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# Upper Campanian and Maastrichtian ammonites from the Petites-Pyrénées, southern France

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## ABSTRACT

The Upper Campanian and Maastrichtian sediments of the Petites-Pyrénées in the Subpyrénéean Zone of southern France have yielded several small but important ammonite faunas of mixed boreal and tethyan affinities in association with nannofossils, benthonic and planktonic forams which allow speculation on the correlation of the Maastrichtian stage. In the anticlines of Plagne and Saint-Martory–Saint-Marcet, the Marnes de Plagne yielded a single specimen of the North American *Hoploscaphites pumilis* STEPHENSON 1941 associated with elements of the *Ceratolithoides aculeus* Zone. The niveau de transition between the Marnes de Plagne and the succeeding Calcaire nankin yielded *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894, *Pseudokossmaticeras tercense* (SEUNES 1891) and *Baculites leopoliensis* NOWAK 1908, but no associated microfauna or microflora; it is regarded as Lower Maastrichtian because it occurs above the highest Marnes de Plagne which yield a *Globotruncana contusa* Zone fauna and are thus already Lower Maastrichtian. In the Blajan–Bazordan anticline the Marnes bleues de Saint-Loup yields a remarkable Upper Maastrichtian association of *Hoploscaphites constrictus* (J. SOWERBY 1817) and *Eubaculites lyelli* (D'ORBIGNY 1847) with rarer *Anapachydiscus fresvillensis* (SEUNES 1890). *Saghalinites* sp. and *Baculites vertebralis* LAMARCK 1801 and numerous larger forams including *Orbitoides (S.) gensacicus* (LEYMERIE 1851), *Lepidorbitoides socialis* (LEYMERIE 1851), *Orbitoides apiculata* SCHLUMBERGER 1901 and *Siderolites calcitrapoides* LAMARCK 1801. The upper part yields forms of *Hoploscaphites constrictus* (var. *crassus* LOPUSKI 1911) that are characteristic of the upper Upper Maastrichtian *Belemnella casimirovensis* Zone of the Boreal Realm, associated with the coccolithophore *Micula mura* (MARTINI 1961). The *crassus* form of *H. constrictus* also occurs in the succeeding Marno-Calcaires jaunes.

## RÉSUMÉ

Dans les zones sud-pyrénéennes, les dépôts du Campanien supérieur et du Maastrichtien des Petites-Pyrénées ont livrés plusieurs petites mais importantes faunes d'Ammonites où se mêlent affinités téthysiennes et boréales, en association avec des nannofossiles et des Foraminifères benthiques et planctoniques et grâce auxquels il est possible de proposer des corrélations avec l'étage Maastrichtien. Dans les anticlinaux de Plagne et de Saint-Martory–Saint-Marcet, les Marnes de Plagne ont donné un unique spécimen de l'espèce nord-américaine *Hoploscaphites pumilis* STEPHENSON 1941 associé à une nannoflore de la Zone à *Ceratolithoides aculeus*. Le niveau de transition entre les Marnes de Plagne et le Calcaire nankin sus-jacent renferme *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894, *Pseudokossmaticeras tercense* (SEUNES 1891) et *Baculites leopoliensis* NOWAK 1908, mais il n'y est pas associé de microfaune ou de microflore bien caractéristique; le niveau de transition est considéré comme Maastrichtien inférieur en raison de sa position au dessus des Marnes de Plagne dont la partie sommitale appartient déjà à la Zone à *Globotruncana contusa* du Maastrichtien inférieur. Dans l'anticlinal de Blajan–Bazordan les Marnes bleues de Saint-Loup contiennent une remarquable association du Maastrichtian supérieur avec *Hoploscaphites constrictus*

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(J. SOWERBY 1817) et *Eubaculites lyelli* (D'ORBIGNY 1847), quelques rares *Anapachydiscus fresvillensis* (SEUNES 1890), *Saghalinites* sp. et *Baculites vertebralis* LAMARCK 1801, ainsi que de très nombreux Foraminifères parmi lesquels *Orbitoides (S.) gensacicus* (LEYMERIE 1851), *Lepidorbitoides socialis* (LEYMERIE 1851), *Orbitoides apiculata* SCHLUMBERGER 1901 et *Siderolites calcitrapoides* LAMARCK 1801. La partie sommitale de cette formation livre des formes d'*Hoploscaphites constrictus* (var. *crassus* LOPUSKI 1911) qui sont caractéristiques de la partie supérieure du Maastrichtien supérieur, Zone à *Belemnella casimirovensis* du domaine boréal; elles sont associées au Coccolithophoridé *Micula mura* (MARTINI 1961). La forme *crassus* de l'*H. constrictus* est aussi présente dans la formation des Marnocalcaires jaunes.

## 1. Introduction

(M. Bilotte, B. Lepicard, F. Segura)

With the exception of the Coniacian–Santonian sequences of the Corbières (BILOTTE & COLLIGNON 1983), ammonites are rare in the Upper Cretaceous of the eastern Pyrénées. Occurrences are scattered, and in general of no more than local interest. We describe here however a series of Upper Campanian and Maastrichtian faunules from the Petites-Pyrénées, including rich associations from the Upper Maastrichtian Marnes bleues de Saint-Loup in the Blajan–Bazordan anticline. These occur associated with planktonic and larger benthonic forams, while typically Boreal ammonites (*Hoploscaphites constrictus* (J. SOWERBY 1817)) co-occur with typically Tethyan ones (*Eubaculites lyelli* (D'ORBIGNY 1847)), and provide a basis for interregional correlation.

The Maastrichtian outcrops in the Petites-Pyrénées along the valley of the Garonne, where it is exposed in a series of anticlines (Fig. 1), the most important of which are, from east to west, the Plagne, Saint-Martory–Saint-Marcet and Blajan–Bazordan anticlines. The Maastrichtian sequence varies from structure to structure (Fig. 2) as follows:

### *1.1 Plagne and Saint-Martory–Saint-Marcet anticlines*

The Maastrichtian succession in these structures includes three units, recognised by LEYMERIE (1881):

At the base are the Marnes de Plagne (3000 m average thickness). Only the upper part outcrops and it is dated as Upper Campanian, *Globotruncana stuartiformis* Zone and Lower Maastrichtian *Globotruncana contusa* Zone. They yield *Bolivinoides draco-miliaris* 50 m from the summit and in the upper part *Globotruncana contusa, G. gansseri, G. trinidadensis, G. patelliformis* and *G. ventricosa* (SEGURA 1979; BILOTTE 1985). In the Saint-Martory anticline the Upper Campanian sponge horizon of Paillon (LAGNEAU-HERENGER 1960) has yielded a single specimen of *Hoploscaphites pumilis* STEPHENSON 1941 (Fauna 1, Fig. 2), previously known only from the eastern seaboard and Gulf Coast of the United States (COBBAN 1974) associated with elements of the *Ceratolithoides aculeus* Zone.

The niveau de transition between the Marnes de Plagne and the Calcaire nankin (SEGURA 1979) yielded a small assemblage (Fauna 2, Fig. 2) with *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894, previously known only from Maurens in the Dordogne, *Pseudokossmaticeras tercense* (SEUNES 1891), a Lower Maastrichtian marker fossil known from Carinthia, Austria, Bulgaria, the USSR and Tercis (Landes) and *Baculites leopoliensis* NOWAK 1908, also known from the Lower Maastrichtian of Lvov in the Ukrainian SSR (formerly Lemberg, Galicia).

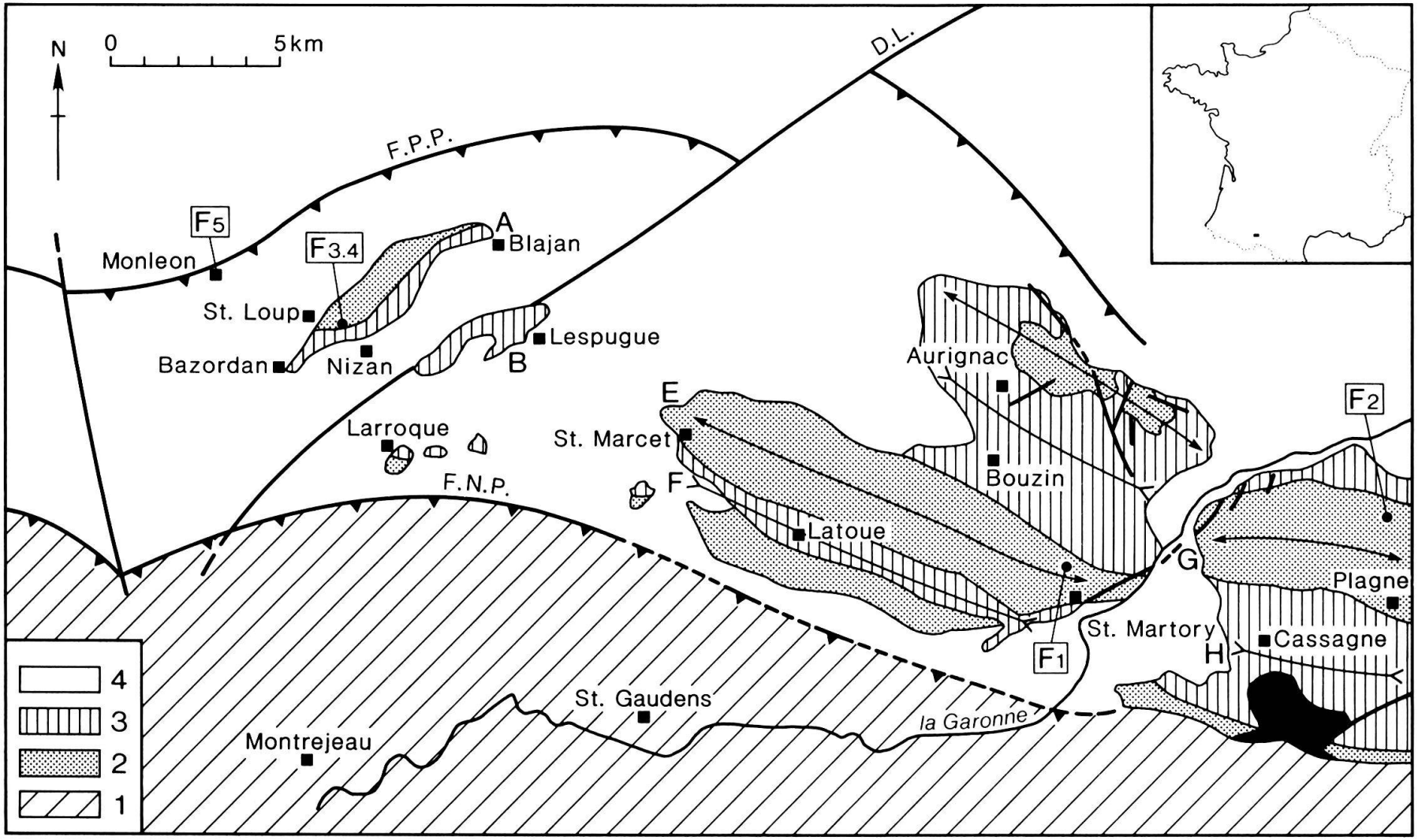


Fig. 1. Locality map of the Petites-Pyrénées. – 1: North Pyrenean and Sub-Pyrenean Zones; 2: Upper Cretaceous; 3: Paleocene–Eocene; 4: Post-Eocene. Structural elements are as follows: A: Blajan–Bazordan anticline; B: Lespurge–Montmaurin Dome; C: Aurignac anticline; D: Bouzin syncline; E: Saint-Marcet–Saint-Martory anticline; F: Latoue syncline; G: Plagne anticline; H: Cassagne syncline; FNP: North-Pyrenean Front; Fpp: Petites-Pyrénées Front; DL: Lespurge strike-slip fault. F1–F5 refer to the fossil assemblages mentioned in the text.

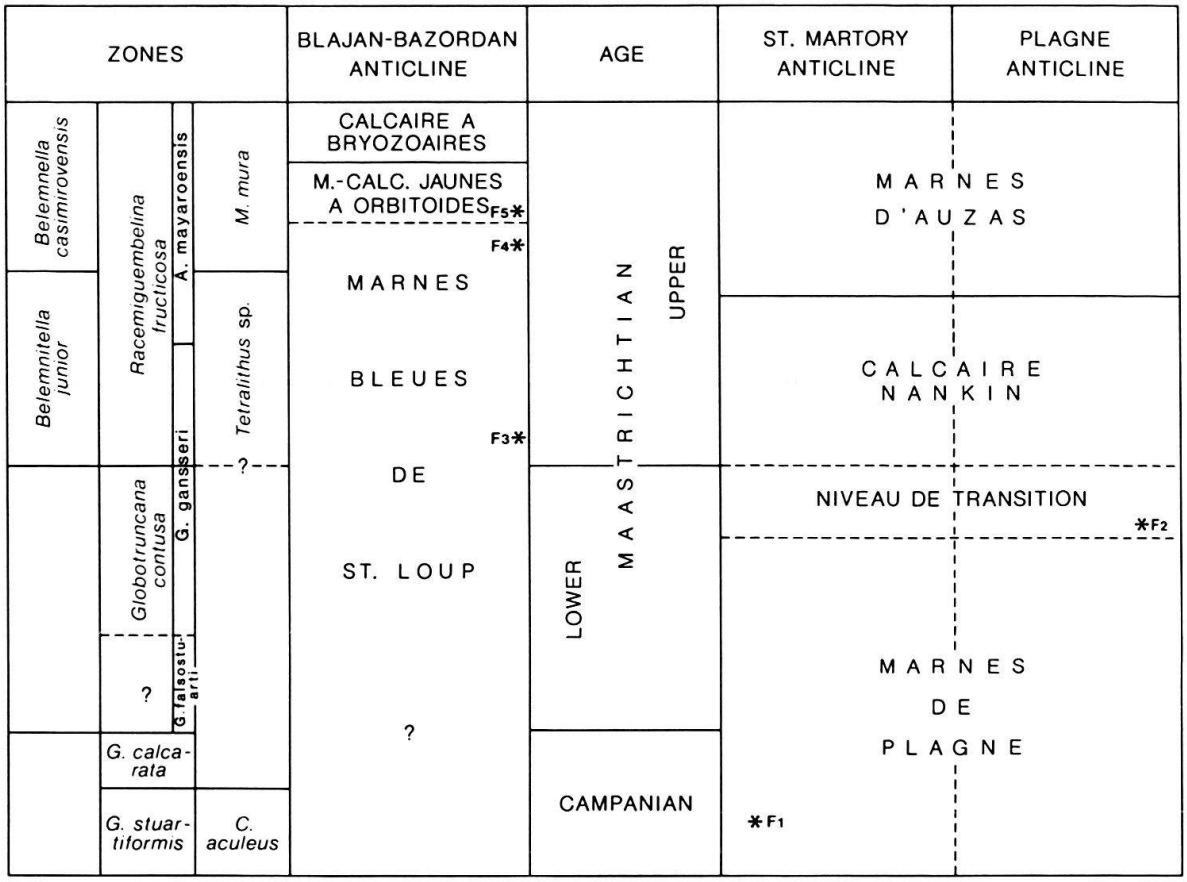


Fig. 2. Correlation of lithostratigraphic units, ammonite faunas, micro- and macrofossil zones recognized in the Petites-Pyrénées with the boreal belemnite succession.

The Calcaire nankin is a silty calcareous platform sequence 150 m thick, rich in larger benthic forams including *Orbitoides apiculata* SCHLUMBERGER 1901, *Siderolites calcitrapoides* LAMARCK 1801 and *Omphalocyclus macroporus* (LAMARCK 1816) but, as yet, no ammonites.

The sequence Marnes de Plagne to Calcaire nankin is a regressive one, and this culminates in the Marnes d'Auzas (250 m), a complex with continental, lagoonal and marine faunas and floras, also attributed to the Maastrichtian (MASSIEUX, TAMBAREAU & VILLATTE 1979; BILOTTE 1980; BILOTTE, TAMBAREAU & VILLATTE 1985).

### *1.2 Blajan–Bazordan anticline*

The sequence is essentially marls throughout. The lowest unit is the Marnes Bleues de Saint-Loup, well-exposed in a large quarry southeast of St-Loup-en-Comminges (coordinates X, 457,5; Y, 105). The sequences consist of thinly bedded blue-grey marls and nodular marly limestones, the latter becoming more important towards the top of the sequence, exposed along a face of 100 m. Ammonites occur as pyritic nuclei and as composite moulds. LEYMERIE (1951), DE GROSSOUVRE (1901) and others have noted ammonites in the sequence, the former describing (as *Ammonites monteleonensis*) pyritic nuclei of *Hoploscaphites constrictus* (J. SOWERBY 1817) which occur with *Eubaculites lyelli* (D'ORBIGNY 1847) low in the quarried interval (Fauna 3 in Fig. 2), while 30 m higher

(Fauna 4 in Fig. 2) the same species co-occur, together with *crassus* forms of *Hoploscaphites constrictus* (J. SOWERBY 1817) that typify the upper Upper Maastrichtian *Belemnella casimirovensis* Zone in northern Europe and *Baculites vertebralis* LAMARCK 1801.

Specimens of *Anapachydiscus fresvillensis* (SEUNES 1890) and *Saghalinites* sp. are also present in this sequence, the whole assemblage showing the exposure of the Marnes bleues de Saint-Loup to be high in the Upper Maastrichtian. This is supported by the microfaunas, which are characteristic of the Upper Maastrichtian *Racemigumbelina fructicosa* Zone (SIGAL 1977) and the nannoflora, with *Lithraphidites quadratus* BRAMLETTE & MARTINI 1964, *Arkhangelskiella cymbiformis* VERKSHINA 1959, *Ceratolithoides kamptneri* BRAMLETTE & MARTINI 1964 of the *Tetralithus* sp. Zone of LAMBERT (1980) and *Micula mura* (MARTINI 1961) at the top of the unit (determinations by B. Lambert).

Above, the Marno-Calcaires jaunes (5–10 m) in the environs of Monléon–Magnoac yield a small assemblage of *Hoploscaphites constrictus* (J. SOWERBY 1817) (including *crassus* forms) (Fauna 5, Fig. 2) together with abundant larger benthonic forams including *Orbitoides* (*S.*) *gensacicus* (LEYMERIE 1851), *Lepidorbitoides socialis* (LEYMERIE 1851), *Orbitoides apiculata* SCHLUMBERGER 1901, *Clypeorbis mammilata* (SCHLUMBERGER 1902), *Omphalocyclus macroporus* (LAMARCK 1816), *Hellenocyclina beotica* REICHEL 1949, *Siderolites calcitrapoides* LAMARCK 1801 and *S. denticulatus* DOUVILLÉ 1906.

The succeeding Calcaire à Bryozoaires (10 m) yield, at the base, *C. mamillata* (SCHLUMBERGER 1902), *Lepidorbitoides* sp., and *Planorbulina cretae* MARSSON 1878.

## 2. Discussion

Figure 2 summarizes the stratigraphic sequences in the study area, places the five fossil assemblages noted above in sequence, and correlates them with associated nannofossil and foram assemblages.

The oldest ammonite recognized is *Hoploscaphites pumilis* STEPHENSON 1941 which occurs with elements of the *Ceratolithoides aculeus* nannofossil Zone in the Marnes de Plagne. In the United States the holotype of *pumilis* is no older than the *Globotruncana fornicata–stuartiformis* assemblage Zone, *R. subcircumnodifer* Subzone, *G. lapparenti* ss. Zonule of PESSAGNO (1969) and no younger than the same authors' *G. contusa–stuartiformis* assemblage Zone, *G. gansseri* Subzone. Specimens of the species from the base of the Navesink Formation in New Jersey (COBBAN 1974) are dated as uppermost Campanian.

The fauna from the niveau de transition, with *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894 *Baculites leopoliensis* NOWAK 1908 and *Pseudokossmaticeras tercense* (SEUNES 1891) is also Maastrichtian, as it occurs above the Marnes de Plagne with their *Globotruncana contusa* Zone foram assemblage. *B. leopoliensis* occurs in the Lower Maastrichtian of the Ukraine while *P. tercense* (SEUNES 1891) is undoubtedly Lower Maastrichtian. The age of the types of *Sphenodiscus ubaghsi* (DE GROSSOUVRE 1894) in Aquitaine is problematic. The specimens come from Assise $R^2$ of Arnaud at Maurens (Dordogne), a locality that also yields *Baculites* like *leopolensis* (Arnaud Collection, now housed in the Université Pierre et Marie Curie, Paris). Both Upper Campanian and Lower Maastrichtian rocks are present at Maurens according to NEUMANN, ANDREIEFF, LAMBERT & PLATEL (1984). These authors place *S. ubaghsi* in the Upper Campanian on the basis of an oral communication from Kennedy, but this is a misquotation! As noted by KENNEDY (1985a) there is

no direct evidence in *ammonite* terms for the age of this species in Aquitaine. All the present records indicate is that the species ranges into the Lower Maastrichtian.

We are unable to make a first order correlation between Faunas 1 and 2 and the Boreal belemnite Zones.

Fauna 3 with *Hoploscaphites constrictus* (J. SOWERBY 1817) and *Eubaculites lyelli* (D'ORBIGNY 1847) is dated as Upper Maastrichtian by virtue of the morphology of the scaphitids and the associated forams and nannofossils.

Fauna 4, which yields the same two ammonite species plus *crassus* forms of *H. constrictus* (restricted to the upper Upper Maastrichtian *Belemnella casimirovensis* Zone: *fide* BIRKELUND 1979, BLASZKIEWICZ 1980 and KENNEDY 1986) and *Baculites vertebralis* LAMARCK 1822 (restricted to the Upper Maastrichtian: BIRKELUND 1979, KENNEDY 1986) is correlated with the upper Upper Maastrichtian *Belemnella casimirovensis* Zone, as is Fauna 5 above.

## 3. Systematic paleontology

(W. J. Kennedy)

### *Repositories of specimens*

| | |
|---|---|
| BMNH: | British Museum (Natural History), London. |
| EMP: | Ecole des Mines Collections, now in the Université Claude Bernard, Lyon. |
| MMC: | Mineralogisk Museum, Copenhagen. |
| MNB: | Museum für Naturkunde, Berlin (GDR). |
| NHMW: | Naturhistorisches Museum, Vienna. |
| OUM: | Geological Collections, University Museum, Oxford. |
| SP: | Sorbonne Collections, now in the Université Pierre et Marie Curie, Paris. |
| UPST: | Laboratoire de Géologie Sédimentaire et de Paléontologie, Université Paul Sabatier, Toulouse. |

### *Suture terminology*

The suture terminology of WEDEKIND (1916, see KULLMAN & WIEDMANN 1970) is followed in the present work:
Is = Internal lobe with septal lobe
U = Umbilical lobe
L = Lateral lobe
E = External lobe

### *Dimensions of specimens*

All dimensions given below are in millimetres: D = diameter, Wb = whorl breadth, Wh = whorl height, U = umbilicus. Figures in parentheses are dimensions as a percentage of the total diameter. The term *rib index* as applied to heteromorphs is the number of ribs in a distance equal to the whorl height.

### Order ***Ammonoidea*** ZITTEL 1884

### Suborder ***Lytoceratina*** HYATT 1889

### Superfamily ***Tetragonitaceae*** HYATT 1900

### Family ***Tetragonitidae*** HYATT 1900

## Genus *Saghalinites* WRIGHT & MATSUMOTO (1954, p. 110)

*Type species.* – By original designation; *Ammonites cala* FORBES (1846a, p. 104, Pl. 8, Fig. 4).

### *Saghalinites* sp.

Pl. 2, Fig. 9, 10

*Material.* – UPST 8a, from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne). Collected loose.

*Discussion.* – The specimen is distorted into an ellipse with a maximum diameter of 45 mm. The evolute coiling with flattened flanks and venter suggesting an originally polygonal whorl section, siphonal ridges and grooves show it to be a *Saghalinites* (see illustrations in BIRKELUND 1965 and KENNEDY & KLINGER 1977). No constrictions are visible, but growth lines and striae on the last-preserved part of the specimen are prorsiradiate, convex on the outer flank and cross the venter with a shallow concavity. The specimen is specifically indeterminate but of interest as a further record of *Saghalinites* from the Upper Maastrichtian of western Europe. The genus is also known from the Lower Maastrichtian of Neuberg, Steiermark, Austria (KENNEDY & SUMMESBERGER, 1986), the Upper Maastrichtian of Kunraed, Limburg, Holland (KENNEDY, in press), around the Lower/Upper Maastrichtian boundary in north Germany (BIRKELUND 1982) and from the top of the Lower to the top of the Upper Maastrichtian in Denmark (BIRKELUND 1979) while there are less precise records from the Maastrichtian of Brenno, Lombardy, Italy (as *Hauericeras pseudo-gardeni* SCHLÜTER sp., of MARIANI 1898, p. 57 (7), Pl. 8 (1), Fig. 6), Beerenbach, Switzerland (*Tetragonites subepigonum* BÖHM, 1909, p. 52, Pl. 1, Fig. 5) and Leszczyny, Galicia, now in the Ukrainian SSR (WISNIOWSKI 1907, p. 201 (11), Pl. 17 (1) Fig. 5a–c, as *Lytoceras (Tetragonites)* sp.).

*Occurrence.* – As for material.

## Suborder ***Ammonitina*** HYATT 1889

## Superfamily ***Desmoceratáceae*** ZITTEL 1895.

(*nom. transl.* WRIGHT & WRIGHT 1951, p. 18, *ex* Desmoceratidae ZITTEL 1895)

## Family ***Kossmaticeratidae*** SPATH 1922

(*nom. transl.* SPATH 1923, p. 35, *ex* Kossmaticeratinae SPATH 1922)

## Subfamily ***Kossmaticeratinae*** SPATH 1922

## Genus *Pseudokossmaticeras* SPATH 1922, p. 126)

*Type species.* – By original designation; *Ammonites pacificus* STOLICZKA (1865, p. 160, Pl. 77, Fig. 9).

### *Pseudokossmaticeras tercense* (SEUNES 1891)

Pl. 1, Fig. 6, 7

1890a *Pachydiscus* aff. *galicianus* FAVRE; SEUNES, p. 238, Pl. 9, Fig. 5.
1891 *Pachydiscus galicianus* FAVRE sp. mut. *Tercensis* SEUNES, p. 16, Pl. 15 (6), Fig. 4.

1894 *Pachydiscus brandti* REDTENBACHER, sp. var. *Pégoti* DE GROSSOUVRE, p. 194, Pl. 30, Fig. 3.
1925 *Kossmaticeras galizianum* var. *tescensis* SEUNES; DIENER, p. 98.
1954 *Pseudokossmaticeras tercense* SEUNES; COLLIGNON, p. 48.
1955a *Pseudokossmaticeras tercense* SEUNES; COLLIGNON, p. 44.
1959 *Pseudokossmaticeras galicianum* (FAVRE); NAIDIN & SHIMANSKIJ, p. 189, Pl. 13, Fig. 1.
1964 *Pseudokossmaticeras galicianum tercense* (SEUNES 1890); TZANKOV, p. 158, Pl. 6, Fig. 1; Pl. 7, Fig. 2.
1974 *Pseudokossmaticeras galicianum* (FAVRE 1869); NAIDIN, p. 179, Pl. 65, Fig. 4.
1976 *Pseudokossmaticeras tercense* (SEUNES); THIEDIG & WIEDMANN, p. 18, Pl. 1, Fig. 2; Pl. 2, Fig. 2.

*Lectotype.* – Here designated, the original of SEUNES (1891, Pl. 15 (6), Fig. 4) from Tercis, Landes. The original is in the Arnaud Collection in the Sorbonne Collections, now housed in the Université Pierre et Marie Curie, Paris.

*Material.* – UPST 90 from the Lower Maastrichtian niveau de transition, Picon de Roquefort (Haute-Garonne).

*Description.* – The specimen is a crushed composite mould with a maximum diameter of 48 mm. Coiling is moderately involute, the whorls slowly expanding, compressed, with a low rounded umbilical wall, rounded umbilical shoulder, flattened flanks, broadly rounded ventrolateral shoulders and venter. The whorl breadth to height ratio is 0.75.

Ornament consists of numerous crowded primary and secondary ribs. The primary ribs arise, singly or in pairs, from sharp umbilical bullae. The secondaries generally intercalate low on the flank, and may link to the umbilical bullae by feeble striae. All ribs are prorsiradiate, and generally one secondary is inserted between the primaries. The ribs are straight on the inner to middle flank and flex forwards over the ventrolateral shoulders, strengthening and passing straight across the venter. It is not possible to determine the number of ribs due to poor preservation; the total is estimated at approximately 60.

*Discussion.* – THIEDIG & WIEDMANN (1976, p. 18) refer to the original of SEUNES (1890 b, Pl. 6, Fig. 4; reproduced in DE GROSSOUVRE 1894, Pl. 30, Fig. 3) from the Lower Maastrichtian, Pas-de-Gazaille near Sainte-Croix (Haute Garonne) as the holotype of this species. This I presume to be an error for SEUNES (1891, Pl. 15 (6), Fig. 4) from Tercis. As Seunes specifically refers to *specimens* of his mut. *tercensis* the figure individual is a syntype, designated lectotype above.

*Pseudokossmaticeras tercense* differs from all other species of the genus by its relatively high whorls and crowded, dense ribs, as discussed by SEUNES (1891) and THIEDIG & WIEDMANN (1976). The inner whorls are particularly distinctive, but the same style of ornament persists to maturity in Austrian specimens (THIEDIG & WIEDMANN 1976, Pl. 1, Fig. 2).

*Occurrence.* – The type material from Tercis is imprecisely localized, but material from Krappfeld, Carinthia, Austria, Bulgaria and the USSR is from the Lower Maastrichtian, as is the present example from the Picon de Roquefort (Haute-Garonne).

## Family ***Pachydiscidae*** SPATH 1922

## Genus *Anapachydiscus* YABE & SHIMIZU 1926

(= *Neopachydiscus* YABE & SHIMIZU 1926)

### *Anapachydiscus fresvillensis* (SEUNES 1890)

Pl. 1, Fig. 4, 5

? 1851 *Ammonites lewesiensis* LEYMERIE (*non* MANTELL), p. 188.

1861 *Ammonites colligatus* BINKHORST, p. 25 *(pars)*, Pl. 6, Fig. 3a–f(?); Pl. 7, Fig. 2c; Pl. 8, Fig. 1, 2.
1890a *Pachydiscus fresvillensis* SEUNES, p. 3, Pl. 2 (1), Fig. 1.
1890b *Pachydiscus fresvillensis* SEUNES; SEUNES, p. 236, Pl. 7, Fig. 1, Pl. 8, Fig. 1–3.
? 1890b *Pachydiscus auritocostatus* SCHLÜTER, sp.; SEUNES, p. 239, Pl. 8, Fig. 4 (non SCHLÜTER).
non 1891 *Pachydiscus fresvillensis* SEUNES; SEUNES, p. 14, Pl. 12 (3), Fig. 1.
1894 *Pachydiscus colligatus* VON BINKHORST, sp. emend. A. DE GROSSOUVRE; DE GROSSOUVRE, p. 202 *(pars)*, Pl. 24, Fig. 1, 3 only (*non* Pl. 33, Fig. 1).
1895 *Pachydiscus Quiriquinae* PHILLIPI, STEINMANN; p. 74, Pl. 6, Fig. 3; Textfig. 5.
1895 *Pachydiscus Fresvillensis* SEUNES; STEINMANN, p. 77.
1906 *Pachydiscus supremus* PETHÖ, p. 88, Pl. 5, Fig. 1.
1908 *Pachydiscus colligatus*, BINKHORST VAN DEN BINKHORST sp. emend. DE GROSSOUVRE; DE GROSSOUVRE, p. 28 *(pars)*, Pl. 4, Fig. 1–3; Pl. 5, Fig. 1, Pl. 6, Fig. 1.
? 1930 *Pachydiscus sumneri* MAURY, p. 155, Pl. 13, Fig. 1, 2.
? 1930 *Parapachydiscus poseidon* MAURY, p. 155, Pl. 15.
? 1930 *Canadoceras riogramense* MAURY, p. 169, Pl. 21, Fig. 2.
1930 *Parapachydiscus* sp. indet. WETZEL, p. 86, Pl. 14, Fig. 1.
1938 *Parapachydiscus fresvillensis* SEUNES; COLLIGNON, p. 101 (51), Pl. 7, Fig. 4, 5; Textfig. O, P.
? 1952 *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST; COLLIGNON, p. 79, Pl. 26, Fig. 2.
? 1955b *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST; COLLIGNON, p. 74, Pl. 26, Fig. 2.
1969 *Pachydiscus colligatus fresvillensis* SEUNES; ATABEKIAN & AKOPIAN, p. 13, Pl. 6, Fig. 1.
1971 *Pachydiscus fresvillensis* SEUNES; COLLIGNON, p. 30, Pl. 652, Fig. 2408.
1985 *Pachydiscus (Pachydiscus) fresvillensis* SEUNES, 1890; HENDERSON & MCNAMARA, p. 78, Pl. 8, Fig. 3–6; Pl. 9, Fig. 1, 2; Textfig. 12b, 13a, 15b.
1986 *Anapachydiscus fresvillensis* (SEUNES, 1890); KENNEDY, p. 42, Pl. 7, 8; Pl. 9, Fig. 1–3; Textfig. 3M, N, Q, 4A

*Lectotype.* – By the subsequent designation of KENNEDY (1986, p. 44, EMP A 1186), the original of SEUNES (1890, p. 3, Pl. 2 (1), Fig. 1), from the Upper Maastrichtian Calcaire à *Baculites* of Fresville, Manche.

*Material.* – UPST 40a, from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).

*Description.* – The specimen is a crushed composite mould of a phragmocone with a maximum diameter of 120 mm, distorted into an ellipse. Coiling is involute with a small deep umbilicus. The umbilical wall is rounded and undercut, the umbilical shoulder rounded. The original proportions are distorted by crushing, but flanks and venter were broadly rounded. Ornament consists of 18 primary ribs on the outer whorl, most of which arise on the umbilical wall and strengthen into weak, rounded umbilical tubercles. A few are flat-topped and were the septate bases of umbilical spines. These tubercles give rise to pairs of ribs, while shorter intercalated ribs arise low on the flank to give a total of 40 ribs per whorl at a diameter of 120 mm. The ribs are narrow and rounded, prorsiradiate on the flank, projected forwards and concave on the ventrolateral shoulder, crossing the venter in a broad convexity. A shallow groove marks the site of the siphuncle.

The poorly preserved sutures are finely subdivided, and rather typical for the genus.

*Discussion.* – This species is discussed by KENNEDY (1986), where differences from other forms are reviewed at some length. The present specimen, a macroconch, closely resembles the lectotype, when differences in preservation are taken into account, and has the same rib density as that somewhat larger (148 mm diameter) specimen. It also is close to specimens from the Upper Maastrichtian Marnes de Nay between Gan and Rébenacq (Pyrénées Atlantiques) in the Ecole des Mines Collections and Sorbonne Collections; SEUNES (1890b, Pl. 7, Fig. 1; Pl. 8, Fig. 1–3) and DE GROSSOUVRE (1894, Pl. 24, Fig. 1, 3) have also illustrated macroconchs from this locality while the former (1890b, Pl. 8, Fig. 4)

figured (as *Pachydiscus auritocostatus* SCHLÜTER) what may be the microconch of the species.

*Occurrence.* – Where well-dated this species is always Upper Maastrichtian. There are records from Haute-Garonne, Pyrénées Atlantiques and Manche in France, Limburg, The Netherlands, Denmark, Yugoslavia, Armenia, southern India, Madagascar, western Australia, Chile and Brazil(?).

## Superfamily ***Acanthocerataceae*** DE GROSSOUVRE 1894

[*nom. correct.* WRIGHT & WRIGHT 1951, p. 24 (pro Acanthoceratida HYATT 1900, p. 585), *nom. transl. ex* Acanthoceratidae HYATT 1900, p. 585, *nom. correct. ex* Acanthoceratidés DE GROSSOUVRE 1894]

## Family ***Sphenodiscidae*** HYATT 1900

( = Libycoceratidae ZABORSKI 1982)

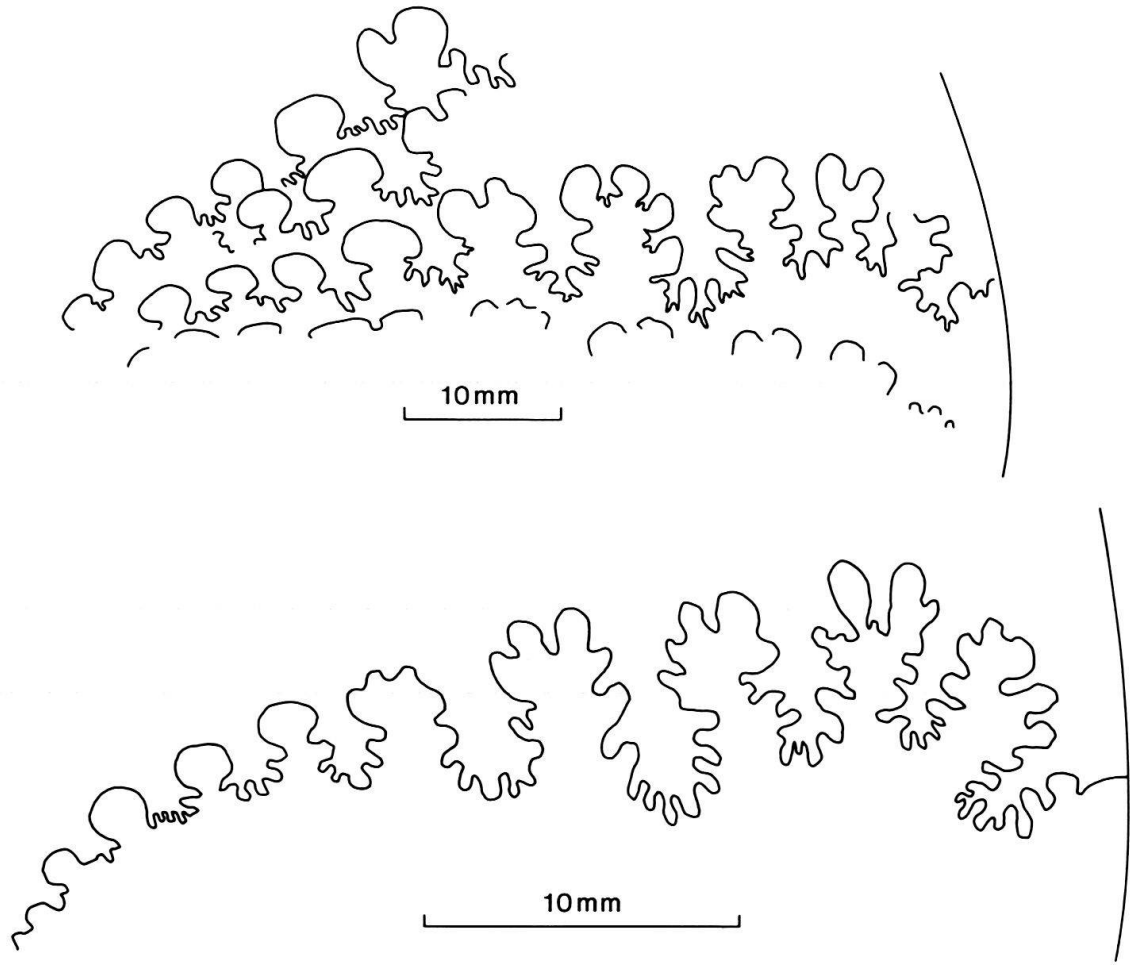


Fig. 3. *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894. External sutures of a: the lectotype, SP unregistered, the original of DE GROSSOUVRE (1894, Pl. 9, Fig. 4), from Assize R of Arnaud at Maurens (Dordogne); b: UPST 85 from the Lower Maastrichtian Niveau de Transition, Pas-de-Gazaille, Anticlinal de Richou-Montfa (Haute-Garonne). – Bar scales are 10 mm.

## Genus *Sphenodiscus* MEEK 1871, p. 298

( = *Austrosphenodiscus* OLSSON 1944)

*Type species.* – By original designation; *Ammonites lenticularis* OWEN (1852, p. 579) (*non* PHILLIPS 1829, Pl. 6, Fig. 5) = *Ammonites lobatus* TUOMEY (1856, p. 168).

### *Sphenodiscus ubaghsi* DE GROSSOUVRE 1894

Pl. 2, Fig. 13–15; Textfig. 3 a, b

1894 *Sphenodiscus ubaghsi* A. DE GROSSOUVRE, n.sp., p. 141, Pl. 9, Fig. 4, 6; Textfig. 60.
? 1894 *Sphenodiscus rutoti* A. DE GROSSOUVRE, n.sp., p. 143, Textfig. 61.
1903 *Sphenodiscus ubaghsi* GROSSOUVRE; HYATT, p. 82.
? 1903 *Sphenodiscus rutoti* GROSSOUVRE; HYATT, p. 83.
1908 *Sphenodiscus Ubaghsi*, DE GROSSOUVRE; DE GROSSOUVRE, p. 19, Pl. 1, Fig. 2.
? 1908 *Sphenodiscus Rutoti*, DE GROSSOUVRE; DE GROSSOUVRE, p. 19, Pl. 1, Fig. 3.
1925 *Sphenodiscus Ubaghsi* GROSSOUVRE; DIENER, p. 223 (with additional synonymy).
? 1925 *Sphenodiscus Rutoti* GROSSOUVRE; DIENER, p. 223.

*Types.* – Lectotype, here designated, the original of DE GROSSOUVRE (1894, Pl. 9, Fig. 4; Textfig. 60), from the Calcaire gréseux à Thécidées, Assise R of Arnaud, of Maurens (Dordogne); paralectotype is the original of DE GROSSOUVRE (1894, Pl. 9, Fig. 6) from the Calcaire blanc, Pierre de taille de Maurens, Assise R of Arnaud of Maurens (Dordogne). Both specimens are in the Arnaud Collection in the Sorbonne Collections, now in the Université Pierre et Marie Curie, Paris.

*Material.* – Two specimens, UPST 85 and 91, from the Lower Maastrichtian niveau de transition of the Pas-de-Gazaille and Crabé (Haute-Garonne).

*Dimensions.* –

| | *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|---|
| Lectotype | – (–) | 20 (–) | 60 (–) | 0.33 | – (–) |
| Paralectotype | 95 (100) | 17.3 (18.2) | 57.5 (60.5) | 0.3 | – (–) |
| UPST 85 | 84 (100) | 19.6 (23.3) | 49.0 (58.3) | 0.4 | – (–) |

*Description.* – The two specimens are both wholly septate. UPST 85 is distorted into an ellipse with a maximum diameter of 84 mm; UPST 91 is over 250 mm in diameter. Both specimens are completely smooth oxycones with a tiny occluded umbilicus and sharp venter. The juvenile suture, shown in Textfigure 10 b includes 10 or 11 saddles, the outer five subdivided, the inner ones entire. The adult suture is poorly exposed.

*Discussion* – These specimens are referred to *S. ubaghsi* on the basis of the smooth oxycone shell and similar suture line. *S. rutoti* DE GROSSOUVRE (1894, p. 143, Textfig. 61) is based on the holotype only, from the same locality and horizon as *S. ubaghsi*. It differs in details of the suture line, but this is a variable feature in *Sphenodiscus* (*fide* ZABORSKI 1982) and it may be a synonym of *ubaghsi*. Many authors have commented on the difficulty experienced in separating the smooth species of *Sphenodiscus*, and DE GROSSOUVRE himself noted (1908, p. 19) that *S. lenticularis* (OWEN, 1852) and *S. lobatus* (TUOMEY, 1856) had sutures on the same basic pattern. Without more and better material it is impossible to assess the relationship of French and other forms.

The only other *Sphenodiscus* recorded from western Europe is *Sphenodiscus binkhorsti*

(BÖHM 1898), which is restricted to the Upper Maastrichtian. This has faint prorsiradiate striae and around ten low ribs – or folds – per whorl, which strengthen into feeble outer lateral bullae in some specimens, with a spiral angulation marking a change in outer flank slope profile.

*Occurrence.* – Lower Maastrichtian, niveau de transition of the Pas de Gazaille in the anticlinal de Richou–Montfa and Crabé in the anticlinal de Plagne (Haute-Garonne). The lectotype and paralectotype from Maurens are among the youngest ammonites known from the Aquitaine Basin. KENNEDY (1985) was unable to state definitely whether they were uppermost Campanian or Maastrichtian, but the work of NEUMANN, ANDRIEFF, LAMBERT & PLATEL (1984) claims the species as Upper Campanian. On the present evidence, the species certainly occurs in the lower Maastrichtian.

## Suborder ***Ancyloceratina*** WIEDMANN 1966

## Superfamily ***Turrilitaceae*** GILL 1871

(= Diplomocerataceae BRUNNSCHWEILER 1966)

## Family ***Baculitidae*** GILL 1871

(= Eubaculitinae BRUNNSCHWEILER 1966)

### Genus *Baculites* LAMARCK 1799, p. 80

[= *Homaloceratites* HUPSCH 1768, p. 110 *(non binomen)*; *Euhomaloceras* SPATH 1926, p. 80].

*Type species.* – By the subsequent designation of MEEK (1876, p. 391), *Baculites vertebralis* LAMARCK (1801, p. 103).

### *Baculites vertebralis* LAMARCK 1801

Pl. 1, Fig. 8, 9

1799 Corne d'ammon droite ... FAUJAS-SAINT-FOND, p. 140, Pl. 21, Fig. 2, 3.
1801 *Baculites vertebralis* LAMARCK, p. 103.
1822 *Baculites faujasii* LAMARCK, p. 647.
1986 *Baculites vertebralis* LAMARCK 1801; KENNEDY, p. 57, Pl. 11, Fig. 6–11; Pl. 12, Fig. 1–6; Textfig. 3A–D, 7D, F, 8 (with synonymy).

*Lectotype.* – By the subsequent designation of KENNEDY (1986a, p. 57) the original of FAUJAS-SAINT-FOND (1799, Pl. 21, Fig. 2, 3) from the Upper Maastrichtian of St. Pietersberg, Limburg, The Netherlands. This is the holotype, by monotypy, of *Baculites faujasii* LAMARCK 1822, which is thus a subjective synonym.

*Material.* – UPST 37, from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).

*Description.* – The specimen is a crushed body chamber 125 mm long, with a maximum preserved whorl height of 23.5 mm. The whorl section is compressed (Wb:Wh is 0.53). The whorl section is ovoid with the dorsum more broadly rounded than the venter and the sides flattened. The surface of the mould is smooth except for growth lines and striae on the outer flank and venter, which they cross in a narrow convexity. A prominent

bilobed area on the dorsum at the apical end of the body chamber is delineated by a narrow groove, corresponding to what was a ridge on the inside of the shell. This structure closely resembles what KENNEDY & COBBAN (1976, p. 10, Pl. 2, Fig. 1a–b, 5) have termed retractor muscle scars.

The last suture is only imperfectly visible but included deeply incised bifid elements.

*Discussion.* – An extensive synonymy of *Baculites vertebralis* is given by KENNEDY while material from the Calcaire à *Baculites* comparing closely with the present specimen (given the marked differences in preservation) are figured by KENNEDY (1986). *B. vertebralis* includes both smooth and ribbed variants, and is best distinguished from the other widely occurring European Upper Maastrichtian *Baculites, B. anceps* LAMARCK 1822, by the whorl section which is pyriform in the latter with an acute venter, commonly flanked by grooves. In addition, the growth lines and riblets of *B. anceps* intersect the line of the venter at a much smaller angle and the suture lines are much simpler.

*Baculites knorrianus* DESMAREST 1817 (p. 48, Pl. 1, Fig. 3) is a much larger species which seems to be exclusively Lower Maastrichtian (see range data in BIRKELUND 1979). It too has an ovoid whorl section, but the dorsum is more broadly rounded with strongly convergent flanks and a narrowly rounded venter. The suture is deeply and intricately incised.

*Baculites leopoliensis* NOWAK 1908, discussed further below (p.1014) is a Lower Maastrichtian form with flattened dorsum, subparallel flanks and rather broadly rounded venter. The flank ribs are coarser than in ribbed variants of *B. vertebralis,* while there are fine secondary ribs on the venter, retained to a large size.

*Occurrence.* – This is an exclusively Upper Maastrichtian species, known, apart from the present record in Haute-Garonne, from the Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France, St. Pietersberg, Maastricht, Kunrade and elsewhere in Limburg, The Netherlands and adjacent parts of Belgium, in north Germany, southern Sweden, Denmark, Poland, the southern USSR and Tunisia.

## *Baculites leopoliensis* NOWAK 1908

Pl. 2, Fig. 1, 2, 11, 12; Pl. 3, Fig. 22–24

1908 *Baculites anceps* LAM. sp. em. NOWAK 1. varietas *Leopoliensis* NOWAK, p. 328 *(pars)*, Pl. 14, Fig. 1–5, 10, 11; ? Textfig. 1–5 on p. 329; ? Textfig. 5–10 on p. 331.
non 1951 *Baculites anceps* LAM. var. *leopoliensis* NOWAK; MIKHAILOV, p. 46, Pl. 3, Fig. 15.
non 1964 *Baculites anceps leopoliensis* NOWAK 1908; TZANKOV, p. 149, Pl. 10, Fig. 2.
non 1974 *Baculites anceps leopoliensis* NOWAK; NAIDIN & SHIMANSKIJ, p. 164, Pl. 53, Fig. 5.
non 1976 *Baculites anceps leopoliensis* NOWAK; ATABEKIAN & KHAKHIMOV, p. 96, Pl. 11, Fig. 11–13.

*Lectotype.* – Here designated, the original of NOWAK (1908, Pl. 14, Fig. 1) from Lipniki, formerly in Galicia but now in the Ukrainian SSR.

*Material.* – UPST 86, from south of La Verrerie d'en Haut, anticlinal de Plagne; UPST 87, from Maillau, synclinal de Fontane-Gorry; UPST 88, from Charles, Anticlinal de Plagne; UPST 89, from Pas-du-Fauga, Anticlinal de Plagne; UPST 92, from Ruffé-d'en-Haut, Anticlinal de Plagne, all specimens being from the niveau de transition.

*Description.* – Most specimens are crushed, but the whorls are slowly expanding, with a compressed ovoid whorl section, the dorsum somewhat flattened, the dorsolateral area broadly rounded, dorsoventral area flattened and venter rounded. The whorl breadth to

height ratio is 0.77 in the best-preserved specimen (UPST 98) with the greatest breadth well below mid-flank. Ornament consists of strong, quite closely-spaced flank ribs, the rib index varying between 3 and 4, the ribs becoming more widely-spaced in the larger specimens (Pl. 2, Fig. 1, 2).

The ribs are weakened on the dorsum, which they cross in a broad convexity, breaking down into riblets and striae in some cases (Pl. 3, Fig. 22). They are strong on the dorsolateral area and inner to mid-flank, but project strongly forwards and weaken on the outer flank, intersecting the line of the venter at an angle of 20–25°. The ribs break down into riblets and striae over the venter while intercalated ribs develop in the interspaces of some specimens (Pl. 2, Fig. 12), all ornament weakening over the venter which it crosses in a narrow convexity. The sutures are not visible.

*Discussion.* – The taxonomy of most European *Baculites* is confused. The present specimens show, however the same style of flank ornament as *Baculites anceps leopoliensis* NOWAK 1908 (p. 323, Pl. 14, Fig. 1–5, 10, 11), in particular the presence of fine secondaries on the venter. This is a Lower Maastrichtian form, the lectotype being from Lipniki, formerly in Galicia and now in the Ukrainian SSR. True *Baculites anceps* LAMARCK 1822 (see revisions in HOWARTH 1965, p. 363, Pl. 4, Fig. 4; Pl. 5, Fig. 4, 5; Pl. 6, Fig. 1–5; Textfig. 2, 3, 5–12) is from the Upper Maastrichtian and has an utterly distinctive whorl section, with acute venter. *Baculites vertebralis* LAMARCK 1801 (see recent revisions by KENNEDY 1986) has an oval to ovoid whorl section. Most specimens are smooth, but those which are ornamented have flank ribs that intersect the line of the venter at a higher angle, lacking the secondaries of the present form.

*Baculites leopoliensis* has generally been confused with *Baculites knorrianus* DESMAREST 1817 (p. 48, Pl. 1, Fig. 3). Indeed, NOWAK regarded *knorrianus* as a synonym of *leopoliensis,* although DESMAREST's species was validly introduced:

DEUXIÈME ESPÈCE

*Baculite de knorr. (Baculites knorriana)* Nob.

«Je ne la connois que par la figure qui est à la fin du supplément plément du grand Ouvrage de Knorr sur les Fossiles, tome IV, pl. XII, et par la très-courte description que l'accompagne, pag. 202 du même volume. Ses sutures ne sont point apparentes, parce que le test semble exister, mais la cassure transversale de cette coquille indique que les productions rameuses qui la forment sont peu développées.

Cette baculite est remarquable par sa compression excessive et par ses grandes dimensions; son grand diamètre transversale à 0 m, 067, et le petit 0 m, 023 seulement.

Elle a été trouvé, comme celle de Klein, aux environs de Dantzick, elle paroit chargée en matière silicieuse.

Walch croit avoir trouvé un vestige de siphon dans l'échantillon représenté par Klein (*Oryctographia,* p. 111, fig. 2 et 3a).»

The distinctive whorl section shown in the figures matches that of the large, smooth *Baculites* from the environs of Lemburg, Galicia (now Lvov in the Ukrainian SSR) like that illustrated by FAVRE (1869, p. 27, Pl. 7, Fig. 2). Of 20 topotype specimens available for study (BMNH, MMK, NHMW collections), none develop the flank ornament typical of the present material, and Nowak's description and textfigures seem to include specimens of both species.

*Occurrence.* – Lower Maastrichtian of the environs of Lvov, Ukrainian SSR (formerly Lemburg, Poland), niveau de transition in the Petites-Pyrénées, Assise $R^2$ of Arnaud at Maurens (Dordogne).

## Genus *Eubaculites* SPATH 1926

(= *Giralites* BRUNNSCHWEILER 1966, p. 33; *Eubaculiceras* BRUNNSCHWEILER 1966, p. 33; *Cardabites* BRUNNSCHWEILER 1966, p. 38).

*Type species* – By original designation; *Baculites vagina* var. *Ootacodensis* STOLICZKA (1866, p. 199, Pl. 90, Fig. 14).

*Diagnosis.* – Large, curved or straight, with pyriform whorl section, truncated by narrow tabulate venter with sharp ventrolateral shoulders or fastigiate. Dorsum flattened with angular or narrowly rounded shoulders. Smooth, or ornamented by crescentic ribs and riblets. Dorsolateral and lateral bullae present or not. Venter smooth, notched or with transverse riblets, which may extend onto the ventrolateral region. Suture with plump, minutely frilled elements.

*Discussion.* – *Eubaculites* was introduced without diagnosis, and it is to WRIGHT (1957) and MATSUMOTO (1959) that we owe the first clear diagnoses of the genus. Both workers stressed the tabulate venter as an important characteristic, although as KLINGER (1976) has noted, STOLICZKA's figure shows a specimen with a fastigiate venter, confirmed from a cast of the lectotype before me, although his description indicates specimens with a tabulate venter (1866, p. 199). Other workers have described adult specimens with both tabulate and fastigiate venters and two radically different approaches to these ammonites are available. BRUNNSCHWEILER (1966) studying material from the Upper Maastrichtian of western Australia recognized a subfamily Eubaculitinae plus genera *Eubaculites, Giralites* BRUNNSCHWEILER 1966, *Eubaculiceras* BRUNNSCHWEILER 1966 and *Cardabites* BRUNNSCHWEILER 1966, with some 11 species referred to these genera, all the material coming from a limited stratigraphic interval. KLINGER (1966) regarded BRUNNSCHWEILER's genera as synonyms of *Eubaculites* and recognized four morphological groups, a view adopted here with minor modification; the groups are:

1. With flattened dorsum and fastigiate venter, including the nominate species *Baculites ootacodensis* STOLICZKA 1866, *Baculites vagina* var. *simplex* KOSSMAT 1895, *Baculites rioturbioensis* HÜNICKEN, 1965, *Eubaculiceras fastigiatum* BRUNNSCHWEILER, 1966, *Cardabites scimitar* BRUNNSCHWEILER, 1966 *(Baculites argentinicus* WEAVER, 1927 is a *nomen dubium,* possible a corroded fragment of *B. rioturbioensis).*

2. With flattened dorsum and tabulate venter, ornamented individuals with dorsal and dorsolateral tubercles, some individuals smooth; *Baculites vagina* FORBES 1846, *Baculites ornatus* D'ORBIGNY 1847.

3. With flattened dorsum and tabulate venter, generally ornamented by flank ribs, with some smooth individuals in populations; *Baculites lyelli* D'ORBIGNY 1847, *Eubaculites kossmati* BRUNNSCHWEILER 1966, *Eubaculites multicostatus* BRUNNSCHWEILER 1966, *Giralites latecarinatus* BRUNNSCHWEILER 1966, *Giralites quadrisulcatus* BRUNNSCHWEILER 1966, *Eubaculiceras compressum* BRUNNSCHWEILER, 1966, *Cardabites tabulatus* BRUNNSCHWEILER 1966.

The *ootacodensis* group are so far unknown in western Europe; the *vagina* group are known from a single specimen only from the Maastrichtian Flysch of the Ukrainian SSR (WISNIOWSKI 1907, Pl. 17, Fig. 9); the *lyelli* group are know from a single specimen from the Upper Maastrichtian of Maastricht (BINKHORST 1861, p. 42, Pl. 5d, Fig. 5a–d), a few individuals from the Lower Maastrichtian of Neuberg, Steiermark, Austria (KENNEDY & SUMMESBERGER, 1986) and abundant material from the Upper Maastrichtian of the

Petites-Pyrénées described here, and the most remarkable feature of the present faunas, for *E. lyelli* has a dominantly austral occurrence.

*Occurrence.* – *Eubaculites* ist restricted to the Maastrichtian, with records from southern India, Assam, western Australia, Zululand, Mozambique, Madagascar, Peru, Chile, Patagonia, Argentina, California, southwestern France (the present occurrences), Austria, Holland and the Ukrainian SSR. Records from New Zealand (WOODS 1917) and Yugoslavia (PETHO 1906) are doubtful.

## *Eubaculites lyelli* (D'ORBIGNY 1847)

Pl. 1, Fig. 1–3; Pl. 2, Fig. 3–8; Pl. 3, Fig. 2–8, 13–21

1846 *Baculites vagina* E. FORBES; DARWIN, p. 126.
1846 b *Baculites vagina* FORBES; FORBES, Pl. 5, Fig. 3.
1847 *Baculites lyelli* D'ORBIGNY, Pl. 1, Fig. 3–7.
1850 *Baculites lyelli* D'ORB.; D'ORBIGNY, p. 215.
1861 *Baculites anceps* LAMARCK; BINCKHORST, p. 42, Pl. 5 d, Fig. 3 a–d.
1864 *Baculites chicoensis* GABB, p. 80 *(pars)* Pl. 14, Fig. 29, 29 a, *non* Pl. 17, Fig. 27, 27 a; *non* Pl. 14, Fig. 27 b.
1895 *Baculites vagina* FORBES n. var. *simplex* KOSSMAT, p. 156 (60), Pl. 19 (5), Fig. 14 a, b only.
1895 *Baculites vagina* var. *Otacodensis* STOL.; KOSSMAT, p. 157 (61) *(pars)*, Pl. 19 (5), Fig. 16, ? *non* 15.
1895 *Baculites vagina* FORBES; STEINMANN, p. 89, Pl. 6, Fig. 4; Textfig. 8–10.
1897 b *Baculites vagina* FORBES; KOSSMAT, Pl. 6, Fig. 4.
1904 *Baculites vagina* FORBES; WILKENS, p. 188.
*non* 1907 *Baculites vagina* var. *cazadoriana* PAULCKE, p. 11, Pl. 16, Fig. 5 a–c.
1925 *Baculites vagina* FORBES; DIENER, p. 63 *(pars)*.
*non* 1925 *Baculites vagina* var. *cazadoriana* PAULCKE; DIENER, p. 63.
1925 *Baculites vagina* FORBES var. *otacodensis* STOLICZKA, DIENER, p. 63 *(pars)*.
1930 *Baculites vagina* FORBES; WETZEL, p. 90, Pl. 10, Fig. 3, 4.
1940 *Eubaculites otacodensis* STOLICZKA; SPATH, p. 49, Pl. 1, Fig. 3; Textfig. 1 b.
? 1940 *Eubaculites* aff. *vagina* FORBES; SPATH, p. 50.
? 1944 *Baculites lyelli* D'ORBIGNY; OLSSON, p. 104, Pl. 16, Fig. 3–5; Textfig. 1.
1953 *Eubaculites lyelli* D'ORBIGNY; SPATH, p. 46–47.
1957 *Eubaculites otacodensis* (STOLICZKA); WRIGHT, p. L218, Fig. 245, 6a–b.
1957 *Baculites vagina* FORBES; HOFSTETTER, FUENZALIDA & CECIONE, p. 300, 302.
1959 *Eubaculites otacodensis* (STOLICZKA), MATSUMOTO, p. 166, Pl. 43, Fig. 6; Pl. 44, Fig. 1–3; Textfig. 84a, b; 85a, b.
1963 *Eubaculites lyelli* D'ORBIGNY; MATSUMOTO & OBATA, p. 97.
1964 *Eubaculites argentinicus* (WEAVER); LEANZA, p. 95, Pl. 1, Fig. 1–5; Textfig. 1.
1966 *Eubaculites ootacodensis* (STOLICZKA, 1866); BRUNNSCHWEILER, p. 27, Pl. 1, Fig. 9–14; Textfig. 9–11.
1966 *Eubaculites vagina* (FORBES 1846); BRUNNSCHWEILER, p. 29, Pl. 1, Fig. 7; Pl. 2, Fig. 1–14; Textfig. 12–14.
1966 *Eubaculites kossmati* sp. nov. BRUNNSCHWEILER, p. 31, Pl. 2, Fig. 15–17; Pl. 3, Fig. 1–7; Textfig. 15.
1966 *Eubaculites multicostatus* sp. nov.; BRUNNSCHWEILER, p. 32, Pl. 3, Fig. 8–12; Textfig. 16.
1974 *Eubaculites ootacodensis* (STOLICZKA); RICCARDI, p. 388, Pl. 1, Fig. 1–7; Pl. 21, Fig. 1–4, 6; Pl. 3, Fig. 1–6; Pl. 4, Fig. 1–7; Textfig. 2.
1975 *Eubaculites lyelli* (D'ORBIGNY); HÜNICKEN & COVACEVICH, p. 149, Pl. 1, Fig. 5–12; Pl. 2, Fig. 4–9; Pl. 3, Fig. 1–8; Pl. 4, Fig. 1–8; Pl. 5, Fig. 1–4; Textfig. 6–28.
1976 *Eubaculites ootacodensis* (STOLICZKA), 1865; KLINGER, p. 90 (*pars*), Pl. 39, Fig. 1, *non* 3; Pl. 41, Fig. 1, 2; Pl. 42, Fig. 3, 8,; ? *non* Pl. 43, Fig. 1; Textfig. 11 c.
1986 *Eubaculites lyelli* (D'ORBIGNY 1847); KENNEDY & SUMMESBERGER, p. 194, Pl. 14, Fig. 1–5, 9-14.

*Types.* – Lectotype, here designated, MNHP R1020a; paralectotypes are MNHP R1020b–c (formerly d'Orbigny Collection no. 7206). These specimens are presumed to be the basis of d'Orbigny's highly restored and idealized figures (1847, Pl. 1, Fig. 3–7). The

catalogue of the d'Orbigny Collection gives the locality as "Concépcion", but the locality is given as Quiriquina Island in the Prodrome (D'ORBIGNY 1850, p. 215). The lectotype is illustrated here on Plate 1, Figures 1–3.

*Material.* – UPST 12 M, from the Upper Maastrichtian Marnes bleues of Pouy (Hautes-Pyrénées); UPST 50T to 55T, from the Upper Maastrichtian Marnes bleues of Tuc–Millais (Haute-Pyrénées); UPST 35a, from Fauna 4; UPST 39a, 40a, 41a, 43a, 44a, 45a, 46a and 47a from Fauna 3; UPST 27a, 29a, 30a, 31a and 35a collected loose, all from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).

*Description.* – Shell slowly expanding, material studied varying from 4.5 to 26 mm in whorl height. Some specimens are undoubtedly crushed; the whorl breadth to height ratio varies from 0.60 to 0.74 in the best-preserved specimens. The dorsum is flattened, the dorsolateral shoulders broadly rounded, the inner-mid-flanks rounded, the outer flanks flattened and convergent. A groove separates the flank from the narrowly rounded ventrolateral shoulders. The venter is narrow and tabulate.

The flanks are ornamented by strong, coarse crescentic ribs from the smallest diameter (Pl. 3, Fig. 8), the rib index varying between 2.5 and 4 in medium-sized specimens. The ribs are strongest on the dorsolateral area, and are linked across the dorsum by a low rib (Pl. 3, Fig. 19) with, in some specimens groups of fine riblets and striae, sometimes distinctly looped (Pl. 2, Fig. 3, 6). The ribs project forwards on the ventrolateral region and decline. In some specimens the venter is smooth (Pl. 3, Fig. 5) and there is every transition to specimens with transverse ribs, twice as numerous as the flank ribs, with notched ventrolateral shoulders, and secondary ribs extending onto the ventrolateral region (Pl. 3, Fig. 2, 3, 18, 21).

None of the specimens show complete sutures which appear to have consisted of plump broad bifid elements.

*Discussion.* – The specimens from the Petites-Pyrénées match well with the lectotype as well as the numerous specimens illustrated by HÜNICKEN & COVACEVICH (1975, Pl. 1, Fig. 5–12; Pl. 2, Fig. 4–9; Pl. 3, Fig. 1–8; Pl. 4, Fig. 1–8; Pl. 5, Fig. 1–4; Textfig. 6–28). The name *lyelli* was published by D'ORBIGNY without description in 1847. His Plate 4, Figure 3, is a reconstruction of a complete individual; Figures 4–5 a restored aperture; Figure 6a a restored septal face. None of the figures resemble the surviving specimens in the d'Orbigny Collection (a not uncommon observation).

As will be seen from the synonymy, *E. lyelli* is taken to include the many ribbed specimens with a tabulate venter that have been referred to *E. ootacodensis*. The figure of the lectotype of *ootacodensis* (here designated) (STOLICZKA 1866, Pl. 90, Fig. 14) shows a fastigiate venter and a rib index of one confirmed from a study of a cast of the specimen, and similar specimens are illustrated by COTTREAU (1922, p. 180 (72), Pl. 18 (9), Fig. 11) and COLLIGNON (e.g. 1971 as *Baculites simplex*: p. 15, Pl. 645, Fig. 2388–2389; as *Eubaculites ootacodensis,* p. 18, Pl. 645, Fig. 2395) among others. Should subsequent work confirm a gradation between specimens with tabulate and fastigiate venters in the same population as envisaged by KLINGER (1976, p. 90) then *ootacodensis* may prove to be a junior synonym of *lyelli*; we retain them separate here. The *Baculites anceps* of BINKHORST (1861, p. 42, Pl. 5d, Fig. 5a–d) is a *Eubaculites* with smooth tabulate venter like that of the specimen shown here as Plate 3, Figures 5–7. *Baculites vagina* var. *simplex* of KOSSMAT (1895, p. 156 (60) (*pars*), Pl. 19 (5), Fig. 14a, b only], *Eubaculites otacodensis*

MATSUMOTO 1959 *non* STOLICZKA, *E. ootacodensis, vagina, kossmati* and *multicostatus* of BRUNNSCHWEILER 1966 are all regarded as synonyms of *E. lyelli.*

*E. lyelli* is readily separated from most individuals of *Eubaculites vagina* (FORBES 1846a) (p. 114, Pl. 10, Fig. 4) (see excellent figures of syntypes in KLINGER 1976, Pl. 35, Fig. 1–4; Pl. 36, Fig. 1–4; Pl. 37, Fig. 1–5; Pl. 38, Fig. 1–4, Pl. 39, Fig. 2), of which *Baculites ornatus* D'ORBIGNY 1847 (Pl. 6, Fig. 3–6) is a synonym, which has dorsolateral and lateral tubercles. The very compressed species *Giralites latecarinatus* BRUNNSCHWEILER 1966 (p. 33, Pl. 3, Fig. 13, 14; Pl. 4, Fig. 1–5; Textfig. 17, 18) with a whorl breadth to height ratio of 0.6; *G. quadrisulcatus* BRUNNSCHWEILER 1966 (p. 35, Pl. 4, Fig. 11–14; Textfig. 20) with a whorl breadth to height ratio of 0.59; *Eubaculites compressum* BRUNNSCHWEILER 1966 (p. 36, Pl. 4, Fig. 15–17; Pl. 5, Fig. 1–3; Textfig. 21) with a whorl breadth to height ratio of 0.45 and *Cardabites tabulatus* BRUNNSCHWEILER 1966 (p. 38, Pl. 5, Fig. 16–21; Textfig. 24) with a whorl breadth to height ratio of 0.43 seem to be a different species or species, as discussed by KLINGER (1976).

*Occurrence.* – *Eubaculites lyelli* first appears associated with *Pachydiscus neubergicus* (HAUER 1858) and other Lower Maastrichtian species at Neuberg, Steiermark, Austria (KENNEDY & SUMMESBERGER 1986), and ranges to the upper Upper Maastrichtian. The geographic range extends from Steiermark, Austria, to Maastricht, Limburg, The Netherlands, the Petites-Pyrenées in southwestern France (the present records), Zululand, Madagascar, southern India, western Australia, Argentina, Chile and California.

## Superfamily ***Scaphitaceae*** GILL 1871

(*non transl.* WRIGHT & WRIGHT 1951, p. 13 *ex* Scaphitidae GILL)

## Family ***Scaphitidae*** GILL 1871

## Subfamily ***Scaphitinae*** GILL 1871

(*nom. transl.* WRIGHT 1953, p. 473 *ex* Scaphitidae GILL)

## Genus *Hoploscaphites* NOWAK 1911, p. 565

[= *Mesoscaphites* ATABEKIAN 1979, p. 523 (*nom. nud.*)]

*Type species:* By original designation; *Ammonites constrictus* J. SOWERBY (1817, p. 189, Pl. A, Fig. 1).

### *Hoploscaphites pumilis* STEPHENSON 1941

Pl. 5, Fig. 18–20

1941 *Scaphites pumilis* STEPHENSON, p. 426, Pl. 90, Fig. 10–12.
1974 *Scaphites pumilis* (STEPHENSON); COBBAN, p. 16, Pl. 11, Fig. 9–12.

*Holotype.* – By monotypy: USNM 21041 from USGS Mesozoic locality 762, Nacatoch Sand near Chatfield, Navarro County, Texas.

*Material.* – UPST 12 A, from the Upper Campanian part of the Marnes de Plagne of Paillon (Haute-Garonne).

*Description.* – The specimen is a crushed body chamber fragment. The whorl section, although distorted, appears to have been trapezoidal, with the greatest breadth at the umbilical bullae. The inner flanks are swollen, the outer flattened and convergent, the

ventrolateral shoulders sharply defined, the venter broadly rounded. Well-developed umbilical bullae, three of which survive, give rise to groups of faint ribs while there are additional intercalated ribs, all of which connect to small conical ventrolateral tubercles (Pl. 5, Fig. 18–20) of which 12 survive on the fragment. These tubercles are linked over the venter by groups of 2–3 equal ribs. The aperture, which is imperfectly preserved, appears to be contracted.

*Discussion.* – This little known species was based on the holotype only, while COBBAN (1974) records four more. The venter of the holotype is shown to be smooth in Stephenson's figure, but Cobban's specimens show ribs that vary from very fine as in his Plate 11, Figures 9, 10 to coarse as in his Plate 11, Figures 11, 12. The French specimen bears a striking resemblance to the latter, a cast of which (OUM KT 6920) was available for comparison.

*Occurrence.* – ?Lower Maastrichtian, Nacatoch Sand of Navarro County, Texas, ?Upper Campanian, base of the Navesink Formation Atlantic Highlands, New Jersey, Upper Campanian part of the Marnes de Plagne of Paillon (Haute-Garonne).

## *Hoploscaphites constrictus* (J. SOWERBY 1817)

Pl. 3, Fig. 1, 9–12; Pl. 4, Fig. 1–19; Pl. 5, Fig. 1–17, 24–26

1817 *Ammonites constrictus* J. SOWERBY, p. 189, Pl. A, Fig. 1
1858 *Scaphites multinodosus* HAUER, p. 9, Pl. 1, Fig. 7–8.
1872 *Scaphites constrictus* SOW. sp.; SCHLÜTER, p. 92, Pl. 28, Fig. 5–9 (with synonymy).
1873 *Scaphites constrictus* SOW. sp.; REDTENBACHER, p. 127.
non 1873 *Scaphites* spec. indet. cfr. *Scaphites constrictus* SOW.; REDTENBACHER, p. 130, Pl. 30, Fig. 12.
1894 *Scaphites niedzwiedzkii* UHLIG, p. 220, Fig. 2.
1911 *Scaphites constrictus* var. *crassus mihi;* LOPUSKI, p. 115, 134, Pl. 2, Fig. 5–6; Pl. 3, Fig. 1–2.
1911 *Hoploscaphites constrictus* SOWERBY *vulgaris* NOWAK, p. 583, Pl. 32, Fig. 6; Pl. 33, Fig. 8–12.
1915 *Scaphites constrictus* SOWERBY; FRECH, p. 562 *(pars)*, Textfig. 9, ?10.
1925 *Discoscaphites constrictus* SOWERBY; DIENER, p. 210 (with synonymy).
1979 *Mesoscaphites grossouvrei* ATABEKIAN, p. 523.
1979 *Mesoscaphites kneri* ATABEKIAN, p. 523.
1980 *Hoploscaphites constrictus anterior* BLASZKIEWICZ, p. 37, Pl. 18, Fig. 4–10.
1982 *Hoploscaphites constrictus* (SOWERBY 1818); BIRKELUND, p. 19, Pl. 3, Fig. 1–14 (with synonymy).
1982 *Hoploscaphites constrictus constrictus* (SOWERBY 1817); TZANKOV, p. 24, Pl. 7, Fig. 6–8.
1982 *Scaphites (Hoploscaphites) constrictus* J. SOWERBY; MARTINEZ, p. 172, Pl. 30, Fig. 6.
1986 *Hoploscaphites constrictus* (J. SOWERBY 1817); KENNEDY, p. 64, Pl. 13, Fig. 1–13, 16–24; Pl. 14, Fig. 1–38; Pl. 15; Textfig. 9–11 A–H (with synonymy).
1986 *Hoploscaphites constrictus* (J. SOWERBY 1817); KENNEDY & SUMMESBERGER, p. 198, Pl. 16, Fig. 1–5, 6–10, 13; Textfig. 7.

*Types.* – Lectotype, by the subsequent designation of KENNEDY (1986, p. 68) BMNH C 36733, the original of J. SOWERBY (1817 Pl. A, Fig. 1); paralectotypes are BMNH C 43988 and C 70645-7. All these specimens are refigured by KENNEDY (1986), and are from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France.

*Material.* – Numerous specimens; UPST 10 M, 11 M, from the Upper Maastrichtian Marnes bleues of Monléon-Magnoac (Hautes-Pyrénées); 49 T, from the Upper Maastrichtian Marno-Calcaires jaunes of Tuc-Millais (Hautes-Pyrénées); UPST 28 A, 42 A, 48 A, from Fauna 3; UPST 32 A 1–14, 33 A, 34 A, 36 A 1–3, 38 A from Fauna 4 and UPST 2 A–7 A, 9 A, 10 A 1–6, 11 A 1–8, 12 A–25 A, collected loose from the Upper Maas-

trichtian Marines bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).

*Description.* – The more than 50 specimens available for study include a series of pyritic nuclei and fragments showing development from the protoconch to the end of the phragmocone plus a series of crushed composite moulds including several complete adults.

The protoconch is succeeded by a smooth serpenticone stage that extends for approximately 1.75 whorls (Pl. 4, Fig. 7, 11) the first ornament to appear is broad, fold-like primary ribs (Pl. 4, Fig. 5 shows this stage well), after which the whorl section becomes progressively more compressed, with coiling becoming more involute, the inner to mid-flanks being rounded, the outer flanks flattened and convergent, the venter somewhat flattened. Ornament consists of narrow flexuous prorsiradiate primary ribs which arise at the umbilical seam. They vary from straight to feebly concave on the inner flank, are feebly convex at mid-flank, concave on the outer flank and projected forwards on the ventrolateral shoulder, crossing the venter in a narrow convexity. The primary ribs subdivide low on the flank, while secondary ribs are inserted both low and high on the flank. Primaries and secondaries branch again on outer flank (Pl. 4, Fig. 1–4, 7–19) to give a dense, crowded flank ornament in some individuals (Pl. 4, Fig. 1–4, 7, 10, 14, 17, 18); others have far fewer secondary ribs and a generally blunter ornamentation (Pl. 4, Fig. 12, 13, 15, 16, 19). Tubercles appear at variable diameters, below 10 mm they are scarcely perceptible strengthenings of rib endings which progressively develop into distinct nodes (Pl. 4, Fig. 15, 18, 19); other specimens lack all trace of ventral tubercles at a diameter of 18 mm (Pl. 4, Fig. 16).

A few specimens show feeble, variably developed umbilical bullae (Pl. 4, Fig. 16) and, occasionally, an inner to mid-lateral swelling on some ribs (Pl. 4, Fig. 15).

Adult specimens with body chambers are invariably crushed, and most are fragmentary. Macroconchs are characterized by high whorls and an umbilical bulge at the beginning of the body chamber; all are distorted, with maximum lengths of 35–47 mm (e.g. Pl. 3, Fig. 9, 10; Pl. 5, Fig. 21–23). Microconchs are much rarer, the one measurable specimen is 32 mm long (Pl. 3, Figs. 11, 12; Pl. 5, Fig. 1–4).

Body chamber ornament varies widely. At one extreme (Pl. 3, Fig. 10) are specimens with a few small umbilical bullae and very fine ribs over the whole of the body chamber; at the other (Pl. 5, Fig. 21–23) coarse bullae extend to the beginning of the final hook, giving rise to two or three distant narrow wiry ribs, with additional ribs intercalated low on the flank or just outside the umbilical shoulder. A third variant has coarse ribs of this type on the early body chamber but very fine ribs over the final part of the hook (Pl. 5, Fig. 1–5, 16–17). Ventral tubercles are variably developed. In some coarsely ornamented individuals they extend to the aperture and most ribs connect to them, in groups or singly (Pl. 5, Fig. 21–23). In others (Pl. 3, Fig. 9; Pl. 5, Fig. 10, 11, 15) tuberculate groups of ribs are separated by nontuberculate ribs which extend to the end of the body chamber. A few specimens with very fine ribs throughout show a similar pattern, although the tubercles become very small towards the aperture (Pl. 3, Fig. 10). Specimens with coarse ornament at the beginning of the body chamber but fine ornament at the aperture may lack all but occasional tubercles on the final portion before the aperture (Pl. 5, Fig. 16, 17). Ventral ornament is highly variable. In specimens with dense ribbing, the ribs generally cross the venter, looping between tubercles and intercalating (Pl. 5, Fig. 11, 14). Coarsely orna-

mented specimens show near-smooth venters over most of the early body chamber, sometimes with a feeble siphonal swelling, the ribbing reappearing on the final section before the aperture (Pl. 5, Fig. 1–4, 21–23).

Adult apertures are constricted in both macroconchs (Pl. 5, Fig. 21–23) and microconchs (Pl. 5, Fig. 1–4).

Juvenile sutures are shown by several of the pyritic specimens; they are simple and little-incised.

*Discussion.* – *Hoploscaphites constrictus* from the Petites-Pyrénées are highly variable and markedly dimorphic, as with other assemblages of the species described recently (BIRKELUND 1982; KENNEDY & SUMMESBERGER, 1986; KENNEDY 1986) and no dividing lines can be drawn between our specimens. I follow the authors mentioned above in regarding the Lower Maastrichtian *Scaphites multinodosus* HAUER 1858 (*non* 1866) and *Hoploscaphites constrictus anterius* BLASZKIEWICZ 1980 as based on small macroconchs of the species, *Scaphites niedzwiedzkii* UHLIG 1894 as a microconch and *Hoploscaphites constrictus crassus* LOPUSKI 1911, *Hoploscaphites constrictus vulgaris* NOWAK 1911, *Mesocaphites grossouvrei* ATABEKIAN 1979 *(nomen nudum)* and *M. kneri* ATABEKIAN 1979 *(nomen nudum)* as the latest of the many synonyms of this species (see extensive synonymy in KENNEDY 1986).

*Hoploscaphites tenuistriatus* (KNER 1848) (p. 10, Pl. 1, Fig. 5) is regarded as a separate species, following BIRKELUND (1982). It characterizes the Lower/Upper Maastrichtian boundary of the White Chalk successions of western Europe and is easily differentiated from *H. constrictus* on the basis of its very fine ribbing and lack of ventral tubercles at any stage of development. Forms with tubercles that were referred to *tenuistriatus* by NOWAK (1911 pl. 33, Fig. 13) are best regarded as *H. constrictus*. *Acanthoscaphites schmidi* BIRKELUND 1982 (p. 17, Pl. 1, Fig. 7–10; Pl. 2, Fig. 1–4) seems rather to be a *Hoploscaphites* (fide KENNEDY 1986). It has weak siphonal nodes on the body chamber, very fine ribs close to the aperture and is much larger than *H. constrictus,* the holotype, a microconch, being 47 mm long, the macroconch an estimated 100 mm long.

*Hoploscaphites constrictus* is of some value as a stratigraphic indicator within the Maastrichtian stage. In the White Chalk successions it first appears 3.5 to 5 m above the base of the *Belemnella lanceolata* Zone at Kronsmoor (SCHULZ 1979) and is rare in the lower part of its range. It extends to high in, if not to the top of the *Belemnella casimirovensis* Zone (e.g. Denmark; fide BIRKELUND 1979).

BLASZKIEWICZ (1980) and KENNEDY & SUMMESBERGER (1986) have illustrated the range of variation in middle Lower Maastrichtian specimens; BIRKELUND (1982) variation in the middle of the stage and KENNEDY (1986), variation in the Upper Maastrichtian, while BIRKELUND (1982) has described changes in ornament and morphology throughout the stage, showing a decrease in the number of ribs on the last part of the body chamber of macroconchs as one ascends the stage and the persistence of tubercles to the adult aperture. These characters were taken as diagnostic of *Hoploscaphites constrictus crassus* LOPUSKI 1911 (p. 115, 134, Pl. 2, Fig. 5–6; Pl. 3, Fig. 1–2), regarded as subspecifically distinct by some authors, although there is in fact every gradation between such forms and the lectotype of *H. constrictus* (fide KENNEDY 1986). The *crassus* forms of *H. constrictus* are restricted to the upper Upper Maastrichtian *Belemnella casimirovensis* Zone in Europe (Denmark: BIRKELUND 1979; Poland: BLASZKIEWICZ 1980; northern France: KENNEDY 1986; the Maastricht area: KENNEDY 1984).

All the present adult material of *H. constrictus* is of Upper Maastrichtian aspect, individuals matching well with those from the Calcaire à *Baculites* of the Cotentin (KENNEDY 1986) and the Meerssen and Nekum Chalks and Calcaire de Kunrade of Limburg and Hainault (KENNEDY, in press). Undoubted specimens of *crassus* type dominate the assemblage (e.g. Pl. 4, Fig. 9, 11–12; Pl. 6, Fig. 12–15, 21–26) and occur *in situ* in the Marno-Calcaires jaunes of the Monléon–Magnoac to Tuc–Millais area, and both the upper and lower fossiliferous levels in the Marnes bleues de Saint-Loup in the Gensac–Saint-Loup area. The single *Hoploscaphites constrictus* from the Marno-Calcaires jaunes of Larcan is poorly preserved (Pl. 5, Fig. 9) but appears to be an Upper Maastrichtian form, preservation precluding firm reference to the *crassus* form, however.

*Occurrence.* – As noted above, this species first appears just above the base of the lower Lower Maastrichtian *Belemnella lanceolata* Zone and ranges to high in, if not to the top of, the upper Upper Maastrichtian *Belemnella casimirovensis* Zone in Denmark. The species occurs as a rarity in northern Spain (Ernst Collection; Lleida: MARTINEZ 1982, p. 172, Pl. 30, Fig. 3) although unknown in the classic Zumaya section (WARD & WIEDMANN 1983). It is widespread in the Upper Maastrichtian of the Petites-Pyrénées, as documented here, and also occurs at Tercis (Landes) (OUM collections). It is frequent in the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula (Manche) and the Upper Maastrichtian Nekum and Meerssen Chalks and Calcaire de Kunrade of Limburg and Hainault in The Netherlands and Belgium. It occurs widely in the Lower and Upper Maastrichtian of the Germanies, Denmark, southern Sweden, Poland, Bulgaria, the USSR Carpathians, Donbass region, Transcaspia, Kopet-Dag and the Lower Maastrichtian of Styria, Austria.

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## Plate 1

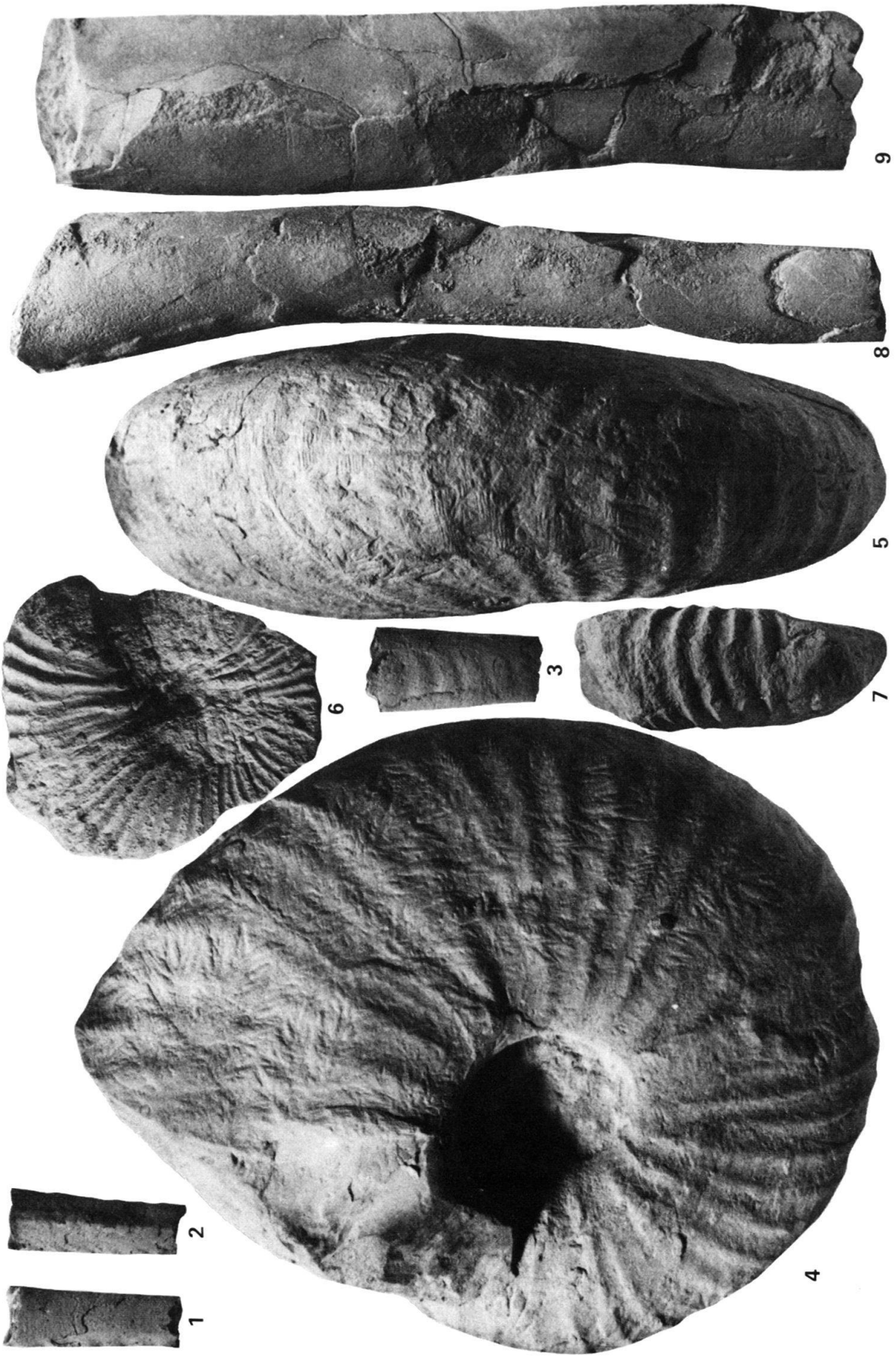
All Figures are natural size.

Fig. 1–3. *Eubaculites lyelli* (D'ORBIGNY 1847). MNHP R 1020 A, the lectotype, from Quiriquina Island, Chile.

Fig. 4–5. *Anapachydiscus fresvillensis* (SEUNES 1890). UPST 40 a, from the Upper Maastrichtian Marnes Bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).

Fig. 6, 7. *Pseudokossmaticeras tercense* (SEUNES 1891). UPST 90, from the Lower Maastrichtian niveau de transition, Picon de Roquefort (Haute-Garonne).

Fig. 8, 9. *Baculites vertebralis* (LAMARCK 1801). UPST 37, from the Upper Maastrichtian Marnes Bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne).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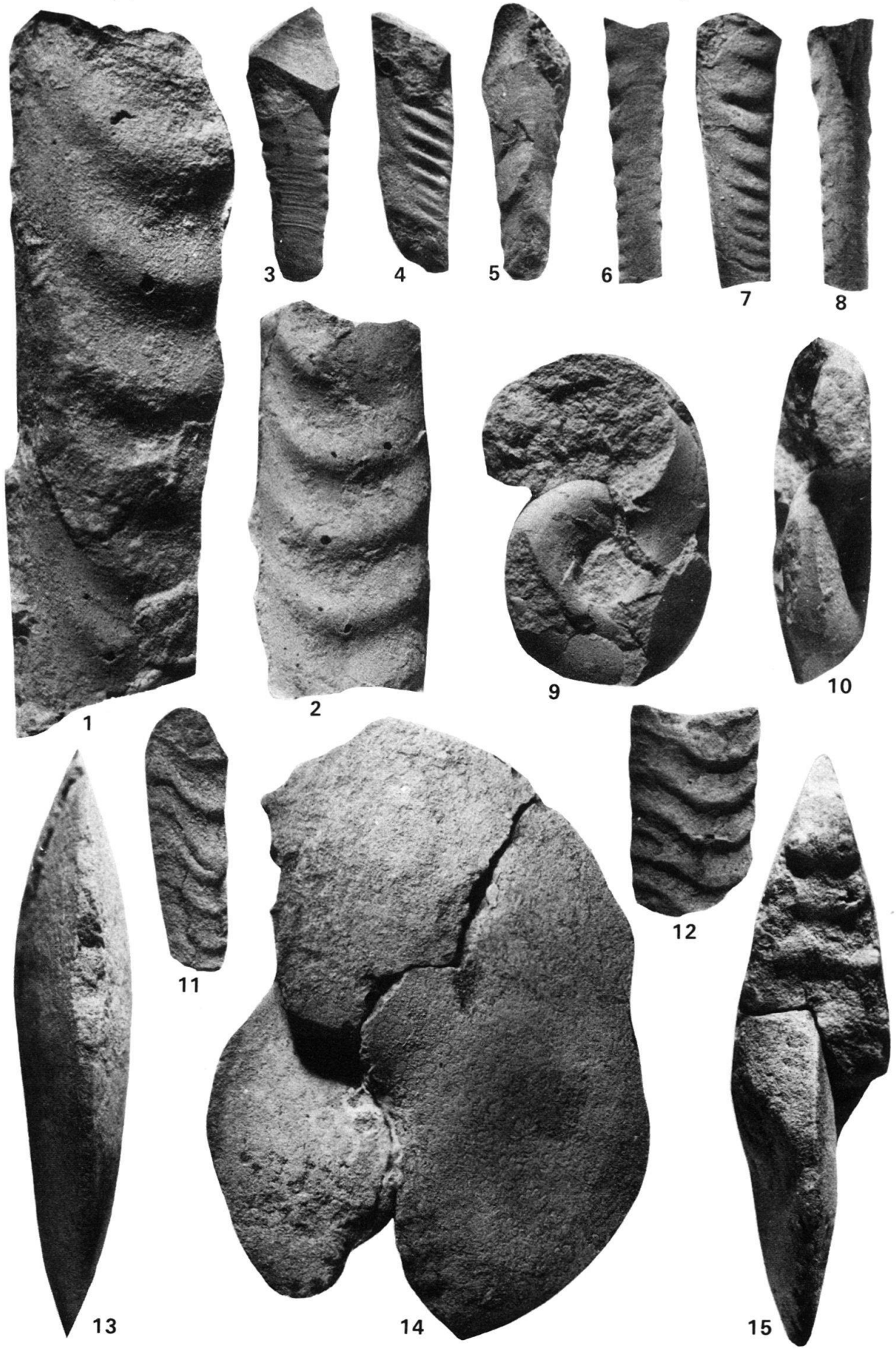
## Plate 2

All Figures are natural size.

Fig. 1, 2, 11, 12. *Baculites leopoliensis* (Nowak 1908). 1, 2: silicone casts taken from UPST 92 external moulds from the Lower Maastrichtian, niveau de transition of Ruffe-d'en-Haute, Anticlinal de Plagne (Haute-Garonne). 11: UPST 89a; 12: UPST 89b, from the Lower Maastrichtian niveau de transition, Pas-de-Fauga, Anticlinal de Plage (Haute-Garonne).

Fig. 13–15. *Sphenodiscus ubaghi* De Grossouvre 1894. UPST 85, from the Lower Maastrichtian niveau de transition, Pas-de-Gazaille, Anticlinal de Richou-Montfa (Haute-Garonne).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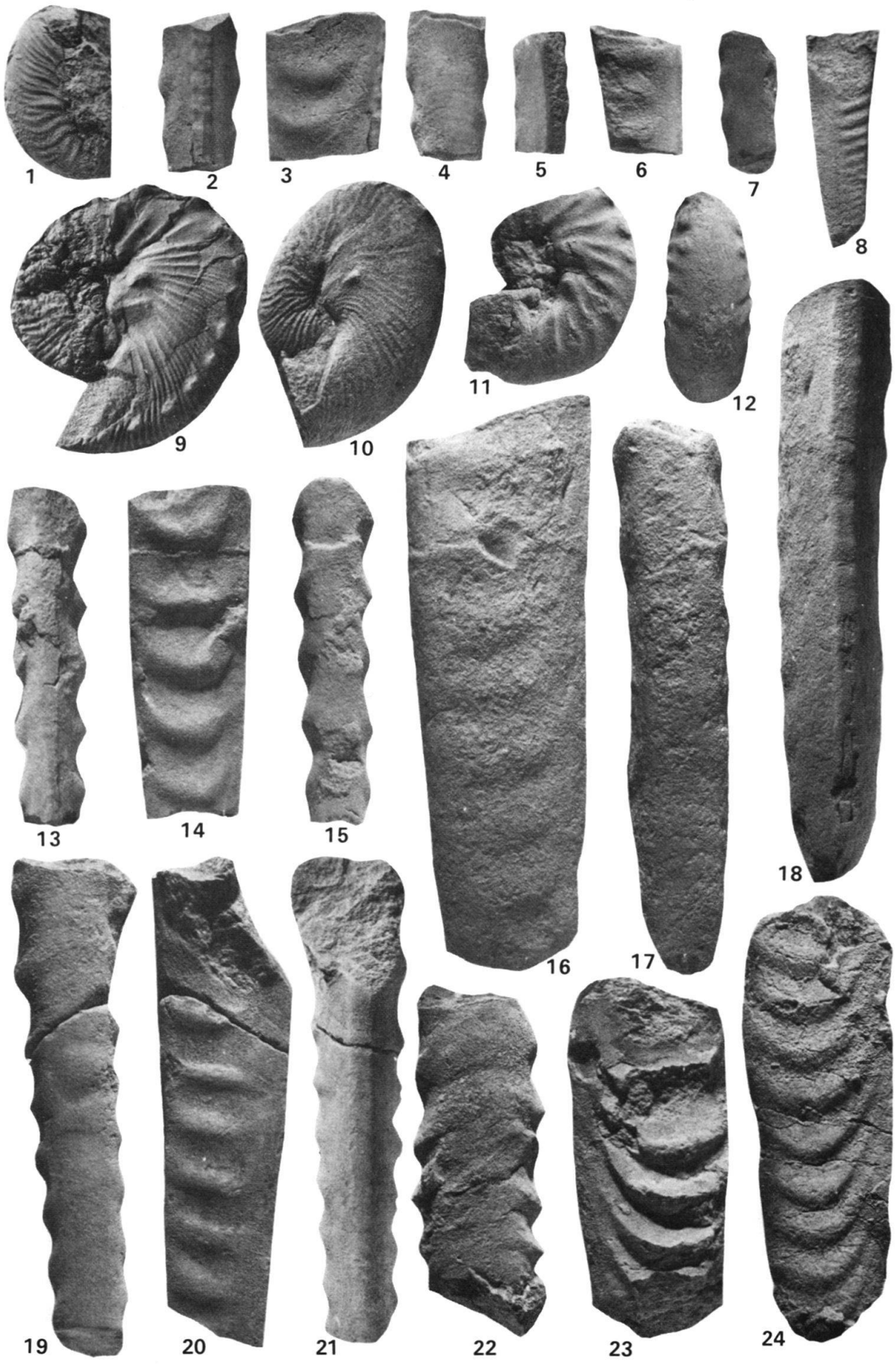
## Plate 3

All Figures are natural size.

Fig. 1, 9–12. *Hoploscaphites constrictus* (J. SOWERBY 1817). 1 is UPST 2A; 9 is UPST 25a (a *crassus* form); 10 is UPST 9a, all from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne); 11, 12 are UPST 11M ( a *crassus* form), from the Upper Maastrichtian Marnes bleues of Monléon-Magnoac (Hautes-Pyrénées).

Fig. 2–8, 13–21. *Eubaculites lyelli* (D'ORBIGNY 1847). 2–4: UPST 51T; 5–7: UPST 25T; 13–15: UPST 55T, all from the Upper Maastrichtian Marnes bleues de Saint-Loup of Tuc-Millais (Haute-Garonne); 8: UPST 35a; 19–21: UPST 1A, from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne); 16–18 UPST 12M, from the Upper Maastrichtian Marnes bleues of Pouy, northeast of Monléon–Magnoac (Haute-Garonne).

Fig. 22–24. *Baculites leopoliensis* NOWAK 1908. 22, 23: UPST 87; 24: UPST 88, from the Lower Maastrichtian niveau de transition, Maillau, Synclinal de Fontane–Gorry and Charles, Anticlinal de Plagne (Haute-Garonne), respectively.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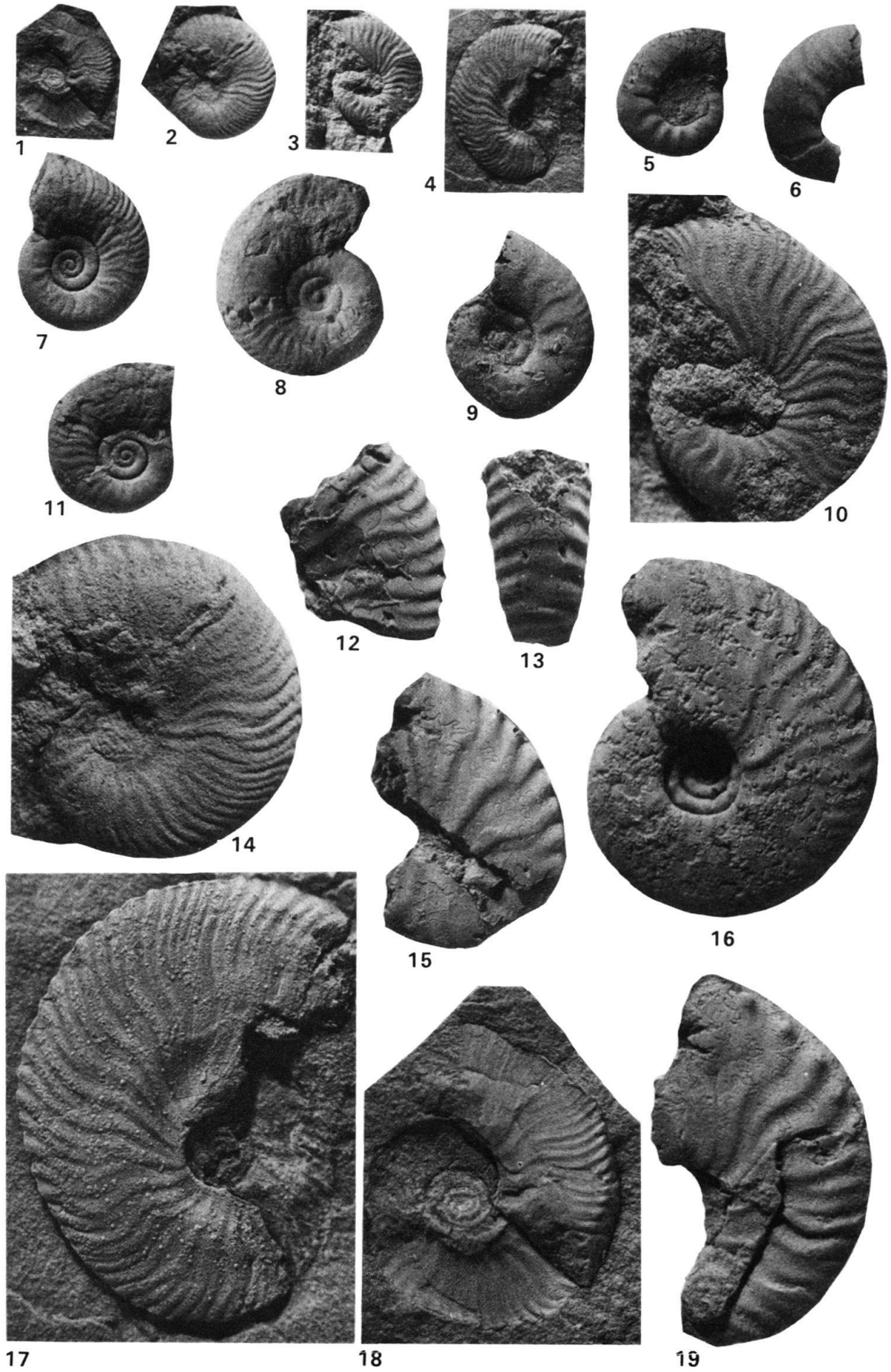
## Plate 4

Fig. 1–4 are natural size; Fig. 5–19 are magnified × 3.

Fig. 1–19. *Hoploscaphites constrictus* (J. SOWERBY 1817). 1, 18: UPST 15a, 2, 14: UPST 12A; 4, 17: UPST 38a; 5. UPST 32a; 6: UPST 32A; 7: UPST 21A; 8: UPST 11a2; 9: UPST 32a3; 12, 13: UPST 32a4; 15: UPST 36a1; 16: UPST 36a2; 19: UPST 36a3, all from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne). 3, 10: UPST 49T, from the Upper Maastrichtian Marno-Calcaires jaunes of Tuc-Millais (Hautes-Pyrénées).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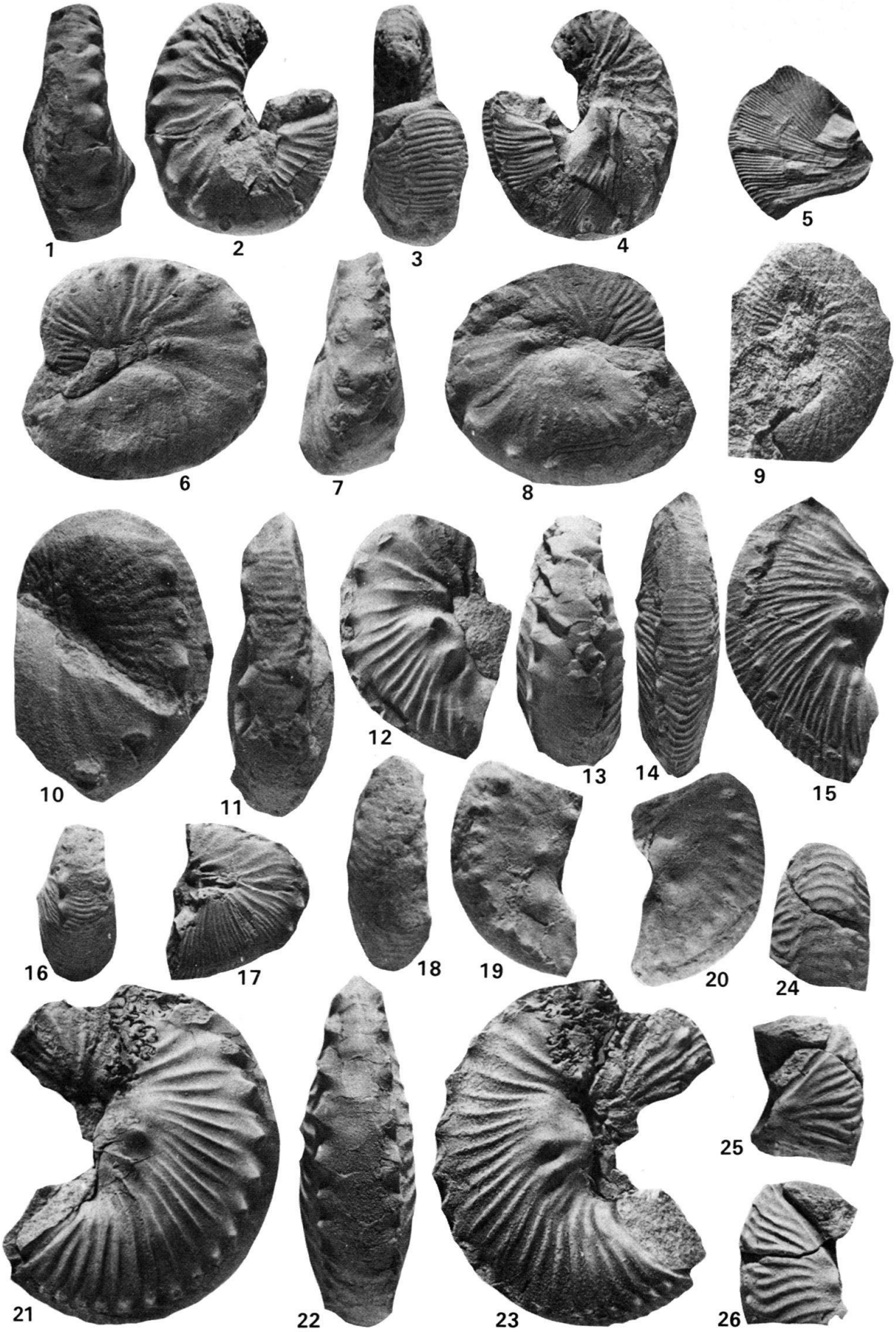
## Plate 5

All Figures are natural size.

Fig. 1–17, 24–26. *Hoploscaphites constrictus* (J. SOWERBY 1817). 1–4: UPST 24a; 5: UPST 19a; 6–8: UPST 28a; 9: UPST 30c; 12, 13: UPST 21a (a *crassus* form); 14–15: UPST 24 (a *crassus* form); 16, 17: UPST 22a; 21–23: UPST 34a (a *crassus* form); 24–26: UPST 6A (a *crassus* form), all from the Upper Maastrichtian Marnes bleues de Saint-Loup, quarry southeast of Saint-Loup (Haute-Garonne). 10–11 are UPST 10M from the Upper Maastrichtian Marnes bleues of Monléon-Magnoac (Hautes-Pyrénées).

Fig. 18–20. *Hoploscaphites pumilis* STEPHENSON 1941. UPST 12B, from the Upper Campanian part of the Marnes de Plagne of Paillon in the Anticlinal de Saint-Martory–Saint Marcet (Haute-Garonne).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