). —FIG. 55, 3d–e. *J. suevicum* (RENZ), St.-Quentin Fallavier (Isère), France,  $\times 1$  (Rulleau, Bécaud, & Neige, 2003, fig. 15-6a, 6b).

### Subfamily LEUKADIELLINAE Macchioni & Venturi, 2000

[Leukadiellinae MACCHIONI & VENTURI, 2000, p. 323]

Mainly evolute forms with rounded-rectangular whorl section, a flat, keeled venter, and depressed inner whorls that become more compressed later; ribs strong and rursiradiate, usually single, but sometimes bifurcating; large ventrolateral tubercles or spines are common, and smaller umbilical tubercles occur in some forms; suture reduced and simplified from probable Hildoceratininae ancestors. The earliest

FIG. 53. *Hildoceratidae* (p. 78).

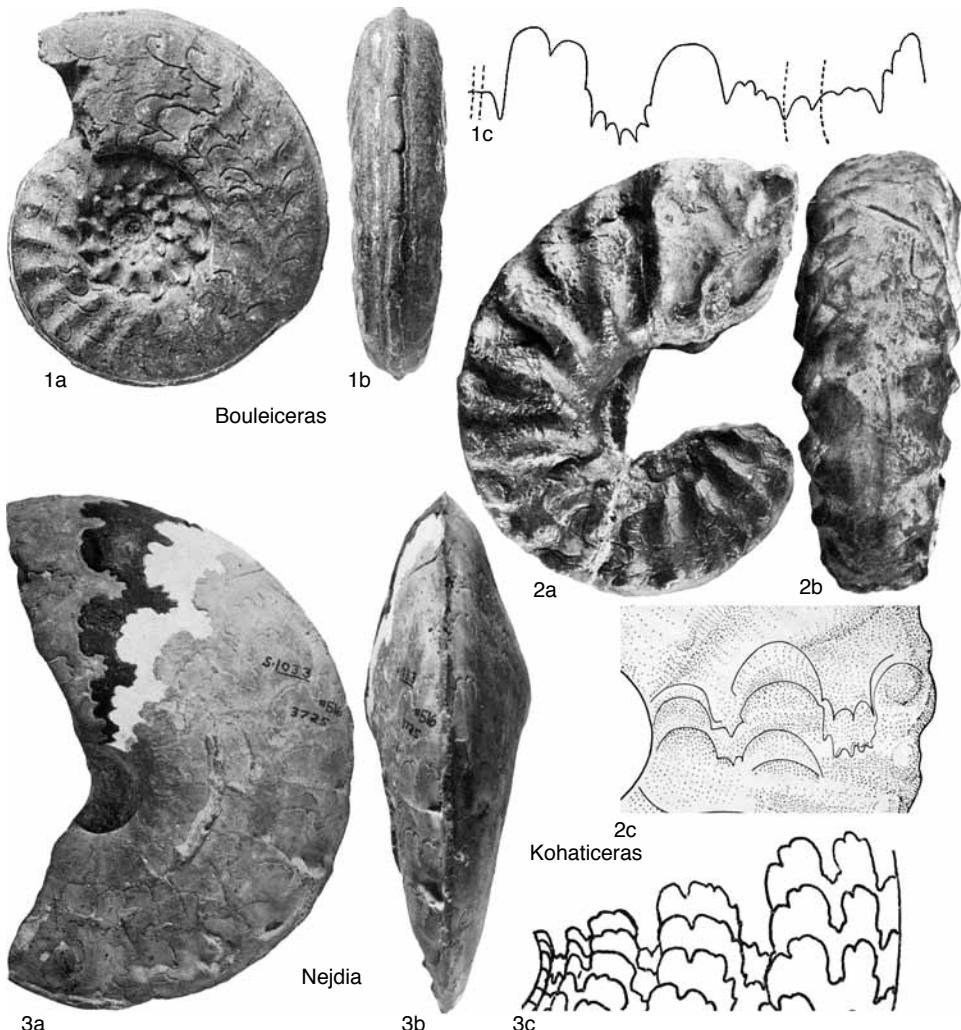


FIG. 54. Hildoceratidae (p. 81).

genus (*Renziceras*) probably derived from *Hildaites* at the top of the *Falciferum* Zone, quickly gave rise to *Leukadiella*, and this derivation from the Hildoceratinace is the reason for separation of the subfamily from the Bouleiceratinae (MACCHIONI & VENTURI, 2000). Lower Jurassic (lower Toarcian, top *Falciferum* Zone–*Bifrons* Zone): Europe (especially Tethys), Algeria, western Canada, Chile.

**Renziceras** ARKELL, 1953, p. 36 [\**Hildoceras nausikaae* RENZ, 1913, p. 607; OD]. Small (up to 60 mm in diameter), evolute, whorl section quadrate; strong

keel on flat venter; inner whorls coronate with strong, rursiradiate, simple ribs ending in large ventrolateral tubercles; tubercles disappear on outer whorls and ribs project forward on venter; suture hildoceratid, but somewhat reduced. Lower Jurassic (lower Toarcian): Spain, Greece, Italy, Algeria.—

FIG. 56, 1a–c. \**R. nausikaae* (RENZ); a–b, holotype, Epirus, Greece,  $\times 1$  (Renz, 1913, p. 609, fig. 25); c, Migiani di M. Malba, Umbria-Marche Appennines, Italy,  $\times 1.5$  (Macchioni & Venturi, 2000, pl. 3, 5).

**Leukadiella** RENZ, 1913, p. 584 [\**L. heleneae*; M]. Evolute, whorl section quadrate, venter unicarinate or tricarinate-bisulcate; ribs rursiradiate, distant, simple or twinned from umbilical edge, ending in tubercles, parabolic nodes or clavi at ventrolateral edge, which

may overtop the keel sunk in a concave venter; sutures simplified, both lobes and saddles digitate or ceratitic. All known European and northern African examples are less than 60 mm in diameter, while much larger specimens up to 155 mm in diameter occur in British Columbia, Canada (JAKOBS, 1995). *Lower Jurassic (lower Toarcian, Bifrons Zone)*: England, Italy, Greece, Spain, Algeria, Canada (British Columbia), Chile, Argentina.—FIG. 56,2a–c. \**L. helenae*, holotype, Anavryssada, Leukas, Greece,  $\times 1.5$  (Wendt, 1966, pl. 13,2).—FIG. 56,2d–e. *L. ionica* RENZ & RENZ, Whiteaves Bay, Moresby Island, Queen Charlotte Islands, British Columbia, Canada,  $\times 0.45$  (Jakobs, 1995, p. 93, fig. 5-1, 5-2).

### Subfamily ARIETICERATINAE Howarth, 1955

[Arieticeratinæ HOWARTH, 1955, p. 166] [=Seguenziceraten ROSENBERG, 1909, p. 287; invalid vernacular name; =Seguenziceratidae SPATH, 1924, p. 192, invalid because based on the genus *Seguenziceras* LEVI, 1896, p. 272, an objective synonym of *Arieticeras* SEGUENZA, 1885, p. 255, and replaced by Arieticeratinæ before 1961 (in accordance with ICZN Code, 1999, Art. 40.2), ICZN direction 70, 1957]

Evolute planulates, with quadrate to compressed whorls and mainly unicarinate venter; ribs weak to strong, straight, slightly sinuous or occasionally smooth; some forms uni- or bituberculate; dimorphism not documented. Evolute developments of lower Pliensbachian Harpoceratinæ, probably derived from *Protogrammoceras* at the *Margaritatus* Zone, *Stokesi-Subnodosus* Subzone boundary. FUCINI, 1901a, 1901b, 1902, 1903, 1905, 1907, 1911, 1929, 1931, 1935; WIEDENMAYER, 1977, 1980; BRAGA, 1983. Eight generic names were proposed by FUCINI (1931) for this subfamily without original fixation of their type species, contrary to the requirements of ICZN Code (1999), Article 13.3. HAAS (1947, p. 80) pointed out that all were invalid because the type species were not fixed in the original descriptions. This was accepted for five of the genera by VECCHIA (1949, p. 142) and CANTALUPPI (1970, p. 14–17), but they maintained that three genera were valid because of the tautonomy of genus and species names in the original description. This is not correct: ICZN Code (1999), Article 68.4 only allows type species fixation in the original description by “absolute tautonomy,” for which the genus and species names have to be identical. “Virtual tautonomy”—genus and species names derived from the same root, as in the three FUCINI genera—can only be taken into account in

the subsequent designation of a type species, which is not an allowable procedure for genus-group names proposed after 1930 (Article 69 and Recommendation 69A.2). None of the species names used by FUCINI in 1931 are identical with his newly proposed genera; all eight are therefore unavailable and are replaced here, where appropriate, by subsequent valid uses of the same names. *Lower Jurassic (upper Pliensbachian–lower Toarcian, Tenuicostatum Zone)*: typically Tethyan, rarely boreal.

*Arieticeras* SEGUENZA, 1885, p. 255, *non* QUENSTEDT, 1882 in 1882–1888, p. 44, rejected as a generic name by ICZN Opinion 337, 1955c [\**Ammonites algovianus* OPPEL, 1862, p. 137; SD LEVI, 1896, p. 272] [=*Seguenziceras* LEVI, 1896, p. 272, obj., ICZN Opinion 337, 1955c; =*Meneghinia* VECCHIA, 1949, p. 142 (FUCINI, 1931, p. 108 (118), *nom. nud.*, type species not designated), *non* SILVESTRÌ, 1889 (Protozoa) (type, *Ammonites ruthenensis* RÉYNES, 1868, p. 94, OD); =*Distefania* FUCINI, 1931, p. 143 (153), *nom. nud.*, type species not designated, *non* CHECCHIA-RISPOLI, 1917 (Crustacea); =*Protoarieticeras* CANTALUPPI, 1970, p. 40 (type, *Arieticeras apertum* MONESTIER, 1934, p. 50, OD); =*Pseudoarieticeras* CANTALUPPI, 1970, p. 40 (type, *Harpoceras (Hildoceras) geyeri* DEL CAMPANA, 1900, p. 607, OD); =*Geczya* FANTINI SESTINI, 1977, p. 710, 724 (type, *Ammonites radians amalthei* OPPEL, 1853, p. 51, OD)]. Evolute, whorl section quadrate to compressed, usually with rounded ventrolateral shoulders; venter with strong keel, with or without sulci; ribs strong, single, straight to sinuous, projected forward near venter; no tubercles. *Lower Jurassic (upper Pliensbachian, Margaritatus Zone, basal Subnodosus Subzone–Spinatum Zone)*: Europe, northern Africa (Atlas Ranges), Caucasus, Russia (Far East), Vietnam, Japan, Canada (British Columbia), USA (Alaska, Nevada, Oregon, California), Mexico, Chile, Argentina.—FIG. 57,1a. \**A. algovianum* (OPPEL), lectotype (designated by WIEDENMAYER, 1977, p. 86), *Margaritatus* Zone, Tannheim, Tirol, Austria,  $\times 1.5$  (new, Bayerische Staatssammlung für Paläontologie und Geologie, Munich).—FIG. 57,1b–c. *A. amalthei* (OPPEL), neotype (designated by Fischer, 1975, p. 71), Reutlingen, Württemberg, Germany (type species of *Geczya*); b,  $\times 1$ ; c, cross section,  $\times 1$  (Fischer, 1975, pl. 2,10, p. 72, fig. 16).

*Emaciaticeras* VECCHIA, 1949, p. 142 (FUCINI, 1931, p. 119 (129), *nom. nud.*, type species not designated) [\**Ammonites emaciatus* CATULLO, 1847, p. 3; OD] [=*Seguentia* FUCINI, 1931, p. 122 (132), *nom. nud.*, type species not designated; =*Trinacrioceras* FUCINI, 1931, p. 147 (157), *nom. nud.*, type species not designated]; =*Ugdulenia* CANTALUPPI, 1970, p. 40 (type, *Harpoceras (Grammoceras) ugdulenai* GEMMELLARO, 1886b, p. 193, OD); =*Ugdulenia* FANTINI SESTINI, 1977, p. 709, *nom.*

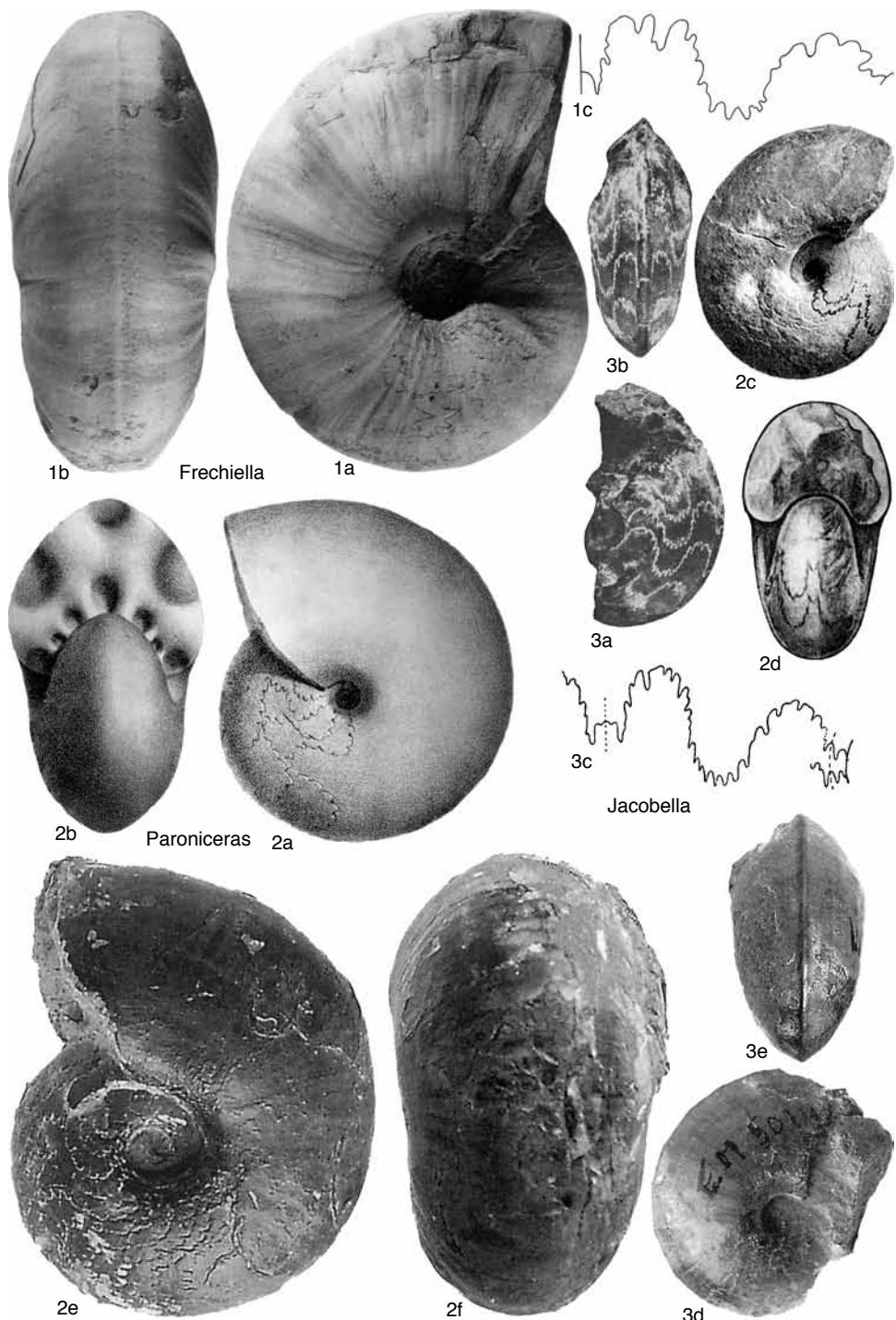


FIG. 55. *Hildoceratidae* (p. 81).

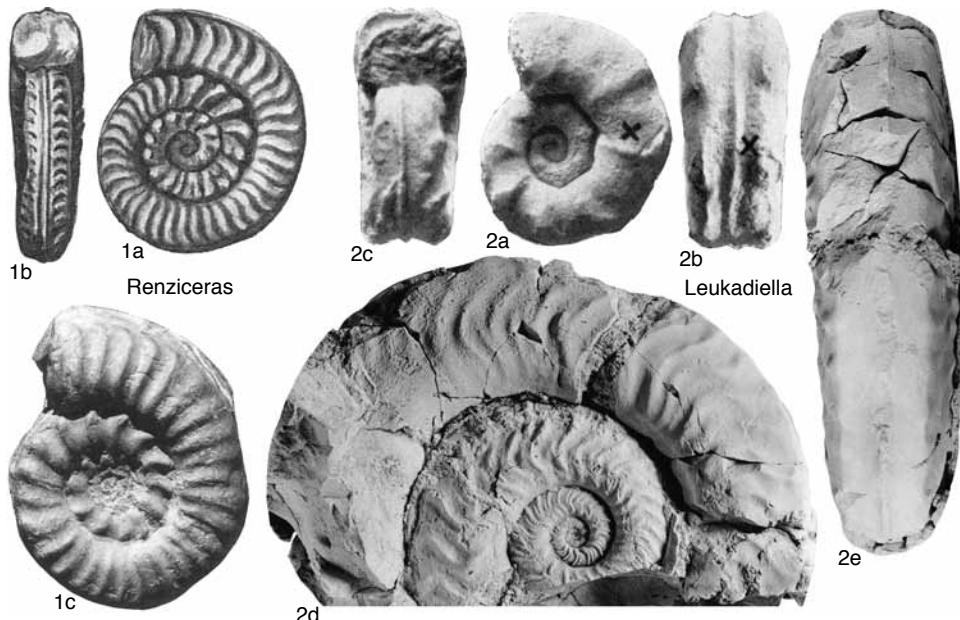


FIG. 56. Hildoceratidae (p. 83–84).

*null.*, misspelling of *Ugdelenia*]. More compressed and slightly more involute than *Arieticeras*, and has higher, flat-sided whorls, with straight, rursiradiate, slightly curved or gently flexuous ribs that end abruptly at ventrolateral edge in some forms; some ribs on inner whorls may bifurcate; no tubercles. BRAGA, 1983, p. 269; COMAS RENGIFO, 1985, p. 511. *Lower Jurassic (upper Pliensbachian, mid-Margaritatus Zone–Spinatum Zone)*: Italy, Switzerland, Spain, Portugal, France, Austria, Hungary, Morocco, Algeria.—FIG. 57,2a–b. \**E. emaciatum* (CATULLO), holotype, Venetia, Italy,  $\times 1$  (Fucini, 1931, pl. 11 (27),4).—FIG. 57,2c. *E. ugduenai* (GEMMELLARO), neotype, type species of *Ugdelenia*, Don Matteo, Taormina, Sicily, Italy,  $\times 1$  (Pavia in Pavia & Cresta, 2002, p. 132, fig. 78a) [The lectotype of *E. ugduenai* (FUCINI, 1931, pl. 9 (25),1), selected by BRAGA (1983, p. 247), from the same locality, is missing].

**Canavaria** GEMMELLARO, 1886b, p. 190 [\**Harpoceras (Dumortieria) haugi* GEMMELLARO, 1886a, p. 111; SD HOWARTH, 1955, p. 167] [=*Naxensiceras* FUCINI, 1931, p. 137 (147), nom. nud., type species not designated; =*Naxensiceras* VECCHIA, 1949, p. 142 (type, *Harpoceras (Grammoceras) naxense* GEMMELLARO, 1886a, p. 112, OD); =*Oregonites* WIEDENMAYER, 1980, p. 124 (type, *O. imlayi*, OD)]. Differs from *Arieticeras* in development of ventrolateral tubercles and some umbilical tubercles; ribs tend to be stronger, straighter, and more widely spaced. *Lower Jurassic (upper Pliensbachian, Spinatum Zone)*: England, France, Italy, Spain, Portugal, northern Africa (Atlas Ranges), Japan, Canada

(British Columbia), USA (Oregon).—FIG. 57,3. \**C. haugi* (GEMMELLARO), lectotype, Valle Agonia, Taormina, Sicily,  $\times 0.8$  (Pavia in Pavia & Cresta, 2002, p. 135, fig. 80a).

**Tauromeníceras** MOUTERDE, 1967, p. 223 [*Tauromenia elisa* FUCINI, 1931, p. 115 (125); OD] [=*Tauromenia* FUCINI, 1931, p. 114 (124), nom. nud., type species not designated, non SEGUENZA, 1885; =*Neomaciaticeras* CANTALUPPI, 1970, p. 39, obj.]. Differs from *Canavaria* in being slightly more involute, with higher whorls and is more compressed; ribs are straighter and rursiradiate; umbilical and ventrolateral tubercles are more pronounced, and ribs are sometimes twinned from umbilical tubercles. BRAGA, 1983, p. 308; COMAS RENGIFO, 1985, p. 522; DUBAR & MOUTERDE, 1978. *Lower Jurassic (upper Pliensbachian, Spinatum Zone)*: Italy, Spain, Portugal, France, Hungary, Morocco.—FIG. 57,4. \**T. elisa* (FUCINI), lectotype, Paladino, Taormina, Sicily,  $\times 0.8$  (Fucini, 1931, pl. 10 (26),1).

**Fontanelliceras** VECCHIA, 1949, p. 142 (FUCINI, 1931, p. 110 (120), nom. nud., type species not designated) [\**Harpoceras fontanellense* GEMMELLARO, 1886a, p. 118; OD]. Evolute, more serpenticone and whorl section more depressed than *Canavaria*; venter tricarinate-bisulcate; ribs simple, straight, distant and thick; most species have umbilical and ventrolateral tubercles. *Lower Jurassic (upper Pliensbachian)*: France, Italy, Spain, Japan, Canada (British Columbia), USA (Oregon).—FIG. 57,5. \**F. fontanellense* (GEMMELLARO), lectotype (designated by BRAGA, 1983, p. 265), Fontanelle,

Taormina, Sicily,  $\times 1.5$  (Pavia in Pavia & Cresta, 2002, p. 146, fig. 88a).

**Leptaleoceras** BUCKMAN, 1918b, p. 284 [*L. leptum*; OD]. Evolute, whorl section compressed, elliptical, with narrow, angled, or keeled venter; ribs fine to moderate, straight, sinuous, or curved gently backward, becoming striate or smooth on outer whorls; no tubercles. *Lower Jurassic (upper Pliensbachian, Margaritatus–Spinatum Zone)*: England, France, Italy, Spain, ?Hungary, Canada (British Columbia), USA (Alaska, Oregon), Mexico, Chile.—FIG. 57,6a–b. *L. leptum*, holotype, *Spinatum Zone*, South Petherton, Somerset, England,  $\times 0.8$  (Buckman, 1918b, pl. 26,1).

**Arctomercaticeras** REPIN, 1968, p. 140 [*A. costatum*; OD]. Cadicone, whorl section depressed, whorl height/breadth ratio about 1:2; rounded ventrolateral shoulders; venter flat or slightly arched, with keel; ribs curved strongly forward on whorl side and venter. *Lower Jurassic (lower Toarcian, Tenuicostatum Zone)*: Russia (northeast, Omolon Basin).—FIG. 58a–b. *A. costatum*, holotype, Golovnoy river, Omolon, Russia (northeast),  $\times 1$  (Hillebrandt & others, 1992, pl. 18,2).

### Subfamily GRAMMOCERATINAE Buckman, 1905

[Grammoceratinae BUCKMAN, 1905a, p. cxviii] [=Dumortieriae MAUBEUGE, 1950, p. 391; =Hudlestoniae MAUBEUGE, 1950, p. 391; =Dumortieriinae SCHINDEWOLD, 1964, p. 366; =Monestierinae SAPUNOV, 1965, p. 129]

Mainly evolute, straight-ribbed derivatives of Hildoceratiniae, giving rise to more involute forms; ribs gently curved, occasionally almost straight, and falcoid or sharply bent style of ribbing of earlier subfamilies has been lost; large whorls may become smooth. Dimorphism marked in some genera, and long lateral lappets appear in adult mouth borders of microconchs for the first time. BUCKMAN, 1887–1907. *Lower Jurassic (upper Toarcian, Variabilis Zone)–Middle Jurassic (Aalenian, Opalinum Zone)*: worldwide.

**Grammoceras** HYATT, 1867, p. 99 [*Ammonites striatulus* J. DE C. SOWERBY, 1823b, p. 23; SD BUCKMAN, 1890, p. 158] [=Costigrammoceras BUCKMAN, 1926, pl. 686 (type, *C. costigerum*, OD)]. Evolute, compressed elliptical whorls, with rounded umbilical slope, no umbilical edge, and blunt ventral keel; ribs simple, straight to sinuous, projected on venter; umbilical slope and inner part of whorl usually smooth or only striate. Dimorphic: microconchs small (20–25 mm in diameter), with long spatulate lateral lappets. *Lower Jurassic (upper Toarcian, Thouarsense Zone)*: Europe, northern Africa (Atlas Ranges), Caucasus, northern Iran, Russia (Far East), Japan, Indonesia (Sulawesi),

Canada (British Columbia), USA (Alaska, Nevada, Oregon).—FIG. 59,1a–e. *\*G. striatulum* (J. DE C. SOWERBY), *Striatulum Subzone*; a–b, neotype (designated herein; holotype is lost), macroconch, Ravenscar, Whitby, Yorkshire,  $\times 1$  (Dean, Donovan, & Howarth, 1961, pl. 74,3); c–e, microconch, Buckholz Wood, Stroud, Gloucestershire, England; c–d,  $\times 1.5$ ; e, lappet from latex cast of external mold,  $\times 2$  (new; Sedgwick Museum, Cambridge, J.6449, also figured in Buckman, 1890, pl. 28,20).

**Pseudogrammoceras** BUCKMAN, 1901, p. 266 [*Ammonites strickmanni* DENCKMANN, 1887, p. 72; M; ICZN Opinion 324, 1955b] [=Monestieria COSSMANN, 1922, p. 103, nom. nov. pro *Lapparentia* MONESTIER, 1921, p. 39, non BERTHELIN, 1885, p. 455 (gastropod) (type, *L. ressouchei*, M)]. Either evolute with quadrate whorls and marked umbilical edge, or more involute with compressed elliptical whorl section. Differs from *Grammoceras* in stronger and sometimes more sinuous ribs that always reach to umbilical edge. Dimorphism not recorded. The type specimen of *Monestieria* is an abnormal *Pseudogrammoceras* without a keel. *Lower Jurassic (upper Toarcian, Variabilis Zone–Thouarsense Zone, Fallaciosum Subzone)*: Europe, northern Africa (Atlas Ranges), Caucasus, Japan, Vietnam, Indonesia (Sulawesi), Spitzbergen, Canada (British Columbia), USA (Alaska).—FIG. 59,2a–b, *\*P. strickmanni* (DENCKMANN), lectotype (designated herein), *Variabilis Zone*, Dörnthen, Germany,  $\times 0.75$  (new, Göttingen Geological Institute, 458–14).—FIG. 59,2c–d. *P. regale* BUCKMAN, holotype, *Thouarsense Zone*, *Fallaciosum Subzone*, Coaley Wood, Stroud, Gloucestershire, England,  $\times 0.5$  (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 2402; also figured in Buckman, 1904a, p. cxlv, fig. 138).—FIG. 59,2e–f. *P. ressouchei* (MONESTIER), *?Thouarsense Zone*, Saint-Paul, Aveyron, France (type species of *Monestieria*),  $\times 1$  (Monestier, 1921, pl. 2,19, pl. 4,39).

**Podagrosites** GUEX, 1973d, p. 470 [*\*Pseudogrammoceras podagrosum* MONESTIER, 1921, p. 18; OD]. Evolute, whorl section subquadrate, venter tricarinate-bisulcate on inner whorls, but sulci and lateral keels lost on larger whorls; strong sinuous ribs single or bifurcate from umbilical edge. Differs from *Pseudogrammoceras* in being more evolute, less compressed, has sulci bordering ventral keel on inner whorls and generally stronger ribbing. *Lower Jurassic (upper Toarcian, Variabilis–Thouarsense Zones)*: France, England, Germany, Spain, Canada (British Columbia).—FIG. 60,1a–b. *\*P. podagrosum* (MONESTIER), lectotype (designated herein), le Guilhomard, Aveyron, France,  $\times 1$  (Monestier, 1921, pl. 3,23, pl. 4,19).—FIG. 60,1c–d. *P. late-scens* (SIMPSON), holotype, Peak, Whitby, England,  $\times 1$  (Buckman, 1913, pl. 79).

**Pseudolillia** MAUBEUGE, 1949b, p. 150 [*\*P. murvilensis*; M]. Inner whorls moderately evolute, with quadrate whorl section and venter with keel and sulci on venter; straight simple ribs curve forward near venter; outer whorls become smooth, more involute, and whorl section becomes convergent

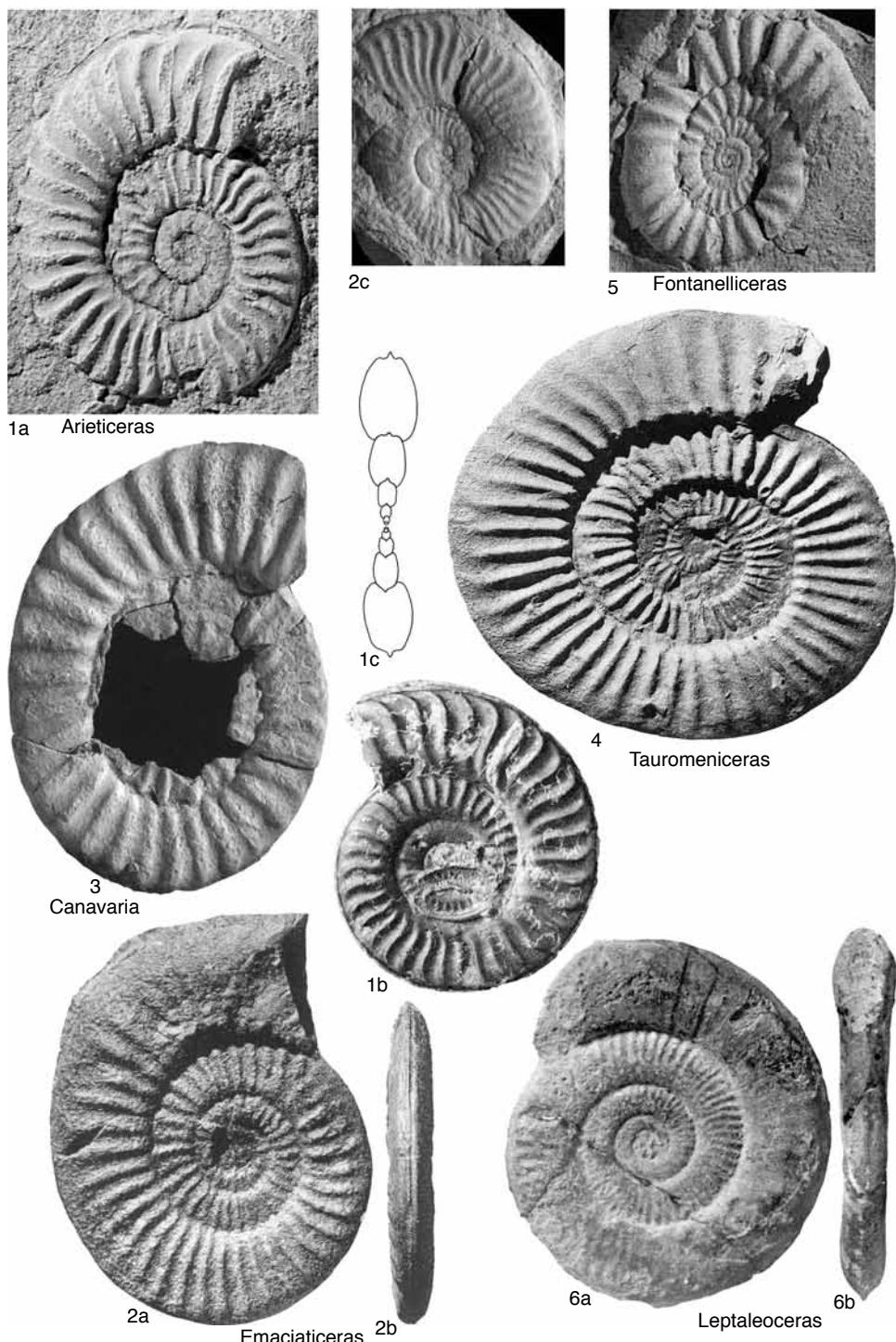


FIG. 57. Hildoceratidae (p. 84–87).

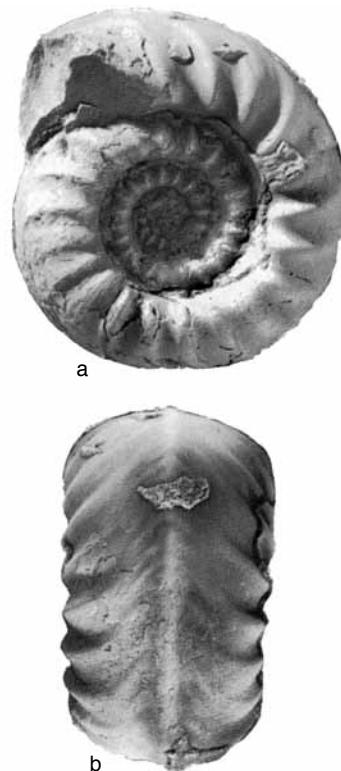
toward venter, which has no sulci. DONOVAN, 1962. Lower Jurassic (upper Toarcian, Thouarsense Zone, Fallaciosum Subzone [=Erbense Zone, Bayani Subzone]): France, Spain, Morocco.—FIG. 60,2a–b. \**P. murvillensis*, holotype, Mine de Murville, Meuthe & Moselle, France,  $\times 0.5$  (new, Muséum d'Histoire Naturelle, Paris).

**Shakraceras** BASSE in BASSE & KARPOFF, 1957, p. 329 [*\*S. loeve*; M]. Single known specimen is moderately evolute, with robust quadrate whorls, ventral keel, and vague spiral depression in center of whorl side; low sinuous ribs are mainly on dorsal half of whorl, and there are low swellings at umbilical edge. Relationships unknown. Lower Jurassic (lower Toarcian, Bifrons Zone or lower upper Toarcian): central Saudi Arabia.—FIG. 59,3a–b. \**S. loeve*, holotype, Shakra, Jebel Tuwaiq,  $\times 0.5$  (Basse & Karhoff, 1957, pl. 19,1–2).

**Phlyseogrammoceras** BUCKMAN, 1901, p. 266 [*\*Ammonites dispansus* LYCETT, 1860, p. 146; M, ICBN Opinion 324, 1955b] [=*Gruneria* GABILLY, 1974, p. 1247 (type, *Ammonites grunerii* DUMORTIER, 1874, p. 70, OD)]. Moderately involute, compressed, lanceolate whorl section, sloping umbilical walls, and high ventral keel; sinuous ribs emerge in bundles from radially elongated umbilical tubercles, and are projected forward on venter; final whorl tends to become smooth. Lower Jurassic (upper Toarcian, Levesquei Zone, Dispansum Subzone): Europe, Canada (British Columbia), Chile, Argentina.—FIG. 61,1a–b. \**P. dispansum* (LYCETT), lectotype (designated herein), Frocester Hill, Stroud, Gloucestershire, England,  $\times 0.5$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 24924, also figured in Buckman, 1922, pl. 340).

**Hudlestonia** BUCKMAN, 1891, p. 225 [*\*Ammonites affinis* SEEBACH, 1864, p. 143; OD]. Involute oxycone, compressed, triangular or lanceolate whorl section, angled venter; inner whorls may have keel and sinuous ribs that are bundled or bifurcate at umbilical tubercles; outer whorls smooth; suture simplified. Lower Jurassic (upper Toarcian, Levesquei Zone): Europe.—FIG. 61,2a–e. \**H. affinis* (SEEBACH); a–c, holotype, Levesquei Zone, Dispansum Subzone, Rökengraban, Wentzen, Germany,  $\times 0.7$  (new, Göttingen Geological Institute, 460–29); d–e, Bethel, Bielefeld, Germany,  $\times 0.75$  (Schlegelmilch, 1976, pl. 47,3).

**Dumortieria** HAUG, 1885, p. 665, 666, 710 [*\*Ammonites levesquei* D'ORBIGNY, 1844 in 1842–1851, p. 230; SD BUCKMAN, 1891, p. 231] [=*Phenakoceras* MAUBEUGE, 1949a, p. 131 (type, *P. phenax*, OD); =*Phenakocerites* MAUBEUGE, 1950, p. 397, obj.; =*Paradumortieria* ELMI & CALOO-FORTIER, 1985, p. 46 (type, *P. tectiforme*, OD)]. Evolute planulatates, with rounded to quadrate whorl section and ventral keel; ribs variable, strong and distant to fine or striate, almost straight, sometimes bundled at umbilical edge, curving forward on venter, but disappear before reaching keel. Dimorphic: mouth border of microconch has small lateral lappet, macroconch mouth border plain with ventral rostrum. Type specimen of *Phenakoceras*



Arctomercaticeras

FIG. 58. Hildoceratidae (p. 87).

in an abnormal *Dumortieria* without a keel. Lower Jurassic (upper Toarcian, Levesquei Zone, Levesquei-Moorei Subzones): Europe, northern Africa (Atlas Ranges), Turkey, northern Iran, China (Tibet), Vietnam, Borneo, Canada (British Columbia), USA (Oregon), Chile, Argentina.—FIG. 62,1a–b. \**D. levesquei* (D'ORBIGNY), lectotype (designated by FISCHER, 1994, p. 59), macroconch, Charolles, Saône-et-Loire, France,  $\times 0.75$  (Fischer, 1994, pl. 36,3).—FIG. 62,1c–d. *D. subundulata* (BRANCO), microconch, Moorei Subzone, Buckholt Wood, Stroud, Gloucestershire, England,  $\times 1$  (new, Sedgwick Museum, Cambridge, England, J.6235, also figured in Buckman, 1892, pl. 45,1–2).

**Troitsaia** POULTON & TIPPER, 1991, p. 30 [*\*T. westermanni*; OD]. Derived from *Dumortieria*, which it resembles, but has small spines or tubercles at umbilical edge, and whorl height is lower on inner and intermediate whorls. Middle Jurassic (Aalenian, lower half of Opalinum Zone): Canada (British Columbia).—FIG. 62,2a–b. \**T. westermanni*, Troitsa Peak, Whitesail Range, British Columbia; a, holotype,  $\times 1$ ; b, venter of paratype,  $\times 1$  (Poulton & Tipper, 1991, pl. 7,14,17).

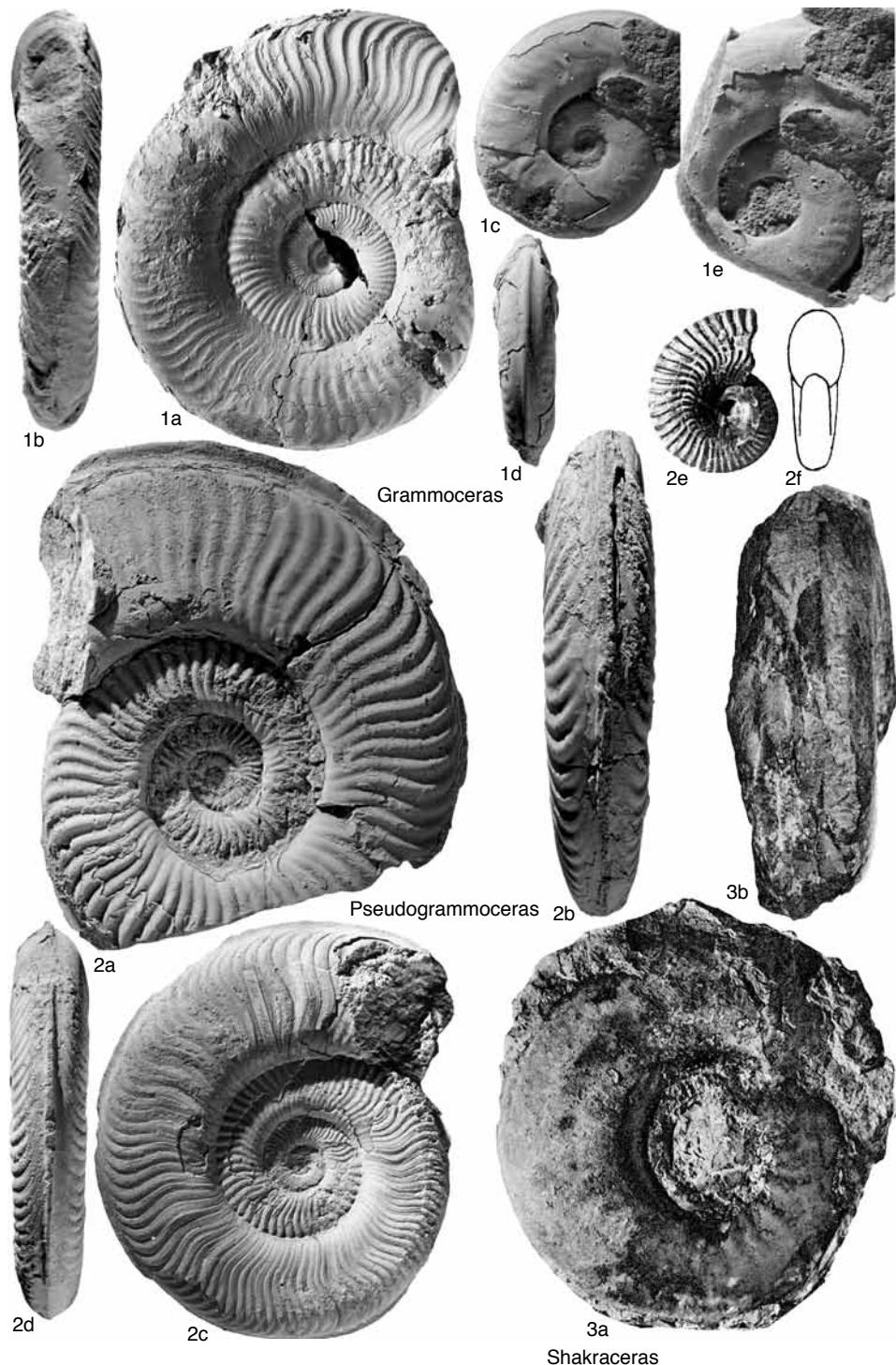


FIG. 59. Hildoceratidae (p. 87–89).

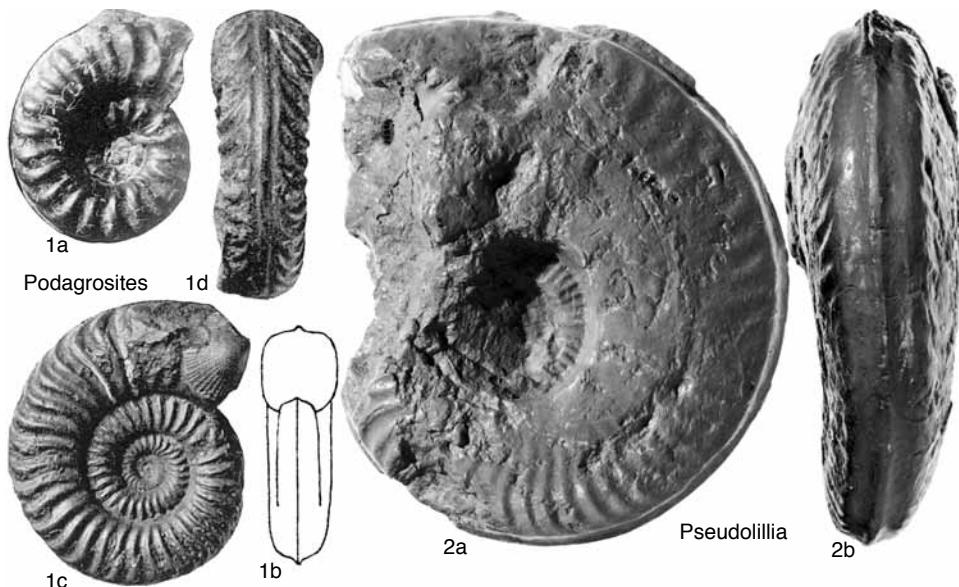


FIG. 60. Hildoceratidae (p. 89).

*Catulloceras* GEMMELLARO, 1886c, p. 203 [*Ammonites dumortieri* DUMORTIER, 1874, p. 269; SD BUCKMAN, 1892, p. 276] [=*Dactylogrammites* BUCKMAN, 1925a, pl. 573 (type *D. digitatus*, OD)]. Whorls more evolute, thicker and more quadrate than *Dumortieria*, and venter flat with poorly developed keel; ribs strong, straight or concave, inclined forward on venter. Lower Jurassic (upper Toarcian, Levesquei Zone, Levesquei-Moorei Subzones): Europe, northern Africa (Atlas Ranges), Canada (British Columbia), USA (Oregon), Chile. — FIG. 62, 3a–b. \**C. dumortieri* (DUMORTIER), lectotype (designated herein), Verpillière, Rhône, France, ×0.75 (Dumortier, 1874, pl. 57, 3–4).

*Pleydellia* BUCKMAN, 1899, supplement pl. 10, explanation for fig. 11–13 [\**P. comata*; M] [=*Cotteswoldia* BUCKMAN, 1902, p. 3 (type, *Ammonites costulatus* ZIETEN, 1830 in 1830–1833, p. 10, SD BUCKMAN, 1923a, p. 56); =*Canavarina* BUCKMAN, 1904a, p. cxli, nom. nov. pro *Canavarina* BUCKMAN, 1902, p. 3 (type, *C. folleata*, SD herein), non GEMMELLARO, 1886b, p. 190; =*Walkericeras* BUCKMAN, 1913, p. iii (type, *W. burtonensis*, SD herein), nom. nov. pro *Walkeria* BUCKMAN, 1902, p. 5, non FLEMING, 1823 (Bryozoa); =*Gotteswaldia* THEOBALD & MAUBEUGE, 1949, p. 274, nom. null., misspelling; =*Nadorites* ELMI & CALOO-FORTIER, 1985, p. 49 (type, *Cotteswoldia costulata* (SCHLOTHEIM) var. *sourensis* PERROT, 1957, p. 382, OD)]. Moderately evolute to involute, compressed, some tending to oxycone form; strong keel; umbilical edge may be angled; ribs variable, strong to striate, often changing in same specimen, sinuous to falcoid, sometimes bifurcating, or bundled at umbilical edge, and projected strongly forward near venter; small or incipient tubercles at

umbilical edge in some species. Dimorphic: microconchs have long narrow lateral lappet, macroconchs have plain mouth border and ventral rostrum. More involute and with more flexuous ribbing than *Dumortieria*, from which it is derived. Lower Jurassic (upper Toarcian, Levesquei Zone, Aalensis Subzone)–Middle Jurassic (Aalenian, Opalinum Zone): Europe, northern Africa (Atlas Ranges), Turkey, northern Iran, Canada (British Columbia), USA (Alaska, Oregon), Chile, Argentina. — FIG. 62, 4a–b. \**P. comata*, holotype, macroconch, Aalensis Subzone, Burton Bradstock, Dorset, England, ×1.5 (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 2441). — FIG. 62, 4c. *P. egena* (BUCKMAN), microconch, Aalensis Subzone, Buckholt Wood, Stroud, Gloucestershire, England, Museum of Comparative Zoology, Cambridge, Massachusetts, 2438, ×1.5 (new; also figured in Buckman, 1905a, supplement pl. 23, 9–10).

*Yakounia* JAKOBS & SMITH, 1996, p. 130 [\**Y. yakounensis*; OD]. Moderately evolute, compressed, with ventral keel and rounded umbilical edge; ribs generally strong, sinuous or falcoid and bundled from moderate to strong umbilical tubercles or bifurcating on side of whorl. [*Yakounia* was originally referred to the Phymatoceratinae, but some species of *Yakounia* greatly resemble contemporary species of *Pleydellia* that occur at the same horizon, from which it was probably derived by becoming more evolute, increasing size of the tubercles at the umbilical edge and developing generally stronger ribs]. Lower Jurassic (upper Toarcian, Yakounensis Zone [=Levesquei Zone]): Canada (British Columbia). — FIG. 62, 5a–b. \**Y. yakounensis*, holotype, Phantom Creek Formation, Yakoun River, Graham Island, Queen Charlotte

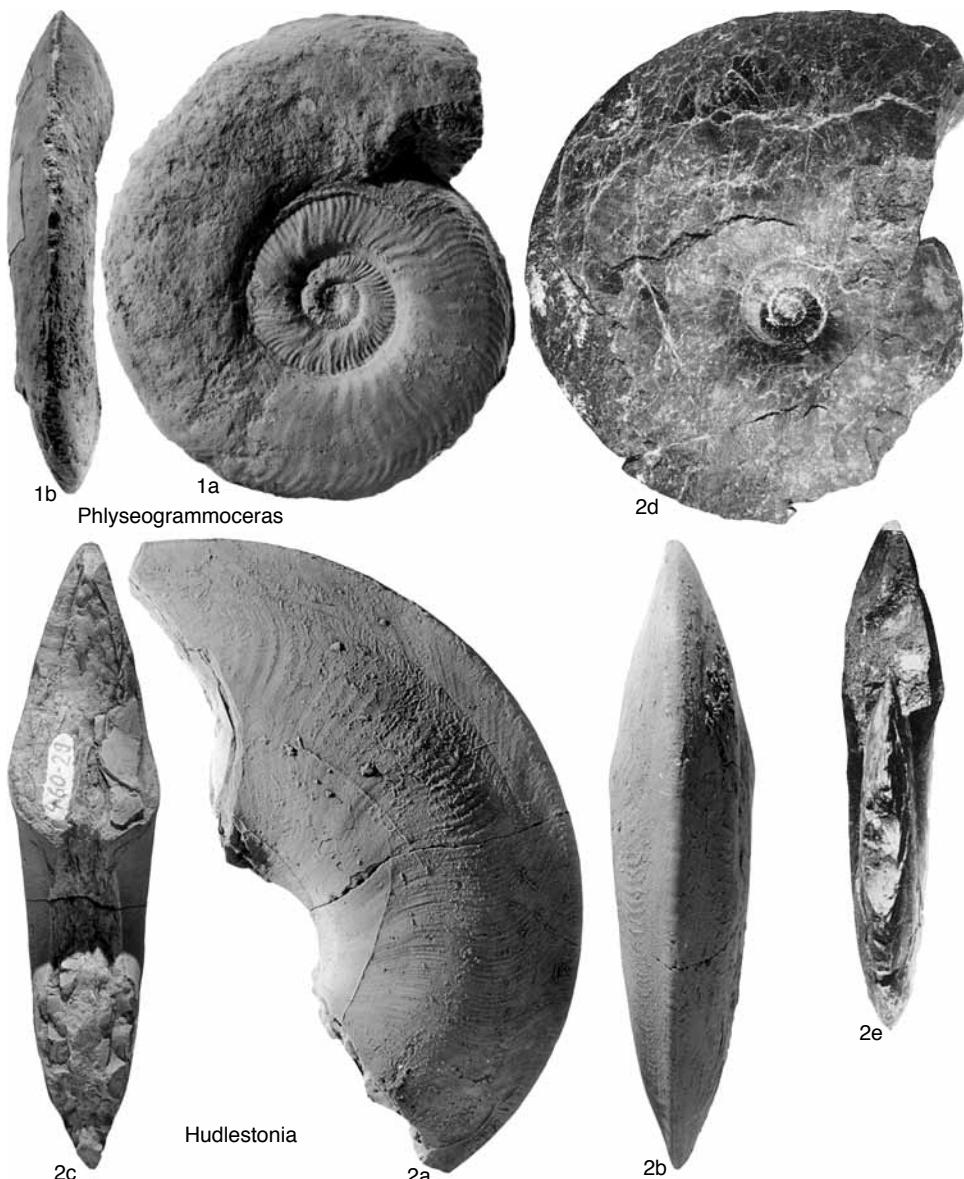


FIG. 61. Hildoceratidae (p. 89).

Islands, British Columbia, Canada,  $\times 1$  (Jakobs, Smith, & Tipper, 1994, pl. 5, 15–16).

#### Subfamily TMETOCERATINAE Spath, 1936

[*Tmetoceratinæ* SPATH, 1936c, p. 3]

Derivatives of Grammoceratinae, especially *Dumortieria* and *Catulloceras*, that have

lost the keel. Lower Jurassic (upper Toarcian)–Middle Jurassic (lower Bajocian): worldwide.

**Tmetoceras** BUCKMAN, 1892, p. 269 [*\*Ammonites scissus* BENECKE, 1865, p. 170; OD] [= *Tmetoites* WESTERMANN, 1964, p. 442 (type, *T. tenuis*, OD)]. Evolute planulate, whorl section subquadrate or rounded, venter flat with deep median groove; ribs simple, straight, ending in a small tubercle at edge of venter; constrictions present at least on outer

whorls. Dimorphic: synonym *Tmetoites* has been used as a subgenus for microconchs, which have short lateral lappets; macroconchs are 2–4 times larger and have plain mouth borders. *Lower Jurassic (upper Toarcian, Levesquei Zone)–Middle Jurassic (Aalenian, Concavum Zone)*: Europe, northern Africa (Atlas Ranges), Thailand, Vietnam, Japan, Canada (British Columbia), USA (Alaska, Oregon, California), Chile, Argentina, Venezuela. —FIG. 63a–b. \**T. scissum* (BENECKE), lectotype (designated herein), macroconch, Aalenian, *Murchisonae* Zone, Cape San Vigilio, Lake Garda, Italy, ×1 (Benecke, 1865, pl. 6, 4). —FIG. 63c–e. *T. tenuis* WESTERMANN, holotype, complete microconch, *Concavum* Zone, Wide Bay, Alaska Peninsula; c–d, ×1.5; e, aperture with lappet, ×3 (Westermann, 1964, pl. 73, I).

## Family GRAPHOCERATIDAE

### Buckman, 1905

[*nom. transl.* ARKELL, 1950, p. 363, ex Graphoceratinae BUCKMAN, 1905a, p. cxcviii]

Moderately to highly involute, compressed whorl section, with unfloored keel; ribs strong, sinuous to falcate, occasionally striate or becoming smooth; tubercles rare; no constrictions. Nearly all genera dimorphic: microconchs have lateral lappets, macroconchs are 3× to 5× larger and have plain mouth borders. BUCKMAN, 1887–1907; DORN, 1935; HOFFMANN, 1913; RIEBER, 1963; CHANDLER, 1997. Collections from a single horizon that undoubtedly belong to a single species can show a very wide range of variation, which apparently embraces the morphology of several described genera (CHANDLER & CALLOMON, 2009). *Middle Jurassic (Aalenian–lower Bajocian, Discites Zone)*: worldwide.

### Subfamily LEIOCERATINAE

#### Spath, 1936

[Leioceratinæ SPATH, 1936c, p. 7] [=Staufenia MAUBEUGE, 1950, p. 391]

Early forms derived from *Pleydellia* that are mainly very involute, with weak to moderate keel. *Middle Jurassic (Aalenian, Opalinum Zone–Murchisonæ Zone)*.

*Leioceras* HYATT, 1867, p. 101 [\**Nautilus opalinus* REINECKE, 1818, p. 55; SD BUCKMAN, 1887, p. 12] [=Ancolioceras BUCKMAN, 1899, p. xlvi (type, *A. substriatum*, OD); =Cypholioceras BUCKMAN, 1899, p. xlvi (type, *C. plicatum*, OD); =Manselia BUCKMAN, 1899, p. lviii (type, *M. subfalcata*, OD)]. Involute, compressed, venter keeled or sharply angled; smooth, striae or finely ribbed; striae and

ribs sinuous or falcoid, sometimes bifurcating; ribs in early whorls often give way to folds or undulations on middle and dorsal part of striae later whorls. Derived from *Pleydellia*. Dimorphic: microconchs have lappets. [REINECKE's original figure is too poor to determine the species, and BUCKMAN (1899, xxxiv, xli) selected the "next specimen figured," i.e., QUENSTEDT, 1846 in 1845–1849, pl. 7, 10, to be the so-called type of the species. QUENSTEDT's figure of a microconch is reproduced here, together with better figures of both dimorphs. *Lioceras* BAYLE, 1878, is a synonym of *Harpoceras* WAAGEN, 1869; see p. 75 herein]. *Middle Jurassic (Aalenian, Opalinum Zone–Murchisonæ Zone, Bradfordensis Subzone)*: Europe, northern Africa (Atlas Ranges), Turkey, Caucasus, Iran, Russia (Transbaikal), Canada (Yukon), Chile, Argentina. —FIG. 64, 1a–e. \**L. opalinum* (REINECKE); a, type selected by BUCKMAN, microconch, Teufelsloch, Boll, Württemberg, Germany, ×1 (Quenstedt, 1846 in 1845–1849, pl. 7, 10); b–c, macroconch, Boll, Württemberg, Germany, ×1 (new, The Natural History Museum, London, 37842); d–e, microconch, Ottenbach, Baden, Germany, ×1 (new, Geology Department, Hull University, England, no. 5118).

*Canavarella* BUCKMAN, 1904a, p. cxxviii [\**C. belophora*; OD] [=Rhaeboceras BUCKMAN, 1899, supplement pl. 11, explanation of fig. 1–6 (type, *R. tortum*, SD BUCKMAN, 1904a, p. lxxii), non MEEK, 1876, p. 462 (an Upper Cretaceous scaphitid); =Costiceras CONTINI, 1969, p. 25 (type, *Leioceras paucicostatum* RIEBER, 1963, p. 35, OD)]. Similar to *Leioceras* but with moderate to strong falcoid ribs, sometimes bifurcating; may also be less involute and less compressed. *Middle Jurassic (Aalenian, Opalinum Zone, Scissum Subzone)*: Europe, northern Africa (Atlas Ranges), Iran. —FIG. 64, 2a–b. \**C. belophora*, holotype, ?microconch, Stoke Knap, Dorset, England, ×1 (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 2430). —FIG. 64, 2c–d. *C. fasciata* (BUCKMAN), holotype, macroconch, Sherborne, Dorset, ×1 (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 2529).

*Cylicoceras* BUCKMAN, 1899, p. xl ix [\**C. undatum*; OD] [=Hyattina BUCKMAN, 1899, p. lvii (type, *H. brasili*, OD); =Geyerina BUCKMAN, 1913, p. iv (type, *G. fasciata*, OD), nom. nov. pro *Geyeria* BUCKMAN, 1899, p. l, non BUCHECKER, 1880 (Insect)]. Similar to *Canavarella*, but more evolute, with thick quadrate whorls and coarse, bifurcating ribs. *Middle Jurassic (Aalenian, Opalinum Zone, Scissum Subzone–Murchisonæ Zone, Haugi Subzone)*: England. —FIG. 64, 3a–b. \**C. undatum*, holotype, macroconch, Haresfield Hill, Stroud, Gloucestershire, ×1 (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 2528).

*Staufenia* POMPECKJ, 1906, p. 251 [\**Ammonites staufensis* OPPEL 1856 in 1856–1858, p. 371; M]. Highly involute oxycone, triangular compressed whorl section, acutely angled venter; sinuous striae or weak ribs on inner whorls, striae or

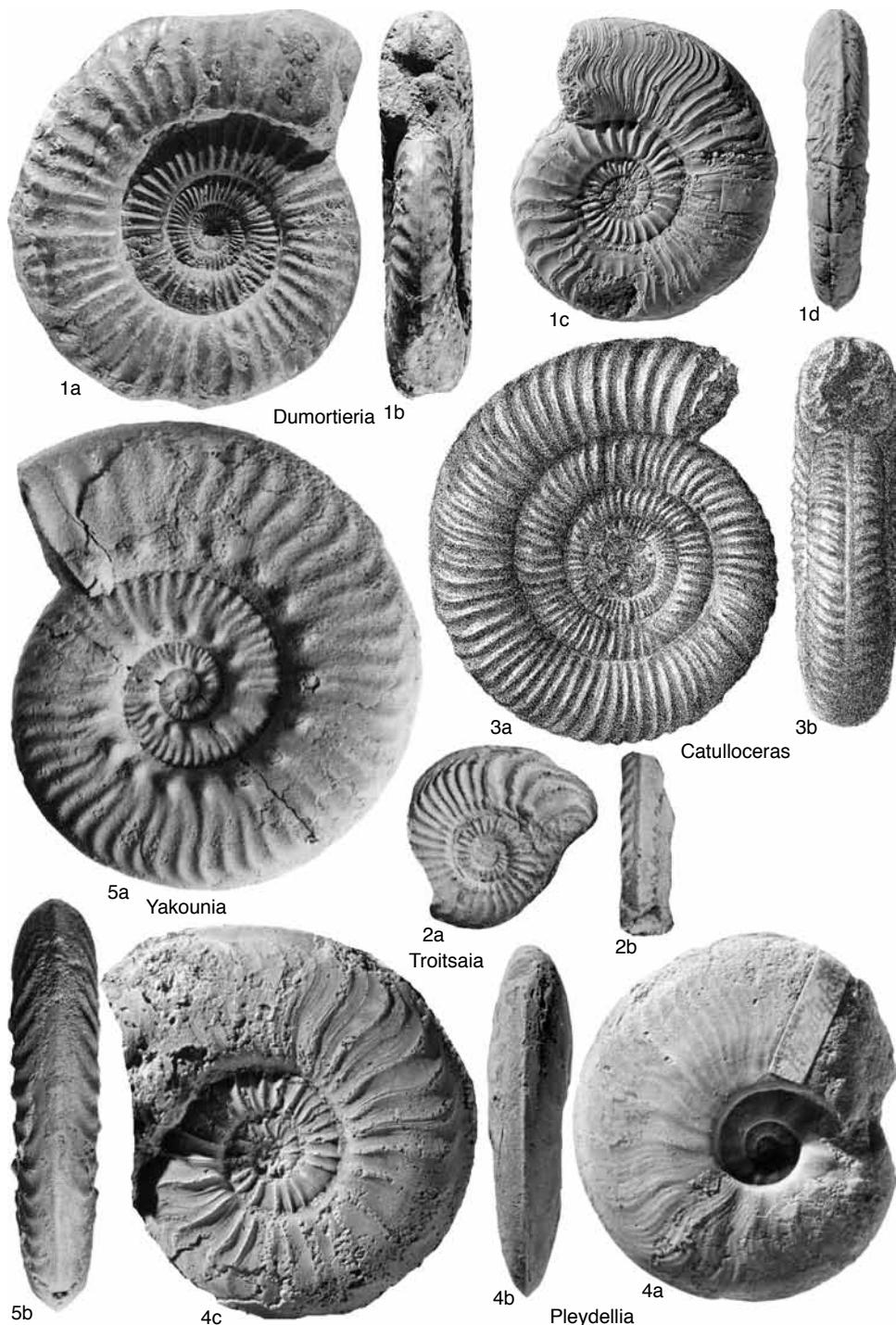


FIG. 62. Hildoceratidae (p. 89–92).

smooth on outer whorls; sutures strongly modified: saddles broad and low, lobes shallow, with simple indentations, and up to 6 auxiliary lobes and saddles. Dimorphic. Middle Jurassic (Aalenian, Murchisonae Zone, Murchisonae–Bradfordensis Subzones): Europe.—FIG. 65, 1. \**S. staufensis* (OPPEL), Heiningen, Württemburg, Germany,  $\times 0.75$  (Hoffmann, 1913, pl. 9, 3).

*Costileioceras* MAUBEUGE, 1950, p. 386 [\**Ludwigia sinon* BAYLE, 1878, pl. 83; OD]. General morphology like *Ludwigia*, but suture modified as in *Staufenia*, although with only 2 or 3 auxiliary lobes. Middle Jurassic (Aalenian, Murchisonae Zone, Murchisonae Subzone only): Europe.—FIG. 65, 2a–b. \**C. sinon* (BAYLE), lectotype, Wasseralfingen, Württemburg, Germany,  $\times 0.8$  (Schlegelmilch, 1985, pl. 10, 4, plaster cast of lectotype).

### Subfamily GRAPHOCERATINAE Buckman, 1905

[Graphoceratinae BUCKMAN, 1905a, p. cxcviii] [=Darelleinae BUCKMAN, 1905a, p. cxcviii; =Hyattinae BUCKMAN, 1905a, p. cxcviii; =Lucyniae BUCKMAN, 1905a, p. cxcviii; =Ludwigiliidae SPATH, 1925b, p. 113; =Ludwiginiae GÉRARD & BICHELONNE, 1940, p. 42]

Moderately evolute forms, with quadrate whorls and strong ribs, giving rise to more involute forms again, in which ribs tend to fade. Keel generally stronger than in Leioceratinæ. Middle Jurassic (Aalenian, Murchisonae Zone, Murchisonae Subzone–lower Bajocian, Discites Zone).

*Ludwigia* BAYLE, 1878, explanation for pl. 79 [\**Ammonites murchisonae* J. DE C. SOWERBY, 1827, p. 95; SD H. DOUVILLÉ, 1879, p. 91] [=*Murchisonia* ENGEL, 1896, p. 218, non D'ARCHIAC & DE VERNEUIL, 1841 (gastropod), nec COSTA, 1861 (gastropod), obj.; =*Cosmogryria* BUCKMAN, 1898a, supplement for pl. 4, explanation for fig. 12–15 (type, *Ammonites murchisonae obtusus* QUENSTEDT, 1846 in 1845–1849, p. 116, SD BUCKMAN, 1899, p. lii); =*Welschia* BUCKMAN, 1898a, supplement pl. 4, explanation for fig. 16–19 (type *W. obtusiformis*, SD BUCKMAN, 1899, p. li); =*Crickia* BUCKMAN 1899, supplement for pl. 11, explanation for fig. 16–18 (type *C. refusa*, M); =*Hyattia* BUCKMAN, 1899, p. lv (type, *H. pustulifera*, OD); =*Kiliania* BUCKMAN, 1899, p. lxiv (type, *K. laciniosa*, OD); =*Ludwigina* BUCKMAN, 1899, p. lxi (type, *L. patula*, OD); =*Pseudographoceras* BUCKMAN, 1899, supplement for pl. 11, explanation for fig. 19–24 (type, *P. literatum*, SD BUCKMAN, 1904a, p. xci); =*Strophogyria* BUCKMAN, 1899, p. lxii (type, *S. cosmia*, OD)]. Moderately evolute, robust whorls, quadrate whorl section in some forms, angled umbilical edge, strong keel; ribs strong, sinuous to falcoïd, bifurcating and rursiradiate on outer part of whorl, occasionally tuberculate near point of bifurcation; adult whorls of macroconchs become striate or smooth and massive. Dimorphic: macroconchs have plain mouth borders, microconchs have narrow lateral

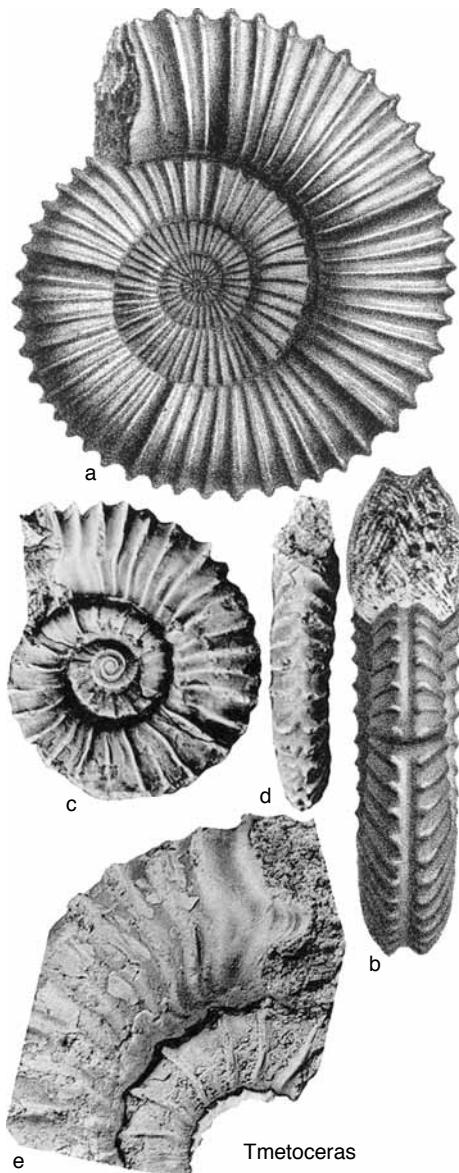


FIG. 63. Hildoceratidae (p. 92–93).

lappets; type species of *Ludwigina* (?and *Pseudographoceras*) are microconchs, all others are macroconchs. Middle Jurassic (Aalenian, Opalinum Zone, Scissum Subzone–Murchisonae Zone): Europe, northern Africa (Atlas Ranges), Caucasus, Iran, Russia (Bureya Basin, northeast).—FIG. 66, 1a–b. \**L. murchisonae* (J. DE C. SOWERBY), holotype, macroconch, Holme, Portree, Isle of Skye, Scotland,  $\times 0.4$  (new, The Natural History Museum,

London, BMNH 43948).—FIG. 66, 1c–d. *L. patula* (BUCKMAN), lectotype (designated herein), microconch, Halfway House, Sherborne, Dorset, England, ×1 (new, Sedgwick Museum, Cambridge, England, J. 6320; also figured in Buckman, 1887, pl. 3, 3).

**Brasilia** BUCKMAN, 1898b, p. 458 [*\*Harpoceras murchisonae* var. *bradfordense* BUCKMAN, 1881, p. 604; OD] [= *Apedogyria* BUCKMAN, 1899, p. lix (type, *A. patellaria*, OD); = *Brasilina* BUCKMAN, 1899, supplement for pl. 10, explanation for fig. 29–31 (type, *Ludwigia murchisonae* var. *bayllii* BUCKMAN, 1887, p. 18, SD BUCKMAN, 1904a, p. lxxxi); = *Paquieria* BUCKMAN, 1899, supplement for pl. 10, explanation for fig. 20–22 (type, *P. floscosa*, M); = *Wiltshireia* BUCKMAN, 1899, supplement for pl. 11, explanation for fig. 31 (type, *Lioceras bradfordense* var. *giganteum* BUCKMAN, 1888, p. 25, M); = *Vacekia* BUCKMAN, 1899, supplement for pl. 10, explanation for fig. 17–19 (type, *V. stephensi*, M); = *Paineia* BUCKMAN, 1904a, p. lxxvi (type, *P. nitens*, OD); = *Planifastigites* BUCKMAN, 1925b, pl. 579 (type, *P. platys*, OD)]. More involute, more compressed and more finely ribbed than *Ludwigia*. Dimorphic: microconchs have narrow lateral lappet; types of the genus and all synonyms are macroconchs. *Middle Jurassic* (*Aalenian*, *Murchisona Zone*, *Bradfordensis Subzone only*): Europe, northern Africa (Atlas Ranges), Iran.—FIG. 66, 2a–b. \**B. bradfordensis* (BUCKMAN), lectotype (designated herein), macroconch, Bradford Abbas, Dorset, England, ×0.65 (new, Sedgwick Museum, Cambridge, England, J. 6325; also figured in Buckman, 1887, pl. 4, 5).—FIG. 66, 2c–d. *B. rude* (BUCKMAN), holotype, microconch, Louse Hill Quarry, Halfway House, Sherborne, Dorset, England, ×1 (new, Sedgwick Museum, Cambridge, England, J. 6331; also figured in Buckman, 1889a, pl. 15, 11–12).

**Graphoceras** BUCKMAN, 1898b, p. 458 [*\*Lioceras concavum* var. *v-scriptum* BUCKMAN, 1888, pl. 10, 5–6; OD] [= *Ludwigella* BUCKMAN, 1901, p. 266 (type, *Ammonites concavus* J. SOWERBY, 1815a, p. 214, M); = *Dapaceras* BUCKMAN, 1902, p. 3 (type, *Lioceras fallax* BUCKMAN, 1888, pl. 14, 10–11, OD); = *Platigraphoceras* BUCKMAN, 1902, p. 4 (type, *Lioceras apertum* BUCKMAN, 1888, pl. 10, 10–11, SD BUCKMAN, 1904a, p. xciii); = *Lucya* BUCKMAN, 1902, p. 4 (type, *L. caducifera*, OD); = *Oedania* BUCKMAN, 1904a, p. cvii (type, *O. falcigera*, OD); = *Stokeia* BUCKMAN, 1904a, p. cxxvii (type, *S. marmorea*, OD); = *Hosoureites* SATO, 1958, p. 155 (type, *Harpoceras ikianum* YOKOYAMA, 1904a, p. 5, OD)]. More involute and more compressed than *Brasilia*, and with distinctive raised umbilical edge; ribs tend to be falcate. Dimorphic: type of *Oedania* is probably a microconch; types of the genus and all other synonyms are macroconchs or immature. *Middle Jurassic* (*Aalenian*, *Concavum Zone–lower Bajocian*, *Discites Zone*): Europe, northern Africa (Atlas Ranges), Caucasus, Iran, Thailand, Japan.—FIG. 67a–b. \**G. v-scriptum* (BUCKMAN), lectotype, macroconch, *Concavum Zone*, Bradford Abbas,

Dorset, England, ×0.5 (new, Sedgwick Museum, Cambridge, England, J. 6341).—FIG. 67c–d. *G. cornu* (BUCKMAN), holotype, microconch with a very long lappet in adult mouth border, *Concavum Zone*, Bradford Abbas, Dorset, England, ×0.9 (new, Sedgwick Museum, Cambridge, England, J. 6324; also figured in Buckman, 1887, pl. 4, 3–4).

**Hyperlioceras** BUCKMAN, 1889a, p. 88 [*\*Ammonites discites* WAAGEN, 1867, p. 599; OD] [= *Darellia* BUCKMAN, 1898b, p. 459 (type, *D. semicostata*, OD); = *Braunsina* BUCKMAN, 1902, p. 3 (type, *B. futilis*, M); = *Deltoidoceras* BUCKMAN, 1902, p. 3 (type, *Hyperlioceras subdiscoideum* BUCKMAN, 1889a, p. 100, M); = *Dissoroceras* BUCKMAN, 1902, p. 3 (type, *D. tabulatum*, M); = *Reynesia* BUCKMAN, 1902, p. 5 (type, *Lioceras decipiens* var. *intermedia* BUCKMAN, 1888, p. 33, OD); = *Reynesella* BUCKMAN, 1902, p. 5 (type, *R. piodes*, M); = *Toxolioceras* BUCKMAN, 1902, p. 5 (type, *Hyperlioceras walkeri* BUCKMAN, 1889a, p. 92, M); = *Braunella* BUCKMAN, 1904a, p. ci (type, *B. lenis*, M), nom. nov. pro *Braunsia* BUCKMAN, 1902, p. 3, non KREICHBAUMER, 1894 (insect); = *Darellina* BUCKMAN, 1904a, p. cvi (type *D. planaris*, OD); = *Hugia* BUCKMAN, 1904a, p. cxi (type, *H. curva*, OD); = *Lopadoceras* BUCKMAN, 1904a, p. cxi (type, *L. arcuatum*, OD); = *Deltotoceras* BUCKMAN, 1904a, p. cxix (type, *D. subsecum*, M), nom. nov. pro *Deltoceras* BUCKMAN, 1902, p. 3, non HYATT, 1894, p. 449]. Very involute, flat whorl sides, greatest whorl breadth at umbilical edge, tall unfloored keel; ribs falcost, bifurcating, but fade rapidly, and some forms almost smooth throughout. Dimorphic: type species of *Reynesella* is a microconch; types of all other synonyms are macroconchs. *Middle Jurassic* (*lower Bajocian*, *Discites Zone*): Europe, northern Africa (Atlas Ranges), ?Japan.—FIG. 68a. \**H. discites* (WAAGEN), holotype, macroconch, Dohusen, Braunschweig, Germany, ×1 (Buckman, 1904a, p. cxxii, fig. 88).—FIG. 68b–c. *H. ruditiscites* BUCKMAN, macroconch, Bradford Abbas, Dorset, England, ×0.7 (new, Sedgwick Museum, Cambridge, England, J. 6382; also figured in Buckman, 1889a, pl. 17, 3–4).—FIG. 68d–e. *H. semicosta* (BUCKMAN), holotype, macroconch, type species of *Darellia*, Bradford Abbas, Dorset, England, ×1 (new, Sedgwick Museum, Cambridge, England, J. 6425).—FIG. 68f–g. *H. piodes* (BUCKMAN), lectotype, adult microconch, type species of *Reynesella*, Bradford Abbas, Dorset, England, ×1.5 (new, Sedgwick Museum, Cambridge, England, J. 6429).

## Family PHYMATOCERATIDAE Hyatt, 1867

[nom. correct. SPATH, 1936c, p. 2, pro *Phymatoidae* HYATT, 1867, p. 88, 97, validated (as *Phymatoceratinae*) by ICZN Opinion 575, 1959a]  
[= *Hauginac* BUCKMAN, 1905a, p. cxcviii]

Planulates, evolute to involute, keeled; ribs strong, straight to sinuous, bundled at umbilical edge, with long secondaries, and

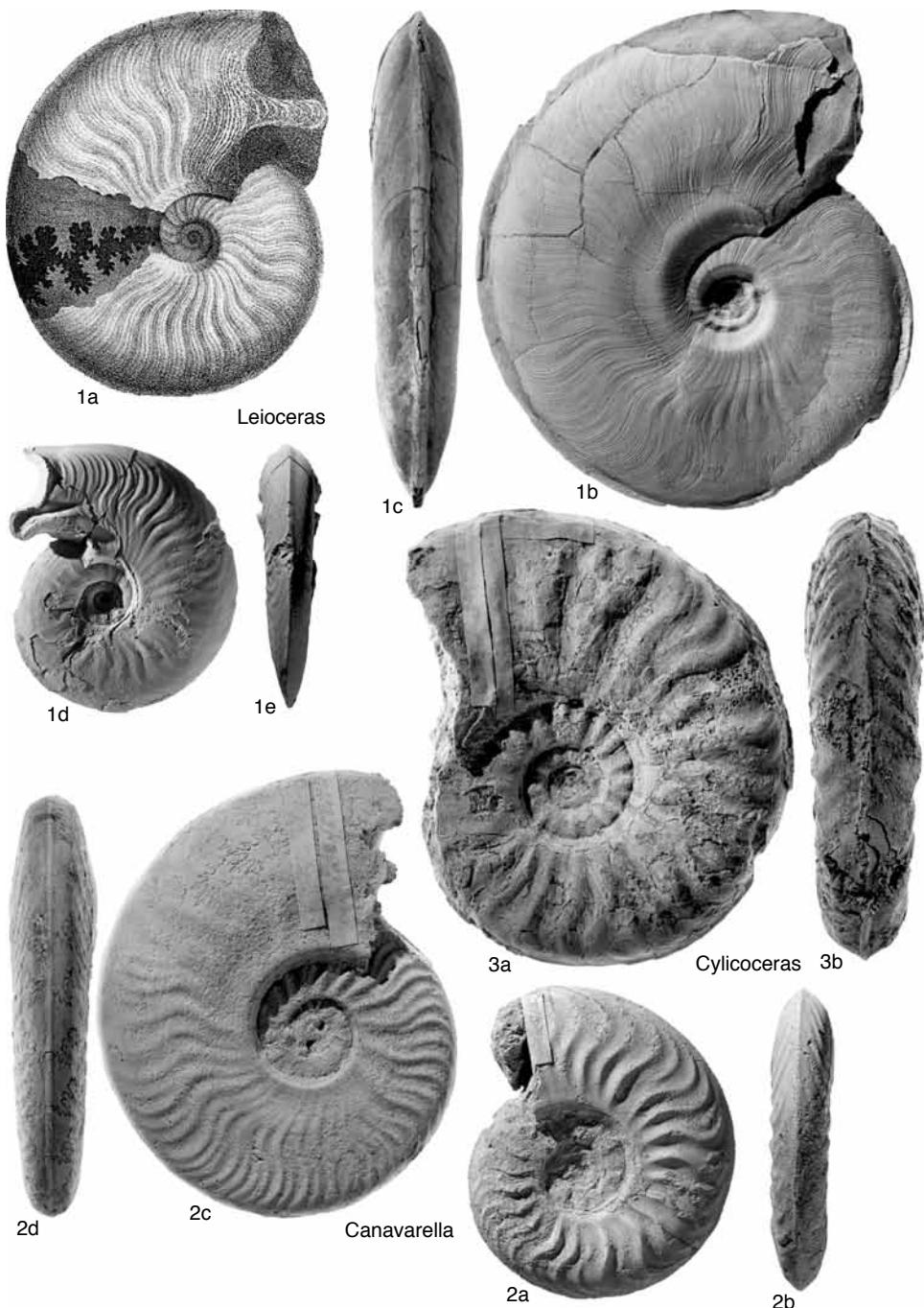


FIG. 64. Graphceratidae (p. 93).

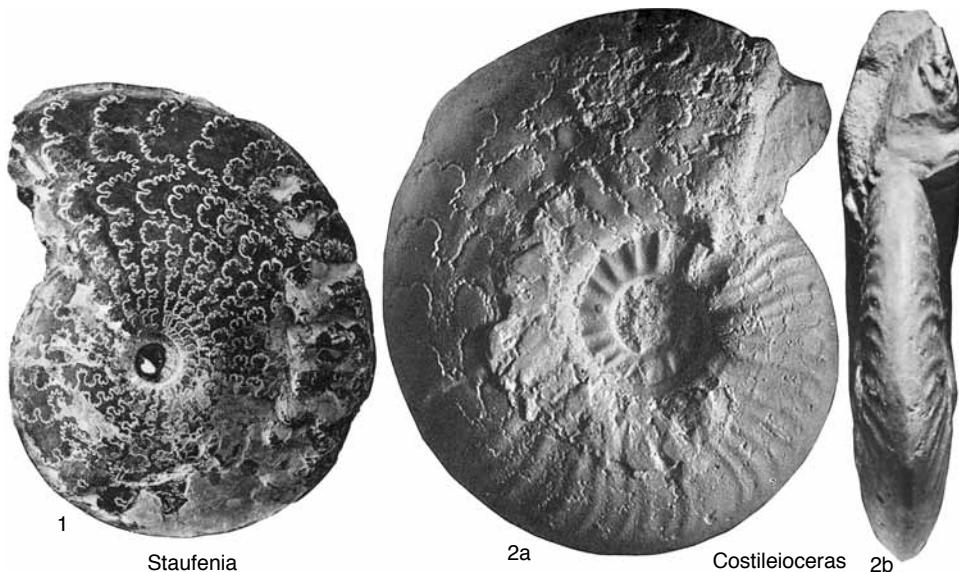


FIG. 65. Graphoceratidae (p. 93–95).

many with lateral tubercles, especially at umbilical edge. Derived from lower Toarcian, *Falciferum* Zone, Hildoceratinae. BUCKMAN, 1887–1907; MERLA, 1933, 1934; ELMI, 1963b; WESTERMANN, 1964; GÉCZY, 1966; GABILLY, 1976. Lower Jurassic (lower Toarcian, top Bifrons Zone–upper Toarcian, Thouarsense Zone [=Erbaense Zone]): worldwide.

**Phymatoceras** HYATT, 1867, p. 88, 97 [\**P. robustum*; SD HYATT 1900, p. 577] [=Pelecoceras HYATT, 1867, p. 98 (type, *P. attenuatum*, M); =Denckmannia BUCKMAN, 1898a, p. ix, xvii (type, *D. tumefacta*, OD); =Picenia FOSSA-MANCINI, 1919, p. 143 (type, *P. undulata*, OD); =Loryella BREISTROFFER, 1949, p. 99 (type, *Ammonites lilli* HAUER, 1856, p. 40, M), nom. nov. pro *Lillia* BAYLE, 1878, pl. 82, I, non BOIE, 1844 (Aves); =Rarenodia VENTURI, 1975, p. 13 (type, *R. planulata*, OD); =Praerycites VENTURI, 1981a, p. 83 (type, *Erycites (Praerycites) seranensis*, OD)]. Evolute, quadrate whorl section, keeled, flat or bisulcate venter, but sulci usually lost in adult; ribs strong, straight to sinuous, usually recirradiate to rursiradiate, and bundled from tubercles at umbilical edge; extent and size of tubercles, and presence or absence of constrictions on inner whorls, is variable, perhaps within same species: some have all ribs bundled at tubercles, others have ribs bundled to a large tubercle, followed by a constriction alternating with 2–4 simple nontuberculate ribs. Lower Jurassic (lower Toarcian, *Falciferum* Zone–upper Toarcian, Thouarsense Zone): Europe, northern Africa (Atlas Ranges), Turkey, Japan, Canada (British Columbia, Alberta),

USA (Alaska, Nevada), Chile, Argentina, Peru.—FIG. 69, 1a–b. \**P. robustum*, lectotype (designated herein), Plateau de Larzac, France,  $\times 1.5$  (new, Museum of Comparative Zoology, Cambridge, Massachusetts, 986).

**Paronychoceras** GUEX, 2000, p. 116 [\**P. pseudoplanum*; OD]. Microconchs, up to 15 mm in diameter. Evolute, with round whorl section and no ventral keel; smooth, or with curved ribs arcing strongly backward on side of whorl; venter smooth. Very similar to *Onychoceras* (Hammatoeratiniae), but more evolute. Probably the microconch of some species of *Phymatoceras*. Lower Jurassic (lower Toarcian, Bifrons Zone): France.—FIG. 69, 2a–c. \**P. pseudoplanum*, holotype, Le Clapier, Aveyron; a–b,  $\times 3$ ; c,  $\times 5$  (Gux, 2000, p. 119, fig. 1A).

**Furloceras** ELMI & RULLEAU, 1995, p. 87 [\**Lillia chelussii* PARISCH & VIALE, 1906, p. 156; OD] [=Mouterdeiceratinae ELMI & RULLEAU, 1995, p. 89 (type, *M. dubourgi*, OD)]. Evolute, compressed whorls, venter tricarinate-bisulcate, becoming tabulate with central keel at large sizes; dense rursiradiate ribs are paired to small umbilical tubercles, but tubercles tend to fade on larger whorls where ribs are mainly single. Differs from *Phymatoceras* in having more compressed whorls, denser ribs, and smaller tubercles at umbilical edge. Lower Jurassic (upper Toarcian, Variabilis–Thouarsense Zones): France, Portugal, Spain, Italy, Hungary, Greece, Turkey.—FIG. 69, 3a–b. \**F. chelussii* (PARISCH & VIALE), holotype, Monti del Furlo, Pesaro, Italy,  $\times 0.8$  (Parisch & Viale, 1906, pl. 11, 10–11).

**Brodieia** BUCKMAN, 1898a, p. xxxi [\**B. curva*; OD] [=Brodiceratinae BUCKMAN, 1899, p. xxxiii, obj.; =Whitbyiceras BUCKMAN, 1913, p. v (type, *Ammonites pinguis* SIMPSON, 1855, p. 100, OD);

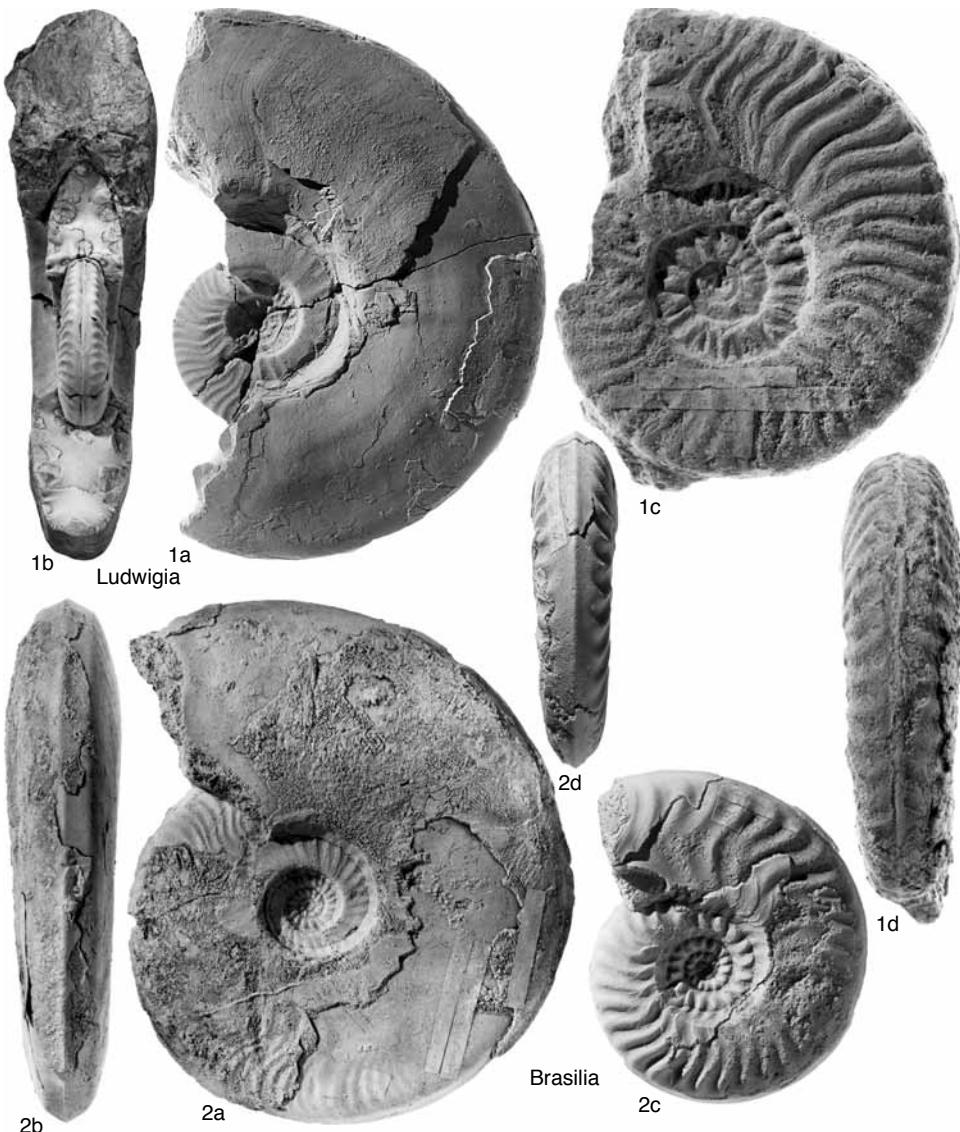


FIG. 66. Graphoceratidae (p. 95–96).

=*Pseudobrodieia* GUEX, 1972, p. 628 (type, *P. lehmanni*, OD); =*Merlaites* GABILLY, 1974, p. 1246 (type, *Brodiceras alticarinatum* MERLA, 1933, p. 37, OD)]. Involute, rounded or elliptical whorl section, with ventral keel; sinuous ribs, projected on venter, may be bundled from umbilical tubercles, or nontuberculate with ribs fading on inner half of whorl. Considered by some (GUEX, 1975, p. 109) to be the microconch of *Haugia*. Lower Jurassic (upper Toarcian, Variabilis Zone): Europe, Canada (British Columbia), USA (Alaska), Chile.—FIG. 69,4a–b. \**B. curva*, holotype, North Nibley, Gloucestershire, England, X1.5 (new, Sedgwick

Museum, Cambridge, England, J. 6302).—FIG. 69,4c–d. *B. pingue* (SIMPSON) (type species of *Whitbyiceas*), holotype, Whitby, Yorkshire, England, X1 (Howarth, 1992a, pl. 5,5).

*Pseudomercaticeras* ARKELL, 1957, p. 266 (MERLA, 1933, p. 39, nom. nud., type species not selected) [*P. parvulum* MERLA, 1933, p. 41; OD]. Evolute, with rounded whorl section and tricarinate-bisulcate venter; strong, curving ribs are single or paired from incipient umbilical tubercles, and are projected forward at the ventral edge. Similar to *Brodieia*, but more evolute, tricarinate-bisulcate venter more prominent and ribs are stronger.

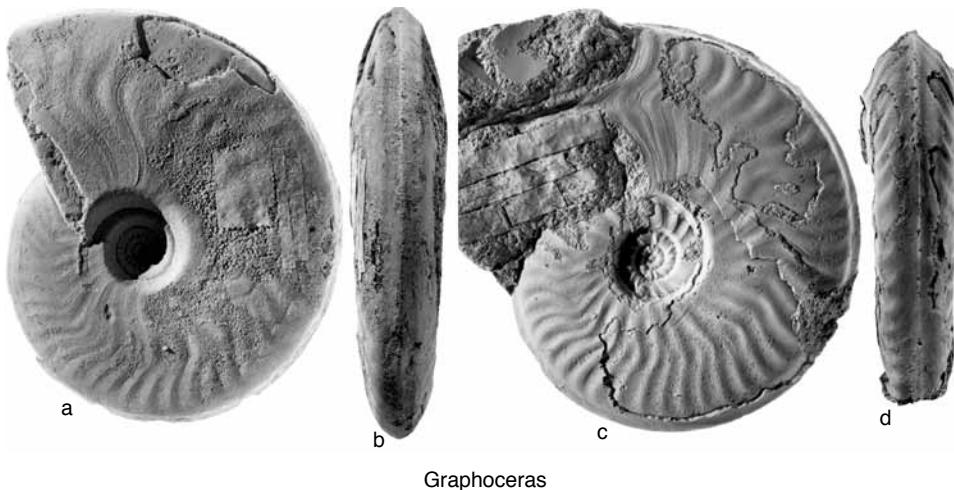


FIG. 67. Graphoceratidae (p. 96).

*Lower Jurassic (upper Toarcian): Italy, France.*—FIG. 69,5a. *\*P. parvilotatum* MERLA, holotype, Porcarella, Sanvicino, Central Apennines, Italy,  $\times 1$  (Merla, 1933, pl. 5,13).—FIG. 69,5b–c. *P. rotaries* MERLA, holotype, Monte dei Fiori, Central Apennines, Italy,  $\times 1$  (Merla, 1933, pl. 5,4a–b).

*Crassiceras* ARKELL, 1957, p. 266 (MERLA, 1933, p. 42, *nom. nud.*, type species not selected) [*\*P. latum* MERLA, 1933, p. 43; OD]. Similar to *Pseudomercaticeras*, but more involute and has thicker and more robust whorls. Differs from *Brodieia* in stronger ribs and more prominent tricarinate-bisulcate venter. *Lower Jurassic (upper Toarcian): Italy.*—FIG. 69,6a–b. *\*P. latum* MERLA, holotype, Porcarella, Sanvicino, Central Apennines, Italy,  $\times 1$  (Merla, 1933, pl. 5,10).

*Haugia* BUCKMAN, 1888, p. 45 [*\*Ammonites variabilis* D'ORBIGNY, 1845 in 1842–1851, p. 350; OD]. Moderately involute, compressed, tall massive ventral keel; ribs strong, twinned or triploid to regular tubercles at umbilical edge; outer whorl becomes smooth. *Upper Jurassic (upper Toarcian, Variabilis Zone): Europe, northern Africa (Atlas Ranges), Thailand, Japan, Canada (?British Columbia, ?Alberta), USA (?Alaska).*—FIG. 70,1a–d. *\*H. variabilis* (D'ORBIGNY); a–b, lectotype, France,  $\times 0.35$  (d'Orbigny, 1845 in 1842–1851, pl. 113, 1–2); c–d, Autun, Saône et Loire, France,  $\times 0.35$  (Fischer, 1994, pl. 33,3).

*Esericeras* BUCKMAN, 1920, pl. 182 [*\*Haugia inaequa* BUCKMAN, 1898a, p. xxix; OD]. Development from *Haugia*; more involute and more compressed, venter keeled or merely angled, ribs weaker, and no tubercles at umbilical edge. *Lower Jurassic (upper Toarcian, Thouarsense Zone, Striatulum Subzone): Europe, Indonesia (Timor, Roti), Peru.*—FIG. 70,2a–b. *\*E. inaequa* (BUCKMAN), holotype, North Nibley, Gloucestershire, England,  $\times 0.6$  (new, Sedgwick Museum, Cambridge, England, J. 6375).

## NOMEN DUBIUM IN PHYMATOCERATIDAE

*Haugiella* GABILLY, 1974, p. 1247 [*\*Cypholioceras vitiosum* BUCKMAN, 1899, supplement p. xliv; OD]. Based on a type species that consists of two unconnected fragments (possibly parts of two specimens) said to have come from strata of *Levesquei* or *Moorei* Subzone (*Levesquei* Zone, upper Toarcian) at Standish Beacon, Gloucestershire, England (BUCKMAN, 1888, p. 44; BUCKMAN, 1890, p. 166; BUCKMAN, 1899, supplement p. xliv). GABILLY (1976, p. 99–100) found apparently similar ammonites high in the *Variabilis* Zone in France, and claimed that BUCKMAN's original specimen(s) must have come from beds of a similar age, i.e., the *Variabilis* Zone, from which they were derived into the higher *Levesquei* Zone strata at the type locality. Both GUEX (1975, p. 108, 120, 127) and GABILLY (1976, p. 98) used *Haugiella vitiosa* as the index species of a *Vitiosa* Subzone at the top of the *Variabilis* Zone. The type specimen of *H. vitiosa* is a small fragment and is not interpretable, so the genus *Haugiella* can only be regarded as a *nomen dubium*. GUEX and GABILLY's specimens from the top of the *Variabilis* Zone probably belong to *Haugia*.

## Family HAMMATOCERATIDAE Buckman, 1887

[*Hammatoceratidae* BUCKMAN, 1887, p. 15]

Descendants of Phymatoceratidae, differing chiefly in ribbing, which branches higher on whorl sides and is differentiated into primaries and secondaries, and sutures



FIG. 68. Graphoceratidae (p. 96).

tend to be more elaborated with retracted umbilical lobe-bearing auxiliaries. Dimorphism known in a few cases: microconchs have lateral lappets; macroconchs have plain contracted mouth borders with a ventral rostrum.

**Subfamily HAMMATOCERATINAE**  
**Buckman, 1887**

[*Hammatoceratinæ* BUCKMAN, 1887, p. 15]

Widely variable in whorl thickness and between evolute and involute forms, even within one genus, but most genera have

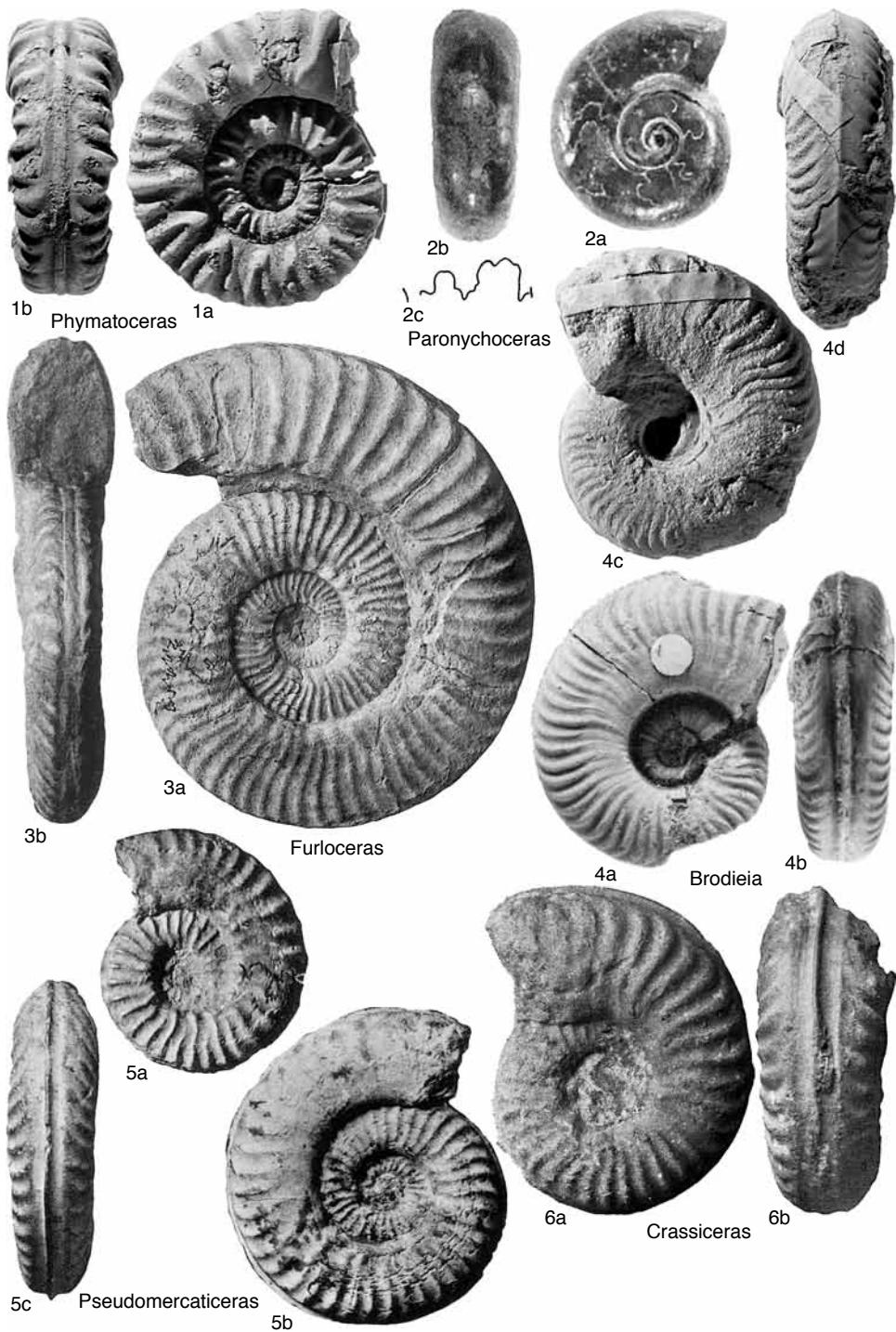


FIG. 69. Phymatoceratidae (p. 98–100).

lateral tubercles and moderate to strong ventral keels. Microconchs are adult at small sizes, but association with the generally much larger macroconchs is sometimes obscure. *Lower Jurassic (upper Toarcian, Thouarsense Zone)–Middle Jurassic (lower Bajocian, Laeviscula Zone)*: worldwide, mainly Tethyan, rarely Boreal.

**Hammatoceras** HYATT, 1867, p. 88 [*\*Ammonites insignis* ZIETEN, 1831 in 1830–1833, p. 20; SD BUCKMAN, 1887, p. 13] [= *Ammatoceras* HYATT, 1867, p. 98, obj., SD BUCKMAN, 1887, p. 13; = *Chartronia* BUCKMAN, 1898a, p. ix, xvi (type, *C. binodata*, OD); ?= *Pachammatoceras* BUCKMAN, 1921, pl. 207 (type, *P. pachu*, OD); = *Geczyceras* MARTÍNEZ GUTIÉRREZ, 1992, p. 65 (type, *Hammatoceras speciosum* JANENSCH, 1902, p. 102, OD); = *Accardia* CRESTA, 1997, p. 34 (type, *Ammonites lorteti* DUMORTIER, 1874, p. 262, OD)]. Evolute to moderately involute, whorl section rounded or subtriangular, with ventral keel; primary ribs short; secondary ribs branch from tubercles situated slightly ventral of edge of umbilicus, then pass on to venter and join keel; outer whorl may become smooth. Holotype of *Pachammatoceras* has rapidly expanding, thick whorls, and is of uncertain age; it could be an involute, thick-whorled species of either *Hammatoceras* or *Euapertoceras*. *Lower Jurassic (upper Toarcian, Thouarsense Zone, Fallaciosum Subzone [=Erbause Zone, Bayani Subzone]–Levesquei Zone)*: Europe, northern Africa (Atlas Ranges), Turkey, Caucasus, Iran, Russia (Bureya basin), Vietnam, Japan, Indonesia (Sulawesi), Canada (British Columbia), USA (Alaska, Oregon), Chile, Argentina. — FIG. 71a–c. *\*H. insigne* (ZEITEN), holotype, Reichenbach, Württemburg, Germany, ×1 (Zieten, 1831 in 1830–1833, pl. 15,2). — FIG. 71d–e. *H. pachu* (BUCKMAN), holotype, type species of *Pachammatoceras*, Charolles, Saône et Loire, France, ×0.5 (Buckman, 1921, pl. 207). — FIG. 71f–g. *H. binodata* (BUCKMAN), type species of *Chartronia*, holotype, Frocester Hill, Stroud, Gloucestershire, England, ×1 (Buckman, 1898a, supplement pl. 1,11–12).

**Crestaites** RULLEAU & ELMI, 2001, p. 76 [*\*Hammatoceras meneghinii* BONARELLI, 1899, p. 208; OD]. Evolute, compressed and flat whorl sides, with rounded venter and keel; fine, straight primary ribs bifurcate or are intercalated at middle or upper part of whorl side, and are projected forward onto venter; no tubercles at umbilical edge or on side of whorl. Resembles the younger *Planammatoceras*, but is more evolute and lacks any tubercles. *Lower Jurassic (Toarcian, Levesquei Zone [Meneghinii Zone in Tethyan Realm])*: Italy, France, Spain. — FIG. 72,1. *\*C. meneghinii* (BONARELLI), holotype, Marconessa, Central Apennines, Italy, ×0.7 (Merla, 1934, p. 10, pl. 1,1).

**Onychoceras** WUNSTRORF, 1905, p. 508 [*\*O. differens*; MJ]. Dwarf *Cymbites*-like microconchs that are adult at 15–20 mm in diameter and have lateral lappets in the mouth border. Whorls globular and depressed, with rounded venter and no keel; ribs arc strongly backward on side of whorl, then disappear, leaving venter smooth, or divide into much reduced striate secondaries on venter. Affinities uncertain, but is possibly microconch corresponding to some species of *Hammatoceras* at same horizon (GUEX, 1967). *Lower Jurassic (upper Toarcian, Levesquei Zone, Dispansum Subzone)*: France, Germany, Thailand. — FIG. 72,2a–d. *\*O. differens*, Gallberg, Salzgitter, Germany; a–c, lectotype (designated herein); a–b, ×1, c, ×2 (Wunstorf, 1905, pl. 20,12–13,16); d, paralectotype, ×1 (Wunstorf, 1905, pl. 20,14).

**Bredya** BUCKMAN, 1910c, p. 111, nom. nov. pro *Burtonia* BUCKMAN, 1910b, p. 97, non BONAPARTE, 1850 (Aves) [*\*Burtonia crassornata* BUCKMAN, 1910b, p. 98; SD BUCKMAN, 1914, p. x; = *Ammonites subinsignis* OPPEL, 1856 in 1856–1858, p. 367] [= *Pseudamatoceras* ELMI, 1963a, p. 59 (type, *Ammonites subinsignis* OPPEL, 1856 in 1856–1858, p. 367, OD)]. Whorls more massive than in *Hammatoceras*, and ribs and tubercles very large and coarse on inner whorls, fading on outer whorls. Dimorphic: microconchs are adult at about 35–40 mm in diameter, have small lappets, and strong secondary ribs up to the end of growth, branching from large dorsolateral tubercles; macroconchs are adult at an average of 240 mm in diameter and have plain, sinuous mouth borders. *Lower Jurassic (Toarcian, Levesquei Zone, Aalensis Subzone)–Middle Jurassic (Aalenian, Opalinum Zone, Scissum Subzone)*: Europe, northern Africa (Atlas Ranges), Caucasus, Vietnam, New Guinea, Indonesia (?Sulawesi), Canada (British Columbia), Chile, Argentina. — FIG. 72,3a–g. *\*B. subinsignis* (OPPEL), *Opalinum* Zone; a–b, lectotype, Gomaringen, Tübingen, Germany, ×1 (Senior, 1977, pl. 84,3–4); c–d, holotype of *B. crassornata*, macroconch, Burton Bradstock, Dorset, England, ×0.4 (Buckman, 1910b, pl. 9,1, pl. 10,1); e–g, microconch, Burton Cliff, Dorset; e–f, ×1; g, detail of lappet, ×3 (Senior, 1977, pl. 84,22–24).

**Planammatoceras** BUCKMAN, 1922, pl. 356 [*\*P. planiforme*; OD]. Evolute, compressed and flat whorled, with rounded venter and keel; fine, gently sigmoidal ribs bifurcate and are intercalated at middle of whorl side, then fade on outer whorl; weak, radially elongated tubercles at umbilical edge also fade on larger whorls. *Middle Jurassic (Aalenian, Opalinum–Murchisonae Zones)*: Europe, ?Tanganyika, Thailand, Vietnam, Japan, Canada (Yukon), USA (Alaska, Oregon), Chile, Argentina. — FIG. 72,4a–b. *\*P. planiforme*, holotype, Haselbury, Somerset, England, ×0.5 (new, British Geological Survey, Keyworth, Nottingham, England, GSM 47156).

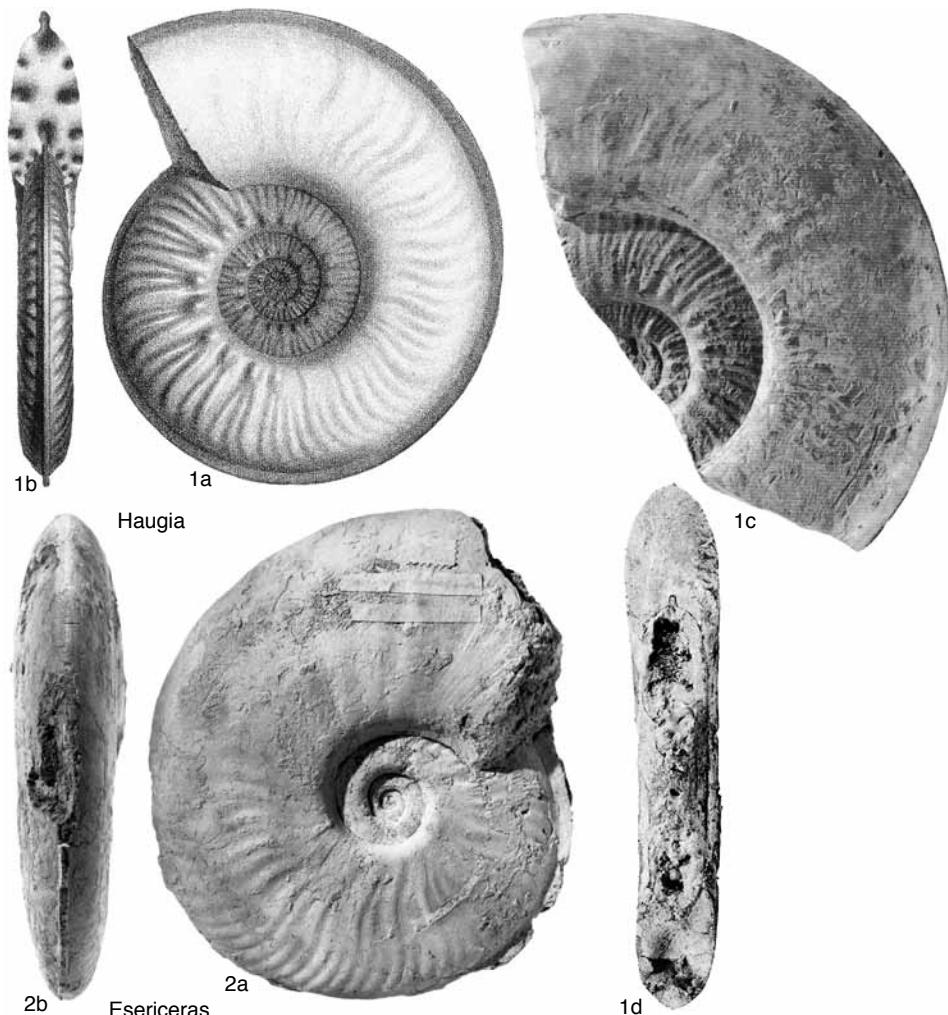


FIG. 70. Phymatoceratidae (p. 100).

**Paviaites** CRESTA in PAVIA & CRESTA, 2002, p. 190 (CRESTA, 1997, p. 35, *nom. nud.*) [*\*Hammatoceras iris* GEMMELLARO, 1886c, p. 206 (9); OD]. Small, adult at 62 mm in diameter or smaller, with a body chamber half a whorl long that has a simple sinuous mouth border; evolute, compressed, subacute or rounded venter with keel; fine, prosiradiate ribs issue from small umbilical tubercles and bifurcate or are intercalated higher on whorl side; ribbing fades on body chamber. Probably a microconch, despite absence of lappets in mouth border, but accompanying macroconch not identified. [*Paviaites* CRESTA, 1997, p. 35, is invalid, because the type species was not fixed in the original publication]. Middle Jurassic (Aalenian, Opalinum-

Murchisonae Zones): Italy.—FIG. 73, 1a–b. *\*P. iris* (GEMMELLARO), lectotype, Fontana Difali, Monte Erice, Sicily; a,  $\times 1$  (Cresta in Pavia & Cresta, 2002, p. 191, fig. 124a); b,  $\times 1$  (Cresta, 1997, p. 37, fig. 13B).

**Pseudaptetoceras** GÉCZY, 1966, p. 77 [*\*Harpoceras klimakomphalum* VACEK, 1886, p. 81; OD]. Involute, almost oxycone, with sharp umbilical edge and vertical umbilical walls; fine, gently sigmoidal ribs bifurcate at middle of whorl side; quickly becomes smooth on outer whorls except for remnants of ribs near ventral edge; no tubercles; reaches large sizes. Much more involute and smoother than *Planammatoceras* and lacks tubercles. Middle Jurassic (Aalenian, Murchisonae Zone): Europe, USA (Alaska),

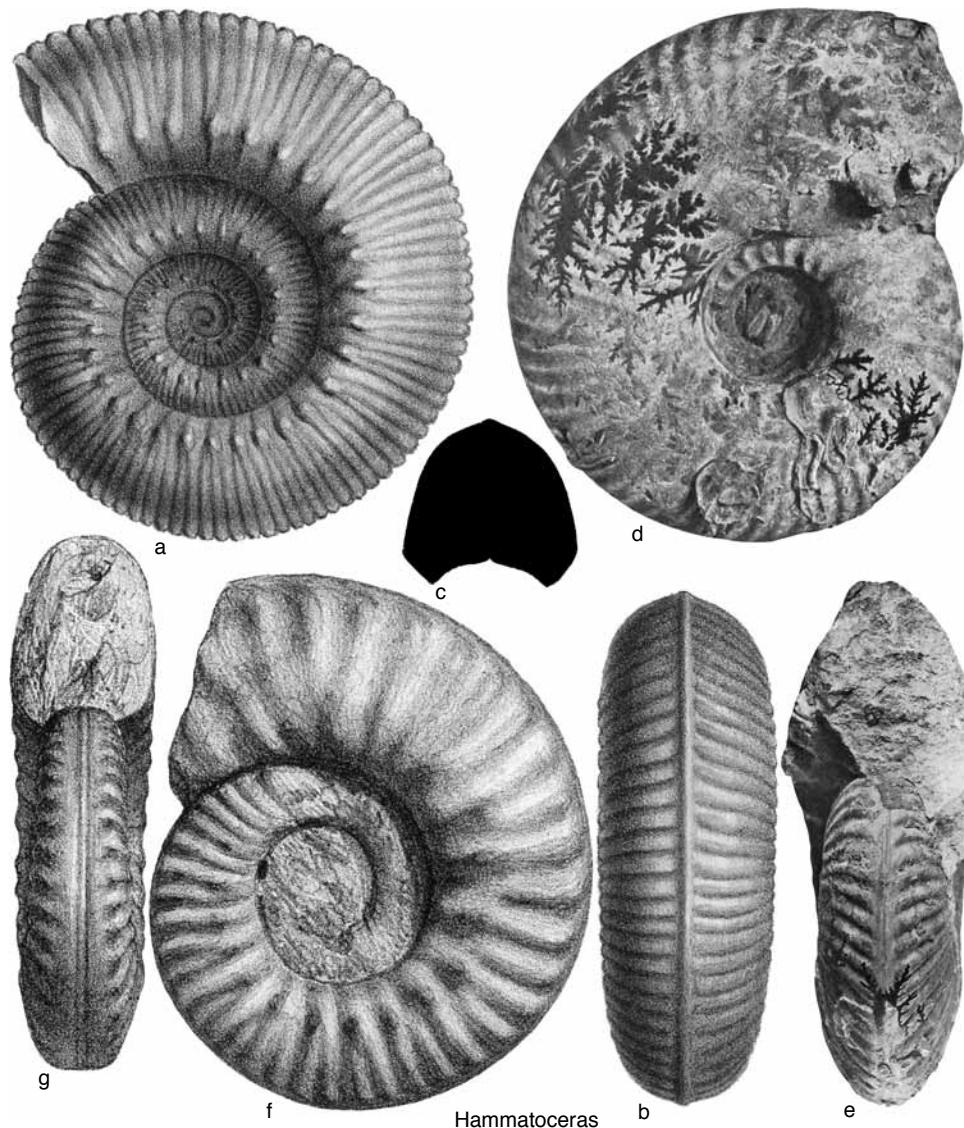


FIG. 71. Hammatoceratidae (p. 103).

Argentina.—FIG. 74, 1a–c. *\*P. klimakomphalum* (VACEK), Cape St. Viglio, Lake Garda, Italy; *a*, lectotype,  $\times 0.5$ ; *b–c*, paralectotype,  $\times 1$  (Vacek, 1886, p. 81, pl. 8, 16, 17, 17a).

*Euapteoceras* BUCKMAN, 1922, pl. 299 [*\*E. euaptetum*; OD] [= *Parammatoceras* BUCKMAN, 1925a, pl. 555 (type *P. obtectum*, OD); = *Csernyeiceras* GÉCZY, 1966, p. 83 (type, *Hammatoceras verpillierense* ROMAN & BOYER, 1923, p. 34, OD); = *Ceccaites* CRESTA, 1997, p. 40 (type, *Ammonites sieboldi*

OPPEL, 1862, p. 144, OD)]. Moderately involute, with heavy, rapidly increasing whorls, rounded venter and keel, and whorl section lanceolate in some; ribs mainly straight, bifurcating at moderate to large lateral tubercle, and smaller tubercles at umbilical edge on inner whorls; ribs and tubercles fade gradually on outer whorls. More involute than *Eudmetoceras*, and becomes smooth on outer whorl or sooner. Middle Jurassic (Aalenian, Murchisonae-Concavum Zones), Europe, northern Africa (Atlas

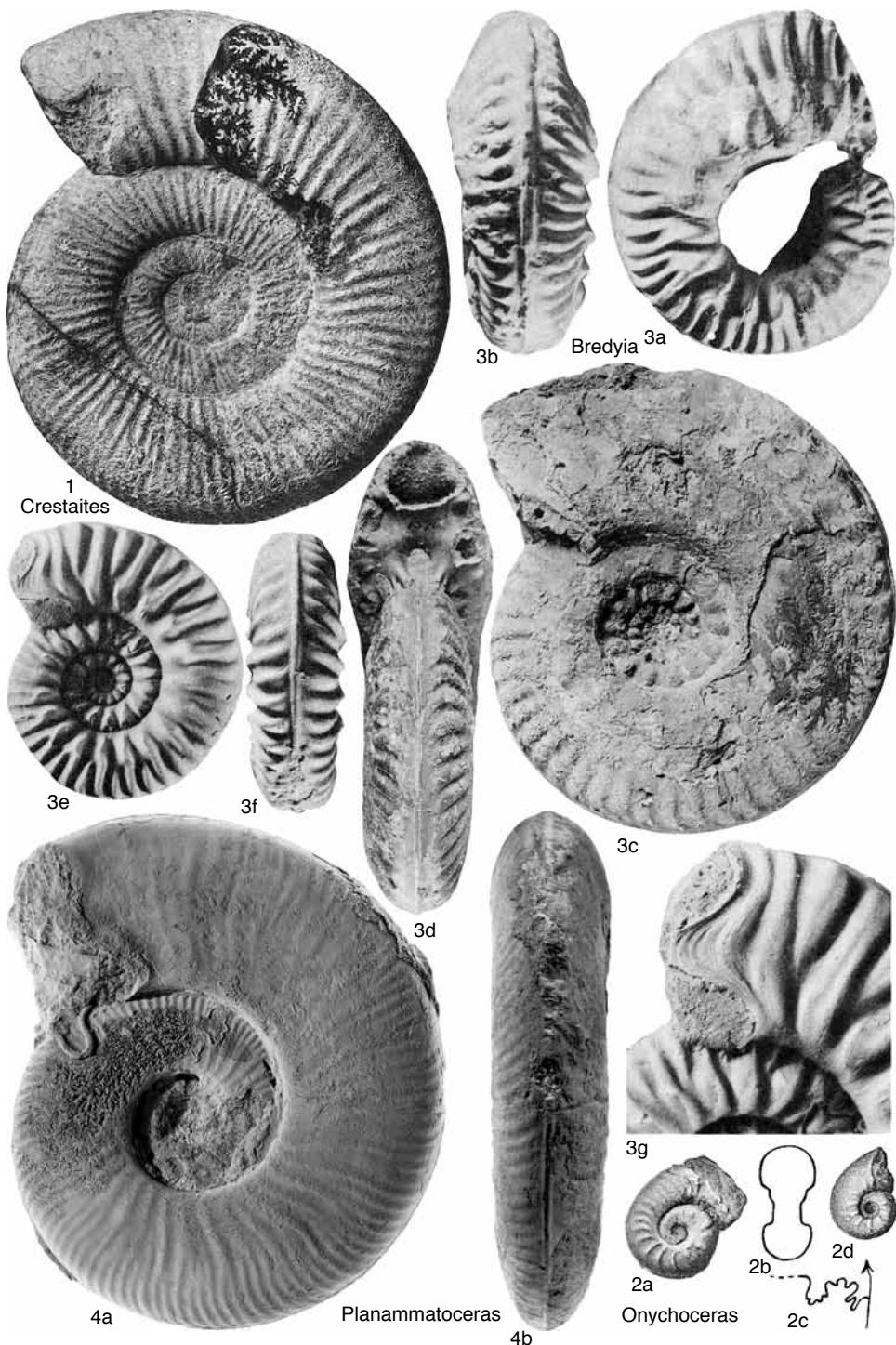


FIG. 72. Hammatoceratidae (p. 103).

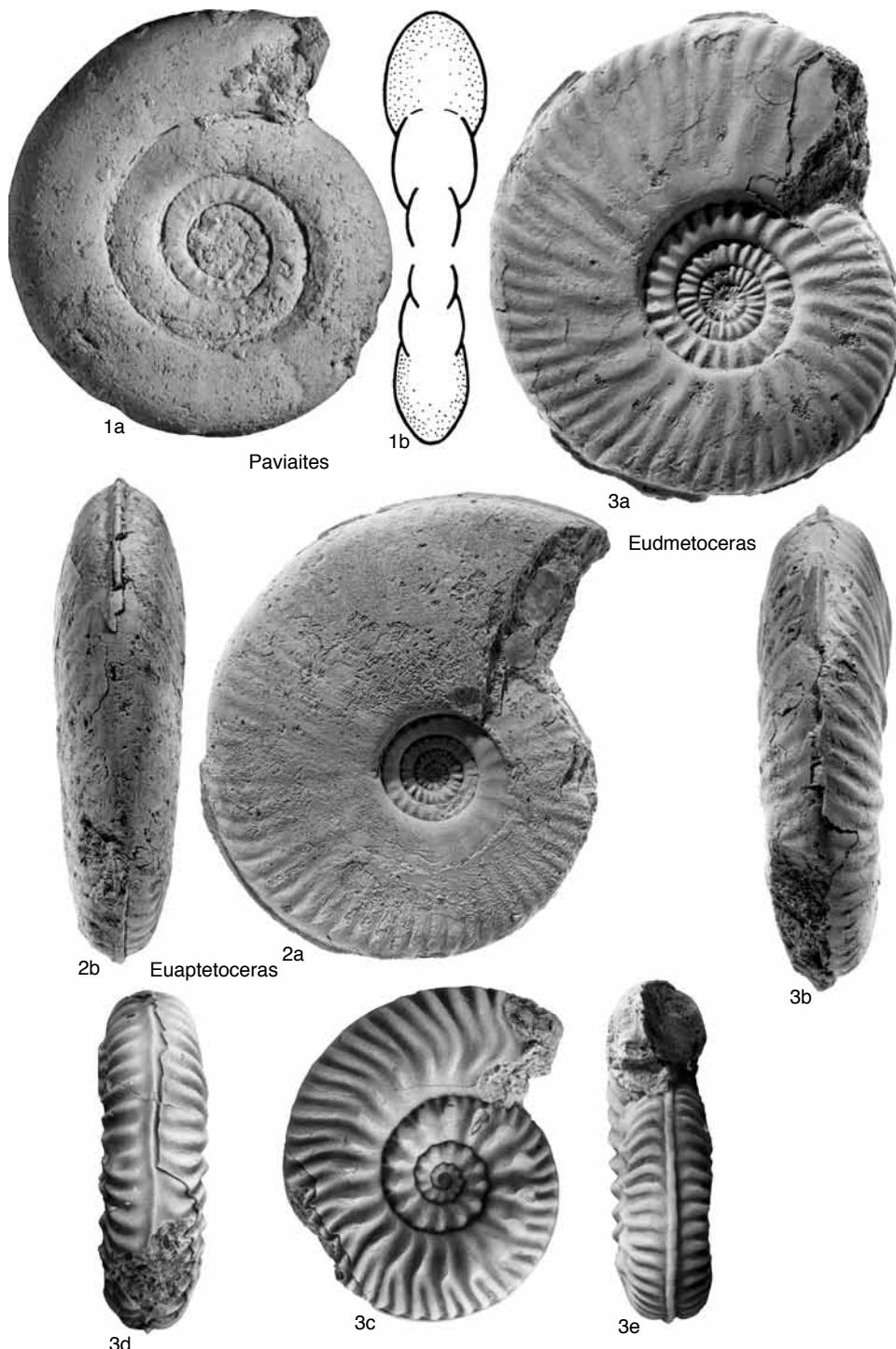


FIG. 73. Hammatoceratidae (p. 104–110).

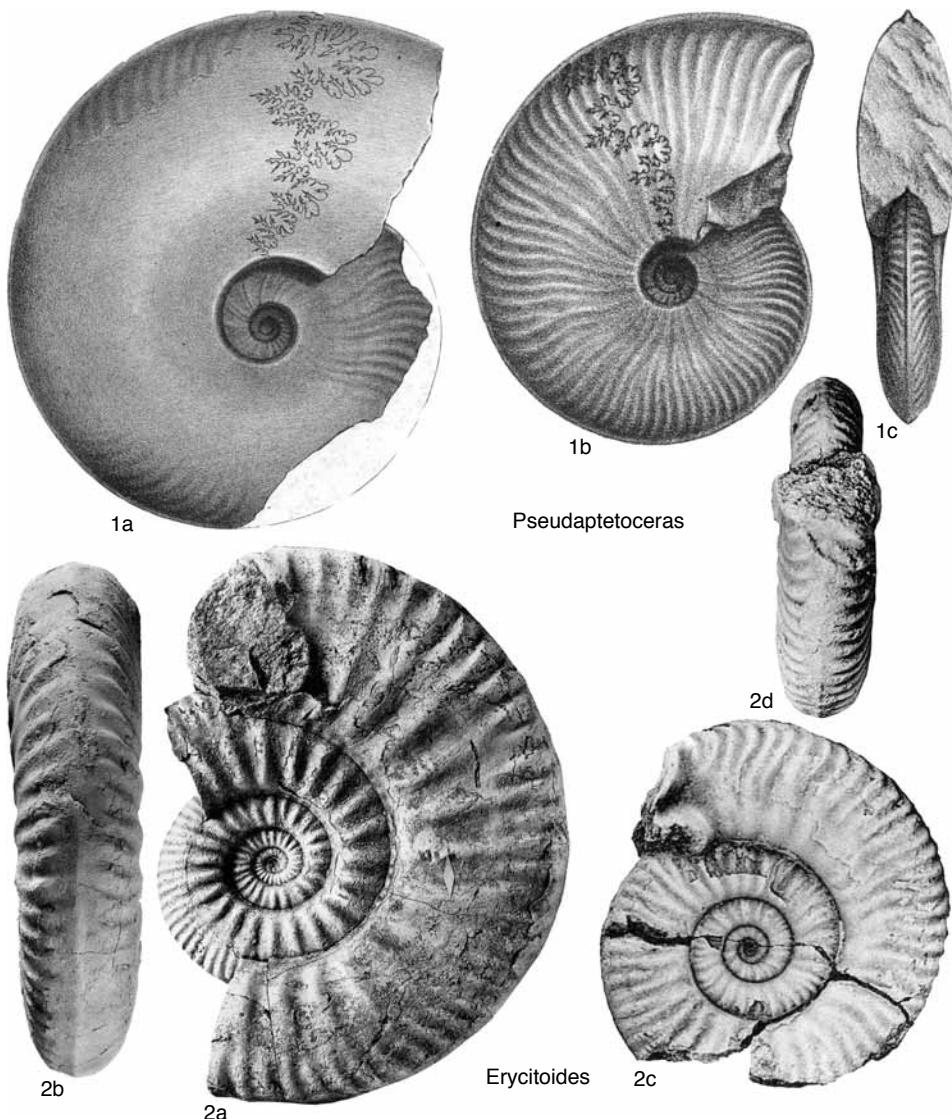


FIG. 74. Hammatoceratidae (p. 104–110).

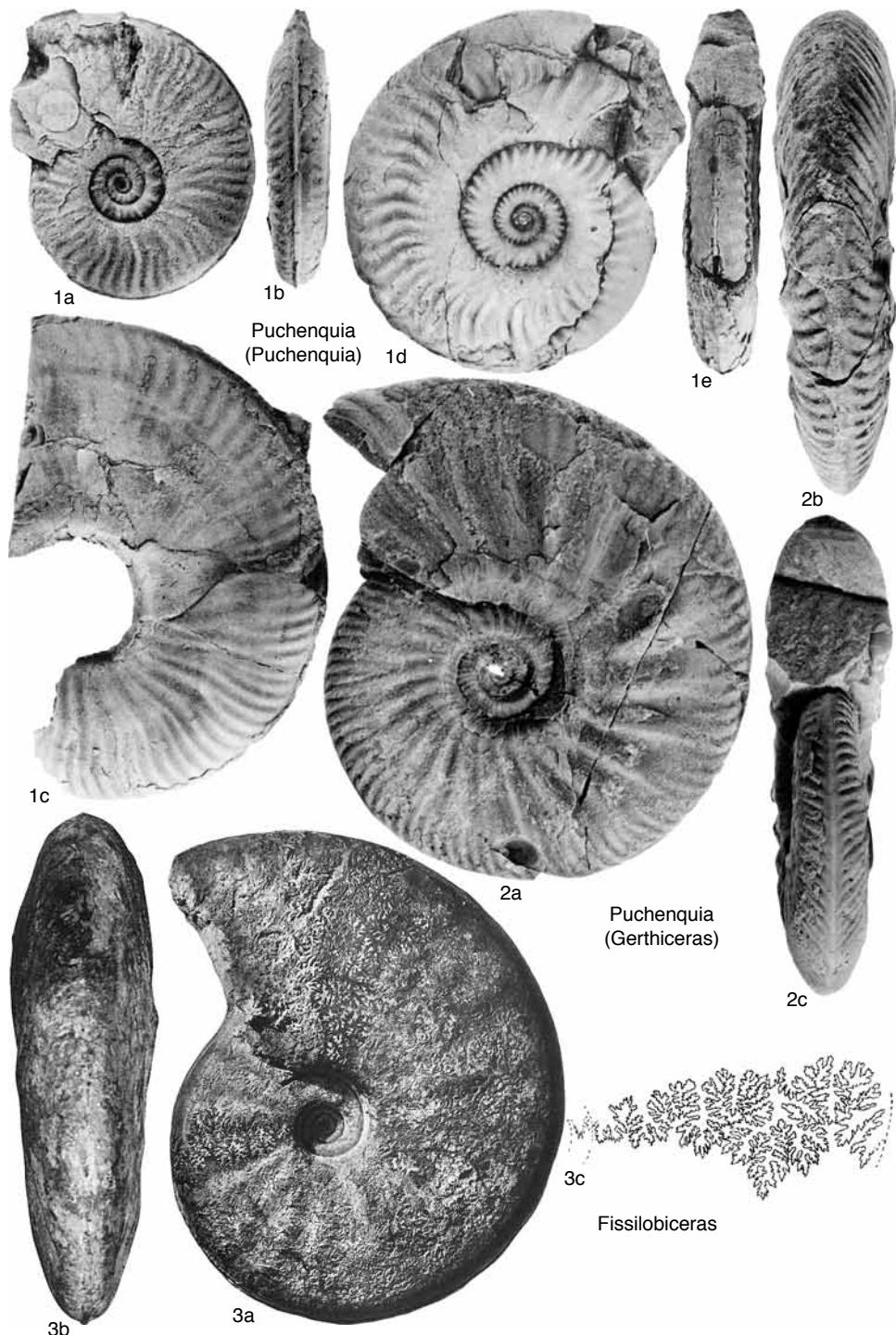


FIG. 75. Hammatoceratidae (p. 110).

Ranges), Turkey, USA (Alaska), Chile, Argentina.—FIG. 73,2a–b. \**E. euapetatum*, holotype, Concavum Zone, Bradford Abbas, Dorset, England,  $\times 0.6$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 47119).

**Eudmetoceras** BUCKMAN, 1920, pl. 179 [\**E. eudmetum*; OD] [=*Rhodaniceras* ELMI, 1963a, p. 59 (type, *Hammatoceras rhodanicum* RENZ, 1925b, p. 15, OD)]. Moderately evolute; whorls have flat sides and rounded venter with keel; primary ribs long, sharp, and prorsiradiate, and branch into secondaries at a small lateral tubercle at middle of whorl side; ribs tend to fade on outer whorl. More evolute than *Euapetoceras* and has sharper, more regular ribs. Dimorphic: microconchs (*Rhodaniceras*) are adult at 35–50 mm in diameter, and have small lappets in adult mouth border, and sharp ribs and tubercles throughout. *Middle Jurassic (Aalenian, Concavum Zone–lower Bajocian, Discites Zone)*: Europe, Iran, USA (Alaska, Oregon), Chile, Argentina.—FIG. 73,3a–b. \**E. eudmetum*, holotype, macroconch, Discites Subzone, Bradford Abbas, Dorset, England,  $\times 0.6$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 32025).—FIG. 73,3c–e. *E. rhodanicum* (RENZ), holotype, microconch, Concavum Zone, La Verpillière, Isère, France, Ecole de Mines, Paris, Deshayes Collection,  $\times 1.2$  (new; also figured in Bayle, 1878, pl. 82,3).

**Erycitooides** WESTERMANN, 1964, p. 358 [\**Ammonites (Lillia) howelli* WHITE, 1889, p. 68; OD] [=*Kialagvikas* WESTERMANN, 1964, p. 391 (type, *Ammonites (Lillia) kialagvikensis* WHITE, 1889, p. 69, OD)]. Evolute planulates, with rounded or subrectangular whorls and a rudimentary ventral keel that may disappear at larger sizes; strong, straight primary ribs bifurcate on middle or upper part of whorl side, and some secondary ribs are intercalated; small ventrolateral and larger midlateral tubercles or spines occur in some species. Macroconchs are known up to 240 mm in diameter and have a simple sinuous peristome; microconchs (synonym *Kialagvikas*) are adult at 25–60 mm in diameter, have lateral lappets in the mouth border, and ribs on body chamber tend to be rursiradiate. [In the similar genus *Erycites*, the whorls are more rounded and the keel is entirely lost]. *Middle Jurassic (Aalenian, Howelli Zone [=Concavum Zone])*: Canada (British Columbia, Yukon), USA (Alaska), Russia (Far East, northeast).—FIG. 74,2a–d. \**E. howelli* (WHITE), Kialagvik Formation, Wide Bay, Alaska Peninsula, Alaska; a–b, lectotype, macroconch,  $\times 0.5$  (Westermann, 1964, pl. 44, pl. 45, 1b); c–d, complete adult microconch with lappet,  $\times 1$  (Westermann, 1964, pl. 62, 4a–b).

**Puchenquia** WESTERMANN & RICCIARDI, 1972, p. 36 [\**Harpoceras malarquense* BURCKHARDT, 1903, p. 12; OD]. Small whorls moderately evolute, becoming more involute later; whorls oval, compressed, with rudimentary ventral keel becoming obsolescent on body chamber; fine, gently sigmoidal ribs bifurcate

at middle of whorl side and are projected on venter; in some species ribs become stronger on body chamber and midlateral tubercles or bullae may develop. Dimorphic: microconchs have lappets at the mouth border and are adult at 35–56 mm in diameter; macroconchs are adult at 70–150 mm in diameter. *Middle Jurassic (Aalenian, Concavum Zone–lower Bajocian, Discites Zone)*: Chile, Argentina, Peru.

**P. (Puchenquia).** Macroconchs are complete at 70–125 mm in diameter and have more involute final whorls and fine ribs that tend to fade on body chamber; no tubercles. Age and geographic range as for genus.—FIG. 75,1a–e. \**P. (P.) malarquense* (BURCKHARDT), Cerro Puchenque, Mendoza, Argentina; a–b, lectotype, phragmocone of macroconch,  $\times 1$ ; c, nearly complete macroconch,  $\times 0.8$ ; d–e, complete microconch,  $\times 1$  (WESTERMANN & RICCIARDI, 1972, pl. 6, 1a–b, 5, pl. 7, 5a–b).

**P. (Gerthiceras)** WESTERMANN & RICCIARDI, 1982, p. 32 [\**P. (Gerthiceras) compressa*; OD]. Larger than *P. (Puchenquia)* and macroconchs are up to 150 mm in diameter; develops thicker whorls and heavier ribs, and lateral tubercles or bullae occur in some species; ornament does not fade on body chamber. Age as for genus: Chile, Argentina.—FIG. 75,2a–c. \**P. (G.) compressa*, holotype, macroconch, Rio Potimalal, Mendoza, Argentina,  $\times 0.8$  (WESTERMANN & RICCIARDI, 1982, p. 36, fig. 6a–c).

**Fissilobicas** BUCKMAN, 1919a, p. xv [\**Ammonites fissilobatus* WAAGEN, 1867, p. 599; OD]. Large, involute oxycones; whorl section oval and compressed, with ventral keel that may persist to end of body chamber; smooth except for vague folds on side of whorl; suture complex and highly divided. Similar to *Shirbuirina* (Sonniniidae, lower Bajocian, Sauzei Zone), but more involute and suture much more complex. *Middle Jurassic (lower Bajocian, Discites Zone–Laeviuscula Zone, Ovalis Subzone)*: Europe, USA (Oregon), Chile, Argentina.—FIG. 75,3a–c. \**F. fissilobatum* (WAAGEN), lectotype (designated by CALLOMON & CHANDLER, 1990, p. 97), Gingen, Schwabia, Germany; a,  $\times 0.3$  (DORN, 1935, pl. 13, 1); b,  $\times 0.3$  (Schlegelmilch, 1985, pl. 17, 4); c, suture,  $\times 0.5$  (DORN, 1935, text-fig. pl. 5, 9).

### Subfamily ERYCITINAE Spath, 1928

[nom. transl. WESTERMANN & RICCIARDI, 1979, p. 113, 115, ex Erycitiidae SPATH, 1928, p. 74]

Whorls are generally more inflated and rounded than in Hammatoceratinæ and have a midventral smooth band, and no ventral keel; the sutures have reduced ventral elements. KOVÁCS & GÉCZY, 2008. *Lower Jurassic (upper Toarcian, Thouarsense Zone)–Middle Jurassic (lower Bajocian, Discites Zone)*: worldwide.

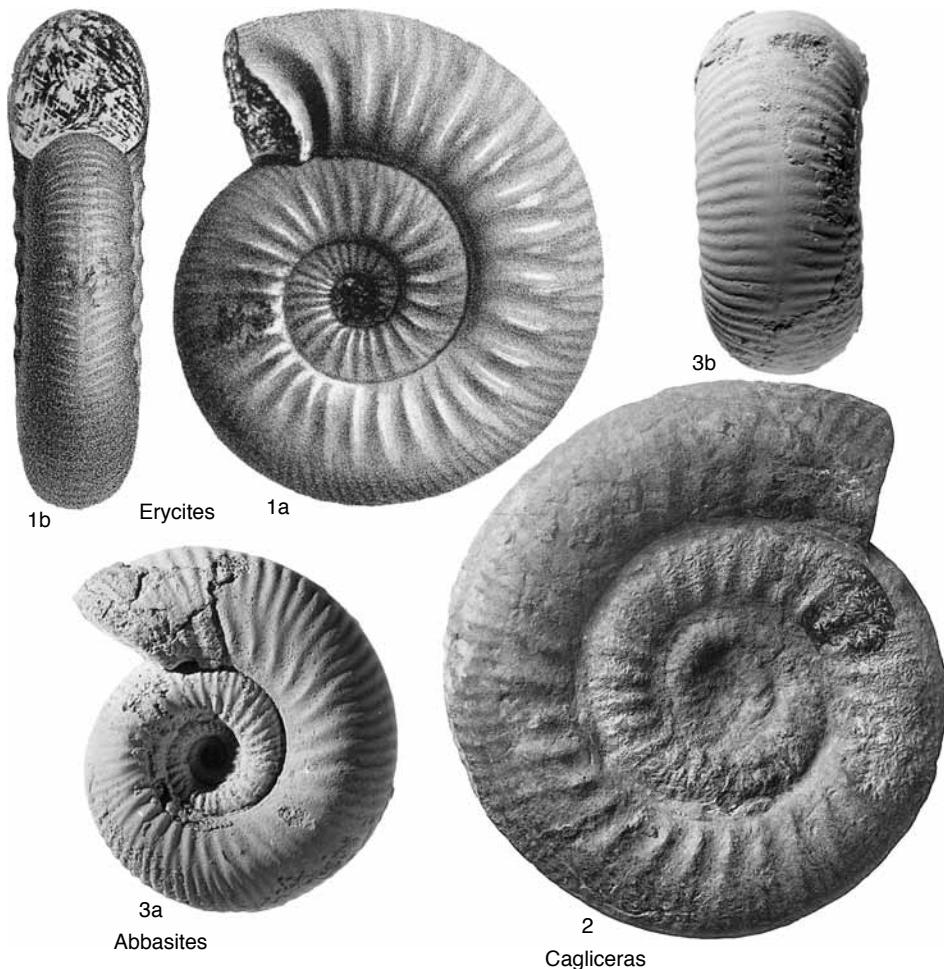


FIG. 76. Hammatoceratidae (p. 110–112).

**Erycites** GEMMELLARO 1886c, p. 205 [*\*Ammonites fallax* BENECKE, 1865 (December), p. 171; SD LOCZY, 1915, p. 381; *non* GUÉRANGER, 1865 (April–August) (Bathonian *Oxycerites*, Oppeliidae), =*E. fallifax* ARKELL, 1957, p. 267] [=*Abbasitoides* GÉCZY, 1966, p. 115 (type, *Coeloceras modestum* VACEK, 1886, p. 100, OD)]. Involute, sphaeroconic inner whorls, then moderately evolute outer whorls; whorl section broad and rounded and without a ventral keel; primary ribs branch into secondaries at middle of whorl side and ribs are interrupted at midventer; no tubercles. Dimorphic: macroconchs (*Erycites*, *Abbasitoides*) have contracted aperture with ventral rostrum; microconchs are small (25–60 mm

diameter) and have large lateral lappets. Lower Jurassic (upper Toarcian, Levesquei Zone)–Middle Jurassic (Aalenian, Opalinum–Concavum Zones): Europe, northern Africa (Atlas Ranges), Turkey, Iran, Caucasus, Russia (Crimea), ?Thailand, China (Tibet), New Zealand, USA (Alaska), Argentina, Chile.—FIG. 76, 1a–b. *\*E. fallifax* ARKELL, lectotype (designated herein), macroconch, *Murchisonae* Zone, Cap San Vigilio, Lake Garda, Italy,  $\times 1$  (Benecke, 1865, pl. 6, 1).

**Cagliceras** RULLEAU & ELMI, 2001, p. 76 [*\*Erycites elaphas* MERLA, 1934, p. 25; OD]. Evolute platycones; whorl section rounded, compressed on final whorl, and without a ventral keel; strong primary ribs are swollen radially or tuberculate

near umbilical edge, then branch into secondaries at middle of whorl side; ribs are interrupted at midventer. Stratigraphically older, more evolute, and more compressed than *Erycites*, and has stronger, swollen or tuberculate primary ribs. *Lower Jurassic (upper Toarcian, Levesquei Zone)*: France, Italy.—FIG. 76,2. \**C. elaphas* (MERLA), holotype, Val d’Urbia, Central Apennines, Italy,  $\times 0.6$  (Merla, 1934, pl. 4,5).

**Abbasites** BUCKMAN, 1921, pl. 236 [\**A. abbas*; OD] [=Ambersites BUCKMAN, 1921, pl. 237 (type, *A. aegrotus*, OD)]. Similar to *Erycites*, but is small, has cadicone, depressed whorls, and ribs are interrupted at midventer; no keel; adults with a plain mouth border are known as small as 40 mm in diameter, but dimorphism has not been found. *Middle Jurassic (Aalenian, Murchisonae Zone, Bradfordensis Subzone)*: Europe, USA (Alaska, Oregon).—FIG. 76,3a–b. \**A. abbas*, holotype, Bradford Abbas, Dorset, England,  $\times 1.2$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 32045).

### Subfamily PODAGROSICERATINAЕ

WESTERMANN & RICCARDI, 1979

[Podagrosiceratinae WESTERMANN & RICCARDI, 1979, p. 114]

Differing from the subfamily Erycitinae only by its normal suture lines, i.e., the ventral elements are not reduced. Podagrosiceratinae are restricted to the central and southern Andes of South America, except for the occurrence of the earliest genus *Sphaeroocoeloceras* in the Toarcian of western Canada. The subfamily is derived from the ancestral Erycitinae. RICCARDI, 2000. *Lower Jurassic (upper Toarcian, Thouarsense Zone)–Middle Jurassic (lower Bajocian, Discites Zone)*: worldwide.

**Sphaeroocoeloceras** JAWORSKI, 1926, p. 259 [\**S. brocchiforme*; OD]. Small sphaerocones, with egressing whorls on final part of phragmocone and body chamber, and sinuous adult mouth border; venter smoothly rounded with no keel; attains only 28–30 mm in diameter when adult; blunt ribs bifurcate, or secondaries are intercalated, at midflank, then curve backward on outer half of whorl and are interrupted at midventer. Similar to *Onychoceras* (Hammatoceratinae), but is larger and has a sinuous mouth border without lappets. Possibly dimorphic, and probably derived from Toarcian species of *Erycites*. *Lower Jurassic (upper Toarcian, Levesquei Zone)*: Canada (British Columbia), USA (Alaska, Nevada, Oregon, California), Mexico, Chile, Argentina.—FIG. 77,1a–e. \**S. brocchiforme*; a–c, lectotype, phrag-

mocone of probable macroconch, Arroyo Negro, Mendoza Province, Argentina,  $\times 2$  (Jaworski, 1926, pl. 3,10); d–e, complete adult probably a microconch, Arroyo Honda, San Juan Province, Argentina,  $\times 2$  (Hillebrandt, 1987, pl. 13,9a,9c).

**Westermanniceras** RICCARDI, 2000, p. 23 [\**Zurcheria groeberi* WESTERMANN & RICCARDI, 1972, p. 94; OD]. Inner whorls globular, becoming evolute on outer whorls with rounded to subrectangular whorl section; venter rounded with no keel; slightly sinuous ribs, are paired from umbilical margin on inner whorls, then simple or bifurcating on upper part of larger whorls; ribs are gently projected up to midventral smooth band, and ribs alternate across venter. *Middle Jurassic (Aalenian, Groeberi–lower Malarguensis Zones [=upper Murchisonae–Concavum Zones])*: Chile, Argentina.—FIG. 77,2a–b. \**W. groeberi* (WESTERMANN & RICCARDI), holotype, Rio Grande, Bardas Blancas, Mendoza, Argentina,  $\times 1$  (Riccardi, 2000, pl. 1,10a–b).

**Podagrosiceras** MAUBEUGE & LAMBERT, 1956, p. 621 [\**P. athleticum*; M]. Whorl section rounded with no ventral keel. Microconchs are complete at 28–42 mm in diameter, have evolute whorls throughout, and long lateral lappets in mouth border; moderate to strong sinuous primary ribs bifurcate at midflank and secondaries are interrupted and alternate at midventer. Macroconchs reach about 90 mm in diameter, have much more involute, thick, rounded whorls, and ribs become fine and prorsiradiate. In *Erycitooides* (Hammatoeratinae), microconchs differ only in having a rudimentary keel, while macroconchs also have a rudimentary keel, but are also larger, more evolute, and compressed, and have stronger ribs throughout. *Middle Jurassic (Aalenian–lower Bajocian, Malarguensis Zone [=Aalenian, Concavum Zone–lower Bajocian, Discites Zone])*: Chile, Argentina.—FIG. 77,3a–d. \**P. athleticum*; a–b, holotype, microconch, Arroyo Picun Leufu, Los Molles, Neuquen, Argentina; a,  $\times 1$  (Maubeuge & Lambert, 1956, pl. 64,1a); b,  $\times 1$  (Westermann, 1964, p. 388, fig. 18); c–d, macroconch, Arroyo de Los Radales, Chos Malal, Neuquen, Argentina,  $\times 0.75$  (Riccardi, 2000, pl. 1,5a,5c).

### Subfamily ZURCHERIINAE Hyatt, 1900

[nom. correct. HOWARTH, herein, pro *Zurcherinae* ARKELL, 1950, p. 361,  
nom. transl. ex *Zurcheridae* HYATT, 1900, p. 577]

Ribbing becomes more tuberculate than in Erycitinae, with both ventrolateral and lower lateral or umbilical rows of tubercles in some; tubercles develop proterogenetically on inner whorls, and may or may not extend to middle and outer whorls. A ventral keel is developed in *Haplopleuroceras*. *Lower Jurassic*

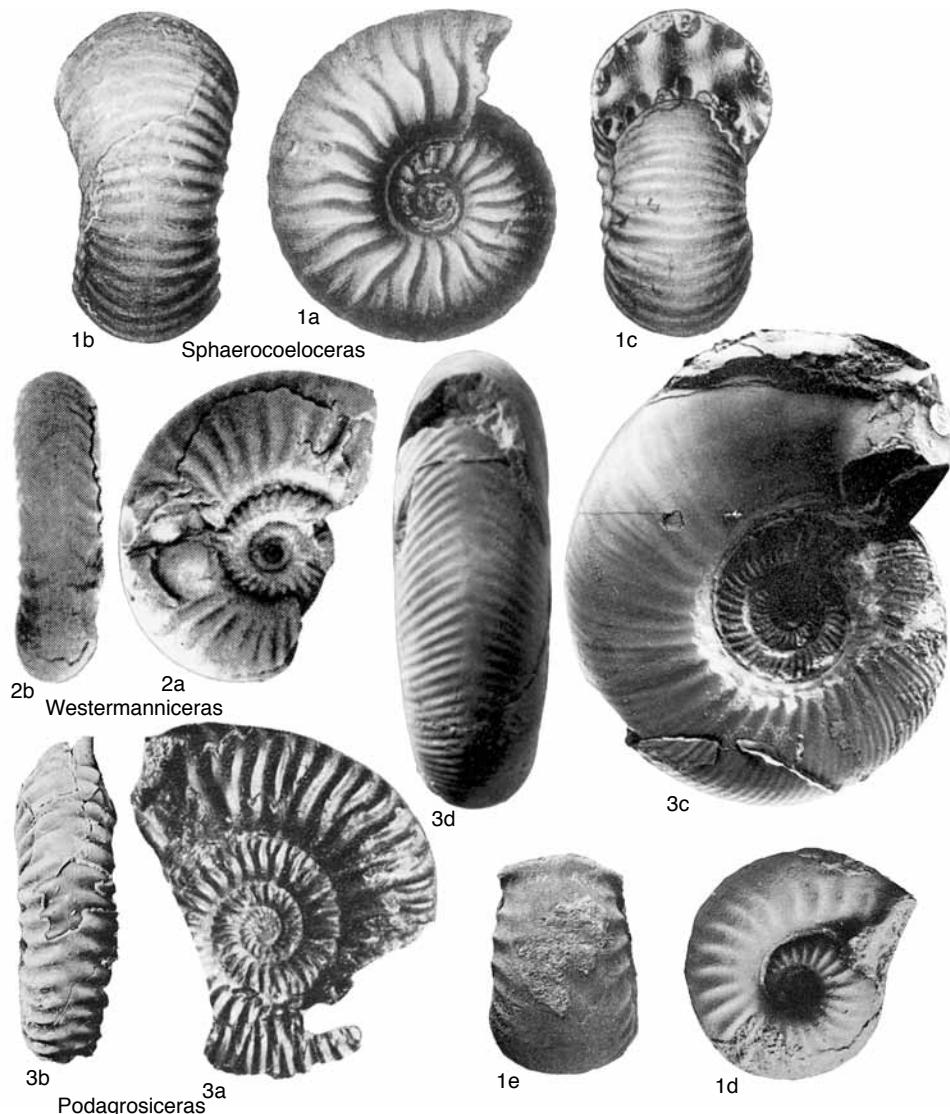


FIG. 77. Hammatoceratidae (p. 112).

(upper Toarcian, Thouarsense Zone)—Middle Jurassic (lower Bajocian, Discites Zone): worldwide.

**Spinamatoceras** SCHINDEWOLF, 1964, p. 340

[\**Hammatoceras pugnax* VACEK, 1886, p. 96; OD]  
[=Shahrudites SEYED-EMAMI in SEYED-EMAMI &

others, 2006, p. 270 (type, *S. asseretoi*, OD)]. Moderately evolute, whorl section cadicone on inner whorls, rounded or oval on middle and outer whorls; venter rounded without keel; on inner whorls, strong primary ribs bi- or trifurcate at ventrolateral tubercles, and there are smaller umbilical tubercles; on larger whorls, ribs issue

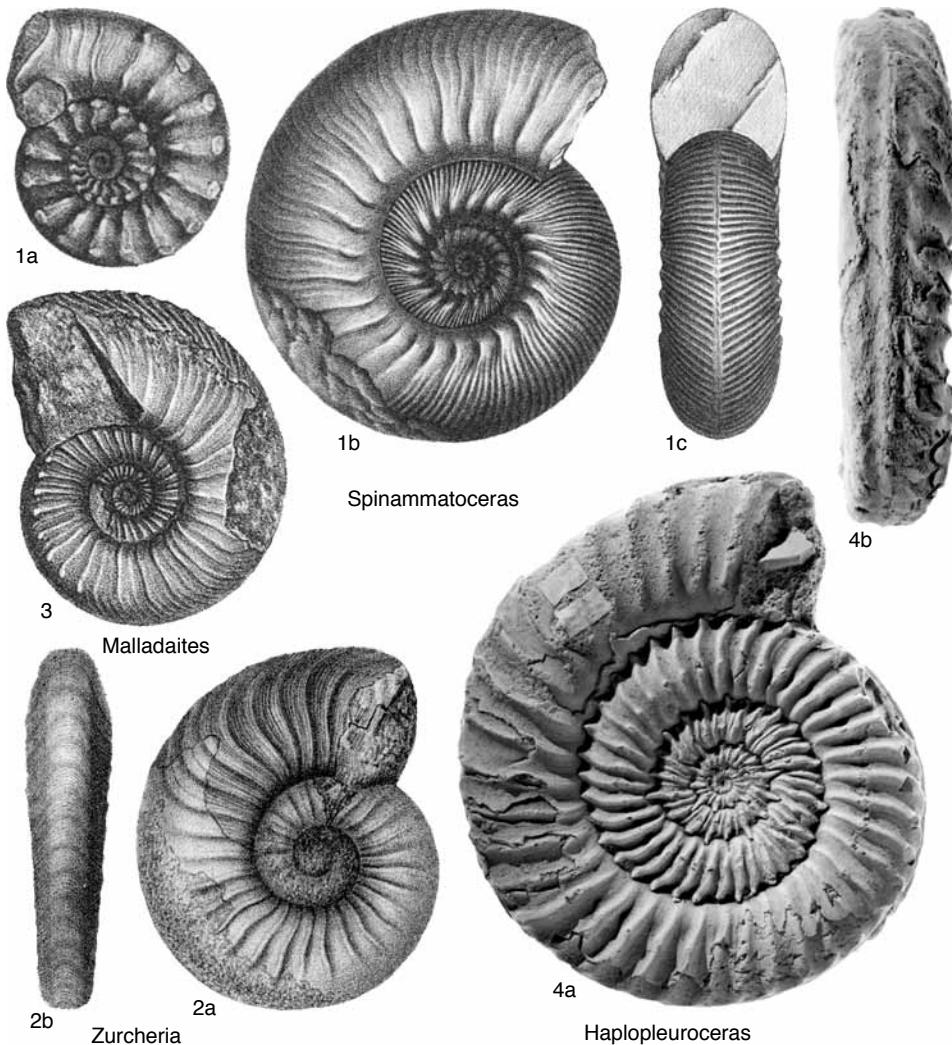


FIG. 78. Hammatoceratidae (p. 113–115).

in bunches from umbilical tubercles, but later ribs become more widely spaced and tubercles diminish. Dimorphic: microconchs are adult and have lateral lappets at the single-ribbed, bituberculate stage; macroconchs have sinuous mouth borders and diminished ornament on final whorl. Similar to *Erycites*, but the latter lacks tubercles and has more constant primary and secondary ribbing throughout. *Middle Jurassic (Aalenian, Opalinum–Murchisonae Zones)*: Italy, Spain, France, Portugal, northern Africa (Atlas Ranges).—FIG. 78, *1a–c*. \**S. pugnax* (VACEK), Cape St. Vigilio, Lake Garda, Italy; *a*, lectotype, microconch,  $\times 1.3$  (Vacek, 1886, pl. 16, *I*); *b–c*, macroconch (lectotype of

*Hammatoceras tenax* VACEK),  $\times 0.8$  (Vacek, 1886, pl. 15, *10, 10a*).

*Zurcheria* DOUVILLE, 1885, p. 36 [\**Z. ubaldi*; OD [=*Parazurcheria* FERNANDEZ-LOPEZ in FERNANDEZ-LOPEZ, MOUTERDE, & ROCHA, 1988, p. 290 (type, *Z. (Parazurcheria) costulata*, OD)]. Moderately evolute, with compressed whorls, rounded venter, and no keel; ribbing weak or striate, but stronger in some, gently flexuous, fading on outer part of whorl and on venter; inner whorls of some species have small ventrolateral tubercles and occasionally smaller tubercles on umbilical edge. Dimorphic: microconchs are up to approximately 50 mm in diameter,

and have small lappets in adult mouth border; macroconchs (*Parazurcheria*) are larger and have a smooth sinuous mouth border. *Middle Jurassic* (*Aalenian*, *Concavum Zone*–*lower Bajocian*, *Discites Zone*): Europe, northern Africa (Atlas Ranges), Chile, Argentina.—FIG. 78, 2a–b. \**Z. ubaldi*, holotype, *Discites Zone*, Valeury, Toulon, France, ×1 (Douville, 1885, pl. 1, 8).

**Malladaites** LINARES & SANDOVAL, 1986, p. 214  
[\**Hammatoceras pertinax* VACEK, 1886, p. 96; OD]. Moderately evolute, whorl section compressed with flat sides and arched venter; rudimentary ventral keel on inner whorls disappears near end of phragmocone; fine ribs projected strongly forward on venter; some ribs issue from small umbilical tubercles, and small ventrolateral tubercles in some species. Dimorphic: microconchs have long lateral lappets; macroconchs have a plain mouth border, and tubercles fade on final whorl. Differs from *Spinammatoceras* in having whorls with flat sides, finer ribs throughout, and much smaller tubercles. *Middle Jurassic* (*Aalenian*, *Murchisonae*–*Concavum Zones*, *lower Bajocian*, *basal Discites Zone*): Italy, Spain, northern Africa (Atlas Ranges), southeastern Iran.—FIG. 78, 3. \**M. pertinax* (VACEK), lectotype, macroconch, Cape St. Vigilio, Lake Garda, Italy, ×1.2 (Vacek, 1886, pl. 16, 5).

**Haplopleuroceras** BUCKMAN, 1892, p. 299 [\**Amathetus subspinatus* BUCKMAN, 1881, p. 606; OD]. Evolute, whorl section quadrate and compressed, with flat whorl sides; venter has a keel and is usually bisulcate; fine, gently sinuous ribs are single or divided from umbilical edge and curve forward on venter; small lower lateral and ventrolateral tubercles or spines occur in some species, and may disappear on outer whorls; thick bisulcate ribs alternate with thin nontuberculate ribs on inner and middle whorls of some species. Probably dimorphic, but evidence is poor. Derived from *Malladaites*, differing by development of a keel and sulci on venter and stronger tubercles (LINARES & SANDOVAL, 1996). *Middle Jurassic* (*Aalenian*, *Concavum Zone*–*lower Bajocian*, *Discites Zone*): England, Spain, Portugal, France, Italy, Greece, Algeria, Morocco, Caucasus, Iran.—FIG. 78, 4a–b. \**H. subspinatum* (BUCKMAN), lectotype (designated herein), probably a macroconch, *Concavum Zone*, Halfway House, Sherborne, Dorset, England, ×1 (new, Sedgwick Museum, Cambridge, J. 6286).

### Family SONNINIIDAE Buckman, 1892

[nom. correct. ARKELL, 1957, p. 267, pro *Sonniniidae* ARKELL, 1950, p. 361,  
nom. transl. ex *Sonniniinae* BUCKMAN, 1892, p. 287]

Typical forms are stout planululates with strong hollow keel, ribs, and midlateral tubercles at least early in growth.

Other forms show great variety, from evolute planulates to sphaerocones and oxycones, but almost all have *Sonninia*-like innermost whorls, and ribs, tubercles, or spines at some stage. Several genera are dimorphic. BUCKMAN, 1887–1907; DORN, 1935; HILTERMANN, 1939; ARKELL & PLAYFORD, 1954; OECHSLE, 1958; WESTERMANN, 1966. *Middle Jurassic* (*Aalenian*–*lower Bajocian*): worldwide, except boreal.

#### Subfamily SONNINIINAE Buckman, 1892

[nom. correct. CALLOMON & CHANDLER in CHANDLER & others, 2006, p. 367, pro *Sonniniinae* BUCKMAN, 1892, p. 287]

Macroconchs of most genera attain large sizes, while microconchs are much smaller (size ratio approximately 1:5) and have plain mouth borders, at least in *Sonninia* and its subgenera, but microconchs of *Dorsetensis* have lateral lappets.

**Sonninia** DOUVILLE, 1879, p. 92, nom. nov. pro *Waagenia* BAYLE, 1878, pl. 84, non KREICHBAUMER, 1874 (insect) [\**Waagenia propinquans* BAYLE, 1878, pl. 84; M)]. Evolute planulates becoming more involute and compressed on larger whorls; whorl section rounded initially, becoming compressed on outer whorls in some forms; strong keel on rounded or arched venter; ribs and tubercles highly variable; ribs are often strong, but may be irregular; large, well-spaced midlateral tubercles or spines occur at least on early and middle whorls. Probably dimorphic, but microconchs have plain mouth borders and are not well known. [The author of *Sonninia* is DOUVILLE, not BAYLE, as always quoted hitherto, because DOUVILLE was the author of the note in which *Sonninia* was proposed as a replacement for BAYLE's preoccupied genus *Waagenia*]. *Middle Jurassic* (*Aalenian*, *Concavum Zone*–*lower Bajocian*, *Sauzei Zone*): worldwide.

**S. (Sonninia).** Tubercles fade on middle whorls, and ribs fade on outer whorls, which become involute and compressed. *Middle Jurassic* (*lower Bajocian*, *Sauzei Zone*): Europe, northern Africa (Atlas Ranges), Madagascar, Caucasus, Azerbaijan, Iran, China (Tibet), Japan, Western Australia, USA (Alaska, Oregon), Chile, Argentina.—FIG. 79, 1a–b. \**S. (S.) propinquans* (BAYLE), lectotype (designated by GILLET, 1937, p. 30, 32), macroconch, Les Moutiers, Caen, Calvados, France, ×0.6 (new, Puzos Collection, Ecole de Mines, Paris; also figured in Bayle, 1878, pl. 84, 1).

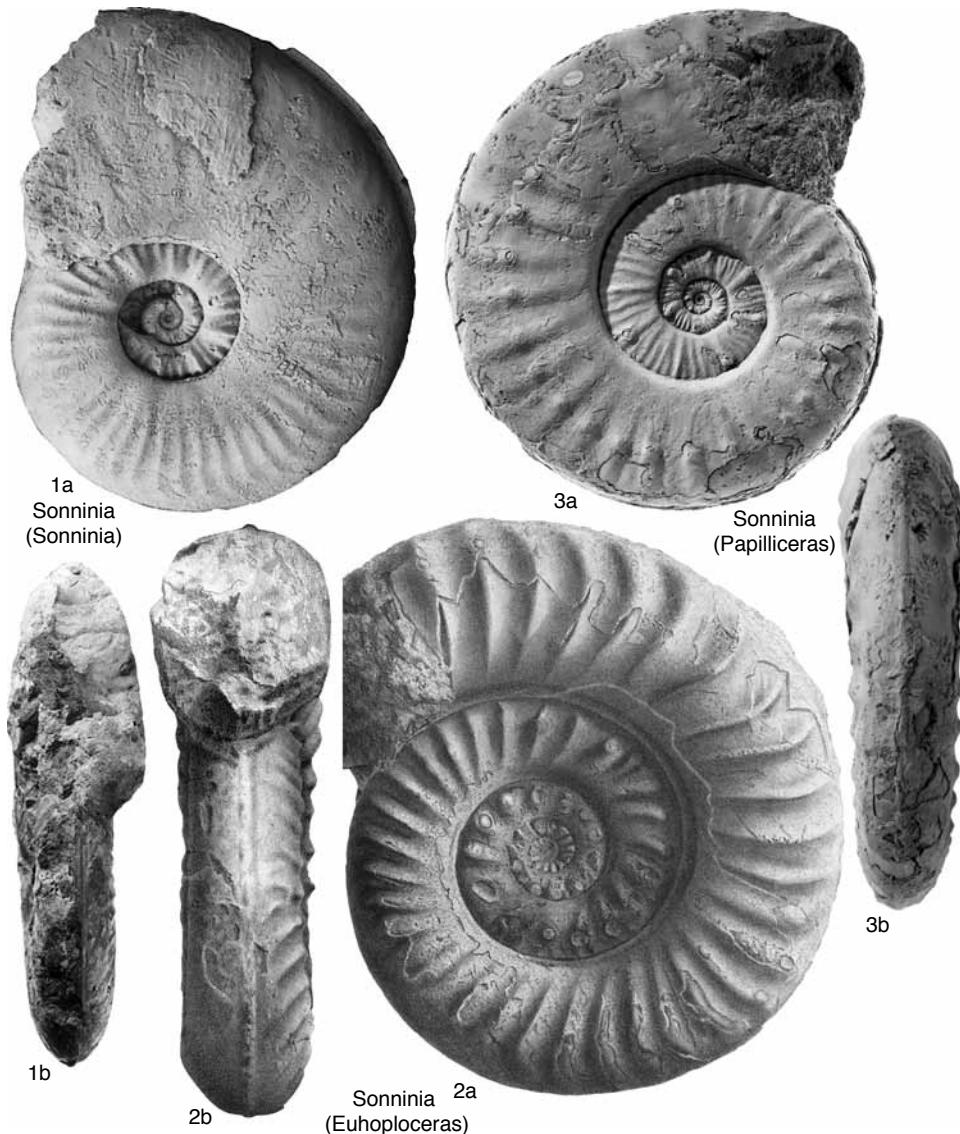


FIG. 79. Sonniniidae (p. 115–117).

**S. (Euhoploceras)** BUCKMAN, 1913, p. iv [\**Sonninia acanthodes* BUCKMAN, 1889b, p. 658; OD] [= *Stiphromorphites* BUCKMAN, 1923a, pl. 398 (type, *S. nodatipinguis*, OD); = *Sherbornites* BUCKMAN, 1923a, pl. 411 (type, *S. projectifer*, OD)]. Outer whorls evolute and massive, with strong rursiradiate ribs, and keel persisting to end of body chamber; attains large sizes. Middle Jurassic (Aalenian, Concavum Zone–lower Bajocian, Laeviuscula Zone): Europe,

northern Africa (Atlas Ranges), China (Tibet), Western Australia, Canada (British Columbia, Alberta), USA (Alaska, Oregon, California), Chile, Argentina.—FIG. 79, 2a–b. \**S. (E.) acanthodes* (BUCKMAN), lectotype, *Concavum* Zone, Bradford Abbas, Dorset, England,  $\times 0.35$  (Buckman, 1892, pl. 60).

**S. (Papilliceras)** BUCKMAN, 1920, pl. 150 [\**P. papillatum*; OD] [= *Prepapillites* BUCKMAN, 1927a, pl. 709 (type, *Ammonites arenatus*

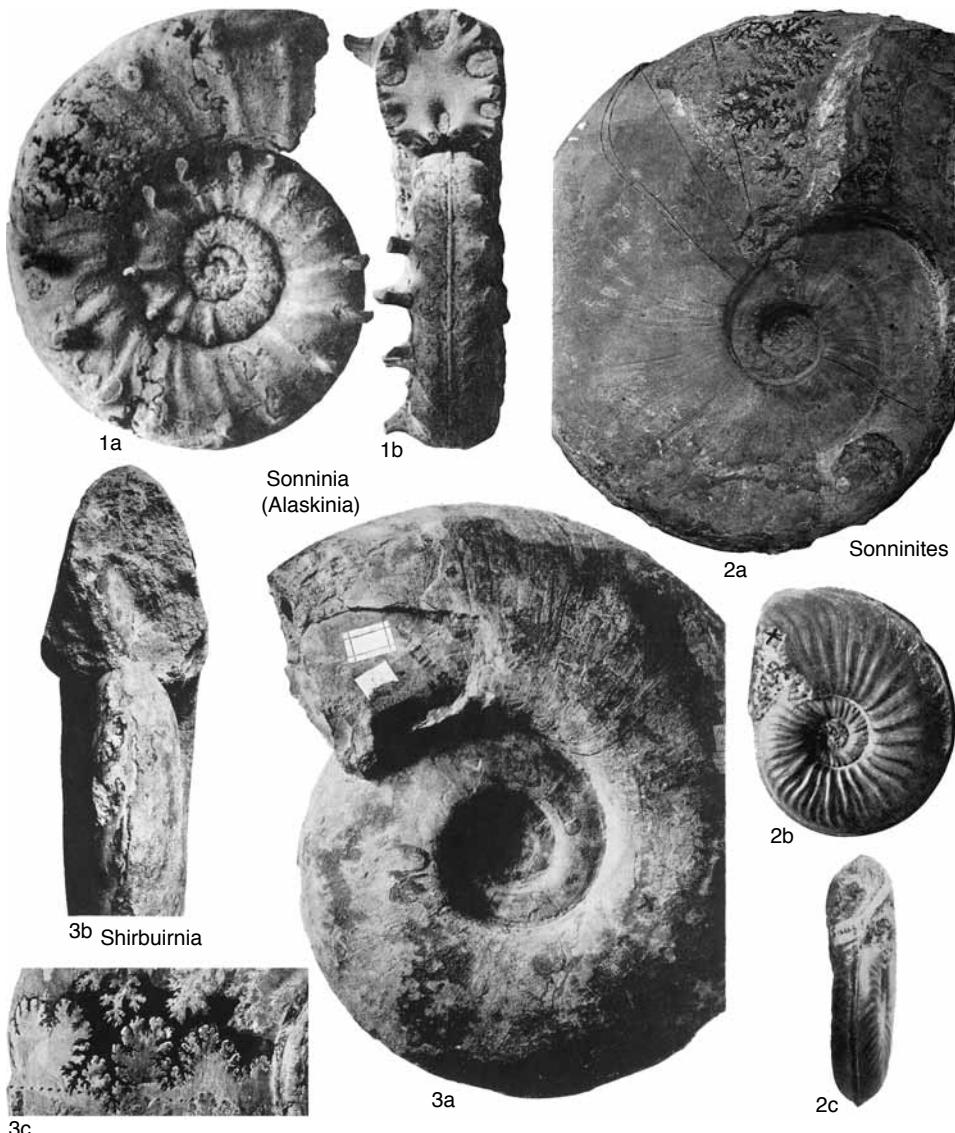


FIG. 80. Sonniniidae (p. 117–119).

QUENSTEDT, 1886 in 1882–1888, p. 482, M)]. Row of lateral tubercles on every rib persists onto evolute compressed body chamber, even after ribs have faded, or tubercles occur only on body chamber; some specimens have strigate ornament. Middle Jurassic (lower Bajocian, Laeviuscula Zone): Europe, Thailand, USA (Alaska, Oregon), Chile, Argentina, Peru.—FIG. 79,3a–b. \**S. (P.) papillatum*

BUCKMAN, holotype, Sherborne, Dorset, England,  $\times 0.35$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 32009).

**S. (Alaskinia)** WESTERMANN, 1978, p. 604, *nom. nov. pro Alaskoceras* WESTERMANN, 1969, p. 102, *non MILLER & KUMMEL*, 1945, p. 126 (Ordovician nautiloid) [\**S. (Alaskoceras) alaskensis*; OD]. Similar to *S. (Euhoploceras)*,

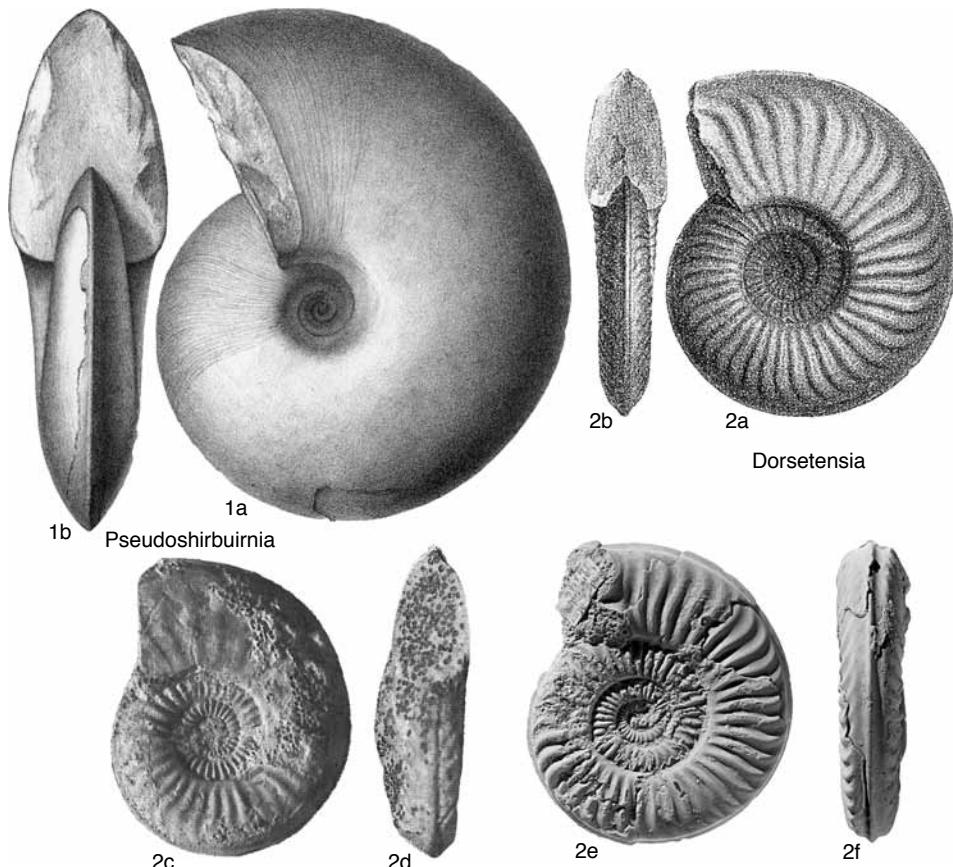


FIG. 81. Sonniniidae (p. 119).

but smaller, with trapezoidal whorl section, divergent whorl sides, and large ventrolateral spines persisting on to body chamber. *Middle Jurassic (lower Bajocian, Laeviuscula Zone–Sauzei Zone)*: Canada (British Columbia, Alberta), USA (Alaska).—FIG. 80, 1a–b. *\*S. (A.) alaskensis* (WESTERMANN), holotype, *Laeviuscula* Zone, Wide Bay, Alaska Peninsula, USA,  $\times 1$  (Westermann, 1969, pl. 27, 3).

**Sonninites** BUCKMAN, 1923b, pl. 428A [*\*S. felix*; OD] [= *Sonnites* BUCKMAN, 1925b, pl. 528A, *nom. null.*, misspelling; = *Dundryites* BUCKMAN, 1926, pl. 687 (type, *D. albidus*, OD)]. Planulate inner whorls, then involute, oxycone middle and outer whorls; whorl section compressed, with flat sides, steep, sharp-edged umbilical walls and rounded to fastigiate keeled venter; ribs on inner whorls fade on middle and outer whorls, which become striate

or smooth; suture complex and highly indented. More involute, smoother, and has a more complicated suture than *Witchellia*, and lacks subquadrate whorl section and bisulcate venter of that genus. DIETZE, CHANDLER, & CALLOMON, 2007, p. 13. *Middle Jurassic (lower Bajocian, Laeviuscula Zone–Sauzei Zone)*: England.—FIG. 80, 2a–c. *\*S. felix*, Sandford Lane, Sherborne, Dorset, England; *a*, holotype,  $\times 0.35$  (Buckman, 1923b, pl. 428A); *b–c*, paratype, inner whorls,  $\times 1$  (Buckman, 1923b, pl. 428B).

**Shirbuirnia** BUCKMAN, 1910b, p. 91 [*\*S. trigonalis*; SD ARKELL in ARKELL & PLAYFORD, 1954, p. 561]. Inner whorls *Sonninia*-like, but soon becomes more involute and smooth; body chamber massive, moderately involute, whorl section subtriangular-rounded, no keel, smooth. *Middle Jurassic (lower Bajocian, Laeviuscula Zone)*: Europe.—FIG.

80,3a–c. \**S. trigonalis*, holotype, Sandford Lane Quarry, Sherborne, Dorset, England; *a–b*,  $\times 0.25$ ; *c*, suture,  $\times 0.5$  (Buckman, 1924, pl. 517A–B).

**Pseudoshirbuirnia** DIETZE & others, 2005, p. 48 [*\*Amaltheus? stephani* BUCKMAN, 1883, p. 138; OD]. Involute, massive whorls expanding rapidly; whorl section compressed and rounded, and has well-rounded umbilical shoulders, a fastigiate venter, and a plain sigmoidal mouth border; weak ribs on inner whorls fade rapidly on middle and outer whorls, which are smooth. More involute than *Shirbuirnia*, and has a more compressed, higher, oval to discoidal whorl section, a more rounded umbilical margin and a simpler suture. *Middle Jurassic (lower Bajocian, Laeviuscula Zone–Sauzei Zone)*: England, Germany.—FIG. 81,1a–b. \**P. stephani* (BUCKMAN), lectotype, Sandford Lane Quarry, Sherborne, Dorset, England,  $\times 0.4$  (Buckman, 1883, pl. 1,I).

**Dorsetenia** BUCKMAN, 1892, p. 302 [*\*Ammonites edouardianus* D'ORBIGNY, 1846 in 1842–1851, p. 392; OD]. Inner whorls evolute, with simple, slightly flexuous ribs and no tubercles; middle and outer whorls more involute, compressed, with sharp, sometimes undercut, umbilical edge, a narrow keeled venter, and becoming smooth. Dimorphic: small, evolute microconchs have ribs to end of body chamber and lateral lappets in mouth border; larger macroconchs are more involute, compressed, smooth on outer whorls, and have plain mouth borders. *Middle Jurassic (lower Bajocian, Humphriesianum Zone)*: Europe, northern Africa (Atlas Ranges), Kenya, Madagascar, Saudi Arabia, Russia (southeastern Pamirs), China (Tibet), USA (Alaska, Oregon, California), Chile, Argentina.—FIG. 81,2a–f. \**D. edouardiana* (D'ORBIGNY); *a–b*, lectotype, macroconch, Bayeux, Calvados, France,  $\times 1$  (d'Orbigny, 1846 in 1842–1851, pl. 130,3–4); *c–d*, Carcagny, Calvados, France,  $\times 1$  (Fischer, 1994, pl. 42,2); *e–f*, microconch with lappet (*Witchellia regrediens* of HAUG, 1893), Sherborne, Dorset,  $\times 1$  (new, Sedgwick Museum, Cambridge, England, J. 6246; also figured in Buckman, 1892, pl. 52,15–16).

### Subfamily WITCHELLIINAE Callomon & Chandler, 2006

[*Witchelliinae* CALMON & CHANDLER in CHANDLER & others, 2006, p. 370]

Macroconchs smaller than those of Sonniinae, and microconchs have final adult mouth borders with lappets that are long and spatulate in some forms.

**Asthenoceras** BUCKMAN, 1899, p. xl ix [*\*Grammoceras nannodes* BUCKMAN, 1890, p. 213; OD]. Small, evolute, compressed whorls, with strong ventral keel, flanked by shallow sulci in some; inner whorls smooth, then develops striae or fine ribs. Probably dimorphic: microconchs may be complete at 15–30 mm in diameter with rudimentary lateral lappets; macroconchs poorly known, possibly 35–70 mm in diameter when complete (WESTERMANN, 1969). *Middle Jurassic (Aalenian, Murchisonae Zone–lower Bajocian, Sauzei Zone)*: England, Canada (British Columbia), USA (Alaska, Oregon).—FIG. 82,1a–b. \**A. nannodes* (BUCKMAN), lectotype, microconch, *Murchisonae* Zone, Stoford, Somerset, England,  $\times 2$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 6726).

**Fontannesia** BUCKMAN, 1902, p. 6 [*\*Dumortieria grammoceroides* HAUG, 1887, p. 137; OD] [=*Darellella* BUCKMAN, 1904a, p. cvii (type, *D. recticostata*, OD); =*Nannoceras* BUCKMAN, 1923b, pl. 445 (type, *N. nannomorphum*, OD); =*Nannina* BUCKMAN, 1927b, pl. 752 (type, *N. evoluta*, OD)]. Almost a Bajocian homeomorph of *Grammoceras*, but attains larger sizes, whorl section is more quadrate, and some ribs usually bifurcate or are twinned at umbilical edge. Dimorphic: microconchs (*Darellella*, *Nannoceras*, *Nannina*) have narrow lateral lappets. *Middle Jurassic (Aalenian, Concavum Zone–lower Bajocian, Discites Zone–Laeviuscula Zone)*: England, France, Germany, Portugal, Spain, Turkey, China (Tibet), Borneo, New Guinea, Indonesia (Sula Islands, Maluku [Moluccas]), Western Australia, Canada (British Columbia), USA (Oregon), Argentina.—FIG. 82,2a–b. \**F. grammoceroides* (HAUG), holotype, macroconch, Dorset, England,  $\times 1$  (new, Manchester University Museum, England, L. 11252a, plaster cast of the original in Strasbourg Museum, which was destroyed by fire in 1967).—FIG. 82,2c–d. *F. recticostata* (BUCKMAN), adult microconch with small lappet, Bradford Abbas, Dorset, England,  $\times 1$  (new, Museum of Comparative Zoology, Cambridge, Massachusetts, USA, 2620; also figured in Buckman, 1904a, supplement pl. 17,10–11).

**Newmarracarroceras** HALL, 1989, p. 6 [*\*Dorsetenia clarkei* CRICK, 1894, p. 388; OD]. Whorls are evolute and discoidal; whorl section compressed oval, without an umbilical edge or separate umbilical wall, and has a rounded venter with keel bordered by grooves of variable development; flexuous ribs curving strongly forward onto venter are moderately strong on inner whorls, then diminish to striae and disappear before end of phragmocone to leave body chamber smooth and with no ventral keel; no tubercles. *Newmarracarroceras* is more compressed and lacks

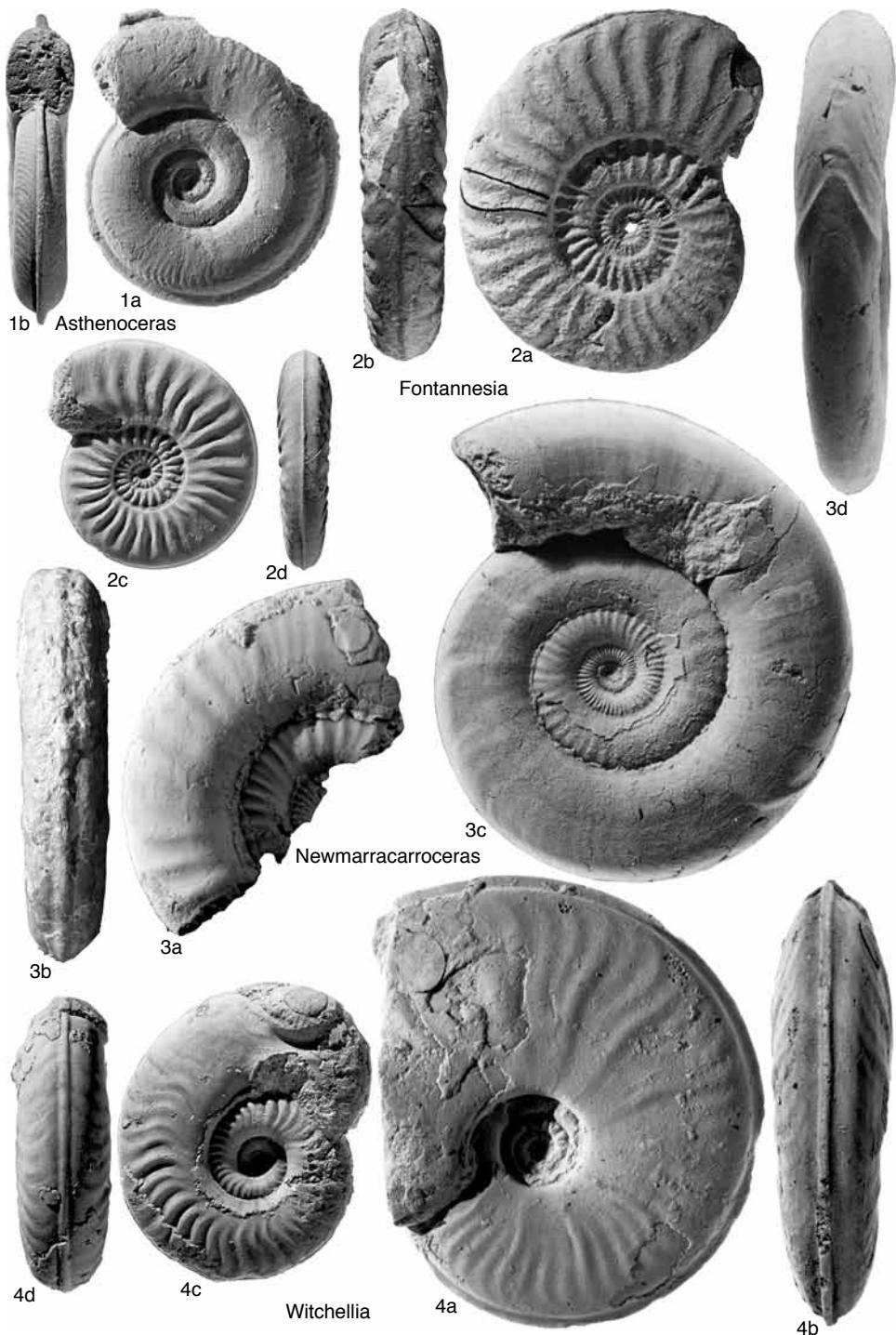


FIG. 82. Sonniniidae (p. 119).

distinct umbilical wall of *Fontannessia*, and has less strong ribbing that disappears before end of phragmocone. Middle Jurassic (lower Bajocian, Laeviuscula Zone). Western Australia.—FIG. 82,3a-d. \**N. clarkei* (CRICK), Newmarracarra Limestone, Champion Bay, Geraldton; a-b, holotype,  $\times 1$  (new, The Natural History Museum, London, C.30376); c-d, large, nearly complete example,  $\times 0.8$  (Hall, 1989, fig. 10a-b).

**Witchellia** BUCKMAN, 1889a, p. 82 [*\*Ammonites laeviusculus* J. DE C. SOWERBY, 1824, p. 73; OD] [=*Zugophorites* BUCKMAN, 1922, pl. 341 (type, *Z. zugophorus*, OD); =*Pelekodites* BUCKMAN, 1923a, pl. 399 (type, *P. pelekus*, OD); =*Hyalinites* BUCKMAN, 1924, pl. 519 (type, *H. hyalinus*, OD); =*Gelasinites* BUCKMAN, 1925b, pl. 593A (type, *G. gelasinus*, OD); =*Rubrileites* BUCKMAN, 1926, pl. 642 (type, *R. ruber*, OD); =*Anolkoleites* BUCKMAN, 1926, pl. 659 (type, *A. plenus*, OD); =*Zugella* BUCKMAN, 1927b, pl. 750 (type, *Z. connata*, OD); =*Spatulites* BUCKMAN, 1928, pl. 765 (type, *S. spatians*, OD); =*Maceratites* BUCKMAN, 1928, pl. 766 (type, *M. aurifer*, OD)]. Innermost whorls evolute, with ribs and some with lateral tubercles like *Sonninia*; middle whorls more involute and compressed, with tabulate, carinate-bisulcate or tricarinate-bisulcate venter, no tubercles, and much reduced ribs; outer whorls involute, compressed, smooth, venter subtabulate, but with high keel. Dimorphic: small microconchs, adult at 35–60 mm in diameter, are ribbed to end of body chamber, and have lateral lappets with very large spatulate ends; types of *Pelekodites*, *Macerites*, and *Spatulites* are microconchs, all others are macroconchs. *Fontannessia* microconchs are similar, and microconch generic names may not be correctly allocated between *Witchellia* and *Fontannessia*. Middle Jurassic (lower Bajocian, Laeviuscula Zone–Humphriesianum Zone): Europe, northern Africa (Atlas Ranges), Madagascar, Caucasus, Iran, China (Tibet), Japan, Western Australia, Canada (British Columbia), USA (Alaska, Oregon), Argentina.—FIG. 82,4a-b. \**W. laeviuscula* (J. DE C. SOWERBY), lectotype, macroconch, Dundry, Somerset, England,  $\times 1$  (new, The Natural History Museum, London, 43950; also figured in Sowerby, 1824, pl. 451,1).—FIG. 82,4c-d. *W. pelekus* (BUCKMAN), holotype, microconch with spatulate lappet, *Laeviuscula* Zone, Rackledown, Dundry, Somerset, England,  $\times 1.2$  (new, British Geological Survey, Keyworth, Nottingham, England, GSM 47187).

**Guhsania** MCLEAR, 1926, p. 98 [*\*G. bella*; OD]. Similar to *Witchellia*, but less involute and ribs become large and widely spaced on outer whorl. Middle Jurassic (lower Bajocian, Laeviuscula Zone): Canada (British Columbia).—FIG. 83,1a-b. \**G. bella*, holotype, Silver Lake, Hudson Bay Mountain,  $\times 0.5$  (new, from plaster cast; also figured in McLearn, 1926, pl. 25,1).

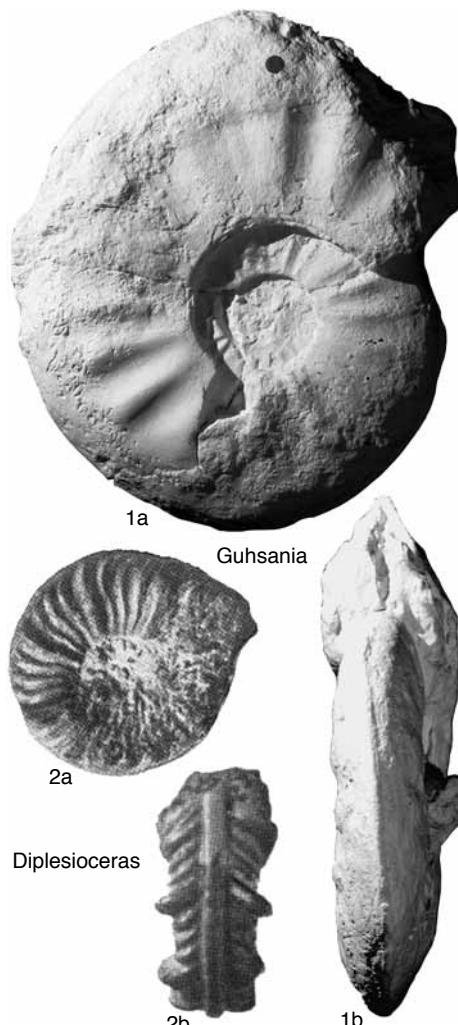


FIG. 83. Sonniniidae and Uncertain (p. 121).

## INCERTAE SEDIS IN HILDOCERATOIDEA

?*Diplesioceras* BUCKMAN, 1920, pl. 177 [*\*D. diplesium*; OD]. Founded on a single small nucleus, with thick keel, ribs, and large widely spaced ventrolateral tubercles. Affinities unknown. Middle Jurassic (upper Bajocian, Garantiana Zone): England, France, Spain.—FIG. 83,2a-b. \**D. diplesium*, holotype, Vetney Cross, Bridport, Dorset, England,  $\times 2$  (Buckman, 1920, pl. 177).

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