

# CENOMANIAN AMMONITES FROM THE CONDENSED DEPOSITS OF THE HELVETIC DOMAIN (WESTERN ALPS, FRANCE AND SWITZERLAND)

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**ABSTRACT**—The Cenomanian ammonites of the Helvetic Domain (French-Swiss Western Alps) are revised and illustrated for the first time since the middle of the Nineteenth Century. The faunas occur in remarkable condensed hemipelagic glauconite-rich biomicrites that also contain planktic foraminifera and small stromatolites. Thirty-three ammonite species referred to 15 genera are described; the assemblage extends from the lower part of the Lower Cenomanian *Mantelliceras mantelli* Zone (*Neostlingoceras carcitense* Subzone) to the lower part of the Middle Cenomanian *Acanthoceras rhotomagense* Zone (*Turritites costatus* Subzone). The assemblage comprises 57 percent trachyostracous forms, 41 percent heteromorphs of the standard N.W. European sequence, and 2 percent leiostracous forms, which inhabited an external shelf biome. The biogeographic affinity of this fauna is essentially cosmopolitan (69 percent), but 31 percent of the specimens belong to the European Boreal biota, with no Tethyan taxa.

## INTRODUCTION

THE AIM of the present paper is to describe the results of reinvestigation of the Cenomanian deposits of the Western External Alps between Chambéry (Savoie, France) and Sion (Valais, Switzerland) (Figure 1) in the southern part of the Helvetic Zone. During the Cretaceous, the Helvetic Domain connected the Jura Platform to the west to the Ultrahelvetic Basin to the east. From late Aptian to mid Cenomanian, thin (5–50 m) siliciclastic and carbonate sediments, rich in glauconite and phosphorites, were deposited in the Helvetic area. These condensed deposits overlie shallow-water Urgonian Limestones (Barremian to early Aptian), and are overlain by the late Cenomanian to Santonian pelagic biomicrites of the Seewen Limestones. The Cenomanian deposits described here form the transition between the Albian phosphate-rich greensands (Lindars sandstones: Delamette, 1988) and the Turonian biomicrites.

## PREVIOUS WORKS

The Cenomanian deposits of the Helvetic Domain were first mentioned by Brongniart (1822). On the basis of phosphatized faunas collected from the “Rochers des Fiz” (Platé Massif, Haute-Savoie), he recognized *Ammonites varians*, now known to be a Lower Cenomanian *Schloenbachia* species. But the earliest illustrations of Cenomanian ammonites from the region were given twenty-five years later in the classic monographs of Pictet and Campiche (1858–1860) and Pictet and Renevier (1866). Most came from the famous outcrop at Cheville (Morcles Massif, Valais), described by Renevier (1866). At this time, the anomalous occurrence of Cenomanian ammonites mixed up with Upper Albian ones was the point of origin of a lengthy dispute about the stratigraphical position of the “Vraconian” faunas of early workers (see discussion in Breistroffer, 1940).

In spite of these early publications, the Cenomanian deposits in the Helvetic domain sank into oblivion for about half a century. During this time, a number of authors, probably misled by the thinness and patchy distribution of these deposits, introduced the concept of a Senonian transgression in the area, above Albian deposits (e.g., Revil, 1910–1913). In later publications (e.g., Tolun, 1948; Carozzi, 1951; Rosset, 1957; Charollais, 1966), Cenomanian planktonic foraminifers were identified together with ammonites, but no illustrations were given. Indeed, no general study of the Helvetic Cenomanian deposits and their faunas has been published this century.

## CHARACTERISTICS OF HELVETIC CENOMANIAN

The Cenomanian of the Helvetic Zone is characterized by hemipelagic glauconitic biomicrites with phosphatic nodules, passing upwards into pelagic biomicrites rich in globotruncanids and calcisphaerulids. This succession is frequently interrupted by gaps and erosional unconformities extending from the early Cenomanian to the late Turonian. Three main facies can be recognized: 1) fossiliferous condensed glauconitic limestones: the Fiz Limestones (Delamette, 1988); 2) remanié conglomerates with a Cenomanian micritic matrix enclosing Albian ammonites as clasts: the Bargy Conglomerate; and 3) foraminiferal biomicrites without glauconite or phosphorite: the Cushmani Biomicrites.

*The Fiz Limestones.*—This facies ranges from a few centimeters up to three meters in thickness, and is biomicrite rich in coarse grains of black glauconite and sparse quartz grains (Figure 6.1). The biophase comprises calcisphaerulids (e.g., *Bonetocardiella conoidea*), globotruncanids, sparse benthic foraminifera (e.g., *Lenticulina*, *Marsonella*), and fragments of echinoderms. The macrofauna, more-or-less phosphatized, includes ammonites as described below, semi-infaunal echinoids (*Holaster*), rare unidentified belemnites, and the hydrozoan *Parakeria* (Delamette et al., 1983).

In most outcrops, the Fiz Limestones yield only Lower Cenomanian ammonites and overlie a phosphatic conglomerate yielding a condensed Upper Albian ammonite assemblage (*Mortonoceras inflatum* Zone and part of the *Stoliczkaia dispar* Zone; Figure 5.1). In the south of the Platé Massif (see Rochers des Fiz in Figure 2), however, they begin with a highly glauconitic biomicrite containing uppermost Albian ammonites such as *Mariella bergeri* (Brongniart, 1822) and *Stoliczkaia* of the *dorsetensis* group, mixed in with lowermost Cenomanian ammonites (Figure 5.2).

The Fiz Limestones are only present in an area comprising the massifs of Morcles, Dents du Midi, Haut-Giffre, Platé, and Aravis (Figure 1). Even within this area, these limestones have a patchy distribution because of local gaps. In fact, detailed correlation between outcrops show that these gaps represent no more than the ultimate evolution of increasing condensation. This lateral evolution is recorded by a progressive reduction of the thickness of the glauconitic biomicrites and the development of small stromatolites (Figure 5.3). In some outcrops, these microbial build-ups may characterize nearly all the Cenomanian

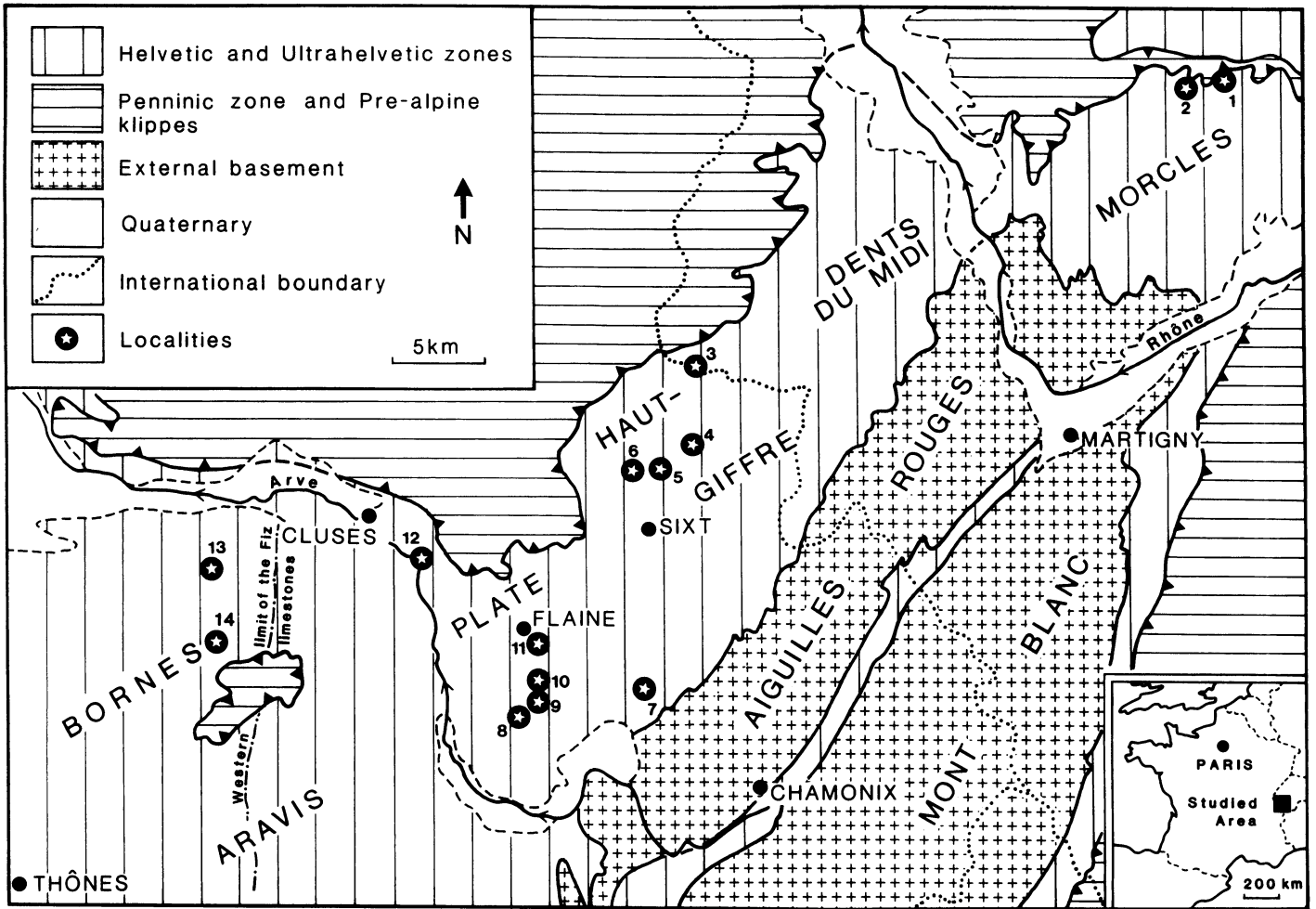


FIGURE 1—Geological sketch map of the study area, adapted from Gidon (1979), showing the location of the main Cenomanian fossiliferous sections mentioned in the text. 1, Cheville; 2, Ecuelle; 3, Lanche des Aux (=Bossetan of authors); 4, Avoudrués; 5, Pointe de l'Ecorchoir; 6, Chalets de Criou; 7, Rochers des Fiz; 8, Barmerousse; 9, Sautet; 10, Lindars; 11, Flaine; 12, Arberroz; 13, Bourgets (=Mt Saxonnet of authors); 14, Colombière.

deposits (Figure 3). The ultimate expression of this condensation is recorded by the trapping of the Cenomanian biomicrites in Upper Albian cavernous phosphorites that are immediately overlain by Turonian biomicrites (Figures 4, 5.4).

**The Bargy Conglomerate.**—West towards Aravis, the Fiz Limestones disappear (see Figure 1), and the top of the mid-Cretaceous deposits, overlain by Turonian biomicrites, is a polyzonal phosphatic conglomerate. This is usually highly fossiliferous, containing reworked Lower, Middle, and Upper Albian ammonites set in an uppermost Albian to Upper Cenomanian micritic matrix (Figure 5.5). Most of the fossils illustrated in the classic work of Pictet and Roux (1847–1854) were extracted from this conglomerate (e.g., the outcrops of Mont Saxonnet, Gaudonière, Reposoir). Detailed study shows that the passage from the Fiz Limestones to the Bargy Conglomerate is due to erosional unconformities cutting down into the Lindars Sandstones (see the Colombière section in Figure 2). On the basis of the microfaunal content of the matrix, the first reworking of Albian phosphatic sediment took place at the end of the Albian (top of the *appenninica* Zone) and persisted in some places until the Turonian (*helvetica* Zone).

**The *Cushmani* Biomicrites.**—The mid-Cretaceous glauconitic and phosphatic deposits are usually overlain by the Turonian

biomicrites of the Seewen Limestones. But in some places (especially in the northeastern part of the area studied here) the base of the Seewen Limestones is older and belongs to the *cushmani* Zone (Figure 6.5). The distribution of these biomicrites is very patchy. No logical sedimentary framework can be detected except for a better development from SW to NE, i.e., from the proximal to distal parts of the shelf.

AMMONITE FAUNAS

**Age.**—Ammonites from the Helvetic Cenomanian can be dated in terms of the standard zonation developed for the Anglo-Paris Basin, including the type area around Le Mans in Sarthe, France (Kennedy, 1984; Wright and Kennedy, 1984), as shown in Figure 7. Lower Cenomanian elements of the assemblage are generally phosphatized, and include indices of both the lower and upper subzones of the *Mantelliceras mantelli* Zone, as well as of the succeeding *Mantelliceras dixoni* Zone. At two outcrops, Cheville in the Morcles Massif and Arberroz in the Platé Massif, there are also unphosphatized representatives of the Middle Cenomanian, including the index and other member species of the lower *Turrilites costatus* Subzone of the *Acanthoceras rhotomagense* Zone. Tolun (1948) identified Middle to Upper Cenomanian ammonites, but we have seen no evidence for any

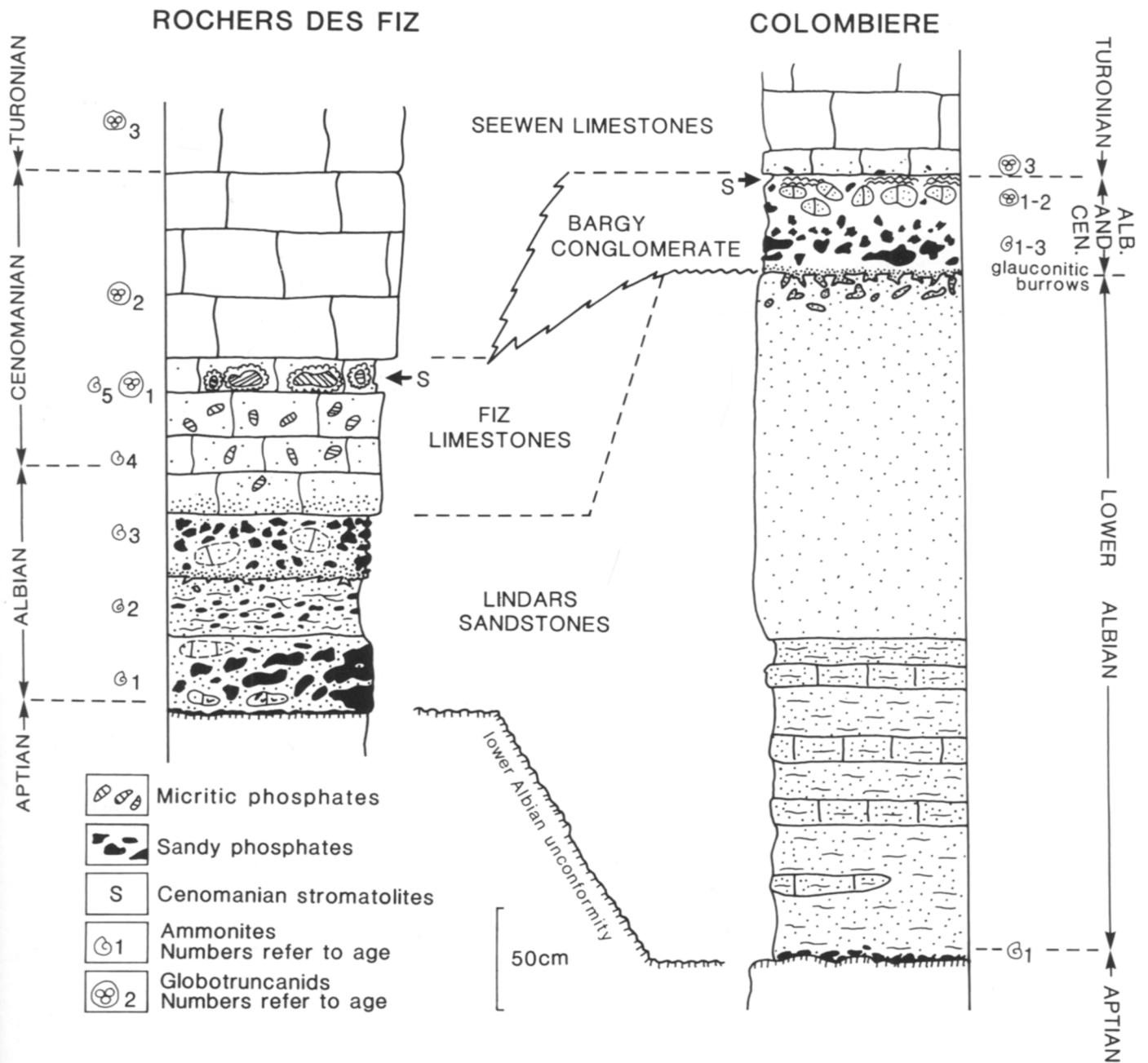


FIGURE 2—Two examples of the mid-Cretaceous succession in the Helvetic domain to show the position and facies of the Cenomanian deposits. With respect to ammonites, 1 = late *jacobi*(?) and *tardifurcata* Zones, 2 = late *mammillatum* and early *dentatus* Zones, 3 = *inflatum* and part of *dispar* Zones, 4 = late *dispar* and *mantelli-dixonii* Zones, 5 = *dixonii* Zone (?). With respect to globotruncanids, 1 = *brotzeni* and *reichli* Zones, 2 = *cushmani* Zone, 3 = *helvetica* Zone.

ammonites younger than the *costatus* Subzone. The Fiz Limestones therefore represent, when complete, a highly condensed unit extending from Upper Albian *Stoliczkaia dispar* Zone (Rochers de Fiz) to the lower part of the Middle Cenomanian *Acanthoceras rhotomagense* Zone (Cheville, Arberroz). At most outcrops, however, it yields only Lower Cenomanian ammonites resting on, and terminated by, unconformities. The fauna described below is: *Puzosia* (*Puzosia*) *mayoriana* (d'Orbigny, 1841), *Hyphoplites curvatus curvatus* (Mantell, 1822), *H. curvatus pseudofalcatus* (Semenov, 1899), *Hyphoplites curvatus ar-*

*ausionensis* (Hébert and Munier-Chalmas, 1875), *Schloenbachia varians* (J. Sowerby, 1817), *Forbesiceras largilliertianum* (d'Orbigny, 1841), *Forbesiceras beaumontianum* (d'Orbigny, 1841), *Forbesiceras chevillei* (Pictet and Renevier, 1866), *Mantelliceras mantelli* (J. Sowerby, 1814), *Mantelliceras cantianum* Spath, 1926a, *Mantelliceras picteti* Hyatt, 1903, *Mantelliceras couloni* (d'Orbigny, 1850), *Mantelliceras saxbii* (Sharpe, 1857), *Mantelliceras lymense* (Spath, 1926b) *Mantelliceras dixoni* Spath, 1926b, *Sharpeiceras laticlavium* (Sharpe, 1855), *Sharpeiceras schlueteri* (Hyatt, 1903), *Acompsoceras* sp., *Acanthoceras rho-*

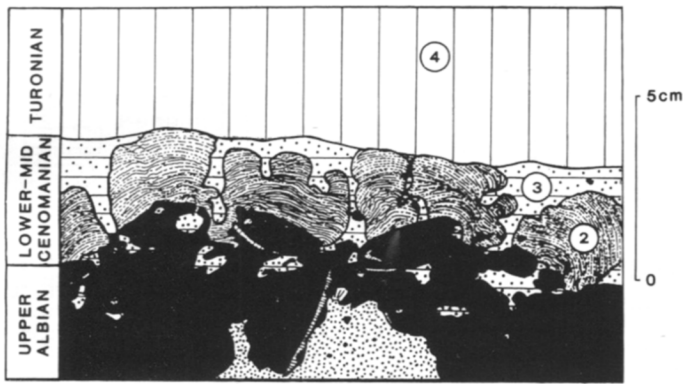


FIGURE 3—Highly condensed Cenomanian deposits (2, 3) lying between Upper Albian phosphatic conglomerate (1) and Turonian pelagic biomicrite (4). 2, small stromatolites encrusting the bioeroded top of the Albian phosphorites and 3, a glauconitic biomicrite with Lower Cenomanian globotruncanids (e.g., *Rotalipora brotzeni*) (drawn from a polished slab from Grandes-Platières in the Platé Massif).

*tomagense* (Brongniart, 1822), *Cunningtoniceras cunningtoni* (Sharpe, 1855), *Cunningtoniceras inerme* (Pervinquier, 1907), *Anisoceras* cf. *perarmatum* Pictet and Campiche, 1861, *Anisoceras cherixi* Pictet and Renevier, 1866, *Turrilites* (*Turrilites*) *costatus* Lamarck, 1801, *Turrilites* (*Turrilites*) *scheuchzerianus* Bosc, 1801, *Neostlingoceras carcitense* (Matheron, 1842), *Hypoturrilites gravesianus* (d'Orbigny, 1842), *H. gravesianus bettraensis* Collignon, 1964, *Hypoturrilites* sp., *Mariella* (*Mariella*) cf. *gallienii* (Boule, Lemoine and Thévenin, 1906), *M. (M.)* sp. a, *Sciponoceras roto* Cieśliński, 1959, *S. baculoide* (Mantell, 1822), and *Scaphites* (*Scaphites*) *obliquus* J. Sowerby, 1813.

**Biogeographic affinities.**—More than 300 specimens were identified during the course of this study, and these form the basis for the quantitative generic composition given in Table 1.

The Cenomanian ammonite assemblage of the Helvetic domain is thus dominated by trachyostracous forms (57 percent) and heteromorphs (41 percent), whereas leiostracous forms are practically missing (2 percent, exclusively desmoceratids). Taking into account the accompanying faunas (virtually monospecific macrobenthos, pelagic hydrozoans), the ammonite assemblage is clearly related to an external shelf biome. It has a distinctive composition characterized by the abundance of heteromorphs, especially turrilitids (17.6 percent) and baculitids (12.7 percent). The same trend was noted by Juignet and Kennedy (1976) in Cenomanian condensed levels in the Anglo-Paris Basin.

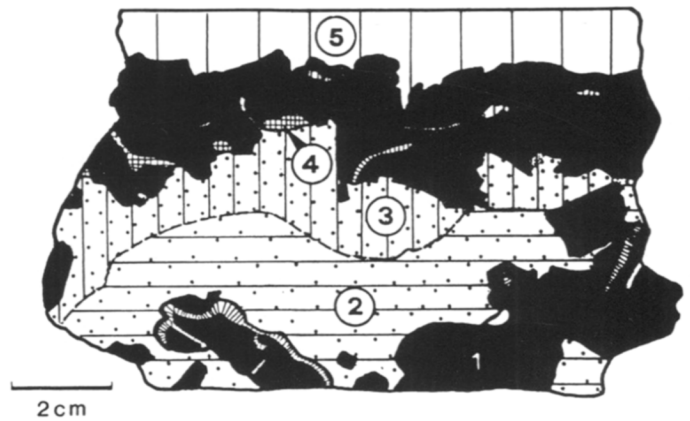


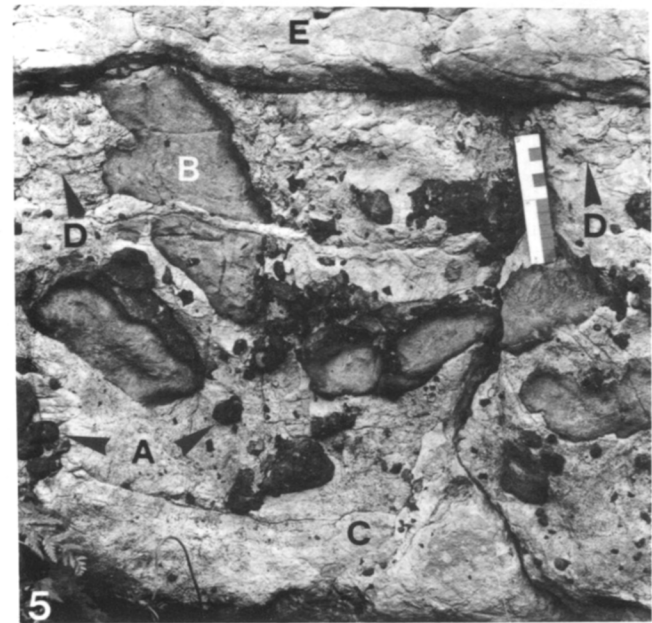
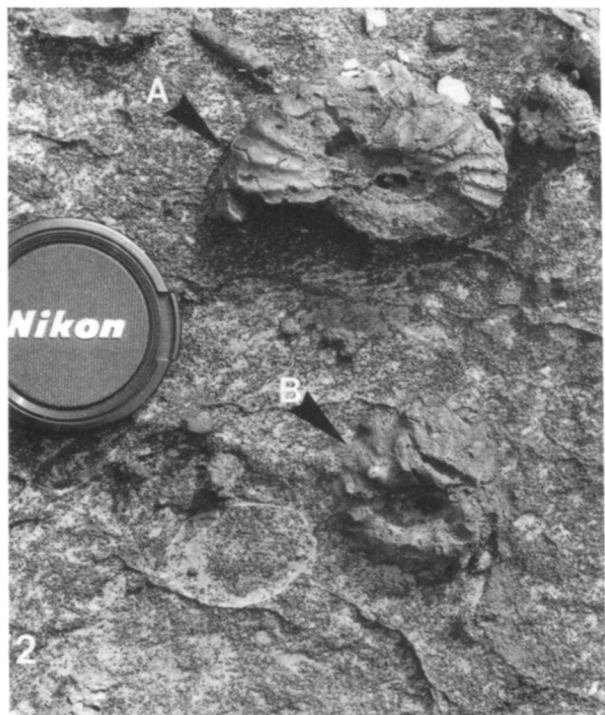
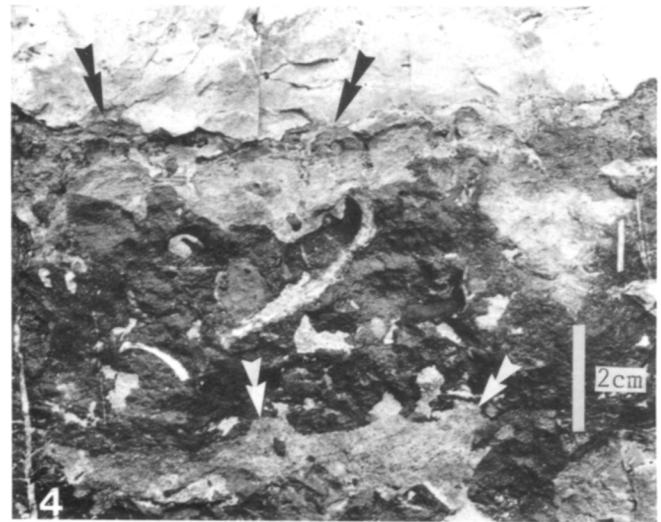
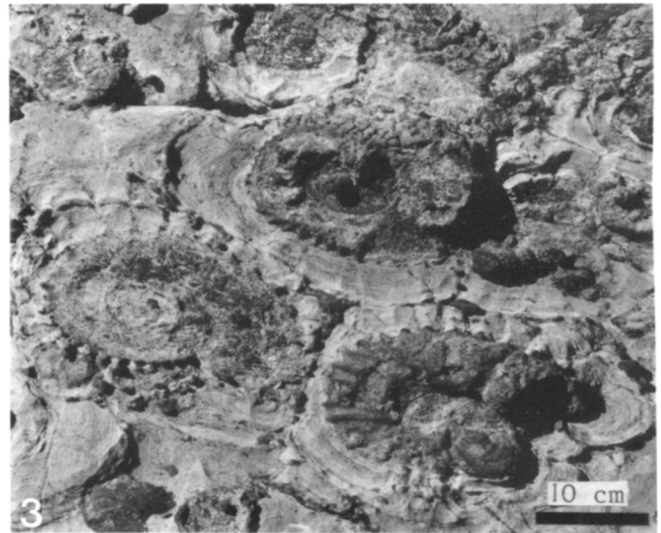
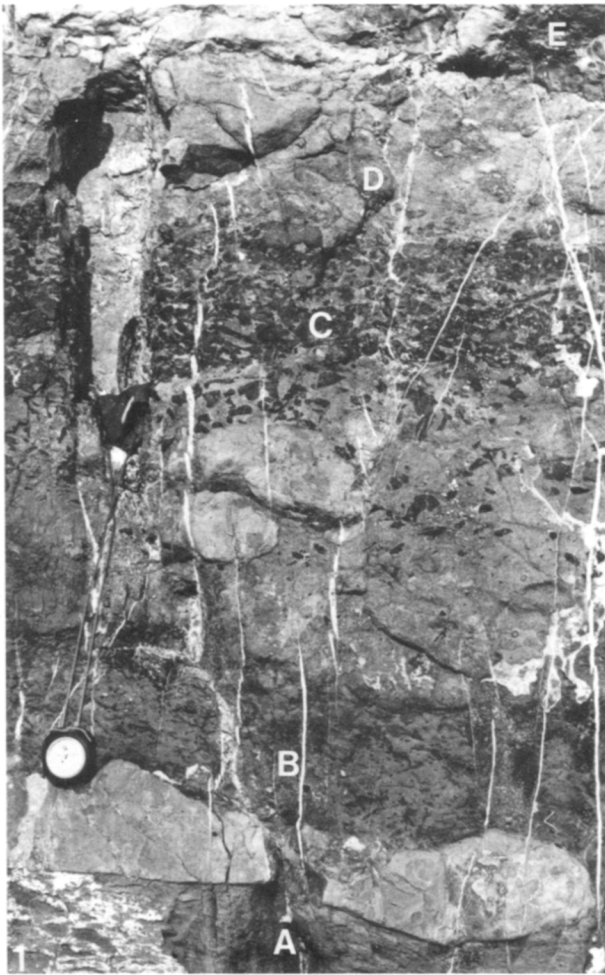
FIGURE 4—Cenomanian internal sediments (2–4) trapped in an Upper Albian phosphatic crust (1) immediately overlain by Turonian biomicrite (5). 2, 3, glauconitic biomicrites with different phosphate contents; 4, void-filling sparry calcite at the top of the cavernous phosphorite. (Drawn from a polished slab from Grand-Grenier in the Platé Massif.)

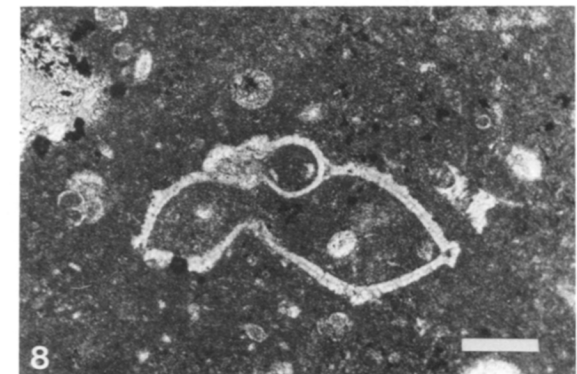
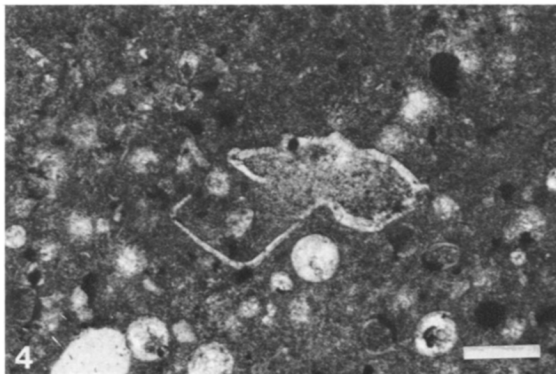
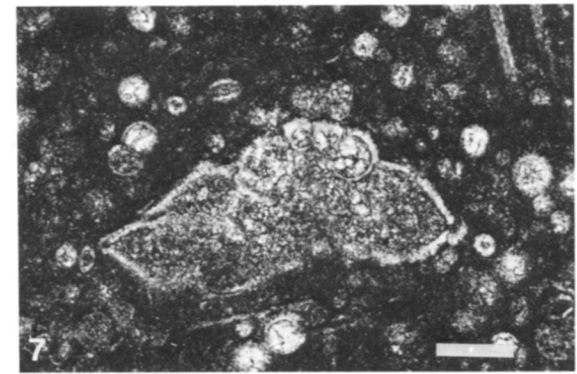
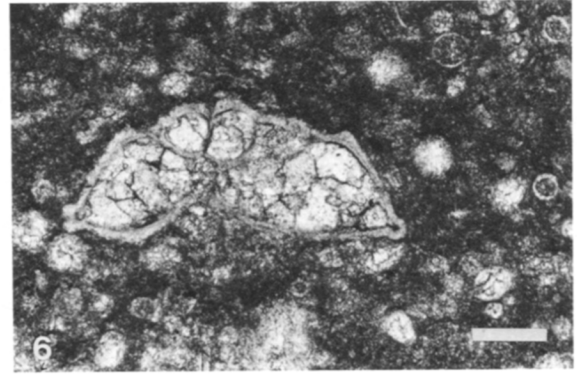
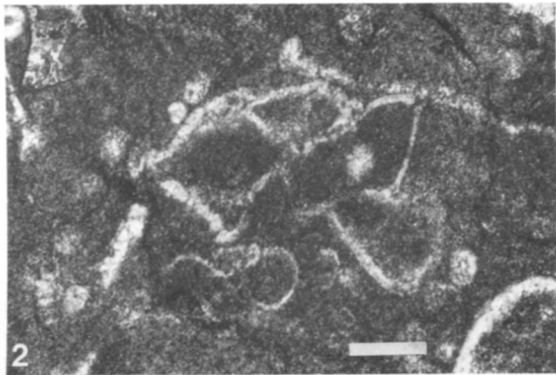
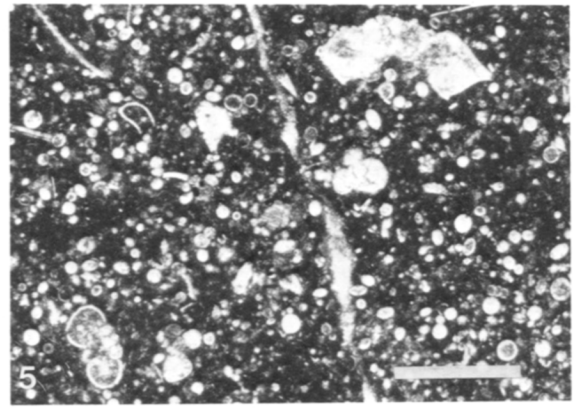
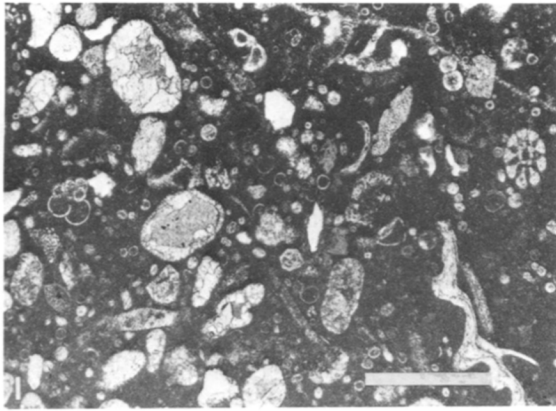
In terms of biogeographic affinities, abundance of *Schloenbachia* (28 percent) places the fauna within the northwest European hoplitid province, with strong links with faunas of the Anglo-Paris Basin, the Germanies, the southern USSR and northern Iran (Juignet and Kennedy, 1976, fig. 20). During the Cenomanian, the Helvetic area was thus located in the southern part of the European Boreal Realm. Mediterranean influences, although well marked in the Upper Albian ammonite assemblages of the area (Delamette, 1988), are weak in the Cenomanian (few desmoceratids and a lack of phylloceratids, gaudryceratids, and tetragonitids). This Boreal Cenomanian ammonite influx could be related to the cooling phase at the end of the Albian indicated by isotopic analyses from the Briançonnais domain (Bourbon, 1980), as could the post-Albian decline of presumably stenothermal Mediterranean ammonites in the Cenomanian assemblage of the Helvetic Domain.

#### PLANKTIC FORAMINIFERA

In contrast to ammonites, which are only preserved in the Fiz Limestones, planktic foraminifera are present in all three facies recognized, and include indices of the standard zonal scheme (Figure 7). Because of the strong condensation of the Cenomanian deposits in the Helvetic Domain, the distinction between *brotzeni* and *reicheli* Zones was not possible because

FIGURE 5—Facies of the Cenomanian deposits in the southern part of the Helvetic Domain. 1, stratigraphic position of the Fiz Limestones (D) at Lindars in the Platé Massif, Haute-Savoie. A = Middle Albian argillaceous sandstones. B = Upper Albian sandstones with glauconitic *Thalassinoides*. C = polyzonal phosphatic conglomerate (*Mortoniceras inflatum* and *Stoliczkaia dispar* Zones). D = Fiz Limestones: glauconitic biomicrites with stromatolites at the top (*Mantelliceras mantelli* and *M. dixonii* Zones). E = Turonian pelagic biomicrites (*Helvetoglobotruncana helvetica* Zone). Note the lack of *Rotalipora cushmani* Zone fossils between bed D and bed E. Scale given by the altimeter, which is 5 cm in diameter. 2, base of the Fiz Limestones at the type-locality, the Rochers des Fiz in the Platé Massif, Haute-Savoie: glauconitic biomicrites with phosphatized ammonites of the uppermost Albian (A = *Stoliczkaia* sp.) and of the Lower Cenomanian (B = *Schloenbachia varians*). Lens cap is 5 cm in diameter. 3, top of the Fiz Limestones at the type-locality: an accumulation of phosphatized ammonites (mainly *Mantelliceras*) is encrusted by stromatolites. View parallel to the stratification. 4, highly condensed Cenomanian deposits at Flaine in the Platé Massif, Haute-Savoie. These deposits are represented by small stromatolites (black arrows) encrusting the irregular top of the Upper Albian phosphatic crust and by biomicrites trapped in the cavities of the phosphatic crust (white arrows). The uppermost white level is Turonian pelagic biomicrite. 5, Bargy Conglomerate at La Gaudinière in the Bornes Massif, Haute-Savoie. A = Lower to Upper Albian phosphatic nodules, B = Upper Albian lag-nodules, C = Cenomanian glauconitic biomicrites, D = overturned Cenomanian stromatolites, E = Turonian pelagic biomicrites. Bar scale is 10 cm.





SUB-STAGE	AMMONITE ZONE	AMMONITE SUBZONE	GLOBOTRUNCANID ZONE
L TURONIAN (part)	Watinoceras coloradoense		Praeglobotruncana helvetica (part)
UPPER CENOMANIAN	Neocardioceras juddii		Whiteinella archaeocretacea
	Metoicoceras geslinianum		
	Calycoceras guerangeri		
MIDDLE CENOMANIAN	Acanthoceras jukesbrownei		Rotalipora cushmani
	Acanthoceras rhotomagense	Turrilites acutus Turrilites costatus	
LOWER CENOMANIAN	Mantelliceras dixoni		Rotalipora reicheli
	Mantelliceras mantelli	Mantelliceras saxbii	Rotalipora brotzeni
		Neostlingoceras carcitanense	
U ALBIAN (part)	Stoliczkaia dispar		

FIGURE 7—Ammonite zones and subzones and globotruncanid zones applied in the Helvetic Domain.

the diagnostic species of these two zones are always mixed together. In the Bargy Conglomerate, marker species of all the Cenomanian globotruncanid zones may co-occur (Figure 2), although *cushmani* and *archaeocretacea* Zone forms are often absent. In some outcrops (Rochers de Fiz: see Figure 2) the *cushmani* biomicrites form the base of the Seewen Limestones and overlie the condensed *brotzeni-reicheli* glauconitic biomicrites.

Where planktic forams were identified in the infillings of ammonite phragmocones, the age given by these microfaunal markers is the same as that of the ammonites. For instance, *Rotalipo-*

*ra reicheli* was identified in the matrix of a *Cunnintonoceras* (Figure 6.2).

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FIGURE 6—Microfacies and planktic foraminifers of the Cenomanian in the southern part of the Helvetic Domain. 1, microfacies of the Fiz Limestones: slightly phosphatized biomicrites with more-or-less calcitized coarse glauconite grains, calcisphaerulids, globotruncanids, and echinoderm debris. Bar scale is 1 mm. Thin section MD 2158a, from the Montagne de Chérente, Aravais Massif, Haute-Savoie. 2–4, rotaliporids from the Fiz Limestones (bar scales are 100 μm). 2, *Rotalipora* cf. *reicheli* trapped in the phosphatized infill of a Middle Cenomanian ammonite (*Cunnintonoceras inerme*, from the *Acanthoceras rhotomagense* Zone). Thin section MD 1336, from Cheville, Morcles Massif, Valais. 3, *Rotalipora* cf. *montsalvensis* trapped in a stromatolite. Thin section MD 2988, from Arberroz, in the Platé Massif, Haute-Savoie. 4, *Rotalipora appenninica*, locality as for 3. 5, microfacies of the Cushmani Biomicrites: calcisphaerulid-rich biomicrites with *Rotalipora cushmani*. Bar scale is 100 μm. Thin section MD 2306 from the Combes aux Puaires, Haut-Giffre Massif, Haute-Savoie. 6–8, rotaliporids from the Cushmani Biomicrites (bar scales are 100 μm). 6, *Rotalipora cushmani*, thin section MD 2303, locality as for 5. 7, *Rotalipora* cf. *gandolfii*, thin section MD 2683, from the Fenêtres à Grappins, Haut-Giffre Massif, Haute-Savoie. 8, *Rotalipora* cf. *montsalvensis*, thin section MD 3082, from the Montagne de Foillis, Haut-Giffre Massif, Haute-Savoie.

TABLE 1—Composition, in percent, of Helvetic Domain Cenomanian ammonite faunas.

<i>Hyphoplites</i> :	2.5
<i>Schloenbachia</i> :	28.5
<i>Mantelliceras</i> :	16.5
<i>Sharpeiceras</i> :	0.9
<i>Acanthoceras</i> :	0.3
<i>Cunningtoniceras</i> :	6.2
<i>Acompsoceras</i> :	0.3
<i>Forbesiceras</i> :	0.9
<i>Puzosia</i> :	1.9
<i>Mariella</i> :	4.0
<i>Hypoturrilites</i> :	7.1
<i>Neostlingoceras</i> :	6.2
<i>Turrilites</i> :	10.3
<i>Scaphites</i> :	0.6
<i>Sciponoceras</i> :	12.7

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## REPOSITORIES OF SPECIMENS

BMNH: British Museum (Natural History), London; EMP: collections of the École des Mines, Paris, now in the Université Claude Bernard, Lyon; GSM: British Geological Survey and Museum collections, Keyworth; MGL: Musée de Géologie, Lausanne (Renevier and Collet collections); MHNG: Muséum d'Histoire Naturelle, Geneva (Pictet, Favre, Tolun, Jayet, and Delamette collections); MNHP: Muséum National d'Histoire Naturelle, Paris; SP: collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris.

## SYSTEMATIC PALEONTOLOGY

Superfamily DESMOCERATACEAE Zittel, 1895

Family DESMOCERATIDAE Zittel, 1895

Family PUZOSIINAE Spath, 1922a

Genus PUZOSIA Bayle, 1878

Subgenus PUZOSIA (PUZOSIA) Bayle, 1878

*Type species*.—*Ammonites planulatus* J. de C. Sowerby, 1827, p. 134, Pl. 570, fig. 5, non Schlotheim, 1820, p. 59 = *Ammonites mayorianus* d'Orbigny, 1841, p. 267, Pl. 79, figs. 1–3. Wright and Kennedy (1984, p. 54) clarified the name of the type species.

PUZOSIA (PUZOSIA) MAYORIANA (d'Orbigny, 1841)

Figure 8.26

*Ammonites planulatus* J. DE C. SOWERBY, 1827, p. 597, Pl. 570, fig. 5 (non Schlotheim, 1820, p. 59).

*Ammonites Mayorianus* D'ORBIGNY, 1841, p. 267, Pl. 79, figs. 1–3.

*Puzosia (Puzosia) mayoriana* (d'Orbigny). WRIGHT AND KENNEDY, 1984, p. 55, Pl. 3, figs. 1, 2, 4, 6, 9–12, Pl. 4, figs. 1, 2, 5–7, text-figs. 1A, B, 2C, H, M, 3N–R, 4A–E (with full synonymy); COOPER AND KENNEDY, 1987, p. 106, figs. 1–7, 9, 10.

*Puzosia (Puzosia) cf. subplanulata* (Schlüter, 1871). IMMEL AND SEYED-EMAMI, 1985, p. 91.

*Lectotype*.—By the subsequent designation of Wright and Kennedy (1984, p. 56) for clarification.

*Collection*.—Two specimens, MGL 42895, the original of Pictet and Renevier (1866, Pl. 4, fig. 1) and MGL 42894, both from Cheville.

*Discussion*.—Both specimens are distorted, but show coiling, whorl section, constrictions and ribbing typical of this species. Both appear to be incomplete macroconchs. Differences from other species are given by Wright and Kennedy (1984, p. 57).

*Occurrence*.—Upper Albian to Upper Cenomanian. In the Cenomanian there are records from many parts of Europe, Africa, southern India, and Japan.

Superfamily HOPLITACEAE H. Douvillé, 1890

Family HOPLITIDAE H. Douvillé, 1890

Subfamily HOPLITINAE H. Douvillé, 1890

Genus HYPHOPLITES Spath, 1922b

*Type species*.—By original designation: *Ammonites falcatus* Mantell, 1822, p. 117, Pl. 21 figs. 6, 12.

HYPHOPLITES CURVATUS CURVATUS (Mantell, 1822)

Figures 8.1–8.5

*Ammonites curvatus* MANTELL, 1822, p. 118, Pl. 12, fig. 18; PICTET AND CAMPICHE, 1858–1860 p. 210 (pars), Pl. 27, fig. 11 only.

*Hyphoplites curvatus curvatus* (Mantell). KENNEDY AND JUIGNET, 1984, p. 117, figs. 8k–n, 10a–c, 11a–c; WRIGHT AND KENNEDY, 1984, p. 71, Pl. 7, figs. 1, 5, 6, 8–10, Pl. 18, figs. 2, 4, 8, 12, 14; text-figs. 6F–L, 9F–H (with full synonymy).

*Hyphoplites curvatus* (Mantell). IMMEL AND SEYED-EMAMI, 1985, p. 93, Pl. 1, fig. 8.

*Holotype*.—By monotypy BMNH 5739, from the Lower Cenomanian Chalk Marl of Hamsey, near Lewes, Sussex, the original of Mantell, 1822, p. 118, Pl. 21, fig. 18.

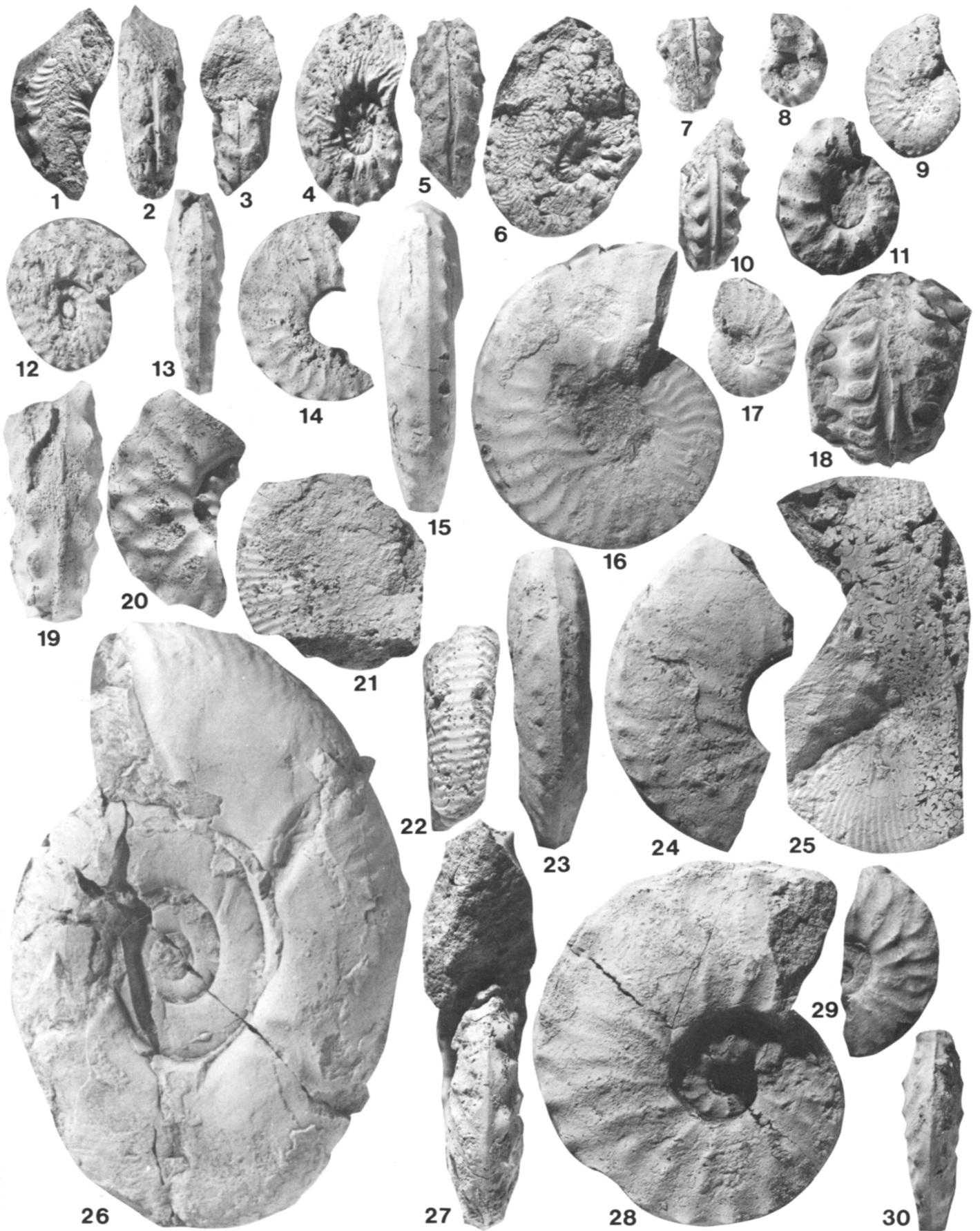
*Collections*.—Four specimens: MHNG 19305 from the Rochers des Fiz, the original of Pictet and Campiche, 1858–1860, Pl. 27, fig. 11; MHNG 1295 from Arberoz, both in the Platé Massif, Haute-Savoie; MGL 42880 and 42881, both from Cheville, Morcles Massif, Valais.

*Discussion*.—*Hyphoplites curvatus curvatus* is compressed and involute with prominent umbilical and inner and outer ventrolateral tubercles. Fine ribs link the umbilical bullae to the inner ventrolaterals, with some ribs extending into the interspaces between the inner ventrolaterals. It is easily separated from other members of the genus: *H. curvatus arausionensis* (Hébert and Munier-Chalmas, 1875) is much more compressed, lacks prominent umbilical bullae, and has weak or no inner ventrolateral tubercles.

*Occurrence*.—The subspecies ranges throughout the Lower Cenomanian. It occurs widely in southern England, from Devon, Dorset, and Somerset to Kent and the Chilterns. In France it is known from the Boulonnais and Haute Normandie to Cassis (Bouches-du-Rhône). There are also records from the Germa-

FIGURE 8—1–5, *Hyphoplites curvatus curvatus* (Mantell, 1822). 1, 2, MHNG 1295; 3–5, MHNG 19305, the original of Pictet and Campiche, 1858–1860, Pl. 27, fig. 11. 6, *Hyphoplites curvatus pseudofalcatus* (Semenov, 1899), MHNG 1276. 7–20, 23, 24, 27–30, *Schloenbachia varians* (J. Sowerby, 1817). 7, 8, MHNG 1234; 9, MHNG 1245; 10, 11, MHNG 1248; 12, MHNG 1244; 13, 14, MHNG 1231; 15, 16, MHNG 19442, the holotype of *Ammonites tollotianus* Pictet, 1847, p. 109, Pl. 10, fig. 5; 17, MHNG 1246; 18, MHNG 1247; 19, 20, MHNG 1232; 23, 24, MHNG 1264; 27, 28, MHNG 1230; 29, 30, MHNG 1269. 21, 22, *Forbesiceras beaumontianum* (d'Orbigny, 1841), MHNG 1271. 25, *Forbesiceras largilliertianum* (d'Orbigny, 1841), MHNG 1270. 26, *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841), MGL 42895. All figures are natural size.





nies, Transcaspiya, the Crimea, and Kopet-Dag in the U.S.S.R. and Iran north of the Zagros.

HYPHOPLITES CURVATUS PSEUDOFALCATUS  
(Semenov, 1899)  
Figure 8.6

*Hoplites pseudofalcatus* SEMENOV, 1899, p. 129.

*Hyphoplites curvatus pseudofalcatus* (Semenov). KENNEDY AND JUIGNET, 1984, p. 118, figs. 3k–m, 8a, b, d–f; WRIGHT AND KENNEDY, 1984, p. 72, Pl. 6, fig. 7, Pl. 7, figs. 4, 7, 11, 13, Pl. 8, figs. 3, 5, 9, text-figs. 6A–E, 7A–D, 8C, 9K (with full synonymy).

*Hyphoplites pseudofalcatus* (Semenov). IMMEL AND SEYED-EMAMI, 1985, p. 91, Pl. 1, fig. 3.

**Lectotype.**—By the subsequent designation of Wright and Wright, 1949, p. 486, the original of Sharpe, 1853, Pl. 7, fig. 5, from the Lower Cenomanian Chalk Marl of the Clayton Tunnel, Sussex. The original specimen is in the Brighton Museum (see Wright and Kennedy, 1984, Pl. 6, fig. 7).

**Collection.**—One specimen, MHNG 1276 from the Rochers des Fiz, Platé Massif, Haute-Savoie.

**Discussion.**—Although distorted, this specimen clearly belongs to the subspecies *pseudofalcatus*. It is much more compressed than *H. curvatus curvatus*, has much weaker umbilical bullae, and lacks an inner ventrolateral tubercle. The presence of an outer ventrolateral tubercle linking several of the fine falcooid ribs differentiates it from *Hyphoplites costosus* Wright and Wright, 1949.

**Occurrence.**—Rare in the *Mantelliceras mantelli* Zone of Devon, Dorset, the Isle of Wight, Wiltshire, Hampshire, Sussex, and Kent in England, Sarthe in France, Transcaspiya and Kopet-Dag in the U.S.S.R., and Iran north of the Zagros.

HYPHOPLITES CURVATUS ARAUSIONENSIS  
(Hébert and Munier-Chalmas, 1875)

*Ammonites arausionensis* HÉBERT AND MUNIER-CHALMAS, 1875, p. 115, pars, Pl. 4, fig. 5 only.

*Hyphoplites curvatus arausionensis* (Hébert and Munier-Chalmas). WRIGHT AND KENNEDY, 1984, p. 72, Pl. 8, figs. 1, 6, 7, 10, 11, 13, 15, 16, Pl. 19, figs. 1–14, text-figs. 7L–N, 8D, 9E, J, L, M (with full synonymy).

*Hyphoplites arausionensis arausionensis* (Semenov, 1899). IMMEL AND SEYED-EMAMI, 1985, p. 92, Pl. 1, fig. 5.

*Hyphoplites arausionensis crassofalcatus* (Semenov, 1899). IMMEL AND SEYED-EMAMI, 1985, p. 92, Pl. 1, fig. 6.

*Hyphoplites arausionensis horridus* Wright and Wright, 1951. IMMEL AND SEYED-EMAMI, p. 93, Pl. 1, fig. 7.

**Lectotype.**—The original of Hébert and Munier-Chalmas 1875, Pl. 4, fig. 5, by the subsequent designation of Wright and Wright, 1949, p. 491, an unregistered specimen in the Sorbonne Collections, now in the Université Pierre et Marie Curie, Paris. From Gacé, Orne, France.

**Collections.**—Two specimens: MHNG 52474 from the Roches de Fiz and MHNG 52486 from Arberroz, both in the Platé Massif, Haute-Savoie.

**Discussion.**—Although too poorly preserved for illustration, these specimens show an ornament of strong umbilical tubercles, inner and outer ventrolateral clavi, linked by broad single ribs. Absence of fine ribs on the flank of the phragmocone readily distinguishes them from *H. c. curvatus* and *H. c. pseudofalcatus*, described above.

**Occurrence.**—This subspecies ranges throughout the Lower Cenomanian and has a wide geographic range, from Devon to Kent and the Chilterns in southern England to the Boulonnais, Normandie, Sarthe, Maine, and Provence in France, Transcaspiya and the Kopet-Dag in the U.S.S.R., and Iran north of the Zagros.

Family SCHLOENBACHIIDAE  
Parona and Bonarelli, 1897

**Remarks.**—For discussion see Kennedy et al., 1979, p. 28.

Genus SCHLOENBACHIA Neumayr, 1875  
(=*Hystrichoceras* Hyatt, 1900;  
*Saltericeras* Atabekian, 1960)

**Type species.**—By the subsequent designation of H. Douvillé, 1890 (p. 290): *Ammonites varians* J. Sowerby, 1817, p. 169, Pl. 176.

**Discussion.**—The wide intraspecific variation shown by species of this genus is well known, following discussions by Juignet and Kennedy (1976), Kennedy et al. (1979), Marcinowski (1980), Hiss (1982), and Kennedy and Juignet (1984). Following these authors, only one species is recognized among the present collection: the Lower Cenomanian *S. varians* (J. Sowerby, 1817).

SCHLOENBACHIA VARIANS (J. Sowerby, 1817)  
Figures 8.18–8.20, 8.23, 8.24, 8.27–8.30, 9.22

*Ammonites varians* J. SOWERBY, p. 169 (pars), Pl. 176, uppermost figure, figure in row below, right-hand figure in row below.

*Ammonites varians* var. *subplana* MANTELL, 1822, p. 166, Pl. 21, fig. 2.

*Ammonites varians* var. *intermedia* MANTELL, 1822, p. 166, Pl. 21, figs. 5, 7.

*Ammonites varians* var. *tetramata* J. DE C. SOWERBY, 1828, p. 166, Pl. 587, fig. 2.

*Ammonites tollotianus* PICTET, 1847, p. 109, Pl. 10, fig. 5.

*Ammonites coupei* var. *inflata* SHARPE, 1853, p. 24, Pl. 8, fig. 1 (= *S. ventriosa* Stieler, 1922).

*Schloenbachia ventriosa* STIELER, 1922, p. 31.

*Schloenbachia subvarians* SPATH, 1926a, p. 81.

*Schloenbachia subvarians aperta* SPATH, 1926b, p. 430.

*Schloenbachia subvarians densicostata* SPATH, 1926b, p. 430.

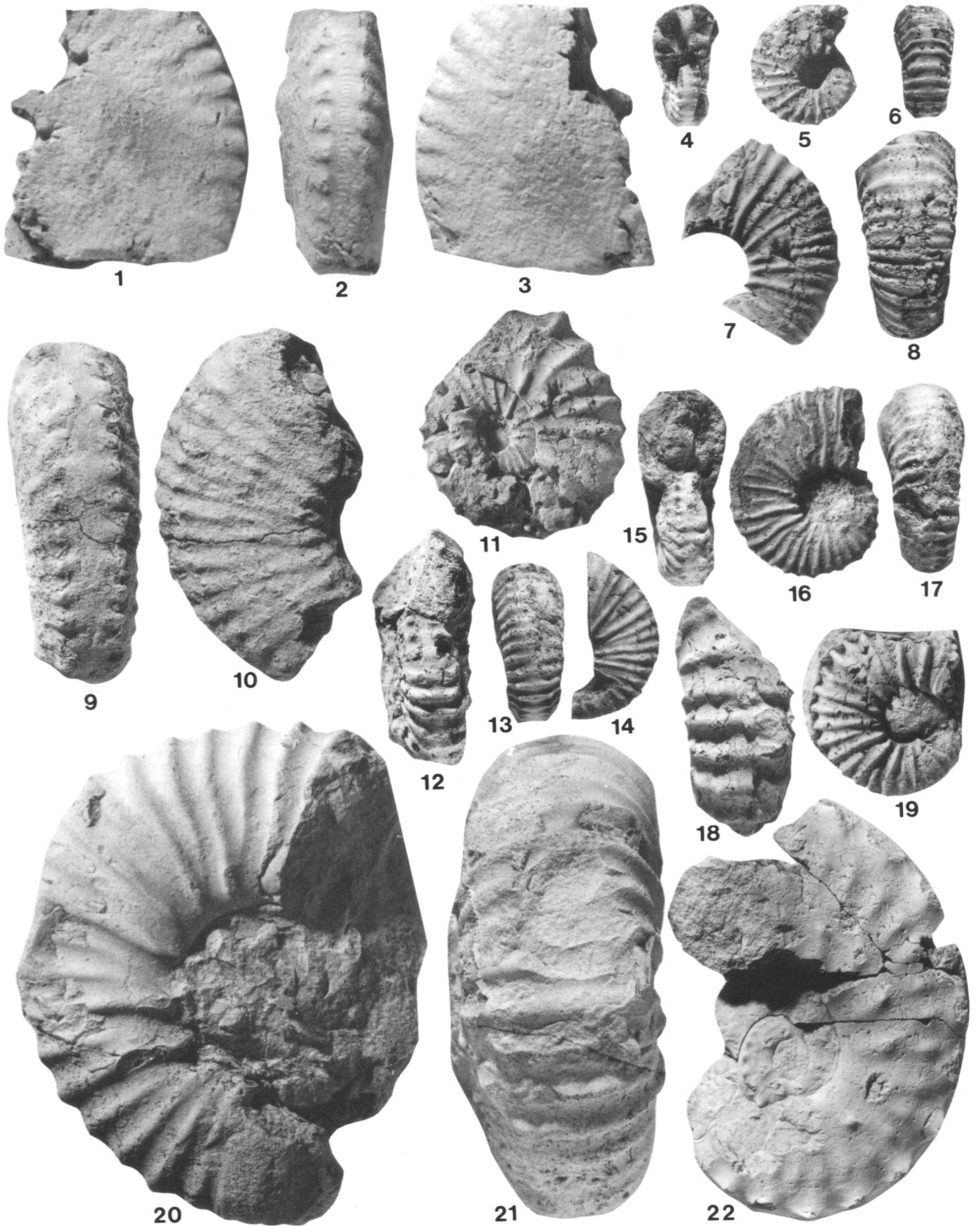
*Schloenbachia ecarinata* SPATH, 1928, p. 241.

*Schloenbachia varians* (J. Sowerby). KENNEDY AND JUIGNET, 1984, p. 123, figs. 11k, l, 12a–l, 14a–g, 15a–k, 16a–l, 17a–f, 18a, b (with full synonymy).

**Lectotype.**—by the subsequent designation of Spath, 1939, p. 544, BMNH 43962b, the original of J. Sowerby, 1817, Pl. 176, top figure, reillustrated by Kennedy and Hancock, 1978, Pl. 3, fig. 1.

**Collections.**—Seventy-three phosphatized specimens: MGL 8345a, b, 8355a, b, 8366, 8368, 43005, 43006a–e, 43007a–c, 43008a–d and MHNG 1244–1249, 19335a–d from Cheville, Morcles Massif, Valais; MHNG 1266, 1267, 1288, 19338 from the Chalets de Criou, Haute Giffre Massif, Haute-Savoie and MHNG 1272, 1273 from Barmerousse; MHNG 1230, 1232, 1234, 1254–1264 from Arberroz; MHNG 19336a, b, 1280, 1282, 1285, 1328a, b, 1333, 1335, 1339a–f from the Rochers des Fiz; MHNG 1265, 1268, 1269, 1331 from Lindars; MHNG 19442, the holotype of *Ammonites tollotianus* Pictet, 1847, p. 109, Pl. 10, fig. 5, from Flaine, Platé Massif, Haute-Savoie.

FIGURE 9—1–3, *Forbesiceras chevillei* (Pictet and Renevier, 1866), holotype, MGL 8402. 4–6, 19–21, *Mantelliceras mantelli* (J. Sowerby, 1814). 4–6, MHNG 1240; 19, MHNG 19379; 20, 21, MHNG 19401. 7, 8, 11–18, *Mantelliceras couloni* (d'Orbigny, 1850). 7, 8, MHNG 1239; 11, 12, 18, MHNG 1322; 13, 14, MHNG 1238; 15–17, MHNG 1237. 9, 10, *Sharpeiceras laticlavium* (Sharpe, 1855), MHNG 1222. 22, *Schloenbachia varians* (J. Sowerby, 1817), MHNG 1268. All figures are natural size.



**Discussion.**—The synonymy lists only the most important specific and varietal names applied to Lower Cenomanian *Schloenbachia*, all of which are here regarded as synonyms of *S. varians*. As the figures show, there is every variation from depressed, hypernodose individuals corresponding to Stieler's *ventriosa* (Figure 8.7, 8.8, 8.18) to ribbed and tuberculate specimens like the lectotype (Figure 8.10, 8.11), those in which the whorls are compressed and ribbing is more important, corresponding to Sharpe's *subtuberculata* (Figures 8.19, 8.20, 8.29, 8.30, 9.22), to those in which ribbing is dominant and the shell compressed, corresponding to Pictet's *tolloitianus* (Figure 8.9, 8.13–8.17). These are linked by passage forms, confirming the view that only a single species is present, as previously demonstrated by Juignet and Kennedy (1976), Marcinowski (1980), Hiss (1982), Kennedy and Juignet (1984), and others. For those who wish to use varietal names for *Schloenbachia*, it should be noted that the holotype of Pictet's *Ammonites tolloitianus* represents the commonest form of this species (Figure 8.15, 8.16). It has feeble umbilical and inner lateral tubercles like individuals commonly referred to *Schloenbachia subvariens* Spath, 1926a, although it differs in detail from the missing holotype (Sharpe, 1853, Pl. 8, fig. 7), which lacks such tubercles. Individuals corresponding to the very compressed, near-smooth variant (*Schloenbachia subplana* (Mantell, 1822) and *intermedia* (Mantell, 1822)) are poorly represented in our collection; the closest fragment is shown in Figure 8.23, 8.24.

**Occurrence.**—Lower Cenomanian of the Old World Boreal Realm from Greenland to Iran north of the Zagros and the Alpes-Maritimes in France. A single specimen is known from Aquitaine and the species is absent from the Iberian Peninsula.

Superfamily ACANTHOCERATAEAE de Grossouvre, 1894  
Family FORBESICERATIDAE Wright, 1952

**Discussion.**—See Wright and Kennedy, 1984, p. 80.

Genus FORBESICERAS Kossmat, 1897  
(=*Discoceras* Kossmat, 1895; *Cenomanites* Haug, 1898;  
*Neopulchellia* Collignon, 1929)

**Type species.**—By the subsequent designation of Diener, 1925, p. 180: *Ammonites largilliertianus* d'Orbigny, 1841, p. 320, Pl. 95.

**Discussion.**—See Wright and Kennedy, 1984, p. 174.

FORBESICERAS LARGILLIERTIANUM (d'Orbigny, 1841)  
Figure 8.25

*Ammonites largilliertianus* D'ORBIGNY, 1841, p. 320, Pl. 95.  
*Forbesiceras largilliertianum* (d'Orbigny). KENNEDY AND JUIGNET, 1984, p. 143, figs. 22b–d, 25a–c, 26i, j, 27c, d, g, h, 28a–f; WRIGHT AND KENNEDY, 1984, p. 89, Pl. 11, figs. 2–6, Pl. 12, figs. 1–3, 9, Pl. 16, fig. 2, text-figs. 12A–L, 13A–S, 14A–H (with full synonymy); IMMEL AND SEYED-EMAMI, 1985, p. 97, Pl. 3, fig. 5.

**Lectotype.**—By the subsequent designation of Wright and Kennedy, 1984, p. 90; the fragment from the Rouen Fossil Bed, Côte Ste Catherine, Rouen, Seine-Maritime, France, in the d'Orbigny Collection (MNHP 6120a) refigured by Wright and Kennedy, 1984, text-fig. 12d, e.

**Collection.**—One specimen: MHNG 1270 from the Pointe de l'Ecorchoir, Haut-Giffre Massif, Haute-Savoie.

**Discussion.**—Our specimen is wholly septate and 70 mm in diameter. It shows the fine ribbing, compressed whorls, and narrow venter typical of this well-known species, closely resembling the better preserved Lower Cenomanian specimens figured by Wright and Kennedy (1984, Pl. 11, figs. 2–6).

This species is only likely to be confused with *F. beaumontianum* (d'Orbigny, 1841) (see below), from which it differs in

its narrower venter and very compressed rather than evenly elliptical whorl section, as well as in details of ornament.

**Occurrence.**—This species ranges throughout the Lower and Middle Cenomanian. It occurs widely, if rarely, in western Europe, with records from Devon, Dorset, Somerset, Wiltshire, Hampshire, the Isle of Wight, Sussex, and Kent in England. It occurs widely in France from the Boulonnais to Sarthe and Provence, northern Spain, Cressier in Switzerland, the German Federal Republic, the U.S.S.R. east to the Carpathians, north Africa, Zululand, Madagascar, and southern India.

FORBESICERAS BEAUMONTIANUM (d'Orbigny, 1841)  
Figure 8.21, 8.22

*Ammonites beaumontianus* D'ORBIGNY, 1841, p. 328, Pl. 98, figs. 1, 2.  
*Forbesiceras beaumontianum* (d'Orbigny). KENNEDY AND JUIGNET, 1984, p. 147, figs. 26d–h, 27i; WRIGHT AND KENNEDY, 1984, p. 91, Pl. 12, figs. 7, 8, Pl. 13, fig. 1, text-figs. 15A–C, 16A–F (with full synonymy).

**Lectotype.**—By the subsequent designation of Wright and Kennedy, 1984, p. 92; EMP 691, the original of d'Orbigny, 1841, Pl. 98, figs. 1, 2 from the Lower Cenomanian Craie Glauconieuse à *Pecten asper* of Lamnay, Sarthe.

**Collection.**—One specimen: MHNG 1271 from Sautet, Platé Massif, Haute-Savoie.

**Remarks.**—Our specimen is a phosphatic fragment only, but the coiling, relatively evolute for the genus, the flat-sided whorls, and broad venter crossed transversely by narrow ribs, which bear outer ventrolateral tubercles, show this to be a *F. beaumontianum* rather than *F. largilliertianum*. The species is fully discussed by Wright and Kennedy (1984, p. 92).

**Occurrence.**—This species is restricted to the lower *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone of the Lower Cenomanian where precisely dated. It is rare in southern England (Sussex, Hampshire, Devon), France (Sarthe, Var), and Madagascar.

FORBESICERAS CHEVILLEI (Pictet and Renevier, 1866)  
Figure 9.1–3

*Ammonites chevillei* PICTET AND RENEVIER, 1866, p. 102, Pl. 4, fig. 2.  
*Forbesiceras chevillei* (Pictet and Renevier). WRIGHT AND KENNEDY, 1984, p. 93, Pl. 13, fig. 2, Pl. 15, figs. 1, 2, text-fig. 17 (with synonymy).  
*Forbesiceras sculptum* Crick, 1907. IMMEL AND SEYED-EMAMI, 1985, p. 97, Pl. 3, fig. 4.

**Holotype.**—By monotypy, the original of Pictet and Renevier, 1866, Pl. 4, fig. 2, from the "couche moyenne" at Cheville Valais, Switzerland, housed in the Musée géologique de Lausanne (MGL 3402).

**Discussion.**—The holotype is a worn phosphatic fragment only. Coiling is very involute, with a tiny umbilicus. The whorl section is highly compressed with broadly rounded flanks and a narrow, flattened venter; the whorl breadth to height ratio is approximately 0.45. There are traces of fine prosiradiate ribs on the inner flank and small rounded tubercles at mid-flank. These give rise to groups of flat broad ribs that strengthen on the outer flank and terminate in long, low ventral clavi. These are linked over the venter by up to six fine transverse riblets with additional riblets in the interspaces.

**Discussion.**—Although only a fragment, the holotype shows well the distinctive ornament that links it to the extensive suite of English specimens described by Wright and Kennedy (1984). This has been a neglected species and no less than five other names have been given to it by other authors.

**Occurrence.**—Lower Cenomanian when precisely dated. The species is also known from Sussex, the Isle of Wright, and Devon in England, Nigeria, Madagascar, Spain, Zululand (South Africa), and Turkmenia (U.S.S.R.).

## Family ACANTHOCERATIDAE de Grossouvre, 1894

## Subfamily MANTELLICERATINAE Hyatt, 1903

## Genus MANTELLICERAS Hyatt, 1903

(=*Couloniceras* Busnardo, 1966; *Promantelliceras* Thomel, 1972; *Neomantelliceras* Thomel, 1972; *Bunburyiceras* Thomel, 1972)

*Type species.*—By original designation: *Ammonites mantelli* J. Sowerby, 1814, p. 119 (ICZN Specific Name No. 1634).

*Discussion.*—See Wright and Kennedy, 1984, p. 200.

## MANTELLICERAS MANTELLI (J. Sowerby, 1814)

Figure 9.4–9.6, 9.19, 9.21

*Ammonites mantelli* J. SOWERBY, 1814, p. 119, Pl. 55, lower figure only.

*Ammonites mantelli* var. *tuberculatus* MANTELL, 1822, p. 114.

*Mantelliceras indianense* HYATT, 1903, p. 115.

*Mantelliceras (Mantelliceras) laticostatum* RENZ, 1963, p. 1107, Pl. 3, fig. 2.

*Mantelliceras mantelli* J. Sowerby. COLLIGNON, 1964, p. 27, Pl. 323, fig. 1436, p. 66, Pl. 337, figs. 1506–1508, p. 68, Pl. 338, figs. 1509, 1510 (var. *percostata*).

*Mantelliceras tuberculatum* Mantell. COLLIGNON, 1964, p. 27, Pl. 323, fig. 1437, p. 68, Pl. 338, fig. 1511 (var. *umbilicata*), p. 512, Pl. 339, figs. 1513–1517 (var. *pinguis*).

*Mantelliceras ampakabense* COLLIGNON, 1964, p. 74, Pl. 341, fig. 1528.

*Mantelliceras isovokyense* COLLIGNON, 1964, p. 76, Pl. 342, figs. 1529, 1530.

*Mantelliceras betiokyense* COLLIGNON, 1964, p. 78, Pl. 343, figs. 1531, 1532.

*Mantelliceras alternans* COLLIGNON, 1964, p. 97, Pl. 351, fig. 1557.

*Mantelliceras (Neomantelliceras) zeilleri* THOMEL, 1972, p. 44, Pl. 13, figs. 1–4.

*Mantelliceras mantelli* (J. Sowerby). SZÁSZ, 1983, p. 243, Pl. 5, fig. 3, Pl. 6, figs. 2, 3, Pl. 12, figs. 1, 2, Pl. 19, fig. 5; WRIGHT AND KENNEDY, 1984, p. 99, Pl. 16, fig. 5, Pl. 17, figs. 1, 3, Pl. 18, figs. 1–3, Pl. 19, figs. 1–6, Pl. 21, figs. 2, 4, Pl. 24, fig. 3, Pl. 36, fig. 1, text-figs. 20A–D, 26A, C, E (with full synonymy); IMMEL AND SEYED-EMAMI, 1985, p. 99, Pl. 4, fig. 5; KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 22, figs. 2a, 4a–g, 10d, e, 23a, b, f.

*Mantelliceras tuberculatum* (Mantell). IMMEL AND SEYED-EMAMI, 1985, p. 99, Pl. 4, fig. 4.

*Lectotype.*—By the subsequent designation of Kennedy, 1971, p. 52: BMNH 43940a from the Lower Cenomanian Chalk Marl of Ringmer Near Lewes, Sussex (=J. Sowerby, 1814, Pl. 55, lower figure only).

*Collections.*—Five specimens: MHNG 19378 and MGL 42990 from Cheville, Morcles Massif, Valais; MHNG 1240 from Arberoz and MHNG 1227 from Lindars, both in the Platé Massif, Haute-Savoie; MHNG 19379 from Bourgets (Mont Saxonnet of authors), Bornes Massif, Haute-Savoie.

*Discussion.*—The synonymy gives only the most important forms regarded as synonyms of this species; see Wright and Kennedy, 1984, p. 99 for additional details. Juveniles of *M. mantelli* are characterized by a polygonal whorl section with 32–40 ribs per whorl, alternating irregularly long and short. The long ribs have umbilical and lateral tubercles and inner and outer ventrolateral clavi. The short ribs all bear inner and outer ventrolaterals while a few of the longer ones have the lateral tubercle as well. Microconchs of the species are adult at 60 mm; macroconchs (Figure 9.20, 9.21) are known to be up to 150 mm in diameter. Lateral and inner ventrolateral tubercles disappear on the adult body chamber, while the outer ventrolaterals decline or disappear to give a rounding venter.

Wright and Kennedy (1984, p. 99) outlined the reasons for regarding the species and varieties listed in the synonymy as inseparable from *M. mantelli*. The species is easily distinguished from *M. lymense* (Spath, 1926b), *M. couloni* (d'Orbigny, 1850), and *M. saxbii* (Sharpe, 1857), which are generally compressed and typically lack lateral tubercles. *Mantelliceras picteti* Hyatt,

1903, has a similar style of ribbing and tuberculation but the whorl section is quadrate and compressed, with rather distant ribbing at maturity. *Mantelliceras cantianum* Spath, 1926a, is very inflated with a whorl section that expands rapidly during development, has a broad venter with strong ribs and feeble outer ventrolateral tubercles, inner ventrolateral tubercles that are lost early in ontogeny, and strong lateral tubercles linked to a weak umbilical bulla by a strong rib.

*Occurrence.*—Elsewhere in Europe the species is commonest in the lower two-thirds of the Lower Cenomanian and is only rarely found above. It ranges from England to northern Ireland (a doubtful record), the Boulonnais, Haute Normandie, Sarthe, Maine, the Argonne, Iserè and south to Cassis (Bouches-du-Rhône) in France and the remainder of western Europe, the U.S.S.R., north Africa, Madagascar, and southern India.

## MANTELLICERAS CANTIANUM Spath, 1926a

Figures 10.1–10.5, 10.10–10.12, 11.7–11.8, 12.1–12.4

*Mantelliceras cantianum* SPATH, 1926a, p. 82.

*Calycoceras souaillonense* RENZ, 1963, p. 1111, Pl. 6, fig. 1.

*Mantelliceras cantianum* Spath. COLLIGNON, 1964, p. 80, Pl. 344, fig. 1532, ?fig. 1533 (var. *unituberculata*), non fig. 1534 (var. *abrupta*).

*Mantelliceras geyeri* COLLIGNON, 1964, p. 99, Pl. 352, fig. 1560.

*Mantelliceras (Bunburyiceras) moulinense* THOMEL, 1972, p. 47, Pl. 14, figs. 3–5.

*Mantelliceras cantianum* Spath. SZÁSZ, 1983, p. 244, Pl. 5, fig. 4, Pl. 6, figs. 4, 5, Pl. 13, figs. 2–4, Pl. 16, fig. 2, Pl. 17, fig. 2; WRIGHT AND KENNEDY, 1984, p. 103, Pl. 17, fig. 2, Pl. 20, fig. 3, Pl. 21, fig. 3, Pl. 24, figs. 1, 2, 4–6, Pl. 25, figs. 1–6, Pl. 26, figs. 1, 2, 4, 5, text-figs. 25A, 27E–H, J–L; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 3, fig. 4; IMMEL AND SEYED-EMAMI, 1985, p. 100, Pl. 4, fig. 4; KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 31, Figs. 2b–e, 6a–c, 7, 8a–c, 16i, j, 18a–e, 20e, f.

*Holotype.*—By original designation, BMNH 36834, from the Lower Cenomanian Chalk Marl of Dover, Kent, paratype BMNH C5027 is from the same unit at Lewes, Sussex. They were figured by Sharpe, 1857 (Pl. 18, figs. 1, 2).

*Collections.*—Nine specimens MGL 8371, MHNG 19411, 1223, 1228 from Cheville and MHNG 19374 from Ecuelle, Morcles Massif, Valais; MHNG 19376 from the Lanche des Aux, Haute-Giffre Massif, Valais; MHNG 1220, 1226, 1337, from Lindars, Platé Massif, Haute-Savoie.

*Discussion.*—The early whorls of this species are generally inflated and expand rapidly. The ribs are coarse, 28–36 per whorl, alternately long and short. The long ribs bear a strong umbilical bulla and even stronger inner lateral tubercle, linked by a strong rib (Figures 10.12, 12.1–12.4) that persists to the beginning of the adult body chamber (Figure 10.11, 10.12).

Both long and short ribs bear inner ventrolateral tubercles that decline and disappear in middle growth and outer ventrolateral tubercles that persist to the beginning of the adult body chamber (Figure 10.10–10.12).

The present collection includes a fine adult macroconch 100 mm in diameter and complete microconchs 62–66 mm in diameter; elsewhere macroconchs are up to 150 mm in diameter, with microconchs 60–80 mm in diameter. One specimen has a more slowly expanding whorl section and serpenticone form, a type found in both England and northern France (Wright and Kennedy, 1984, Pl. 20, fig. 3).

Of other species recognized in the present study, only *Mantelliceras mantelli* is likely to be confused with *M. cantianum*, but the massive, depressed, rapidly expanding whorls with prominent umbilico-lateral tuberculation of the latter are distinctive.

*Occurrence.*—The species ranges throughout the Lower Cen-

omanian in western Europe, although it is rare in the upper third of the substage. In England it is widespread from Norfolk south and southwards, also occurring in northern Ireland. It also occurs in the Boulonnais, Haute Normandie, Sarthe, Maine, the Argonne, Isère south to Cassis (Bouches-du-Rhône) in France, in Switzerland, in Lleida in Spain, Roumania, Iran, Madagascar, and Japan.

MANTELLICERAS PICTETI Hyatt, 1903

Figure 12.5, 12.6, 12.9, 12.10, 12.13, 12.14

*Mantelliceras picteti* Hyatt, 1903, p. 114, pars MARCINOWSKI AND RADWANSKY, 1983, Pl. 7, fig. 10; KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 35, text-figs. 8d, e, 9, 10a-c, 11a-d.

*Mantelliceras tenue* Spath, 1926b, p. 427, 430.

*Mantelliceras cressierense* RENZ, 1963, p. 1105, Pl. 4, fig. 3.

*Mantelliceras antanimangaense* COLLIGNON, 1964, p. 83, Pl. 346, fig. 1539.

*Mantelliceras patens* COLLIGNON, 1964, p. 87, Pl. 347, fig. 1546.

*Mantelliceras crassecostatum* COLLIGNON, 1964, p. 95, Pl. 350, figs. 1553, 1555, ?1554.

*Mantelliceras (Submantelliceras) marrei* THOMEL, 1972, p. 23, Pl. 8, figs. 1-6.

*Mantelliceras (Coulonicerias) couloni ravelense* THOMEL, 1972, p. 30, Pl. 3, figs. 1-3.

*Mantelliceras (Promantelliceras) picteti collignoni* THOMEL, 1972, p. 33, Pl. 5, figs. 3-5, Pl. 6, fig. 3.

*Mantelliceras (Promantelliceras) picteti alpina* forma *crassa* THOMEL, 1972, p. 34.

*Mantelliceras (Promantelliceras) picteti densecostata* THOMEL, 1972, p. 35, Pl. 5, figs. 1, 2.

*Mantelliceras picteti* Hyatt. Szász, 1983, p. 247, Pl. 13, fig. 5, Pl. 16, fig. 2; WRIGHT AND KENNEDY, 1984, p. 117, Pl. 27, figs. 1-5, Pl. 28, figs. 1-3, text-figs. 25g, 27n-q (with full synonymy).

*Mantelliceras tenue* Spath, 1926. IMMEL AND SEYED-EMAMI, 1985, p. 100, Pl. 4, fig. 7.

**Lectotype.**—By subsequent designation of Wright and Kennedy, 1984, p. 117, the original of Pictet and Campiche, 1859, Pl. 26, fig. 3, from the Cenomanian of St. Croix, Switzerland. This is also the holotype, by original designation, of *Mantelliceras tenue* Spath, 1926b, which is thus an objective synonym.

**Collections.**—Three specimens: MHNG 1218, 1224 from the Lanche des Aux, Haut-Giffre Massif, Valais, and MG L42865 from Ecuelle, Morcles Massif, Valais.

**Discussion.**—This species shows moderately evolute coiling, with compressed, subrectangular whorls. The ribs are alternately long and short, and number 34-38 per whorl. The long ribs bear umbilical, lateral, inner and outer ventrolateral tubercles; the short ribs bear inner and outer ventrolaterals only.

Compressed whorls separate this species from *M. mantelli* and *M. cantianum*, while the ornament of the latter is highly distinctive. *Mantelliceras couloni* (d'Orbigny, 1850) and *M. saxbii* (Sharpe, 1857) are also compressed. The former lacks a lateral tubercle and bears high ventral clavi during much of its ontogeny. The latter sometimes bear a feeble or incipient lateral tubercle, but this does not persist as it does in *M. picteti*. The

inner whorls of some variants of *M. dixonii* Spath, 1926b, resemble those of *M. picteti*, but tubercles decline more rapidly in the former, and the bar-like strengthening of the primary ribs on the inner flank is distinctive in juveniles, as is loss of ornament on adult body chambers.

**Occurrence.**—In southern England the species is widespread and restricted to the lower two-thirds of the Lower Cenomanian. It also occurs in the Boulonnais, Haute Normandie, the Argonne and Isère south to the Alpes-Maritimes in France, in northern Spain, Switzerland, Podolia, the Crimea, Iran, and Madagascar.

MANTELLICERAS COULONI (d'Orbigny, 1850)

Figures 9.7, 9.8, 9.11-9.18, 10.6-10.9, 13.1, 13.2

*Turrilites ?babeli* BRONGNIANT, 1822, p. 99, 400, Pl. 9, fig. 16.

*Ammonites Mantelli* Sowerby. D'ORBIGNY, 1841, p. 340 (pars), Pl. 104, figs. 1-4.

*Ammonites couloni* D'ORBIGNY, 1850, p. 147.

?*Mantelliceras couloni* (d'Orbigny). Szász, 1983, p. 246, Pl. 17, fig. 3.

?*Mantelliceras* aff. *couloni* (d'Orbigny). Szász, 1983, p. 247, Pl. 17, fig. 1.

*Mantelliceras couloni* (d'Orbigny, 1850). WRIGHT AND KENNEDY, 1984, p. 119, Pl. 21, fig. 1, Pl. 23, figs. 5, 6, Pl. 29, figs. 1-3, Pl. 30, figs. 1, 2, Pl. 31, figs. 3-5, Pl. 36, fig. 5, text-figs. 25F, H, 27A-D (with full synonymy); KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 41, figs. 1a, 2f, 12, 13, 14a, d-f, 15a-c.

**Lectotype.**—By the subsequent designation of Juignet and Kennedy, 1976, p. 95, is MNHP 1896-27 (ex de Vibraye Collection), the original of d'Orbigny, 1841, Pl. 104, figs. 1, 2, from the Lower Cenomanian Craie Glauconieuse à *Pecten asper* of Lamnay, Sarthe, France. Paralectotypes MNHP 6116 (d'Orbigny Collection) are from Lamnay and were the basis of d'Orbigny's Pl. 104, figs. 3, 4. A further paralectotype, MNHP 6116a (d'Orbigny Collection) is from "Vibrayes."

**Collections.**—Ten specimens: MHNG 19375, 1253, 1300, 1322 and EMP unregistered, the holotype of *Turrilites ?babeli* Brongniart, 1822 (original of Pl. 9, fig. 16), from the Rochers des Fiz. MHNG 1237-1239 from Arberroz, MHNG 1286 from Lindars, MHNG 1289 from Sautet, all in the Platé Massif, Haute-Savoie. Also MHNG 1221 from Bourgets (=Mont Saxonnet of authors), Bornes Massif, Haute-Savoie.

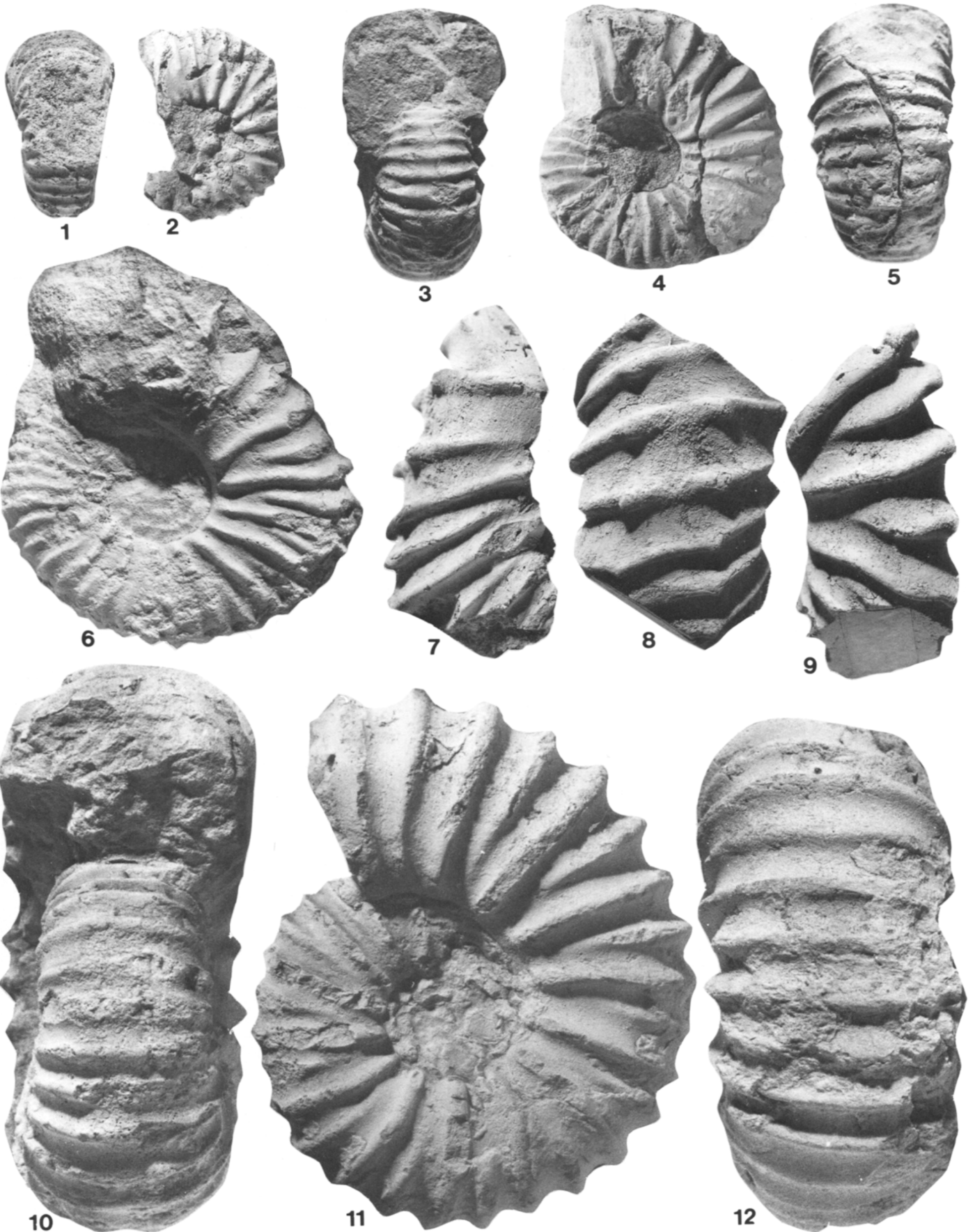
**Discussion.**—The early whorls of this species are densely and flexuously ribbed, the ribs arising singly or in pairs from small umbilical bullae with some shorter intercalated ribs to give a total of up to 40 ribs per whorl. There are inner and outer ventrolateral tubercles during early growth (Figure 9.11, 9.12, 9.15-9.18); the former decline during middle growth in most specimens, but the latter strengthen into high clavi (Figure 10.7-10.9) that persist onto the early part of the adult body chamber. These clavi decline towards the adult aperture, where the venter broadens and rounds and the ribs crowd (Figure 13).

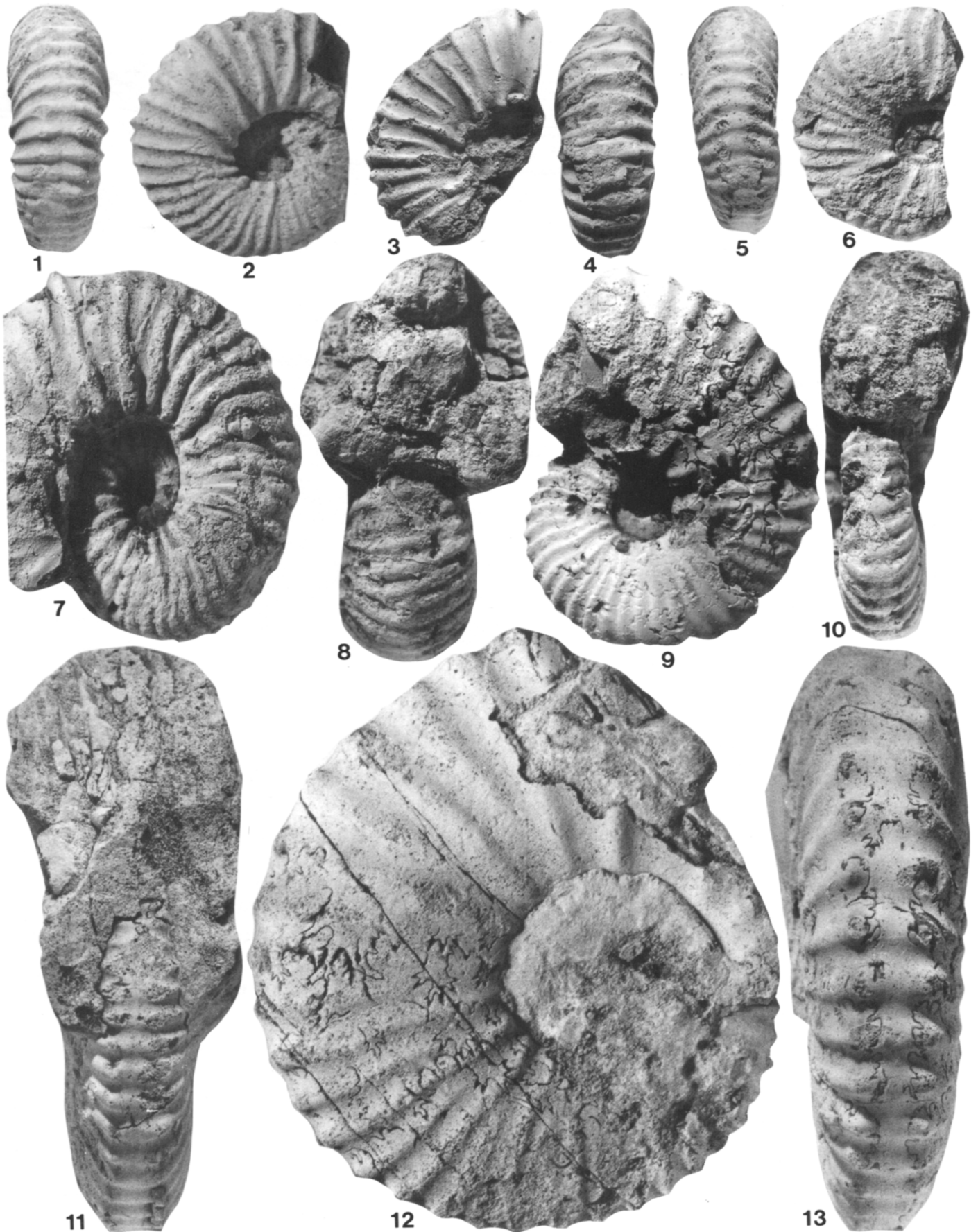
Absence of lateral tubercles separates this species from *M. mantelli*, *M. picteti*, and *M. cantianum*. *Mantelliceras lymense* have inflated whorls and never develop the distinctive clavi of *M. couloni*. There are close similarities to *M. saxbii* (see below)

FIGURE 10—1-5, 10-12, *Mantelliceras cantianum* Spath, 1926a. 1, 2, MHNG 19376; 3-5, MHNG 1226; 10-12, MHNG 19411. 6-9, *Mantelliceras couloni* (d'Orbigny, 1850). 6, MHNG 1286; 7-9, EMP unregistered, the holotype of *Turrilites babeli* Brongniart, 1822, Pl. 9, fig. 16. All figures are natural size.

FIGURE 11—1-4, *Mantelliceras dixonii* Spath, 1926b. 1, 2, MGL 42847; 3, 4, MHNG 1217. 5, 6, 9-13, *Mantelliceras saxbii* (Sharpe, 1857). 5, 6, MHNG 19377; 9, 10, MHNG 1236; 11-13, MHNG 1274. 7, 8, *Mantelliceras cantianum* Spath, 1926a, MHNG 19374. All figures are natural size.

FIGURE 12—1-4, *Mantelliceras cantianum* Spath, 1926a. 1, 2, MHNG 1223; 3, 4, MHNG 1228. 5, 6, 9, 10, 13, 14, *Mantelliceras picteti* Hyatt, 1903. 5, 6, MHNG 1218; 9, 10, MHNG 1225; 13, 14, MHNG 1224. 7, 8, *Mantelliceras lymense* (Spath, 1926b), MGL 42992. 11, 12, *Mantelliceras dixonii* Spath, 1926b, MGL 42853. All figures are natural size.









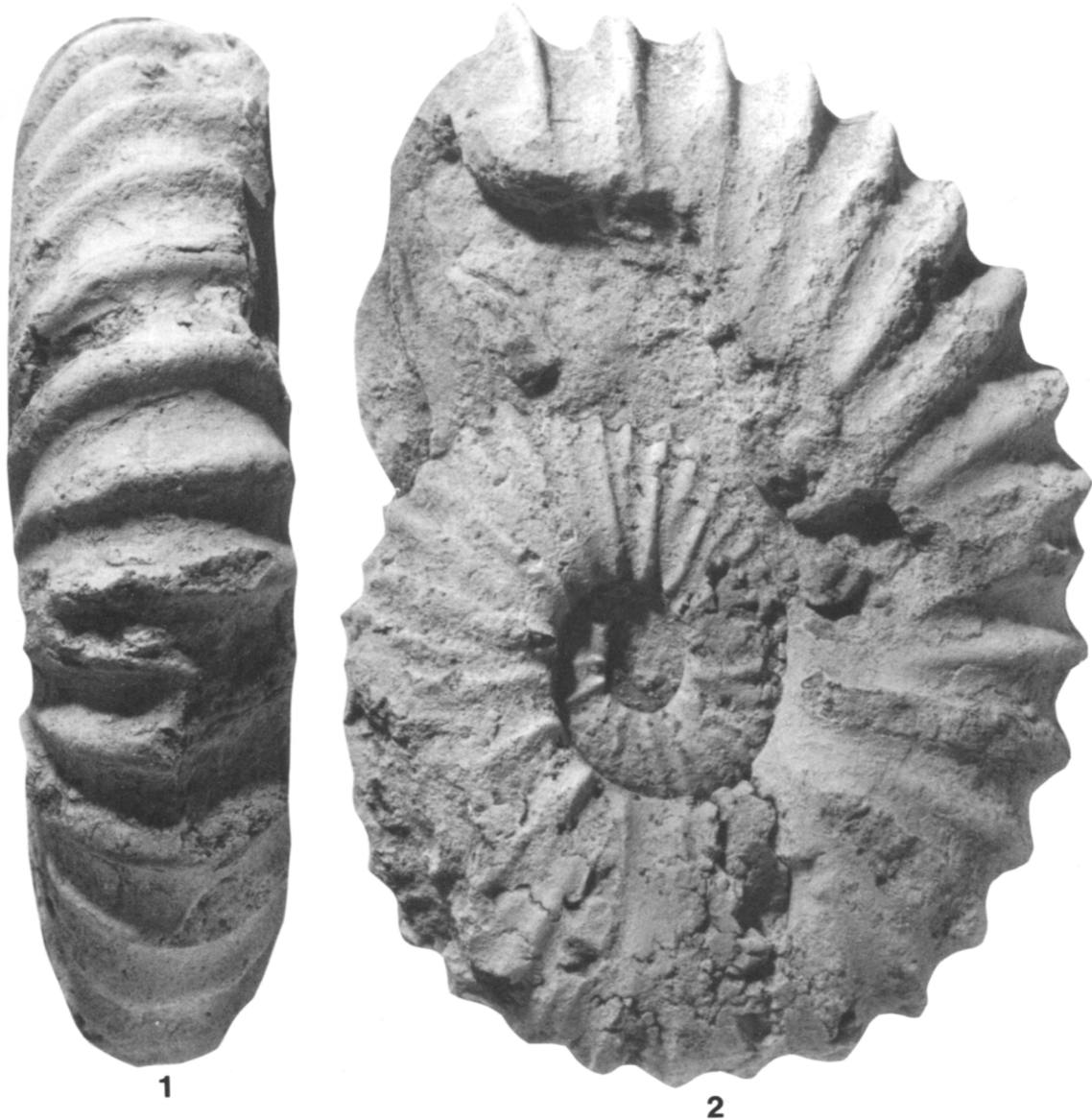


FIGURE 13—1, 2, *Mantelliceras couloni* (d'Orbigny, 1850). MHNG 1221, from Bourgets (=“Mont Saxonnet” of authors), Bornes Massif, Haute-Savoie. All figures are natural size.

which is also a compressed species, but it never develops the exaggerated clavi of the present form. *Turrilites? babeli* Brongniart, 1822 (p. 99, 400, Pl. 9, fig. 16) is based on a poor fragment from the Rochers de Fiz, reillustrated here as Figure 10.7–10.9 that may be a fragment of *M. couloni*.

**Occurrence.**—This species has a very restricted stratigraphic range at the top of the Lower Cenomanian *N. carcitanense* Sub-zone of the *M. mantelli* Zone. At the type locality and elsewhere in Sarthe there are records from the Gaize facies in the lower part of the Craie Glauconieuse à *Pecten asper*. In England it occurs chiefly in Dorset and Devon with a single occurrence in the Isle of Wight, Hampshire. It also occurs in the Lower Cenomanian of southeastern France, Iran, and perhaps Roumania.

**MANTELLICERAS SAXBII** (Sharpe, 1857)  
Figure 11.5–11.6, 11.9–11.13; 14.1–14.4

*Ammonites saxbii* SHARPE, 1857, p. 45, Pl. 20, fig. 3.  
*Ammonites martimpreyi* COQUAND, 1862, p. 172, Pl. 1, figs. 7, 8.

*Mantelliceras ventnorense* DIENER, 1925, p. 170.  
*Mantelliceras subcostatum* SPATH, 1925, p. 197.  
*Mantelliceras batheri* SPATH, 1926b, p. 431, pars.  
*Calycoceras planum* RENZ, 1963, p. 1111, Pl. 5, fig. 2.  
*Mantelliceras hyattiforme* COLLIGNON, 1964, p. 71, Pl. 340, figs. 1521–1524.  
*Mantelliceras biroi* COLLIGNON, 1964, p. 84, Pl. 346, figs. 1540, 1541, Pl. 351, fig. 1540.  
*Mantelliceras agrawali* COLLIGNON, 1964, p. 86, Pl. 347, figs. 1542, 1543.  
*Mantelliceras agrawali* var. *concava* COLLIGNON, 1964, p. 86, Pl. 347, fig. 1544.  
*Mantelliceras agrawali* var. *celsa* COLLIGNON, 1964, p. 87, Pl. 347, fig. 1545.  
*Mantelliceras spissum* COLLIGNON, 1964, p. 90, Pl. 348, figs. 1549, 1550.  
*Mantelliceras divaricatum* COLLIGNON, 1964, p. 97, Pl. 351, fig. 1556.  
*Mantelliceras* (*Couloniceras*) *roqueti* BUSNARDO, 1966, p. 224, Pl. 12, fig. 5, Pl. 14, fig. 1.  
?non *Mantelliceras saxbii paucicostatum* THOMEL, 1972, p. 20, Pl. 1, fig. 7.

- Mantelliceras (Couloniceras) couloni turrettense* THOMEL, 1972, p. 29, Pl. 3, figs. 4–9.
- Mantelliceras saxbii* (Sharpe). SZÁSZ, 1983, p. 245, Pl. 6, fig. 6, ?Pl. 7, figs. 3, 4, ?Pl. 9, fig. 1, ?Pl. 10, fig. 1, ?Pl. 18, fig. 4; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 3, fig. 3; KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 43, figs. 1c, 2d, 9, 11e, 14b, c, 16a–d, g–h, k–l, 17a–d, 19a–c; WRIGHT AND KENNEDY, 1984, p. 121, Pl. 23, fig. 4, Pl. 23, figs. 1–3, Pl. 33, figs. 1–4, Pl. 34, figs. 1–4, Pl. 35, figs. 1–5, Pl. 36, figs. 2, 3, Pl. 39, fig. 1, text-figs. 25B–D, I, 26B, 28 L–P (with full synonymy); non IMMEL AND SEYED-EMAMI, 1985, p. 102, Pl. 6, fig. 5.
- Submantelliceras woodrudgei* (Young). IMMEL AND SEYED-EMAMI, 1985, p. 98, Pl. 4, figs. 1–3.
- Mantelliceras cressierense* Renz, 1963. IMMEL AND SEYED-EMAMI, 1985, p. 101, Pl. 4, fig. 8.

**Lectotype.**—By the subsequent designation of Wright and Kennedy, 1951, p. 38 is GSM 7763, the original of Sharpe, 1857, Pl. 20, fig. 3.

**Collections.**—Nineteen specimens: MHNG 19337 and MGL 42848, 42858 from Cheville, Morcles Massif, Valais; MHNG 1236 from Arberroz, MHNG 1274, 1275, 1277, 1315, 52489 from Lindars, all in the Platé Massif Haute-Savoie; MHNG 1326 from the Tête du Fer à Cheval, Haut-Giffre Massif, Haute-Savoie.

**Discussion.**—This species is described in detail by Kennedy and Hancock (1971), Juignet and Kennedy (1976), and Wright and Kennedy (1984). The early whorls, which are compressed, densely ribbed, and generally lack a lateral tubercle, are easily distinguished from *M. mantelli*, *M. cantianum*, *M. lymense*, *M. picteti* and *M. dixoni*. *Mantelliceras couloni* is more difficult to separate when young, but generally has coarser inner ventrolateral tubercles and, in middle growth, prominent ventral clavi that increase in size through ontogeny, rather than declining, as in the present species.

**Occurrence.**—*Mantelliceras saxbii* ranges throughout the Lower Cenomanian, but is common only in the middle of the substage, being represented by rather stout forms in the lower part of its range and by densely and flexuously ribbed forms in the upper part. It is widespread in southern England, the Boulonnais, Haute Normandie, Maine, Sarthe, and Provence in France and also in the Germanies, northern Spain, Switzerland, Poland, Roumania, Bulgaria, the Soviet Union, Iran north of the Zagros, north Africa, Angola, South Africa, and Madagascar.

#### MANTELLICERAS LYMENSE (Spath, 1926b) Figure 12.7, 12.8

- Ammonites Mantelli* var. *costata* MANTELL, 1822, p. 289 (pars), Pl. 21, fig. 9, non Pl. 22, fig. 1 (= *M. saxbii*).
- Mantelliceras batheri* SPATH, 1926b, p. 431 (pars).
- Eucalycoceras lymense* SPATH, 1926b, p. 427, 431.
- Mantelliceras costatum* (Mantell). SZÁSZ, 1983, p. 245, Pl. 10, fig. 3, Pl. 11, fig. 1, Pl. 14, fig. 1; IMMEL AND SEYED-EMAMI, 1985, p. 102, Pl. 5, fig. 2.
- Mantelliceras lymense* (Spath, 1926). WRIGHT AND KENNEDY, 1984, p. 102, Pl. 10, fig. 9, Pl. 22, figs. 1–6, Pl. 23, figs. 1–3, Pl. 31, figs. 1, 2, Pl. 36, fig. 4, text-figs. 19, 24A, B, 26D, 28F–J; KENNEDY, JUIGNET, AND WRIGHT, 1986, p. 27, Figs. 5a–f, 6d, e, 16e, f.
- Mantelliceras thomeli* Collignon, 1964. IMMEL AND SEYED-EMAMI, 1985, p. 102, Pl. 5, fig. 3.

**Lectotype.**—By the subsequent designation of Wright and Kennedy, 1984, p. 102, the original of Pervinquièrre, 1907, Pl. 16, fig. 15, an unregistered specimen in the Sorbonne Collections, now in the Université Pierre et Marie Curie, Paris, and from north of Bargou, Tunisia.

**Collection.**—MGL 42992 from Cheville, Morcles Massif, Valais.

**Discussion.**—*Mantelliceras lymense* is the correct name for the more familiar *M. costatum* (Mantell, 1822), a junior primary

homonym of *Ammonites costatus* Schlotheim, 1820, p. 68. It is easily distinguished from all other *Mantelliceras* species by its combination of an inflated whorl section and ribs with umbilical bullae and outer ventrolateral tubercles only beyond diameters of 25 mm. Very small specimens may have an inner ventrolateral, but the species never develops a lateral tubercle. The single specimen in the present collections matches well with finer ribbed English specimens (e.g., Wright and Kennedy, 1984, Pl. 31, fig. 1).

**Occurrence.**—This species ranges throughout the Lower Cenomanian. It is recorded from southern England from Devon to Kent and Cambridgeshire; the Boulonnais, Haute Normandie, Sarthe, Maine, the Argonne, and Isère south to Cassis (Bouches-du-Rhône) in France, Germany, Iran, Algeria, Tunisia, and Madagascar.

#### MANTELLICERAS DIXONI Spath, 1926b Figures 11.1–11.4, 12.11, 12.12

- Ammonites Milletianus* d'Orbigny. J. DE C. SOWERBY, 1850, p. 359, Pl. 29, fig. 15.
- Mantelliceras dixoni* SPATH, 1926b, p. 427; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 4, fig. 2; KENNEDY, JUIGNET, AND WRIGHT, 1986, figs. 1b, 3a–d, 18f, g, 19d, e, 20a–d, 21a–e, 22a–d.
- Metacalycoceras Orbigny* COLLIGNON, 1937, p. 45 (24), Pl. 10.
- Mantelliceras charlestoni* KELLUM AND MINTZ, 1962, p. 272, Pl. 3, figs. 1, 2, Pl. 4, fig. 1.
- Mantelliceras portalesi* KELLUM AND MINTZ, 1962, p. 273, Pl. 4, figs. 3, 4.
- Mantelliceras pseudohyatti* COLLIGNON, 1964, p. 73, Pl. 341, fig. 1525.
- Mantelliceras lateretuberculatum* COLLIGNON, 1964, p. 90, Pl. 348, fig. 1548, Pl. 349, fig. 1552.
- Mantelliceras albanense* BUSNARDO, 1966, p. 222, Pl. 12, figs. 1, 2.
- Mantelliceras beynense* THOMEL, 1972, p. 41, Pl. 9, figs. 3–5.
- Mantelliceras beynense baylei* THOMEL, 1972, p. 42, Pl. 10, figs. 1, 2.
- Calycoceras salvadorese* KEMPER AND WEBER, 1979, p. 11, Pl. 1, fig. 1, text-fig. 4.
- Mantelliceras* n. sp. (aff. *M. dixoni* Spath). SZÁSZ, 1983, p. 248, Pl. 11, fig. 2.
- Mantelliceras dixoni* Spath, 1926. WRIGHT AND KENNEDY, 1984, p. 124, Pl. 37, figs. 1–6, Pl. 38, figs. 2–5, Pl. 39, figs. 2–5, Pl. 40, figs. 1–5, text-figs. 21D–F, 22A–G, 23, 25E, J, 27M, R, S (with full synonymy).
- ?*Mantelliceras* gr. *dixoni* Spath. IMMEL AND SEYED-EMAMI, 1985, p. 103, Pl. 5, fig. 5.

**Holotype.**—By original designation, BMNH 33630, from the Lower Chalk of Sussex, the original of *Ammonites milletianus* J. de C. Sowerby (non d'Orbigny) 1850, Pl. 29, fig. 1, 2.

**Collections.**—Four specimens: MHNG 1217 and MGL 42847, 42853, 8375, all from Cheville, Morcles Massif, Valais.

**Discussion.**—MGL 42847 is an adult microconch 50 mm in diameter, and closely comparable to the holotype (Wright and Kennedy, 1984, Pl. 37, fig. 6), MGL 42853, a nearly complete macroconch 82 mm, and MGL 8375 a complete macroconch 91 mm in diameter, are again similar to English specimens (e.g., Wright and Kennedy, 1984, Pl. 40, figs. 3, 4). The ribs are alternately long and short. The long ribs arise at umbilical bullae and are strong and bar-like on the inner flank. They flex back across the outer flank and bear outer ventrolateral clavi only, as do the shorter, intercalated ribs. All ribs are strongly developed across the tabulate venter. These specimens are of interest as the only firm evidence for the high Lower Cenomanian in the present faunas.

**Occurrence.**—This species is restricted to the *Mantelliceras dixoni* Zone of the upper Lower Cenomanian and is known from Cambridgeshire, Kent, Wiltshire, Dorset, and Devon in southern England, the Boulonnais, Haute Normandie, Sarthe, Jura, and Basses Alpes in France, Westphalia, German Federal Republic, Roumania, El Salvador, northern Mexico, and Madagascar, and possibly Iran north of the Zagros.

Genus *SHARPEICERAS* Hyatt, 1903  
(=*Tlahualiloceras* Kellum and Mintz, 1962)

*Type species.*—By original designation: *Ammonites laticlavium* Sharpe, 1855, p. 31, Pl. 14, fig. 1.

*SHARPEICERAS LATICLAVIUM* (Sharpe, 1855)  
Figure 9.9, 9.10

*Ammonites laticlavium* SHARPE, 1855, p. 31, Pl. 14, fig. 1.  
*Sharpeiceras laticlavium* (Sharpe). WRIGHT AND KENNEDY, 1987, p. 127, Pl. 41, fig. 4, text-figs. 29, 30, 34a (with full synonymy).

*Holotype.*—By monotypy, GSM 7755, from the Lower Chalk of Bonchurch, Isle of Wight, the original of Sharpe, 1855, Pl. 14, fig. 1.

*Collection.*—One specimen: MHNG 1222, from Cheville, Morcles Massif, Valais.

*Discussion.*—The fragment from Cheville has a maximum preserved whorl height of 35 mm. It is identical in style, strength, and density of ribbing to the holotype of the species. *Sharpeiceras schlueteri* Hyatt, 1903, is a close ally of *S. laticlavium* and adults of the two species have been confused by authors. Hyatt's form has a more evolute shell, the whorls increasing more slowly, while the ribbing is much coarser and more distant.

*Occurrence.*—The holotype is from the Lower Cenomanian of Bonchurch, Isle of Wight, and probably comes from the *saxbii* Subzone of the *mantelli* Zone or higher. Other English specimens also seem to come from above the base of the Cenomanian. The species also occurs in southeast France, Iran, Madagascar, and, perhaps Roumania.

*SHARPEICERAS SCHLUETERI* (Hyatt, 1903)

*Ammonites laticlavium* Sharpe. SCHLÜTER, 1871, p. 18 (pars), Pl. 7, figs. 4–8.

*Sharpeiceras schlueteri* HYATT, 1903, p. 111; WRIGHT AND KENNEDY, 1987, p. 129, Pl. 41, figs. 1–3, text-figs. 32, 33, 34d, e (with full synonymy).

*Types.*—Hyatt (1903, p. 111) based this species on Schlüter's *Ammonites laticlavium* (1871, p. 18, Pl. 7, figs. 4–8). The figured specimen on which subsequent authors based their interpretation of the species is missing, while the surviving specimens in the Schlüter collection belong to *S. laticlavium*.

*Collections.*—One specimen: MGL 42861, from the Lanche des Aux, Haut-Giffre Massif, Valais.

*Discussion.*—The specimen is distorted into an ellipse with a major diameter of 65 mm. Coiling is quite evolute, with a slightly compressed rectangular whorl section. There are an estimated 26 ribs on the outer whorl. All are single and bear small umbilical bullae, small bullate mid-lateral tubercles, conical inner and stronger clavate outer ventrolateral tubercles. The specimen closely matches the fine juvenile figured by Kaplan et al. (1984, Pl. 2). This species is easily distinguished from *S. laticlavium* at this diameter by the more evolute coiling, lower whorls, fewer, coarser, mainly single ribs, and coarser tuberculation.

*Occurrence.*—This species is restricted to the Lower Cenomanian *M. mantelli* Zone and, in addition to the present record, is known from Sussex, Devon, and Cambridgeshire in England,

Haute Normandie, Sarthe, and Provence in France, the German Federal Republic, Peru, Angola, and Mozambique.

Subfamily ACANTHOCERATINAE de Grossouvre, 1894  
Genus *ACOMPSOCERAS* Hyatt, 1903  
(=*Pseudacompsoceras* Spath, 1925, p. 197)

*Type species.*—*Ammonites bochumensis* Schlüter, 1871, p. 1, Pl. 1, figs. 1–4, by original designation, =*Ammonites renevieri* Sharpe, 1857, p. 44, Pl. 20, fig. 2.

*ACOMPSOCERAS* sp.  
Figure 14.7, 14.8

*Collection.*—One specimen: MGL 42877, from the Lanche des Aux, Haut-Giffre Massif, Valais.

*Discussion.*—This fragment shows only the venter, which is smooth and arched, flanked by clavate outer and conical inner ventrolateral tubercles, and part of a quite finely incised suture with subphyllid folioles. It is clearly an *Acompsoceras* but poor preservation precludes specific assignment. It is either *A. renevieri* (Sharpe, 1857), which lacks a lateral tubercle, or *A. inconstans* (Schlüter, 1871) where a lateral is present.

Genus *ACANTHOCERAS* Neumayr, 1875  
(=*Metacanthoplites* Hyatt, 1900;  
*Alternacanthoceras* Marcinowski, 1979)

*Type species.*—By the subsequent designation of de Grossouvre, 1894, p. 27: *Ammonites rhotomagensis* Brongniart, 1822, p. 83, 391, Pl. 6, fig. 2.

*ACANTHOCERAS RHOTOMAGENSE* (Brongniart, 1822)  
Figure 15.12, 15.13

*Ammonites rhotomagensis*, Defr. BRONGNIART in Cuvier and Brongniart, 1822, p. 83, 391, Pl. 6, fig. 2.

*Acanthoceras (Acanthoceras) rhotomagense rhotomagense* (Brongniart, 1822). MARCINOWSKI, 1980, p. 305, Pl. 17, fig. 1, Pl. 18, figs. 1, 2.

*Acanthoceras rhotomagense* (Brongniart). WRIGHT AND KENNEDY, 1987 p. 156, Pl. 42, fig. 8, Pl. 44, figs. 1–11, Pl. 45, figs. 1–5, Pl. 46, figs. 1–4, 6, Pl. 47, figs. 1, 2, Pl. 48, figs. 1, 2, Pl. 49, figs. 1, 5, 6, text-figs. 47–54, 63f–j, 64a, b, 65a–d, k, 66a, f, g, j, 67a–g, 68, 69 (with full synonymy).

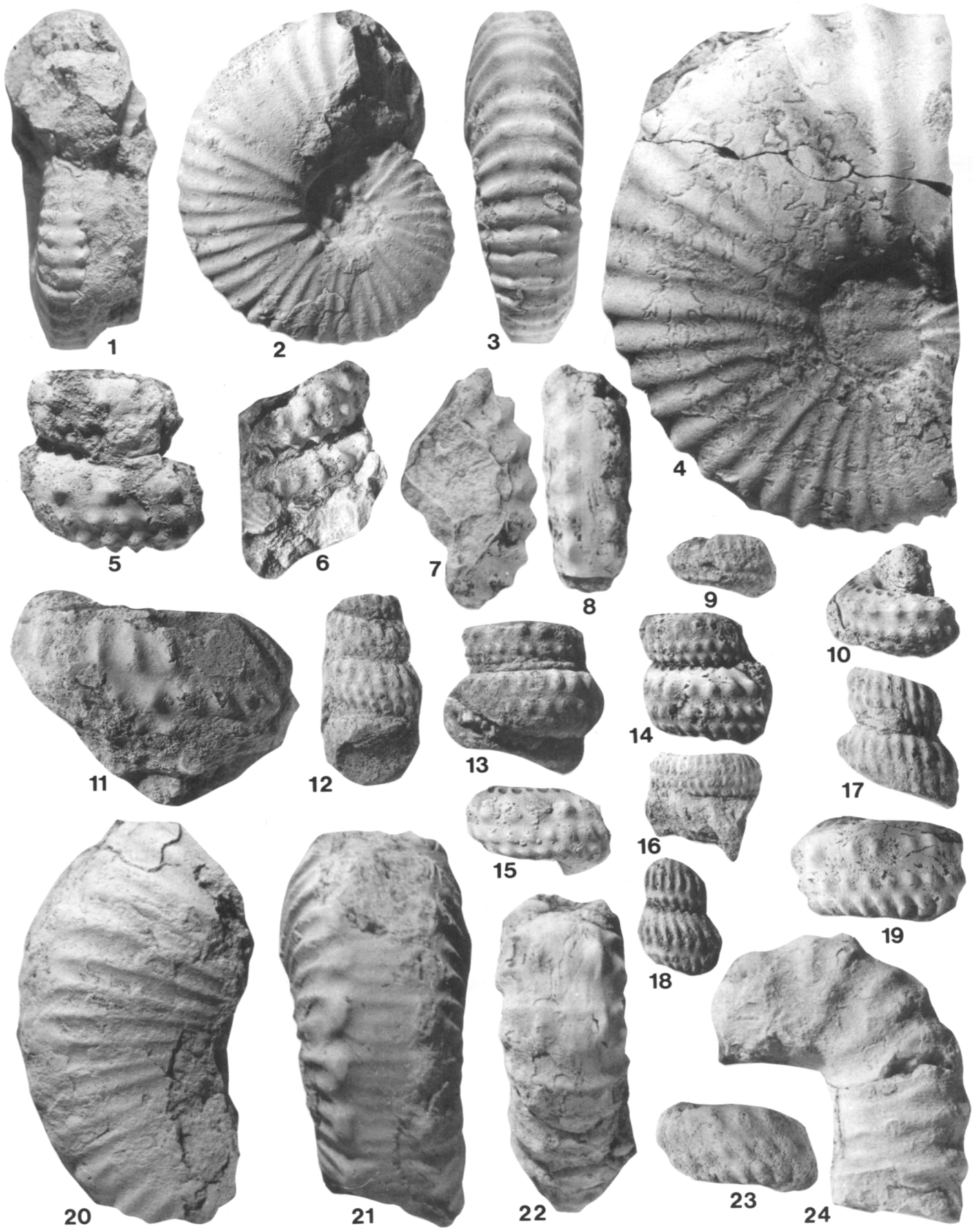
*Lectotype.*—By the subsequent designation of R. Douvillé, 1912, p. 238: the original of Brongniart, 1822, Pl. 6, fig. 2, now preserved in the Sorbonne Collections, housed in the Université Pierre et Marie Curie, Paris.

*Collection.*—One specimen: MHNG 19480 from Cheville, Morcles Massif, Valais.

*Discussion.*—The present specimen is a well-preserved juvenile 77 mm in diameter. All the visible ribs are primaries, numbering 12 on the last half whorl. The whorl section is compressed, with a whorl breadth to height ratio of 0.78. The specimen is one of the common variants intermediate between *sussexense* of Mantell, 1822, and *subflexuosum* of Spath, 1923 (see e.g. Kennedy and Hancock, 1970, Pl. 92, fig. 1). The specimen is easily distinguished from juvenile *Acanthoceras jukesbrownei* Spath, 1926a (p. 82; see Kennedy, 1971, p. 88, Pl. 52, figs. 1–3, Pl. 53, fig. 1, Pl. 54, fig. 1, Pl. 55, figs. 1, 2), where primary

→

FIGURE 14—1–4, *Mantelliceras saxbii* (Sharpe, 1857). 1–3, MHNG 1315; 4, MHNG 1277. 5, 10, 13–15, 23, *Hypoturrilites* sp. 5, MHNG 23539; 10, MHNG 1306; 13, MHNG unreg; 14, MHNG 1219; 15, MHNG 13037; 23, MHNG 1312. 6, *Hypoturrilites gravesianus gravesianus* (d'Orbigny, 1842), MHNG 1323. 7, 8, *Acompsoceras* sp., MGL 42877. 9, 16, *Mariella (Mariella)* cf. *gallienii* (Boule, Lemoine, and Thevénin, 1906). 9, MHNG 1329; 16, MHNG 1330. 11, 12, 17, 18, *Mariella (Mariella)* sp. a. 11, MHNG 19254; 12, MHNG 1209; 17, MHNG 1210; 18, MHNG 19253. 19, *Neostlingoceras* sp.?, MHNG 1342. 20, 21, *Anisoceras cherixi* (Pictet and Renevier, 1866), holotype, MGL 894, the original of Pictet and Renevier, 1866, p. 103, Pl. 5, fig. 1. 22, 24, *Anisoceras* cf. *perarmatum* Pictet and Campiche, 1861, MGL 42868. All figures are natural size.



and secondary ribs alternate regularly at a stage where all ribs are long in *rhotomagense*.

*Occurrence.*—*Acanthoceras rhotomagense* is common only in the lower half of the Middle Cenomanian, the *rhotomagense* Zone. It occurs widely in southern and eastern England, across France from the Boulonnais to Provence, in northern Spain, Germany, Switzerland, Poland, Daghestan in the Caucasus, Crimea, north Africa, and Peru.

#### Genus CUNNINGTONICERAS Collignon, 1937

*Type species.*—By original designation: *Ammonites cunningtoni* Sharpe, 1855, p. 35, Pl. 13, fig. 4.

#### CUNNINGTONICERAS CUNNINGTONI (Sharpe, 1855)

Figure 16.1–16.3

*Ammonites cunningtoni* SHARPE, 1855, p. 35, Pl. 15, fig. 2.

*Cunningtoniceras cunningtoni* (Sharpe). WRIGHT AND KENNEDY, 1987, p. 196, Pl. 52, fig. 2, Pl. 53, fig. 4, text-figs. 76–78 (with full synonymy).

*Holotype.*—By monotypy, BMNH 88704, from the Lower Chalk of Upton Scudamore, Wiltshire, England, the original of Sharpe, 1855, p. 35, Pl. 15, fig. 2.

*Collections.*—Five specimens: MHNG 19435, 19438 and MGL 8373, 8374, 42892 from Cheville, Morcles Massif, Valais.

*Discussion.*—This species is characterized by its depressed whorl section, high umbilical wall, and broad venter, plus ornament of 10–13 distant, straight primary ribs with strong umbilical bullae, prominent inner ventrolateral horns, and weaker outer ventrolateral clavi that merge with the inner ventrolateral horn to form a massive ventrolateral horn at maturity. In early-middle growth siphonal tubercles are 2–3 times as numerous as the ventrolateral and are borne on a low siphonal ridge; those opposite the ventrolateral tubercles are linked to these by low transverse riblets, while short tuberculate riblets also intercalate. At maturity this multiple ventral ribbing and tuberculation declines.

*Cunningtoniceras cunningtoni* is easily separated from the *C. inerme* (Pervinquier, 1907), which also occur in the present collections. These have a more quadrate whorl section, lower expansion rate, more numerous primary ribs, up to 20 per whorl, less exaggerated ventrolateral tuberculation, and more numerous ventral riblets and siphonal tubercles.

*Occurrence.*—Where precisely dated this species characterizes the lower part of the *Acanthoceras rhotomagense* Zone, the *Turrilites costatus* Subzone. It is known from Devon, Wiltshire, and Kent in England, from the Alpes-Maritimes in France as well as the present records, from Lleida, Spain, Switzerland, northern Iran, the U.S.S.R., Tunisia, Morocco, Nigeria, southern India, Madagascar, Japan, northern Australia, New Guinea, and, perhaps, Colorado and New Mexico in the U.S.A.

#### CUNNINGTONICERAS INERME (Pervinquier, 1907)

Figure 15.1–15.11, 15.14

*Acanthoceras cunningtoni* var. *inermis* PERVINQUIÈRE, 1907, p. 277.

*Euomphaloceras inerme* (Pervinquier). KENNEDY, 1971, p. 94, Pl. 59, fig. 6, Pl. 61, fig. 1, Pl. 62, fig. 1, Pl. 64, fig. 1; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 15, fig. 6.

*Acanthoceras (Acanthoceras) sowerbyi* THOMEL, 1972, p. 147 (pars), non Pl. 79, figs. 8–10.

*Acanthoceras vergonense* THOMEL, 1972, p. 158, Pl. 78, figs. 2–4, non Pl. 79, figs. 5–7.

*Euomphaloceras inerme* (Pervinquier). ZABORSKI, 1985, p. 40, fig. 44.  
*Cunningtoniceras inerme* (Pervinquier). WRIGHT AND KENNEDY, 1987, p. 194, Pl. 52, fig. 1, Pl. 53, fig. 6, text-figs. 74, 75, 79 (with fully synonymy).

*Holotype.*—By monotypy, GSM Geol. Soc. Collection no. 7754, from the Lower Chalk of Lewes, Sussex, the original of Sharpe, 1855, p. 34, Pl. 15, fig. 1.

*Collections.*—Nine specimens: MHNG 19434, 19436, 19437, 1214–1216, 1336, and MGL 8372, 42891, all from Cheville, Morcles Massif, Valais.

*Description.*—All our specimens are juveniles. Coiling is evolute, with a quadrate whorl section. There are 10 ribs per half whorl, straight and prorsiradiate, with strong umbilical bullae, large conical inner and smaller clavate outer ventrolateral tubercles, the latter linked by a broad rib. The outer ventrolateral clavi are linked by two or three low rounded ribs, each of which bears a rounded siphonal tubercle while additional short ventral ribs with a siphonal tubercle intercalate between the primary ribs. There is great variation in the ventral ornament, as can be seen from Figure 15.1–15.11, 15.14.

*Discussion.*—This distinctive species is much commoner than *C. cunningtoni* in the present fauna; differences from that species are indicated above.

*Occurrence.*—Where precisely dated this species characterizes the lower part of the *Acanthoceras rhotomagense* Zone, particularly the lower part of the *Turrilites costatus* Subzone. The geographic distribution includes Surrey, Sussex, Wiltshire, and Bedfordshire in England, Sarthe and Provence in France, Switzerland, Germany, as well as the present occurrence, and Japan.

#### Superfamily TURRILITACEAE Gill, 1871

#### Family ANISOCERATIDAE Hyatt, 1900

#### Genus ANISOCERAS Pictet, 1854

*Type species.*—*Hamites saussureanus* Pictet, 1847, p. 118, Pl. 13, figs. 1–4, from the Upper Albian of Mont Saxonet, Savoy.

#### ANISOCERAS cf. A. PERARMATUM

Pictet and Campiche, 1861

Figure 14.22, 14.24

*Anisoceras perarmatus* PICTET AND CAMPICHE, 1861, p. 65, Pl. 49, figs. 1–3, 6, 7.

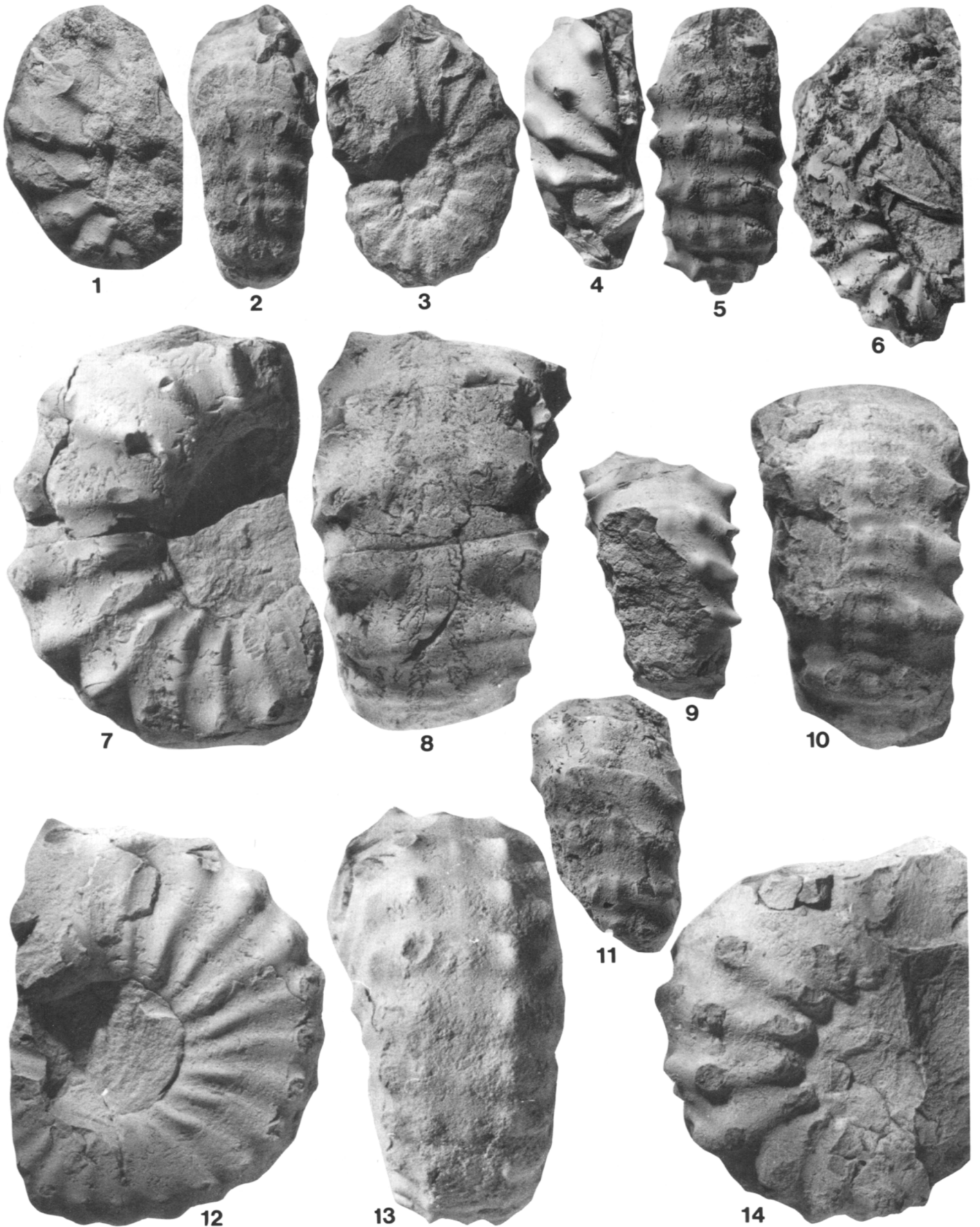
*Anisoceras perarmatum perarmatum* Pictet and Campiche. RENZ, 1968, p. 74, Pl. 13, fig. 5, Pl. 14, figs. 1–3, 5, text-figs. 27a, 28g (with full synonymy).

*Lectotype.*—By the subsequent designation of Renz, 1968, p. 74: the original of Pictet and Campiche, 1861, Pl. 49, fig. 1, from the Upper Albian of La Vraconne, Sainte Croix, Switzerland.

*Collections.*—Two fragments: MGL 42868–9, from Cheville, Morcles Massif, Valais.

*Discussion.*—The fragments are part of a curved section between the sub-parallel limbs of the late growth stages of this species. It shows coarse ribbing and tuberculation of the same general type as the lectotype of *A. perarmatum* (Renz, 1968, Pl. 13, fig. 5), with which it is compared. *Anisoceras plicatile* (J. Sowerby, 1819, p. 281, Pl. 234, fig. 1) is finely ribbed with more numerous intercalatories, and groups of two or three ribs linking tubercles. *Anisoceras perarmatum* is typically Upper Albian and has not been previously recorded from the Cenomanian. The

FIGURE 15—1–11, 14, *Cunningtoniceras inerme* (Pervinquier, 1907). 1, 11, MHNG 1214; 2, 3, MHNG 19436; 4, 9, MHNG 1215; 5, 6, MHNG 19437; 7, 8, MHNG 19434; 10, 14, MHNG 1336. 12, 13, *Acanthoceras rhotomagense* (Brongniart, 1822), MHNG 19430. All figures are natural size.



present specimens, from old collections, may possibly be remanié Albian material within the Cenomanian fauna at Cheville.

**Occurrence.**—Upper Albian *Stoliczkaia dispar* Zone of southern England, France, Switzerland, Sardinia, Tunisia, Nigeria, Madagascar, southern India, and Texas.

**ANISOCERAS CHERIXI** Pictet and Renevier, 1866  
Figure 14.20, 14.21

*Anisoceras(?) Cherixi* PICTET AND RENEVIER, 1866, p. 103, Pl. 5, fig. 1.

**Holotype.**—By monotypy, the original of Pictet and Renevier, 1866, p. 103, Pl. 5, fig. 1, from the 'Couche Moyenne', Cheville, Morcles Massif, Valais.

**Collection.**—The holotype only, MGL 894.

**Description.**—The holotype is a large body-chamber fragment, lacking the dorsum and with a maximum whorl height in excess of 40 mm. The whorl section appears to have been compressed, with broadly rounded flanks and a broad, flattened venter. The flanks are ornamented by narrow, sharply rounded ribs, separated by wide interspaces. They change in direction around the curvature of the fragment, but are feebly prorsiradial and feebly concave on the outer flank. They are linked in pairs to long, blunt ventral clavi, with no intercalatories. Groups of three narrow, weaker ribs link the clavi across the venter with, again, no intercalatories.

**Discussion.**—Absence of a lateral tubercle separates *A. cherixi* from most other species of the genus, while the absence of non-tuberculate intercalatories separates it from species such as *A. exoticum* Spath, 1939 (p. 555, Pl. 59, fig. 7, Pl. 60, fig. 4, Pl. 63, fig. 2, text-fig. 195) and *A. campichei* Spath, 1939 (p. 559, Pl. 63, figs. 6, 7, text-fig. 197). There are closer similarities to *A. auberti* (Pervinquière, 1907) (p. 85, Pl. 3, fig. 32); this species is based on a crushed composite mold showing one flank only, from the Cenomanian of Toukabeur, Tunisia. At the smallest diameter seen it shows pairs of narrow crowded flank ribs linked to ventral clavi, as in the present species, with additional intercalatories, while the final section, which is curved as in the holotype of *cherixi*, shows single ribs, each with a discrete weak ventral clavus.

**Occurrence.**—As for type.

Family TURRILITIDAE Gill, 1871  
Genus TURRILITES Lamarck, 1801  
Subgenus TURRILITES Lamarck, 1801  
(= *Euturrilites* Breistroffer, 1953;

*Turbinites* Dubourdieu, 1953, non Martin, 1809)

**Type species.**—By original designation: *Turrilites costatus* Lamarck, 1801, p. 102.

**TURRILITES (TURRILITES) COSTATUS** Lamarck, 1801  
Figure 17.26, 17.27, 17.29

*Turrilites costata* LAMARCK, 1801, p. 102.

*Turrilites costatus* Lamarck. DIENER, 1925, p. 81 (with synonymy).

*Turrilites (Turrilites) costatus* Lamarck. JUIGNET AND KENNEDY, 1976, p. 63, Pl. 9, figs. 15, 18, 19 (with synonymy); CHIRIAC, 1981, p. 75, Pl. 7, fig. 7; SEYED-EMAMI, 1982, p. 428, text-fig. 4, figs. 4, 5, 11; MARTINEZ, 1982, p. 161, Pl. 27, fig. 2; SZÁSZ, 1982, p. 36, Pl. 4, figs. 1–5; KENNEDY AND JUIGNET, 1983, p. 47, Figs. 25a–o, 26a, b, 27a–i, 28a, b, d (with synonymy).

**Lectotype.**—By the subsequent designation of Kennedy, 1971, p. 30: the specimen in the Lamarck collection from the Côte Ste Catherine, Rouen, Seine-Maritime, France, figured by Douvillé, 1904, p. 54a, fig. 1.

**Collection.**—Seven specimens: MHNG 19252, 1211, 1212, 1251, 1252 and MGL 42870 all from Cheville, Morcles Massif,

Valais. MHNG 52485 from Arberroz, Platé Massif, Haute-Savoie.

**Discussion.**—This well-known species is relatively uncommon in the present collections, but the examples agree well with topotypes we have studied, as well as the extensive suite of specimens from Sarthe, France, recently illustrated by Kennedy and Juignet (1983). Of other species of *Turrilites* in the present collections, *T. costatus* is only likely to be confused with *T. scheuchzerianus*, described below. Adults are utterly distinctive, for *T. scheuchzerianus* have simple ribs only, extending across the whole of the exposed whorl face. In juvenile *T. scheuchzerianus*, however, the ribbing is interrupted at mid-flank (the *Turrilites desnoyersi* of authors), but never develops the tubercles that typify the present species, while the upper and lower whorl faces are smooth, rather than ribbed.

**Occurrence.**—*Turrilites costatus* is first recorded from the top of the Lower Cenomanian, but at least some of these records are based on *T. (Mesoturrilites) boerssumensis* Schlüter, 1876. It has a lower Middle Cenomanian acme, and ranges into the low Upper Cenomanian, with a near world-wide distribution including eastern, western and southern Europe, the U.S.S.R., north, west, and south Africa, Madagascar, the Middle East, Mongolia, southern India, Japan, New Guinea, northern Australia, Mexico, Texas and California in the U.S.A.

**TURRILITES (TURRILITES) SCHEUCHZERIANUS** Bosc, 1801  
Figure 17.23–17.25, 17.28, 17.30, 17.33, 17.42

*Turrilites scheuchzerianus* Bosc in Buffon, 1801, p. 190 (copy of Langius, 1708, p. 112, fig. 6); DIENER, 1925, p. 84 (with synonymy); SEYED-EMAMI, 1982, p. 430, text-fig. 4, figs. 6–8.

*Turrilites (Euturrilites) scheuchzerianus* Bosc. WIEDMANN, 1962, p. 192, Pl. 11, fig. 3 (with synonymy); HISS, 1982, p. 190, figs. 7, 10.

*Turrilites (Turrilites) scheuchzerianus* Bosc. MARTINEZ, 1982, p. 162, Pl. 27, figs. 3–5; KENNEDY AND JUIGNET, 1983, p. 52, text-figs. 27j, 28c, e, 29a–f, 30a (with synonymy); SEYED-EMAMI, FÖRSTER AND MOJTEHEDI, 1984, text-fig. 3, 3; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 5, fig. 4.

**Collections.**—Twenty-three specimens: MHNG 19263, 19267, 19269, 1213, 1250, and MGL 8370, 42862–63, 42999–43001, 12721 from Cheville; MGL 43002–43004 from La Corday; MHNG 19264, 19266 from Ecuelle, all in the Morcles Massif, Valais. MHNG 19265 from the Chalets de Criou and MHNG 1290–1293 from the Pointe de l'Ecorchoir, both in the Haut-Giffre Massif, Haute-Savoie.

**Discussion.**—This well-known species has 19–21 ribs per whorl in typical forms. Juveniles show a distinct interruption of the rib at mid-flank (e.g., Figure 17.25, 17.33) with entire ribs characterizing the adult (Figure 17.23, 17.42). D'Orbigny (1842, Pl. 146, figs. 1, 2) named specimens with interrupted ribbing *Turrilites desnoyersi*, and provided a reconstruction in which this feature is show persisting to maturity. It is indeed true that medium-sized specimens of the same whorl height have both interrupted and entire ribs, but these are juvenile macroconchs and adult microconchs, respectively.

**Occurrence.**—This species first appears in the upper part of the Lower Cenomanian and persists to the Upper Cenomanian with a near world-wide distribution including western, eastern and southern Europe, the U.S.S.R., north, east, west, and south Africa, Madagascar, southern India, Texas, Colorado, and California in the U.S.A., Mexico, Japan, and perhaps British Columbia.

Genus NEOSTLINGOCERAS Klinger and Kennedy, 1978

**Type species.**—By original designation: *Turrilites carcitanensis* Matheron, 1842, p. 267, Pl. 12, fig. 4.



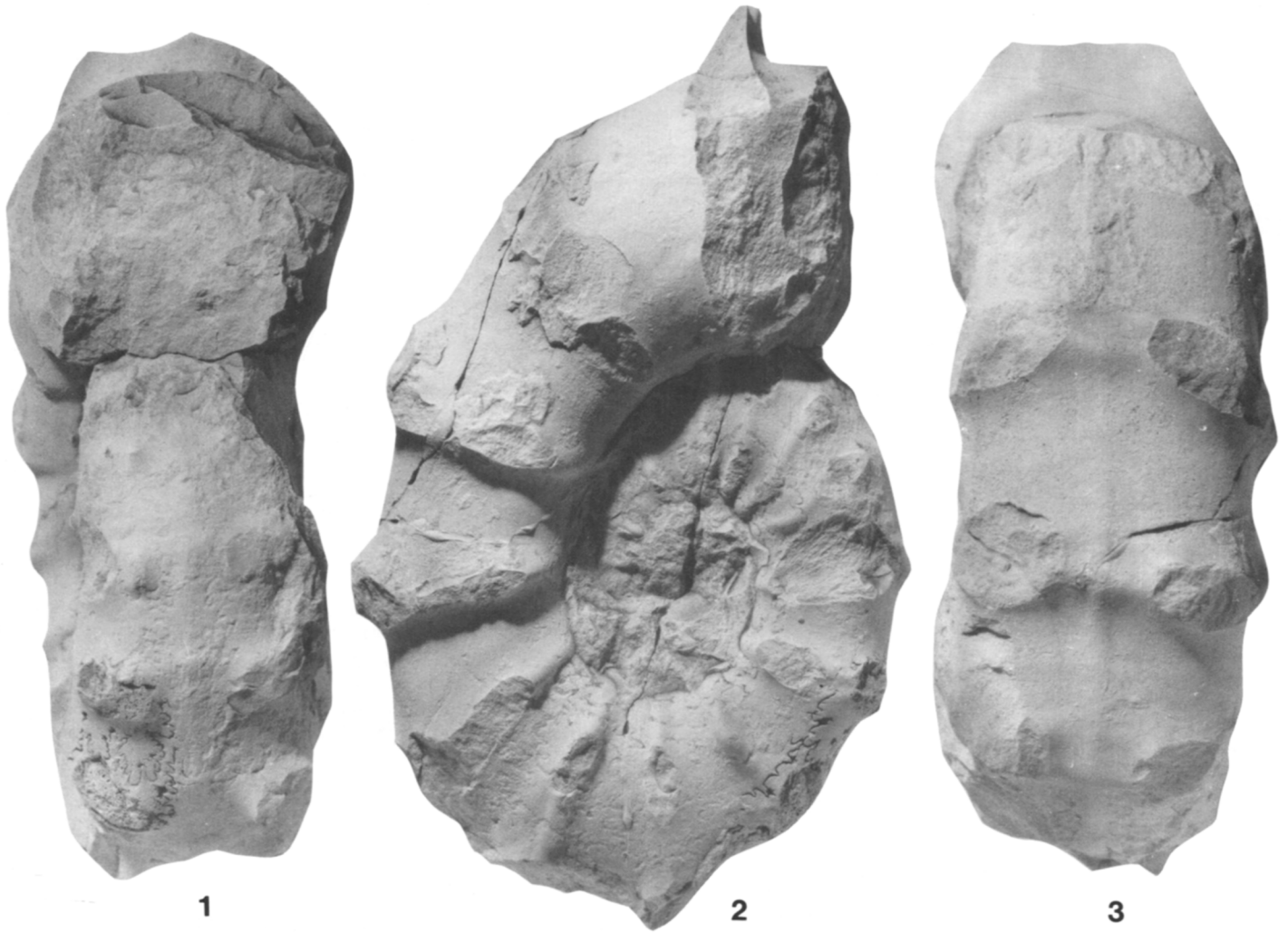


FIGURE 16—1–3, *Cuningtoniceras cunningtoni* (Sharpe, 1853), MHNG 19435. All figures are reduced  $\times 0.7$ .

**NEOSTLINGOCERAS CARCITANENSE** (Matheron, 1842)

Figure 17.31, 17.32, 17.36–17.38, 17.40, 17.41

*Turrilites carcitanensis* MATHERON, 1842, p. 267, Pl. 12, fig. 4.

*Neostlingoceras carcitanense* (Matheron). MARCINOWSKI, 1980, p. 260, Pl. 4, fig. 16; KENNEDY AND JUIGNET, 1983, p. 43, fig. 22a, b, c (?) (with synonymy); SZÁSZ, 1983, p. 239, Pl. 17, figs. 7, 8.

*Hypoturrilites carcitanensis* (Matheron). MARCINOWSKI AND RADWANSKY, 1983, Pl. 7, fig. 7.

*Neostlingoceras* aff. *carcitanense* (Matheron). KENNEDY AND JUIGNET, 1983, p. 44, fig. 22d.

*Holotype*.—By monotypy: the original of Matheron, 1842, p. 267, Pl. 12, fig. 4.

*Collections*.—Nineteen specimens: MHNG 1298 from Avoudrues, Haut-Giffre Massif, Haute-Savoie; MHNG 1229, 1340a–d from Arberroz, MHNG 1278–79, 1314, 1324, 52478 from the Rochers des Fiz, MHNG 1325 from Barmerousse and MHNG 1296, 52488a–b from Lindars, all in the Platé Massif, Haute-Savoie. MGL 8365, 42882, 42884, 42885 from Cheville, Morcles Massif, Valais.

*Discussion*.—The present collection of this well-known species shows a comparable range of variation to that shown by both English (Kennedy, 1971) and French collections (Kennedy and Juignet, 1983), with specimens showing small, sharp tu-

bercles (Figure 17.38), larger blunt ones (Figure 17.41), as well as those with (Figure 17.36, 17.37) and without feeble ribs on the upper part of the exposed whorl face (Figure 17.31, 17.38).

*Occurrence*.—This species is restricted to the lower *N. carcitanense* Subzone of the Lower Cenomanian *Mantelliceras mantelli* Zone with a wide geographic distribution in western Europe, Roumania, Yugoslavia, Poland, Iran, the Middle East, north Africa, Madagascar, Zululand, and perhaps southern India.

**Genus HYPOTURRILITES** Dubourdieu, 1953

*Type species*.—By original designation: **TURRILITES GRAVESIANUS** d'Orbigny, 1842, p. 596, Pl. 144, figs. 3–5.

**HYPOTURRILITES GRAVESIANUS GRAVESIANUS**  
(d'Orbigny, 1842)

Figure 14.6

*Turrilites gravesianus* D'ORBIGNY, 1842, p. 596, Pl. 144, figs. 3–5.  
*Hypoturrilites gravesianus* (d'Orbigny). SEYED-AMAMI AND ARYAI, 1981, p. 25, Pl. 6, figs. 1, 2; SEYED-EMAMI, 1982, p. 423, text-fig. 3, figs. 1–4; MARTINEZ, 1982, p. 159, Pl. 27, fig. 1; HISS, 1982, p. 188, fig. 7; KENNEDY AND JUIGNET, 1983, p. 35, text-fig. 21d, e, i, j, 22g, 23b–g (with synonymy); SZÁSZ, 1983, p. 238, Pl. 8, fig. 1.

*Types.*—Kennedy (1971, p. 21) designated the original of d'Orbigny's Pl. 144, fig. 3 lectotype of the species, but the figure is a composite, based on two or more specimens.

*Collections.*—Ten specimens: MHNG 19281, 19282 and MGL 42854–57, 42874–75, 42988 from Cheville, Morcles Massif, Valais. MHNG 52481 from Sautet, Platé Massif, Haute-Savoie.

*Discussion.*—This distinctive species is represented by fragments only, referred to the species on the basis of their being two large and four small tubercles in a distance equal to the exposed whorl height. The closely allied *H. tuberculatus* (Bosc, 1801) has three large and 5–6 small tubercles in the same distance.

*Occurrence.*—This is chiefly a Lower Cenomanian species, with a few Middle Cenomanian records (the latter discussed by Kennedy and Juignet, 1983, p. 40). It has a wide geographic distribution in Europe, the U.S.S.R., northern Iran, north Africa, Zululand, Madagascar, and northern Australia.

#### HYPOTURRILITES GRAVESIANUS BETAITRAENSIS

Collignon, 1964

Figure 17.35, 17.39

*Hypoturrilites gravesi* d'Orbigny var. *betaitraensis* COLLIGNON, 1964, p. 13, Pl. 320, figs. 1387, 1388; KLINGER AND KENNEDY, 1978, p. 20, Pl. 4, figs. A–C, Pl. 8, fig. F.

*Holotype.*—By original designation: the original of Collignon, 1964, Pl. 320, fig. 1387, from the Cenomanian of Betaitra, Madagascar.

*Collection.*—One specimen: MHNG 19270 from the Chalets de Criou, Haut-Giffre Massif, Haute-Savoie.

*Discussion.*—The fragment is distorted, but shows clearly ribs and tubercles alternating on the upper whorl face as is diagnostic of the form *betaitraensis*.

*Occurrence.*—Lower Cenomanian of Madagascar and Zululand, in addition to the present records.

#### HYPOTURRILITES sp.

Figures 14.5, 14.6, 14.10, 14.13–14.15, 14.23, 17.34

*Collections.*—Ten specimens: MHNG 23539, 1219 from the Lanche des Aux, Haut-Giffre Massif, Valais and MHNG 1303–1309, 1320, 1323 from the Rochers des Fiz, Platé Massif, Haute-Savoie.

*Discussion.*—This distinctive suite of *Hypoturrilites* are characterized by markedly loose coiling. There are 13–18 tubercles in the upper row and 20–22 in the lower three rows, so that in morphological terms, the group spans the *Mariella* (*Mariella*) to *Hypoturrilites* transition, some being very close to *M. (M.)* of the *cenomanensis*–*lewesiensis* group (e.g., Kennedy and Juignet, 1983, text-fig. 25p–r), others approaching *H. tuberculatus*. They are left in open nomenclature.

Genus *MARIELLA* Nowak, 1916

Subgenus *MARIELLA* Nowak, 1916

(=*Paraturrilites* Breistroffer, 1953;

*Hemiturrilites* Breistroffer, 1953;

*Paraturrilites* (*Bergericeras*) Wiedmann, 1962)

*Type species.*—By the original designation of Nowak, 1916, p. 10: *Turrilites bergeri* Brongniart, 1822, p. 99, 394, Pl. 7, fig. 3.

*MARIELLA* (*MARIELLA*) cf. *GALLIENII*  
(Boule, Lemoine, and Thévenin, 1906)  
Figure 14.9, 14.16

compare:

*Turrilites puzosianum* d'Orbigny var. *gallienii* BOULE, LEMOINE, AND THÉVENIN, 1906, p. 40 (60), Pl. 7 (14), figs. 4, 5.

*Turrilites gallienii* Boule, Lemoine, and Thévenin. COLLIGNON, 1931, p. 89 (49), Pl. 9 (5), figs. 15, 16.

*Paraturrilites gallienii* (Boule, Lemoine, and Thévenin). COLLIGNON, 1964, p. 12, Pl. 320, figs. 1379, 1380.

*Ostlingoceras gallienii* (Boule, Lemoine, and Thévenin). KENNEDY, 1971, p. 27, Pl. 7, figs. 3, 4.

*Mariella* (*Mariella*) *gallienii* (Boule, Lemoine, and Thévenin) *evoluta* KLINGER AND KENNEDY, 1978, p. 29, Pl. 3, figs. C, H, I, Pl. 6, figs. B, D, O, Pl. 7, figs. A, B, figs. 1E, 4E–G.

*Collections.*—Six specimens: MHNG 1329, 1330 from the Chalets de Criou, Haut-Giffre Massif, Haute-Savoie and MHNG 52479a–d from the Rochers des Fiz, Platé Massif, Haute-Savoie.

*Discussion.*—These fragments have a low whorl height, the exposed outer face decorated by transverse ribs bearing three rows of tubercles, with a fourth concealed below the suture between whorls. They closely resemble the *Ostlingoceras* aff. *gallienii* of Kennedy, 1971, Pl. 8, fig. 2.

*Occurrence.*—This is a rare species. In western Europe it occurs in the *Mantelliceras mantelli* Zone, *Neostlingoceras carcitanense* Subzone in Dorset, with an allied form present at a slightly higher level on the Devon Coast. It is also known from the Lower Cenomanian of Madagascar, while subspecies *evoluta* characterizes a low level in the Lower Cenomanian in Zululand.

#### *MARIELLA* (*MARIELLA*) sp. a

Figure 14.11, 14.12, 14.17, 14.18

*Collections.*—Four specimens: MHNG 1209, 1210 from Cheville, Morcles Massif, Valais; MHNG 19253 from Avoudrues and MHNG 19254 from the Chalets de Criou, both in the Haut-Giffre Massif, Haute-Savoie.

*Discussion.*—These fragmentary specimens are ornamented by a long rib on the outer upper whorl face, terminating in a tubercle, with a second row of tubercles below and a third housed in notches at the lower whorl contact and a fourth, lying close to the third, concealed below the whorl suture. They resemble the *M. (M.) cenomanensis* (Schlüter, 1876)–*lewesiensis* (Spath, 1926b) group, although the long rib on the upper, outer whorl face of some (Figure 14.17, 14.19) is reminiscent of *Turrilites* (*Turrilites*).

Family *BACULITIDAE* Gill, 1871

Genus *SCIPONOCERAS* Hyatt, 1894

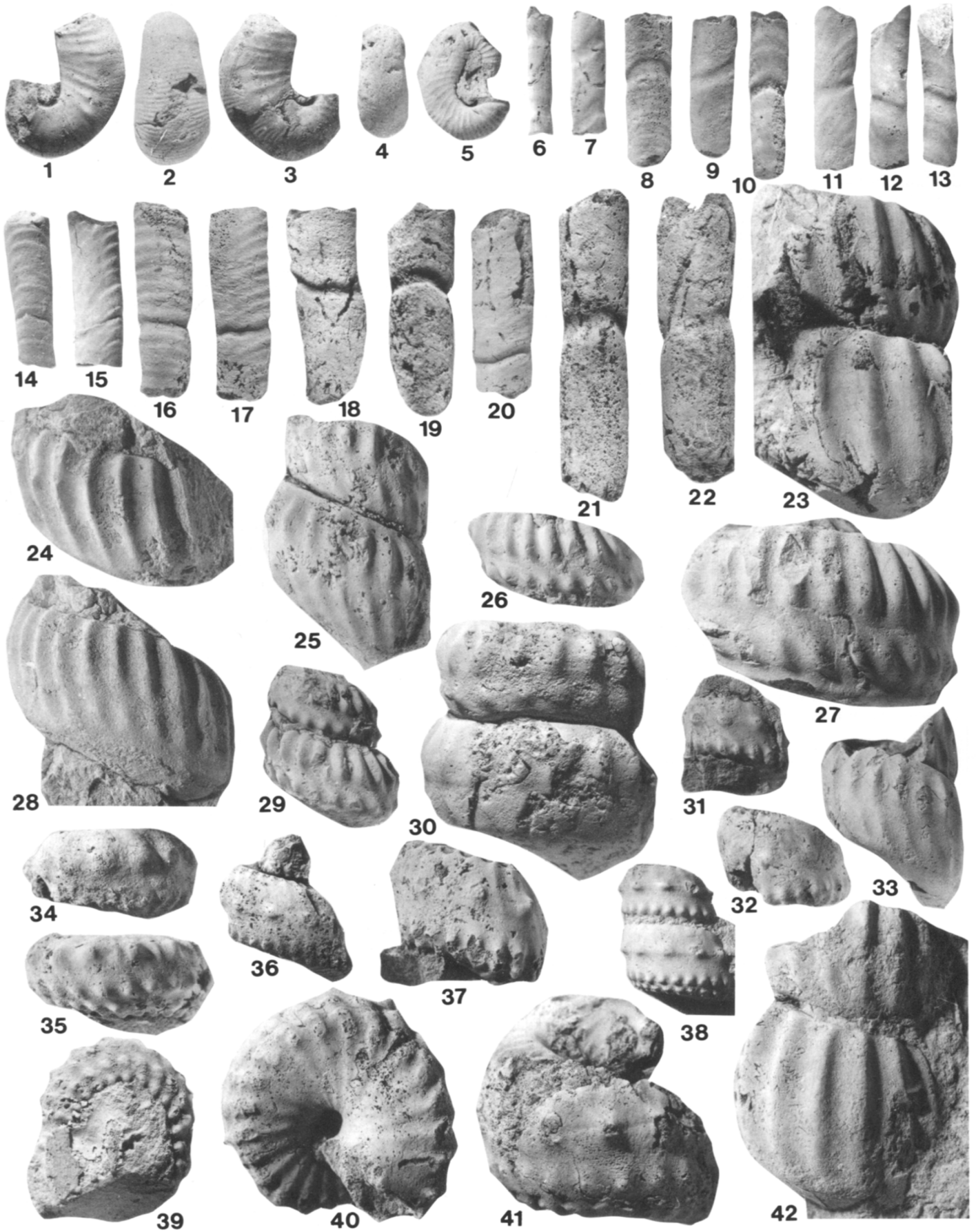
(=*Cyrtochilus* Meek, 1876, non Jakowlew, 1875;

*Cyrtochilella* Strand, 1929)

*SCIPONOCERAS* *ROTO* Cieśliński, 1959

Figure 17.8–17.13, 17.16–17.23

FIGURE 17—1–5, *Scaphites* (*Scaphites*) *obliquus*. J. Sowerby, 1813. 1–3, MHNG 1242; 4, 5, MGL 42879. 6, 7, 14, 15, *Sciponoceras baculoide* (Mantell, 1822). 6, 7, MGL 42886a; 14, 15, MGL 42886b. 8–13, 16–22, *Sciponoceras roto* Cieśliński, 1959. 8, 9, MHNG 1341; 10, 11, MHNG 1310; 12, 13, MHNG 1233; 16, 17, MHNG 1316; 18, 19, MHNG 1317; 20, MHNG 1319; 21, 22, MHNG 1318. 23–25, 28, 30, 33, 42, *Turrilites* (*Turrilites*) *scheuchzerianus* Bosc, 1801. 23, MHNG 19262; 24, MHNG 1213; 25, MHNG 1290; 28, MHNG 19268; 30, MHNG 19266; 33, MHNG 1291; 42, MHNG 1216. 26, 27, 29, *Turrilites* (*Turrilites*) *costatus* Lamarck, 1801. 26, MHNG 1212; 27, MHNG 19252; 29, MHNG 1211. 31, 32, 36–38, 40, 41, *Neostlingoceras carcitanense* (Matheron, 1842). 31, MHNG 1325; 32, MHNG 1298; 36, MHNG 1314; 37, MHNG 1324; 38, MHNG 1296; 40, 41, MHNG 1229. 34, *Hypoturrilites* sp., MHNG 19282. 35, 39, *Hypoturrilites gravesianus betaitraensis* Collignon, 1964, MHNG 19270. All figures are natural size.



*Sciponoceras roto* CIEŚLIŃSKI, 1959, p. 39, 75, 89, Pl. 4, fig. 10, text-fig. 14; WRIGHT, 1963, p. 599; KENNEDY, 1971, p. 10, Pl. 3, fig. 7; HANCOCK, KENNEDY, AND KLAUMANN, 1972, Pl. 81, fig. 8; KENNEDY AND KLINGER, 1975, p. 277; MARCINOWSKI, 1980, p. 254, Pl. 3, figs. 14, 15.

*Sciponoceras cf. roto* CIEŚLIŃSKI, KENNEDY, CHAHIDA, AND DJAFARIAN, 1979, p. 10, Pl. 1, fig. 4.

*Types*.—Cieśliński based this species on nine syntype fragments. We hesitate to designate a lectotype without seeing the original specimen.

*Collections*.—Twenty-one specimens: MHNG 1233 from Cheville, Morcles Massif, Valais; MHNG 1235, 1316–1319, 1322a–k; 1341 from the Rochers des Fiz and MHNG 1310, 1311a, b from Arberroz, both in the Platé Massif, Haute-Savoie.

*Discussion*.—*Sciponoceras roto* is based on fragments with a circular to subcircular whorl section that are smooth between distant constrictions approximately three whorl heights apart. The present collection includes numerous fragments of this type (e.g., Figure 17.12, 17.13) plus those with faint lateroventral ribs and striae (Figure 17.10, 17.11, 17.14, 17.15). Also present are specimens with a circular cross section and very distant constrictions that bear strong lateroventral ribs (Figure 17.16, 17.17); these appear to be body chambers developing a comparable style of ornament to that seen in *S. baculoide* (Mantell, 1822) (e.g., Kennedy, 1971, Pl. 2, figs. 1–5) although the whorl section and distant constrictions separate the two. The direction of constrictions varies from markedly prorsiradiate to near transverse, but this is in part due to post-mortem distortion.

Also present in the collection are fragments with a compressed, oval whorl section, the whorl breadth to height ratio being as little as 0.8, and thus resembling *S. baculoide* (fide Kennedy and Juignet, 1983 p. 19). These specimens have, however, the very distant constrictions typical of *S. roto* and although some have suffered post-mortem compression others appear undistorted, suggesting a wider range of whorl proportions than previously recognized in the species.

*Occurrence*.—This species is known from the low Lower Cenomanian of southern England, Germany, South Africa, and Mangyschak, and is said to range throughout the whole of the Cenomanian in Poland (fide Marcinowski, 1980, p. 254).

#### SCIPONOCERAS BACULOIDE (Mantell, 1822)

Figure 17.6, 17.7, 17.14, 17.15

*Hamites baculoide* MANTELL, 1822, p. 123, Pl. 23, figs. 6, 7.

*Sciponoceras baculoide* (Mantell). KENNEDY AND JUIGNET, 1983, p. 19, figs. 11a–y, 12a–bb, 13a–w, 14a–n (with full synonymy); KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 5, fig. 2.

*Lectotype*.—By the subsequent designation of Kennedy (1971, p. 9): the larger specimen on BMNH 8612, a block figured by Mantell (1822, Pl. 23, fig. 6) from the lower Middle Cenomanian of Hamsey, Sussex.

*Collections*.—Four specimens: MGL 42866, 42993–42995 from Cheville, Morcles Massif, Valais.

*Discussion*.—*Sciponoceras baculoide* is a slender, slowly expanding species characterized by a compressed oval whorl section and a phragmocone with constrictions at intervals of 1.3–2.3 major diameters. In contrast, *S. roto* has an essentially circular whorl section with one constriction every three major diameters. Because of distortion, many fragmentary septate specimens of *Sciponoceras* in the present collections are best left in open nomenclature. Body chambers show prominent prorsiradiate flank ribs, convex on the ventrolateral region and strengthened into a scale-like projection on the venter.

*Occurrence*.—The species is typically Middle Cenomanian, but may range higher and lower. The geographic distribution extends from southern England through France and the German

Federal Republic. There are records from North America, north Africa, south India, Japan, and Madagascar that may or may not refer to this species.

Superfamily SCAPHITACEAE Gill, 1871

Family SCAPHITIDAE Gill, 1871

Genus SCAPHITES Parkinson, 1811

Subgenus SCAPHITES Parkinson, 1811

(= *Anascaphites* Hyatt, 1900; *Jahnnites* Hyatt, 1900; *Yezoites* Yabe, 1910; *Holcoscaphites* Nowak, 1911)

SCAPHITES (SCAPHITES) OBLIQUUS J. Sowerby, 1813

Figure 17.1–17.5

*Scaphites obliquus* J. SOWERBY, 1813, p. 54, Pl. 18, figs. 4–7.

*Sc. (Scaphites) obliquus* J. Sowerby. WIEDMANN, 1965, p. 417, Pl. 56, figs. 1–4, text-fig. 3a, b (with synonymy); KENNEDY, CHAHIDA, AND DJAFARIAN, 1979, p. 22, Pl. 2, figs. 4, 5, 11; MARCINOWSKI, 1980, p. 264, Pl. 5, figs. 1–5; KENNEDY AND JUIGNET, 1983, p. 73, text-figs. 32a, b, 35a–c, 36a–h, 1–q, 37a–g, 38a–d, g–p; MARCINOWSKI AND RADWANSKI, 1983, p. 7, figs. 3, 4; KAPLAN, KELLER, AND WIEDMANN, 1984, Pl. 4, fig. 5.

*Lectotype*.—By the subsequent designation of Kennedy, 1971, p. 33; BMNH 43987a, the original of J. Sowerby, 1813, Pl. 18, figs. 4–6.

*Collections*.—Two specimens: MHNG 1242 from Cheville and MGL 42879 from Ecuelle; both in the Morcles Massif, Valais.

*Discussion*.—MGL 42879 is a complete adult 24 mm long; the MHNG specimen is a body chamber 26 mm long. They show the typical weak flank ribs, bi- or trifurcating into secondary ribs over the venter, with additional intercalatories, and are easily distinguished from *S. equalis* J. Sowerby, 1813 (see Wiedmann, 1965, and Kennedy, 1971, for illustrations of the lectotype), which has strong flank ribs.

*Occurrence*.—This species ranges throughout the Lower and Middle Cenomanian. It is recorded widely from western and eastern Europe, the U.S.S.R., Balkans, Iran north of the Zagros, north and South Africa, Madagascar, and southern India.

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## BIVALVES (MOLLUSCA) FROM THE MAUCH CHUNK GROUP (MISSISSIPPIAN, CHESTERIAN) OF NORTHERN WEST VIRGINIA AND SOUTHWESTERN PENNSYLVANIA

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**ABSTRACT**—Bivalves comprise a major component of the faunules of the Mississippian Mauch Chunk Group in northern West Virginia and southwestern Pennsylvania. Twenty-eight species representing 22 genera have been recognized. Of these, three new species are proposed—*Limipecten greerensis*, *Streblochondria tiltoni*, and *Prothyris (Prothyris) acuticarinata*.

### INTRODUCTION

**C**OLLECTIONS OF bivalves from five localities in the Mauch Chunk Group (Figure 1) form the basis for the present study. The localities (Appendix) coincide with the exposure of the Mauch Chunk outcrop belt along the Chestnut Ridge anticline and are limited to quarry operations in the area. Although many of the specimens are incomplete and poorly preserved, 28 species representing 22 genera are recognized amongst the several hundred specimens collected. It is believed that the following descriptions and illustrations are representative of the bivalve faunules present in the Mauch Chunk Group in this region. A preliminary study of the bivalves from equivalent and slightly younger strata in the Bluefield area of southern West Virginia and southwestern Virginia indicates more diverse faunules in that region than in the study area of this report.

### PREVIOUS WORK

Mauch Chunk invertebrate faunas in the study area have been examined by Meek (1871), Tilton (1928, 1931), Coryell and Sohn (1938), Cooper (1941), Swales (1951), and Busanus (1974). Of these, only Coryell and Sohn and Busanus provided descriptive paleontology, the rest being mainly stratigraphical in nature.

In southern West Virginia, Girty (1923, 1926), Tilton (1931), Butts (1940–1941), Cooper (1944, 1948), Hickman (1951), and Englund et al. (1976) have provided discussions on the inver-

tebrate faunas of the Upper Mississippian. More recently, Henry and Gordon (1977, 1979) and Gordon and Henry (1981) have provided preliminary evaluations of the Late Mississippian and Early Pennsylvanian invertebrate faunas from the area of the proposed stratotype section.

Studies containing Mississippian invertebrates in nearby geographical areas include those by Whitfield (1882b, 1891, 1893), Morse (1911), Fagadau (1952), Hyde (1953), and Szmuc (1957) in Ohio; Lesley (1889–1890) and Benson (1934) in Pennsylvania; Cook (1912) and Brezinski (1989a) in Maryland; and Butts (1940–1941) in Virginia.

### STRATIGRAPHY

The type section of the Mauch Chunk in Pennsylvania is primarily composed of nonmarine shales, siltstones, and sandstones. The lower portion is equivalent to the Greenbrier and Loyalhanna units (Edmunds et al., 1979). The Wymps Gap Limestone Member of the Greenbrier Formation in southwestern Pennsylvania is placed in the Meramecian by Edmunds et al. (1979, fig. 5). Busanus (1974) believed that the Wymps Gap is equivalent to the Union Limestone of northern West Virginia, which underlines the Mauch Chunk Group in the study area.

In northern West Virginia the Mauch Chunk was first detailed by Tilton (1928), who applied the stratigraphic designations as