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# The ammonite fauna of the type Maastrichtian with a revision of *Ammonites colligatus* BINKHORST, 1861

by William James KENNEDY


## Abstract

A revision of the ammonites from Maastricht and adjacent parts of Limburg and Liège based on the BINKHORST Collection in the Museum für Naturkunde, Berlin, the collections of the Institut Royal des Sciences naturelles de Belgique, Brussels, (including material described by A. DE GROSSOUVRE in 1908) and the Natuurhistorisch Museum, Maastricht, revealed the following sequence of faunas. The youngest Campanian ammonite from the Vaals Formation is a specimen of *Hoplitoplacenticeras marroti* (COQUAND, 1859) from Vijlen, Cotessen (Zuid-Limburg, The Netherlands); this is a typical lower Upper Campanian species. The Zeven Wegen Chalk yields *Baculites* at several localities and upper Upper Campanian *Hoplitoplacenticeras coesfeldiense* (SCHLUETER, 1867) and *Trachyscaphites spiniger* (SCHLUETER, 1872) at Vijlenerbosch (Zuid-Limburg, The Netherlands): these are *Bostrychoceras polyplocum* Zone species. An unspecified horizon within the Gulpen Formation of Schneeberg, north of Vaals yields the lower Lower Maastrichtian *Acanthoscaphites tridens* (KNER, 1848); the same species occurs at Vaals.

No ammonites were seen from the Beutenaken Chalk, but the Vijlen Chalk yields phosphatised and unphosphatised *Baculites* at a number of localities, *Hoploscaphites tenuistriatus* (KNER, 1848) at Mesch (Zuid-Limburg, The Netherlands), and there is a record of *Pachydiscus* sp. from Hallembaye, Liège. No ammonites were seen from the Lixhe or Lanaye Chalks. The base of the Valkenburg Chalk yields phosphatised *Baculites anceps* LAMARCK, 1822, and phosphatised *Baculites* sp. at the Blankenberg Quarry, Cadier en Keer (Zuid-Limburg, The Netherlands). No ammonites were seen from the Gronsveld, Schiepersberg or Emael Chalks. Ammonites known to be from the Nekum Chalk, mostly from the environs of Maastricht, are *Anapachydiscus fresvillensis* (SEUNES, 1890), *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 and *Hoploscaphites constrictus* (J. SOWERBY, 1817). There are two records of *Sphenodiscus binkhorsti* BOEHM, 1898 from this unit.

Ammonites known to be from the Meerssen Chalk are *Nostoceras* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 and *Hoploscaphites constrictus* (J. SOWERBY, 1817). The upper part of the Meerssen Chalk only yields frequent *Sphenodiscus binkhorsti* BOEHM, 1898 and the *crassus* form of *Hoploscaphites constrictus*.

A single specimen of *Eubaculites lyelli* (d'ORBIGNY, 1847) from Maastricht is from either the Nekum of the Meerssen Chalk.

Ammonites from the upper part of the "Calcaire de Kunraed" are *Saghalinites* sp., *Pachydiscus (Pachydiscus) gollevillensis* (d'ORBIGNY, 1850), *P. (P.)* cf. *jacquoti* SEUNES, 1890, *Anapachydiscus fresvillensis* (SEUNES, 1890), *Glyptoxoceras* cf. *subcompressum* (FORBES, 1846), *G.* cf. *circulare* SHIMIZU, 1935, *G.* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, which is common, *B. anceps* LAMARCK, 1822, *Hoploscaphites constrictus* (J. SOWERBY, 1817), *H. felderi* sp. nov., *H. pungens* (BINKHORST, 1861), *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841) and *Acanthoscaphites* sp.

These ammonites records are in accord with recent work on the belemnites of the region (SCHULZ and SCHMID, 1983) that has shown the Zeven Wegen to Beutenaken Chalk to be Lower Maastrichtian, the Vijlen to lower Meerssen Chalk to be Upper Maastrichtian, *Belemnitella junior* Zone and only the upper part of the Meerssen Chalk to be Upper Maastrichtian, *Belemnella casimirovensis* Zone. The upper part of the "Calcaire de Kunraed" yields Upper Maastrichtian ammonites that show it to be older than the upper part of the Meerssen Chalk, compatible with microfaunal work by VILLAIN (1977) and the presence of belemnites of the *Belemnitella junior* Zone but *not* of the *Belemnella casimirovensis* Zone.

Also included in this work is a revision of the classic Maastrichtian ammonite *Pachydiscus colligatus* BINKHORST, 1861. The syntypes are shown to belong to two genera, *Pachydiscus* and *Anapachydiscus,* and to at least four species. The lectotype, herein designated in accordance with customary useage, is shown to be from the Upper Campanian of Jauche (Brabant, Belgium).



## Résumé

La révision des Ammonites de Maastricht et des régions avoisinantes du Limbourg et de la province de Liège, basée sur la collection BINKHORST du Museum für Naturkunde, Berlin, sur les collections de l'Institut royal des Sciences naturelles de Belgique, Bruxelles (comprenant des spécimens décrits par A. DE GROSSOUVRE en 1908) et celles du Natuurhistorisch Museum, Maastricht, a permis d'établir la séquence de faunes ci-après.

L'Ammonite la plus jeune du Campanien de la Formation de Vaals est un exemplaire d'*Hoplitoplacenticeras marroti* (COQUAND, 1859) de Vijlen, Cotessen (Zuid-Limburg, Pays-Bas), une espèce typique de la partie inférieure du Campanien Supérieur. Le «Zeven Wegen Chalk» contient des spécimens de *Baculites* sp. à plusieurs endroits et *Hoplitoplacenticeras coesfeldiense* (SCHLUETER, 1867) et *Trachyscaphites spiniger* (SCHLUETER, 1872), de la partie supérieure du Campanien Supérieur, à Vijlenerbosch (Zuid-Limburg, Pays-Bas): il s'agit d'espèces de la Zone à *Bostrychoceras polyplocum.* Un horizon non spécifié de la Formation de Gulpen du Schneeberg, au nord de Vaals (Zuid-Limburg, Pays-Bas) livre *Acanthoscaphites tridens* (KNER, 1848), espèce connue de la partie inférieure du Maastrichtien Inférieur. La même espèce a été retrouvée à Vaals.

Aucune Ammonite du «Beutenaken Chalk» n'a été étudiée, mais le «Vijlen Chalk» a produit des *Baculites* sp. phosphatés ou non dans plusieurs localités, *Hoploscaphites tenuistriatus* (KNER, 1848) à Mesch (Zuid-Limburg, Pays-Bas) et *Pachydiscus* sp. est connu à Hallembaye (Liège).

Aucune Ammonite n'a été étudiée ni du «Lixhe Chalk», ni du «Lanaye Chalk». La base du «Valkenburg Chalk» produit des exemplaires phosphatés de *Baculites anceps* LAMARCK, 1822 et de *Baculites* sp. à la carrière Blankenberg, Cadier, en Keer (Zuid-Limburg, Pays-Bas).
Aucune Ammonite n'a été étudiée du «Gronsveld Chalk», du «Schiepersberg Chalk» ou de l'«Emael Chalk».
Les Ammonites du «Nekum Chalk», en majeure partie des environs immédiats de Maastricht, appartiennent aux espèces suivantes: *Anapachydiscus fresvillensis* (SEUNES, 1890), *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 et *Hoploscaphites constrictus* (J. SOWERBY, 1817). Deux spécimens de *Sphenodiscus binkhorsti* BOEHM, 1898 sont mentionnés de cette unité. Les Ammonites connues comme étant du «Meerssen Chalk» sont: *Nostoceras* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 et *Hoploscaphites constrictus* (J. SOWERBY, 1817). La partie supérieure du «Meerssen Chalk» contient seulement de nombreux *Sphenodiscus binkhorsti* BOEHM, 1898 et la forme *crassus* de *Hoploscaphites constrictus*. Un exemplaire unique d'*Eubaculites lyelli* (d'ORBIGNY, 1847) provient du «Nekum Chalk» ou du «Meerssen Chalk» à Maastricht.
Les Ammonites de la partie supérieure du «Calcaire de Kunraed» sont les suivantes: *Saghalinites* sp., *Pachydiscus (Pachydiscus) gollevillensis* (d'ORBIGNY, 1850), *P. (P.)* cf. *jacquoti* SEUNES, 1890, *Anapachydiscus fresvillensis* (SEUNES, 1890), *Glyptoxoceras* cf. *subcompressum* (FORBES, 1846), *Gl.* cf. *circulare* SHIMIZU, 1935, *Gl.* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, qui y est fréquent, *B. anceps* LAMARCK, 1822, *Hoploscaphites constrictus* (J. SOWERBY, 1817), *H. felderi* sp. nov., *H. pungens* (BINKHORST, 1861), *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841) et *Ac.* sp. Ces données concernant les Ammonites de Maastricht sont en accord avec les travaux récents sur les Bélemnites de la région (SCHULZ et SCHMID, 1983). Ceux-ci ont démontré la présence du Maastrichtien Inférieur du «Zeven Wegen Chalk» au «Beutenaken Chalk», la présence du Maastrichtien Supérieur, Zone à *Belemnitella junior*, du «Vijlen Chalk» à la partie inférieure du «Meerssen Chalk», et qu'uniquement la partie supérieure du «Meerssen Chalk» appartient au Maastrichtien Supérieur, Zone à *Belemnella casimirovensis*. La partie supérieure du «Calcaire de Kunraed» contient des Ammonites du Maastrichtien Supérieur, plus ancien que celui de la partie supérieure du «Meerssen Chalk». Ceci est en accord avec les travaux micropaléontologiques de VILLAIN (1977), la présence de Bélemnites de la Zone à *Belemnites junior* et l'absence de celles de la Zone à *Belemnites casimirovensis*.
Ce travail contient en outre une révision de *Pachydiscus colligatus* BINKHORST, 1861, Ammonite classique du Maastrichtien. L'étude des syntypes à démontré qu'ils appartiennent à deux genres différents, *Pachydiscus* et *Anapachydiscus*, et au moins à quatre espèces. Le lectotypes choisi ici est du Campanien Supérieur de Jauche (Brabant, Belgique).

## Introduction

The Maastrichtian is the highest stage recognised in the Cretaceous system. The term Calcaire de Maastricht was used by DUMONT in 1832, and the term Système Maestrichtien in 1849 [see MOURLON (1878), JELETZKY (1951) and VAN DER HEIDE (1954) for reviews of the early history of stage useage]. Fossils from Maastricht were made famous by FAUJAS - SAINT-FOND in his *Histoire Naturelle de la Montagne de St Pierre de Maëstricht* (1799), and ammonites in particular were described by LAMARCK (1801, 1822), DEFRANCE (1816), BLAINVILLE (1825) and others. BOSQUET listed the ammonites of the Cretaceous of Limburg in 1860, but the first extended account of the ammonite and other faunas of the Maastricht area was that of J. T. BINKHORST VAN DER BINKHORST (1861), and this remains the chief source on many fossil groups. The ammonites of the area were reviewed by DE GROSSOUVRE (1908), but since that time, have received no attention, although the occurrences of *Sphenodiscus* high in the section was noted by many workers.
In 1982 my colleague Dr. A. V. DHONDT of the Institut Royal des Sciences Naturelles de Belgique invited me to study the ammonites of the Maastricht area, Limburg and Liège in the collections of that Institute, while a visit to the Museum für Naturkunde in East Berlin supported by the Royal Society / Academy of Sciences of the German Democratic Republic allowed me to study the surviving specimens in the BINKHORST Collection. These two collections form the basis of the present revision, together with new material collected by W. M. and P. J. FELDER, now housed in the Naturhistorisch Museum, Maastricht, and made available through the courtesy of Dr. A. W. F. MEIJER.
It must be stressed that ammonites (apart from *Baculites*) are uncommon in the Upper Cretaceous of the Maastricht region, and that most of the material decribed here was collected in the last century, when quarries and underground working were excavated by hand.
Precise records are needed for many of the species discussed, and only careful collection over a period of years will provide the degree of stratigraphic precision essential for a proper understanding of ammonite distributions in the area. It is my hope that this museum-based study will stimulate local collectors to carry out this task.
The previous literature on the geology and palaeontology of the Maastricht area is enormous. Fortunately, the excursion report of the joint Paläontologische Gesellschaft and Palaeontological Association (1978) lists most of these, while there are extensive listings in FELDER (1975a, b), VILLAIN (1977) and ROBASZYNSKI *et al.* (1985), to which the reader is referred.

## Stratigraphy

The Cretaceous sediments of south Limburg and Liège (Text-figs. 1, 2) rest unconformably on the Palaeozoic rocks of the Ardennes massif and

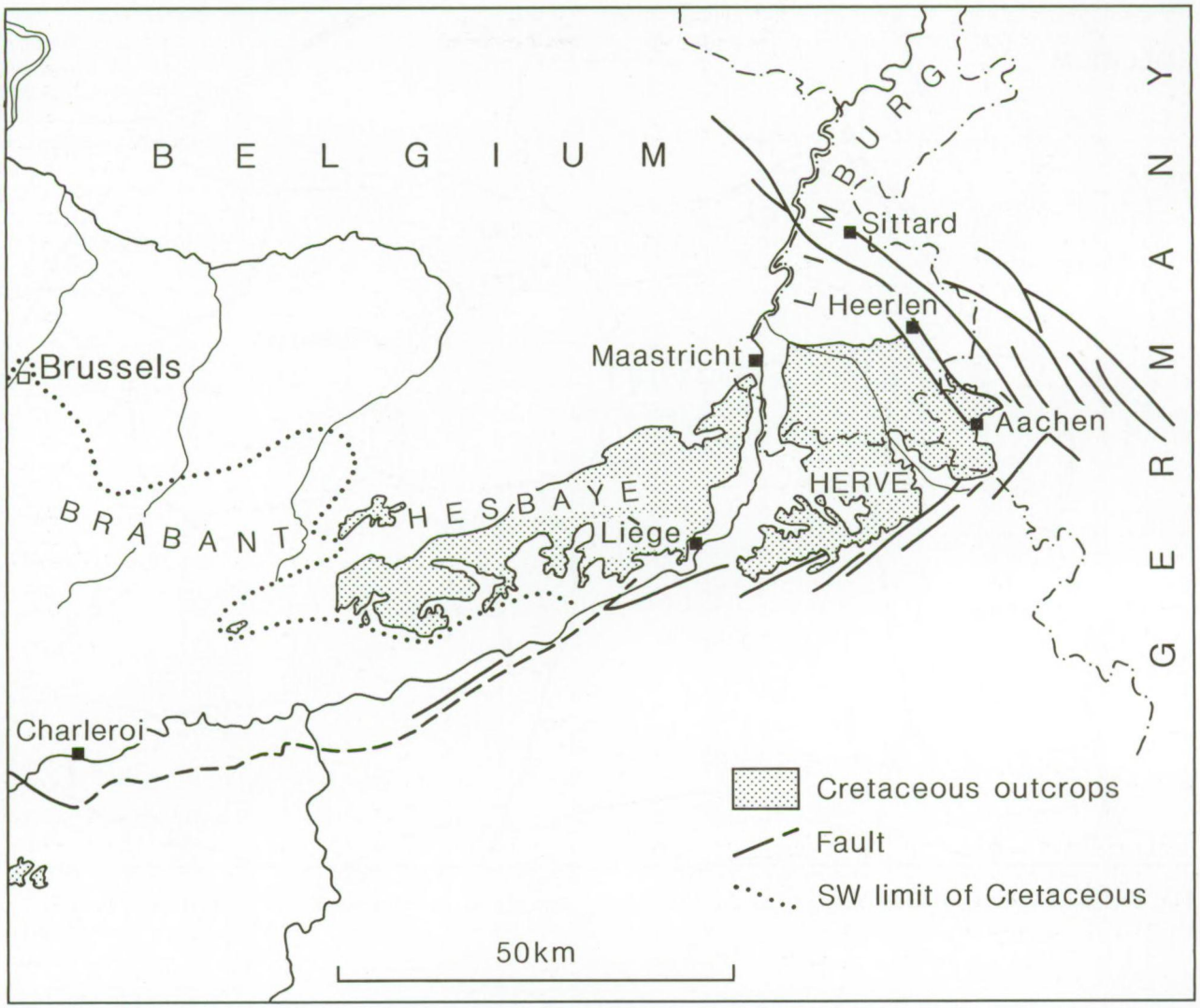



Fig. 1. *Simplified geological map of South Limburg and Liège, showing the distribution of Cretaceous sediments (modified after* DEROO, *1966).*

include a succession of clays, greensands, glauconitic chalks, coccolith chalks and calcarenites, deposited during the late Cretaceous transgressive-regressive pulse (HANCOCK and KAUFFMAN, 1979). They thus include a range of marginal facies typical of the Upper Cretaceous and associated with many of the massif areas of western Europe during the Upper Cretaceous (HANCOCK 1975; FELDER, FELDER and BROMLEY, 1980).

DUMONT (1832) recognised the following divisions in the region:

Calcaire de Maastricht
Craie
Greensand supérieur
Gault
Greensand inférieur

The division derives from the sequence being worked out in England and northern France at that time, but records a basic facies succession still recognised today. Greensand inférieur, Gault and Greensand supérieur correspond to Aken (Aachen) and Vaals Formations, while the Craie and Calcaire de Maestricht correspond to what are now known as the Gulpen and Maastricht Formations (VAN DER HEIDE, 1954; FELDER, 1975a). Text-fig. 3 shows the broad distribution of these units across the area (after POLLOCK, 1974).

Present workers use several systems to divide up this sequence: a number system devised by UHLENBROEK (1912), a letter system as used by HOFKER (1966) and a very detailed lithostratigraphy devised by W. M. FELDER (1975a, 1975b). Text-fig. 4 shows the correlation of these various systems; I follow the useage of FELDER in the present work.

Not all of the divisions of the Gulpen and Maastricht Formations are present across the area, and individual units are cut out at intra-Cretaceous unconformities. The reader is referred to the works of UHLENBROEK, 1912, FELDER, 1975a-b and the joint Paläontologisches Gesellschaft and Palaeonto-

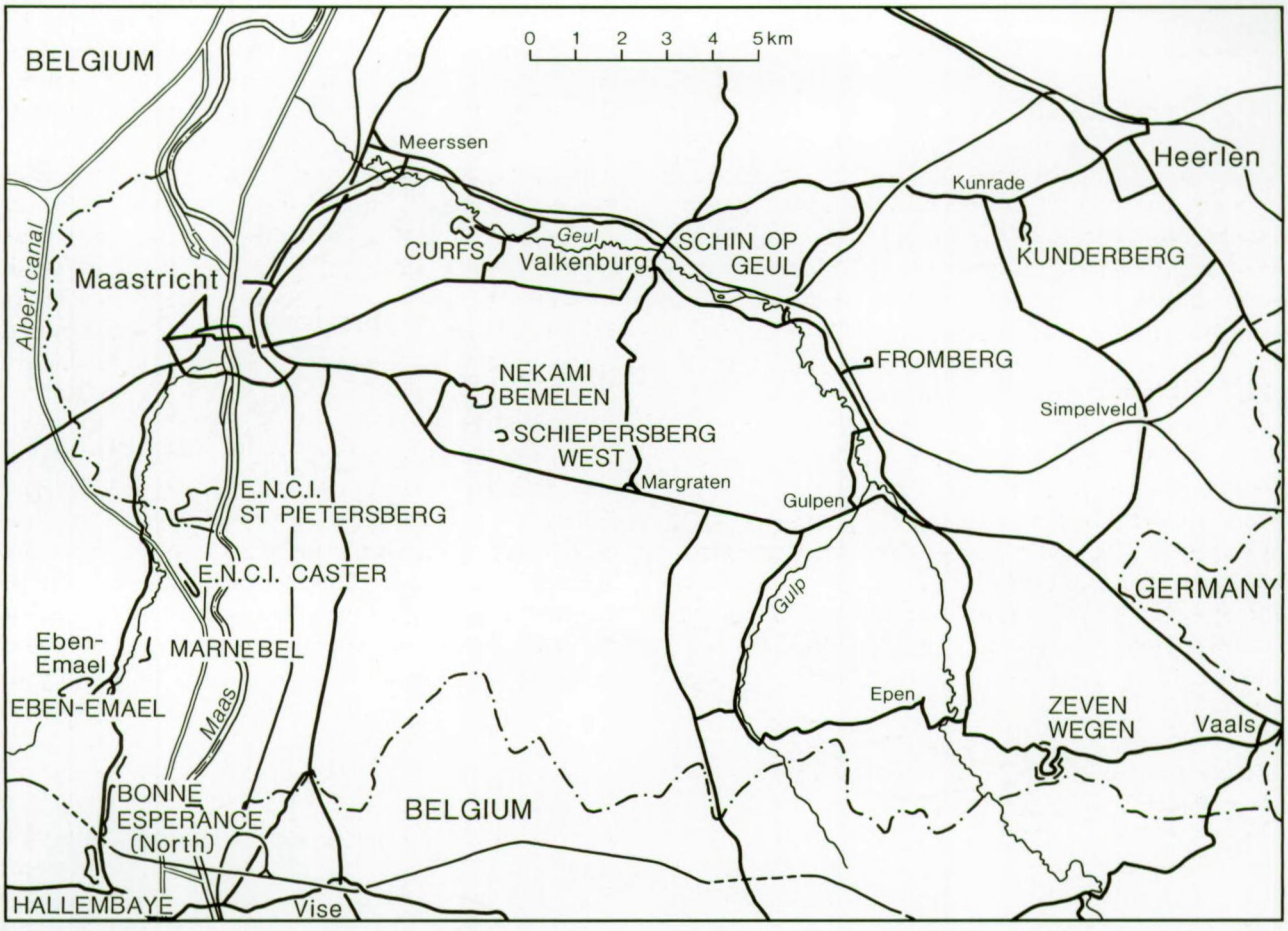
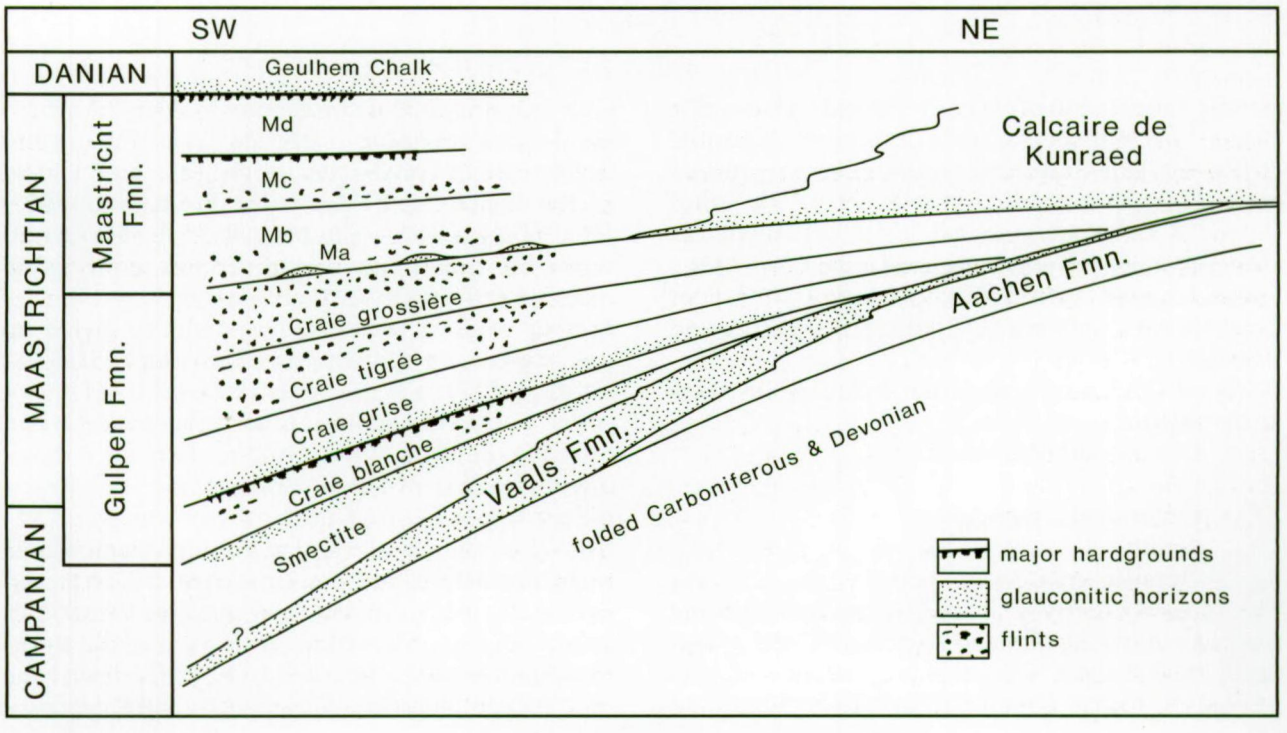



Fig. 2. *Locality map for South Limburg and Liège showing some of the more important localities cited in the text.*

Fig. 3. *Generalised section across South Limburg showing the distribution of the main stratigraphic units (modified after* POLLOCK, *1974).*



logical Association (1978) field guide to the area for details of these lateral changes. There are also important facies changes in the upper part of the sequence, and the Maastricht Formation is replaced to the north-east of Maastricht by the Calcaire de Kunraed, a more terrigenous, glauconite-rich facies. Text-fig. 5 shows the relationship of the two.

The biostratigraphy of the Upper Cretaceous in the Maastricht region has been studied by many workers; ostracodes by VAN VEEN (1928-1929) and DEROO (1966), foraminifera by HOFKER (1966) and VILLAIN (1977) and dinoflagellates by VANGEROW and SCHLOEMER (1967) and WILSON (1971), while the succession at Hallembaye is documented by ROBASZYNSKI *et al.* (1985). These studies have produced conflicting results.

Studies on stratigraphically important macrofossils are limited. The most satisfactory group for correlation in the uppermost Cretaceous of Western Europe are the belemnites, and in the white chalks of north-west Europe, the Maastrichtian has been subdivised as follows (see CHRISTENSEN, 1979 for a review):

Upper Maastrichtian { *Belemnella casimirovensis* / *Belemnitella junior*

Lower Maastrichtian { *Belemnella occidentalis* / *Belemnella laceolata*

SHULZ (1979), working in the White Chalk of north Germany further divided the Lower Maastrichtian into six *Belemnella* Zones:

*Belemnella fastigata*, *Belemnella cimbrica*, *Belemnella sumensis* } *Belemnella occidentalis*

*Belemnella obtusa*, *Belemnella pseudobtusa*, *Belemnella lanceolata* } *Belemnella lanceolata*

The belemnites of the Maastricht region are discussed by SCHMID (1959, 1967), POLLOCK (1974), VAN DER TUUK and BOR (1980) and SHULZ and SCHMID (1983), while Dr. M. G. SCHULZ and Dr. W. K. CHRISTENSEN have kindly supplied me with additional information. Their results are markedly different from those of VAN DER TUUK and BOR (1980) and the reader is referred to SCHULZ and SCHMID (1983) for critical discussion.

The top of the Vaals Formation at Hallembaye yields Lower Campanian belemnites including *Belemnitella mucronata senior* NOWAK, 1913 and *Gonioteuthis quadrata* (BLAINVILLE) (SCHMID, 1959). The Zeven Wegen Chalk, the lowest division of the Gulpen Formation yields what Dr. M. G. SCHULZ believes to be reworked Lower Campanian *Gonioteuthis quadrata* at the base ("craie glauconifère"), while Upper Campanian *Belemnitella* of the *B. mucronata* group (including *Belemnitella minor* JELETZKY, 1951) occur throughout.

The succeeding Beutenaken Chalk yields an assemblage dominated by *Belemnella obtusa* SCHULZ, 1979 (SCHULZ and SCHMID, 1983, p. 34) and is thus Upper Lower Maastrichtian, their being a break between the Zeven Wegen and Beutenaken Chalks corresponding to part of the Upper Campanian and the *lanceolata* and *pseudobtusa* Zones (sensu SCHULZ, 1979) of the Lower Maastrichtian. Elsewhere in the region, as for instance at Hallembaye, the Beutenaken Chalk is missing, and the Vijlen Chalk rests on the Zeven Wegen Chalk. The base of the Vijlen Chalk at such localities yields a mixed fauna including elements derived from the Beutenaken Chalk. SCHULZ and SCHMID (1983, p. 34) record only a single *Belemnella* ex. gr. *junior* NOWAK, 1913 and a specimen tentatively identified as *Belemnella cimbrica* BIRKELUND, 1957, suggesting, perhaps, an upper Lower Maastrichtian age. In Liège, however, SCHULZ and SCHMID note that the Craie Grise at Hallembaye and Boirs (equivalent to the Vijlen Chalk according to ALBERS and FELDER, 1979) is said to yield exclusively *Belemnella* ex. gr. *junior* and thus be Upper Maastrichtian, but on the basis of the new evidence they show the base to the Craie Grise to be upper Lower Maastrichtian (*Belemnella cimbrica* and *fastigata* Zones). *Belemnella* of the *junior* group range from the Vijlen Chalk through to the top of the Meerssen Chalk. It is common in the basal part of the Nekum Chalk and is the dominant belemnite in the Meerssen Chalk, where it is accompanied by rarer *Belemnella casimirovensis* (SKOLOZDROWNA, 1932), which first appears 5-7 m below the top of Meerssen Chalk at the ENCI quarry near Maastricht.

The Calcaire de Kunraed yields *Belemnitella* of the *junior* group but not *B. casimirovensis,* and is thus older than the upper part of the Meerssen Chalk, a view supported by the work of VILLAIN (1977) who concludes from microfaunal evidence that outcrops are equivalent to the upper part of Mb to Md of UHLENBROEK (1912) although marker forms of Md are absent: that is to say the Valkenberg to basal Meerssen Chalk of FELDER. These new results are summarised in Text-fig. 6.

## Age of the Maastrichtian stratotype

The type section of the Maastrichtian stage is in the ENCI Cement Company quarry at Sint Pieterberg, Maastricht, below Lichtenberg Farm (DUMONT, 1849; MOURLON, 1878; ROMEIN, 1962). Detailed sections are given by many authors; the most accessible detailed descriptions of the sequence

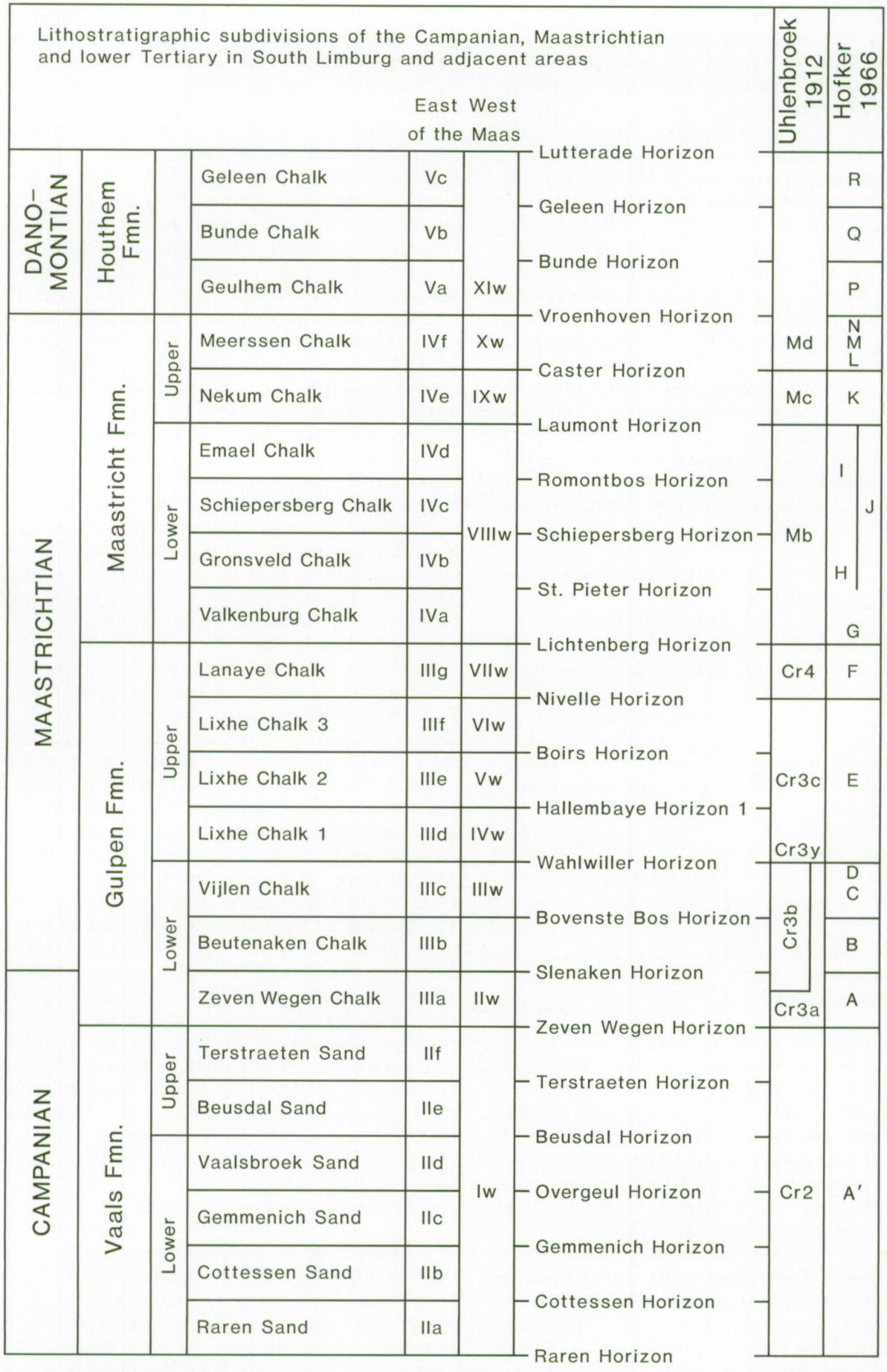



Fig. 4. *Lithostratigraphic subdivisions of the top Campanian to Danian in South Limburg and Liège showing the correlation of schemes of* UHLENBROEK *(1912),* HOFKER *(1966) and W. M.* FELDER *(1975a, 1975b) modified after W. M.* FELDER *(1976).*

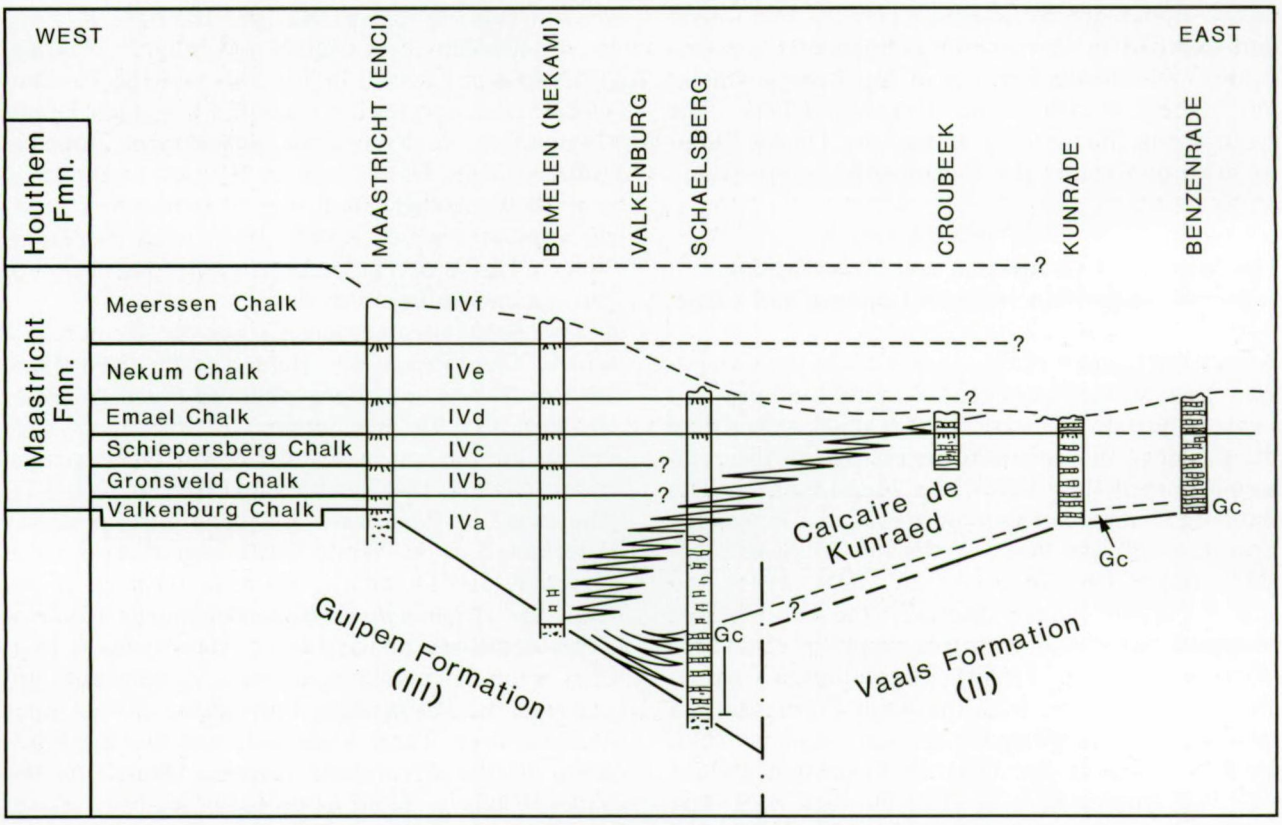
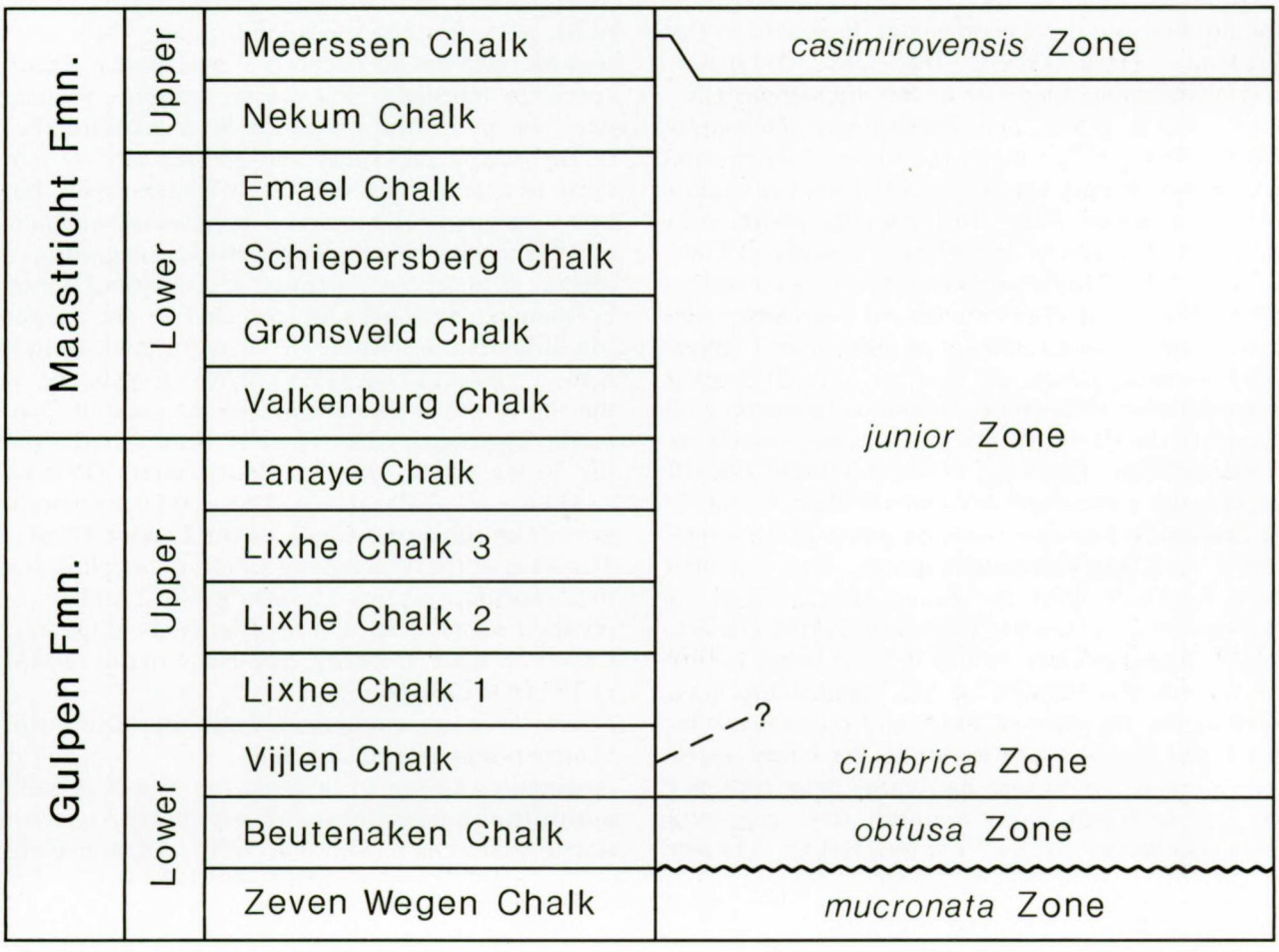



Fig. 5. *Lateral changes in the Maastricht Formation between Maastricht and Heerlen (Benzerade), Limburg, The Netherlands (modified after W. M. FELDER, 1976).*

Fig. 6. *Belemnite zonation of the uppermost Campanian and Maastrichtian in South Limburg, based on results in SCHULZ and SCHMID (1983).*



in the ENCI are by ROMEIN (1962). The lowest unit exposed in the section permanently exposed below Lichtenberg Farm is in the Lanaye Chalk; the highest is within the Meerssen Chalk. The sequence is thus wholly within the Upper Maastrichtian and within the *Belemnitella junior* Zone.

**The uppermost Campanian and Maastrichtian ammonite succession in south Limburg and Liège**

A detailed account of the ammonites of the Campanian part of the sequence in south Limburg and Liège is beyond the scope of this study, other than the evidence they provide for the age of the sediments immediately below the Maastrichtian. The standard Campanian ammonite sequence in western Europe is still that based on the work of SCHLÜTER (1871-1876), DE GROSSOUVRE (1894, 1901) and HAUG (1911); I have discussed the considerable problems associated with this zonation elsewhere (KENNEDY, 1984b, 1985b). The youngest Campanian ammonite seen from the Vaals Formation is a specimen of *Hoplitoplacenticeras marroti* (COQUAND, 1859) in the FELDER Collection (NMM VG1312), shown here in Plate 36, figs. 8, 9. The locality is marker stone 7 on the Dutch/Belgian border at Vijlen, Cottessen. *H. marroti* is generally taken as a lower Upper Campanian species in ammonite terms. This is a significantly younger age than is generally attributed to the Vaals Formation (e.g. JAGT, 1984; ROBASZYNSKI *et al.*, 1985) and ammonites in old collections and illustrated in the literature (HOLZAPFEL, 1887-1888; WEIJDEN, 1943), including *Scaphites* of the *hippocrepis* (DEKAY, 1827) group and *Pachydiscus duelmensis* (SCHLÜTER, 1872) suggest the Lower Campanian. The Zeven Wegen Chalk yields *Baculites* at a number of localities. They are generally poorly preserved, but a suite of specimens are shown as Plate 27, figs. 9-16. These specimens are characterised by the development of closely spaced transverse crescentic ribs. Our knowledge of European Campanian *Baculites* is such that they are best left in open nomenclature at this time. *Hoplitoplacenticeras* also occurs in the Zeven Wegen Chalk; a specimen from Vijlenerbosch, Limburg, Holland (NMM GK840 *ex* FELDER Collection) is shown as Plate 36, fig. 7. It is identified as *H.* cf. *coesfeldiense* (SCHLÜTER, 1867), an Upper Campanian species. There are also two scaphitids from the Zeven Wegen Chalk of Vijlenerbosch (FELDER Collection NMM GK965, 1116), shown in Plate 36, figs. 1-5. Although poorly preserved, the dorsum of the smaller specimen reveals the presence of inner and outer ventrolateral and lateral tubercles while the larger specimen, the phragmocone and early body chamber of a macroconch shows a fourth row, indicating the specimens to be *Trachyscaphites spiniger* (SCHLÜTER, 1872) (p. 82, pl. 25, figs. 1-7; see recent revisions by COBBAN and SCOTT, 1964 and SCHMID and ERNST, 1975). This and the *Hoplitoplacenticeras* species are typical of the upper Upper Campanian *Bostrychoceras polyplocum* Zone of authors. VAN DER TUUK *in* ROBASZYNSKI *et al.* records the exclusively Lower Maastrichtian *Acanthoscaphites tridens* (KNER, 1848) from the Zeven Wegen Chalk of Hallembaye (1985, fig. 12), but this appears to be an error.

I have seen no ammonites from the Beutenaken Chalk. The Vijlen Chalk yields phosphatised (Plate 28, figs. 1, 4-6) and unphosphatised *Baculites* (Plate 27, figs. 19, 20) at a number of localities; more critical are the specimens of *Hoploscaphites tenuistriatus* (KNER, 1848) at Mesch (Plate 31, figs. 4-7). The range of this species has been fairly precisely determined in the White Chalk sequence of north Germany and Denmark, where it is known *in situ* from the *Belemnella fastigata/Belemnella cimbrica* Zone boundary in the Lower Maastrichtian (e.g. high in the *Belemnella occidentalis* Zone of authors) to low in the *Belemnitella junior* Zone of the Upper Maastrichtian. There is also evidence that it extends down to the *Belemnella sumensis* Zone. As the Vijlen Chalk is dated as probably *cimbrica* Zone, the Mesch occurence is compatible with other records. ROBASZYNSKI *et al.* (1985, p. 23) record *Pachydiscus* sp. from this unit at Hallembaye.

SCHLÜTER (1872, p. 94, pl. 28, fig. 3) illustrated a specimen of *Acanthoscaphites tridens* (KNER, 1848) from "Vaels bei Aachen", HOLZAPFEL (1888, p. 63, pl. 5, fig. 1) a specimen from the "Mucronation-Mergeln des Schneeberges" and there is a third specimen labelled: "Craie Glauconifère, Schneeberg" in the Institut Royal des Sciences Naturelles in Brussels. I previously and erroneously showed these as coming from the Zeven Wegen Chalk, but this is an error. The matrix is a yellowish-weathering glauconitic bioclast-rich chalk, suggesting a higher, if imprecisely defined level in the Gulpen Formation. *A. tridens* is restricted to the Lower Maastrichtian elsewhere in western and central Europe; BIRKELUND (1979) shows it occurring at the top of the *Belemnella lanceolata* Zone in Denmark. The species has recently been noted from the Vijlen Chalk "west of Beutenaken" (ROBASZYNSKI *et al.*, 1985, p. 23). I have seen no ammonites from the Lixhe Chalk or the Lanaye Chalk.

The base of the Valkenburg Chalk yields phosphatised *Baculites anceps* LAMARCK, 1822 and phosphatised *Baculites* sp. 1 at the Blankenberg Quarry, Cadier en Keer, Limburg, The Netherlands (NMM *ex* FELDER Collection).

I have seen no ammonites from the Gronsveld, Schiepersberg or Emael Chalks.

Ammonites known to be from the Nekum Chalk, mostly from the environs of Maastricht are *Anpachydiscus fresvillensis* (SEUNES, 1890), *Diplomoceras*

*cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 (*Baculites* are abundant at the base of this unit) and *Hoploscaphites constrictus* (J. SOWERBY, 1817). FELDER (1968) records a specimen of *Sphenodiscus binkhorsti* BÖHM, 1898, from this unit, and Mr. J. W. M. JAGT of Ej Velno tells me he has seen a second specimen, from just above the Laumont Horizon in the ENCI Quarry at Maastricht. Ammonites known to be from the Meerssen Chalk are *Nostoceras* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801, *B. anceps* LAMARCK, 1822 and *Hoploscaphites constrictus* (J. SOWERBY, 1817). The upper part of the Meerssen Chalk only yields *Sphenodiscus binkhorsti* BÖHM, 1898 and the *crassus* form of *Hoploscaphites constrictus*.

The single specimen of *Eubaculites lyelli* (d'ORBIGNY, 1847) from Maastricht is from either the Nekum or the Meerssen Chalk.

The Calcaire de Kunraed yields ammonites from the upper part only according to P. J. FELDER (Personal communication 1983). The fauna is: *Saghalinites* sp., *Pachydiscus (Pachydiscus) gollevillensis* (d'ORBIGNY, 1850), *P. (P.)* cf. *jacquoti* SEUNES, 1890, *Anapachydiscus fresvillensis* (SEUNES, 1890), *Glyptoxoceras* cf. *subcompressum* (FORBES, 1846), *G.* cf. *circulare* SHIMIZU, 1935, *G.* sp., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Baculites vertebralis* LAMARCK, 1801 (common), *B. anceps* LAMARCK, 1822, *Hoploscaphites constrictus* (J. SOWERBY, 1817), *H. felderi* sp. nov., *H. pungens* (BINKHORST, 1861), *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841) and *Acanthoscaphites* sp. P. J. FELDER informs me that he has never seen *Sphenodiscus binkhorsti* BÖHM, 1898 from the Calcaire de Kunraed and that specimens labelled "Kunraed" in old collections are mislabelled.

## Conclusions

The ammonites from south Limburg and Liège described below indicate an Upper (but not uppermost) Campanian age for the top of the Vaals Formation in at least some localities (if the *Hoplitoplacenticeras marrotti* noted above is correctly attributed to this unit) and an Upper (but not uppermost) Campanian age for the Zeven Wegen Chalk.

The presence of *Hoploscaphites tenuistriatus* (KNER, 1848) in the Vijlen Chalk is compatible with the belemnite evidence, which suggests a probable correlation with the *cimbrica* Zone of north Germany.

The fauna of the Nekum Chalk and the lower part of the Meerssen Chalk is Upper Maastrichtian, being associated with *Belemnitella junior* NOWAK, 1913. The presence of *Sphenodiscus binkhorsti* BÖHM, 1898 and the *crassus* form of *Hoploscaphites constrictus* (J. SOWERBY, 1817) in the upper part of the Meerssen Chalk, in association with *Belemnella casimirovensis* (SKOLOZDROWNA, 1932) matches occurrences in Poland (BŁASZKIEWICZ, 1980) while *crassus* forms of *constrictus* are restricted to the *casimirovensis* Zone in Denmark (BIRKELUND, 1979).

The fauna of the Calcaire de Kunraed is associated with *Belemnella junior* NOWAK, 1913 and is also Upper Maastrichtian. There are a number of elements common to it and to the Nekum Chalk and the lower part of the Meerssen Chalk, but among the numerous *Hoploscaphites* no specimens that correspond to the *crassus* form of *H. constrictus*. The upper part of the Calcaire de Kunraed that yields this fauna thus extends no higher than the lower part of the Meerssen Chalk, the same conclusion as that determined independently on the basis of the belemnites (SCHULZ and SCHMID, 1983) and forams (VILLAIN, 1977). There is no ammonite evidence for the correlation of the base of the Calcaire de Kunraed with sequences to the west.

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## Conventions

LOCATIONS OF SPECIMENS

The following abbreviations are used to indicate the location of specimens mentioned in the text:

BMNH : British Museum (Natural History), London.

EMP : École des Mines Collections, formerly in Paris but now in the Université Claude-Bernard, Lyon.
IRSNB : Institut Royal des Sciences Naturelles, Brussels.
MNB : Museum für Naturkunde, Berlin.
MNHP : Muséum National d'Histoire Naturelle, Paris.
NHMW : Naturhistorisches Museum, Vienna.
NMM : Natuurhistorisch Museum, Maastricht.
SP : Collections of the Sorbonne, now in the Université Pierre et Marie Curie, Paris.

SUTURE TERMINOLOGY

The system of WEDEKIND (1916) as reviewed by KULLMANN and WIEDMANN (1970) is used here. E = external lobe, L = lateral lobe, U = umbilical lobe, I = internal lobe.

DIMENSIONS

All dimensions are given in millimeters; D = diameter, Wb = Whorl breadth, Wh = Whorl height and U = umbilicus; c = costal and ic = intercostal. Figures in parentheses refer to dimensions as a percentage of diameter. The term *rib index* as applied to heteromorphs is the number of ribs in a distance equal to the whorl height at the mid point of the interval counted.

## Systematic palaeontology

Phylum MOLLUSCA
Class CEPHALOPODA CUVIER, 1797
Order AMMONOIDEA ZITTEL, 1884, pp. 355, 392
Suborder LYTOCERTINA HYATT, 1889, p. 7
Superfamily TETRAGONITACEAE HYATT, 1900, p. 568
Family TETRAGONITIDAE HYATT, 1900, p. 568
Genus *SAGHALINITES*
WRIGHT and MATSUMOTO, 1954, p. 110

TYPE SPECIES

*Ammonites cala* FORBES, 1846a, p. 104, pl. 8, fig. 4, by original designation.

DISCUSSION

BIRKELUND (1965) and KENNEDY and KLINGER (1977) provide reviews of this genus and its constituent species. It is now clear that *Saghalinites* extends into the Upper Maastrichtian (BIRKELUND, 1979, p. 53, text-fig. 1; 1982, p. 15) and that it occurs much more widely in the European Cretaceous than was previously recognised. There are thus occurrences in the Upper Maastrichtian of the Pyrénées (Haute-Garonne) (Université de Toulouse Collections), in Switzerland (the *Tetragonites subepigonum* BÖHM *in* BÖHM and HEIM, 1909, p. 52, pl. 1, figs. 5, 10), in northern Italy (the *Hauericeras* cf. *pseudogardeni* of MARIANI, 1898), the Maastrichtian of Holland (the present records), Denmark (BIRKELUND, 1979), Germany and Austria (BIRKELUND, 1979, 1982; KENNEDY and SUMMESBERGER, 1986), Zumaya, north-west Spain (WARD and WIEDMANN, 1983) possibly the Santonian of Austria (IMMEL, KLINGER and WIEDMANN, 1982) and the Maastrichtian of the Ukraine (WISNIOWSKI, 1907, pl. 17, fig. 5).

OCCURRENCE

Santonian to Upper Maastrichtian. Antarctica, South Patagonia, Zululand, Madagascar, southern India, Japan, Sakhalin, northern Italy, north-west Spain, south-western France, The Netherlands, Denmark, north Germany, Switzerland, the Ukrainian SSR.

*Saghalinites* sp.
Plate 21, figs. 1, 4; Text-fig. 7D

GROSSOUVRE, A. DE, 1908, *Gaudryceras* cf. *kayei,* FORBES sp., p. 34, pl. 10, fig. 5.

DIENER, C., 1925, *Gaudryceras* cf. *kayei* (FORBES); DE GROSSOUVRE, p. 48.

BIRKELUND, T., 1979, *Saghalinites* n. sp., p. 53.

BIRKELUND, T., 1982, *Saghalinites* sp., p. 15.

MATERIAL

IRSNB 9482 *ex* BOSQUET Collection, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands, the original of DE GROSSOUVRE, 1908, pl. 10, fig. 5; IRSNB IG 6521 *ex* UBAGHS Collection, from the same horizon and locality.

DESCRIPTION

IRSNB 9482 is an external mould plus part of an internal mould; IRSNB IG 6521 a fragment of internal mould. Coiling is very involute, the umbilicus comprising 42.8% of the diameter. It is of moderate depth with a low, rounded, undercut wall. The whorls expand slowly, with a whorl breadth to height ratio of 1.2. The flank and venter are somewhat flattened, with the greatest breadth below mid-flank. The surface of the shell is smooth except for a trace of growth lines and six narrow prorsiradiate constrictions (Pl. 21, fig. 1) per whorl, with,

where well-preserved a low, rounded collar on the apertual side. The constrictions and collars flex back across the ventrolateral shoulder and pass straight across the venter.
Sutures not seen.

DISCUSSION

DE GROSSOUVRE (1908, p. 34) compared this species to *Vertebrites [Gaudryceras] kayei* (FORBES, 1846) and KENNEDY and KLINGER (1979, p. 160) also referred it to the species with a query. BIRKELUND (1979, p. 53; 1982, p. 15) pointed out that it is an undescribed species of *Saghalinites,* differing from *Saghalinites wrighti* BIRKELUND, 1965 (p. 30, pl. 1, fig. 5; pl. 2, figs. 1-5; pl. 3, fig. 1; text-figs. 14-25) a Greenland form known from the lower Upper Maastrichtian *Belemnitella junior* Zone of Denmark and north Germany in having a wider umbilicus and stronger constrictions. While this may be true of Danish and German material, the specimen from Limburg has dimensions that overlap with *S. wrighti.* With such limited material it is fruitless to comment further.

OCCURRENCE

Upper Maastrichtian, Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

Suborder AMMONITINA HYATT, 1889, p. 7
Superfamily DESMOCERATACEA ZITTEL, 1895, p. 426
(*nom. transl.* WRIGHT and WRIGHT, 1951, p. 18 *ex* Desmoceratidae ZITTEL, 1895).
Family PACHYDISCIDAE SPATH, 1922a, p. 132
(*nom. transl.* SPATH, 1923, p. 39 for Pachydiscinae SPATH, 1922a, p. 132).
Genus *PACHYDISCUS* ZITTEL, 1884, p. 466.

TYPE SPECIES

*Ammonites neubergicus* HAUER, 1858, p. 12, pl. 2, figs. 1-4, pl. 3, figs. 1-2, by the subsequent designation of DE GROSSOUVRE, 1894, p. 177.

DIAGNOSIS

Compressed to depressed, moderately involute, with high, flat or convex sides. Ornamented by straight to feebly curved primary ribs, feebly bullate or not, with well-differentiated secondaries. Ornament may persist, reduce to umbilical ribs, with or without feeble umbilical bullae, or disappear completely at maturity. May reach a large size.

OCCURRENCE

Campanian to Maastrichtian, world-wide.

Subgenus *PACHYDISCUS* ZITTEL, 1884, p. 466
(= *Parapachydiscus* HYATT, 1900, p. 570; *Joaquinites* ANDERSON, 1958, p. 218).

DIAGNOSIS

*Pachydiscus* in which ornament persists into middle growth, with umbilical or lateral ribs retained to maturity.

DISCUSSION

The type species, *P. (P.) neubergicus* (HAUER, 1858), is revised by KENNEDY and SUMMESBERGER (1986). A series of very similar Maastrichtian forms are grouped round it, including *P. egertoni* (FORBES, 1846), *P. jacquoti* (SEUNES, 1890), *P. gollevillensis* (d'ORBIGNY, 1850) (the type species of *Parapachydiscus,* which is thus a synonym), *P. compressus* (SPATH, 1922), *P. llarenai* WIEDMANN, 1960, *P. carinthiacus* THIEDIG and WIEDMANN, 1976, *P. excelsus* MATSUMOTO, 1979, *P. subcompressus* MATSUMOTO, 1954, and others. *Pachydiscus fascicostatum* (ANDERSON, 1958) the type species of *Joaquinites,* is a junior synonym of *Pachydiscus subcompressus,* following MATSUMOTO, 1959, p. 46; hence *Joaquinites* is a synonym of *Pachydiscus (Pachydiscus).*
*Pachydiscus (Neodesmoceras)* MATSUMOTO, 1947, p. 39 (republished in English in 1951, p. 24; = *Neodesmoceras* MATSUMOTO, 1938, p. 193, *nom. nud.*) includes the type species, *P. (N.) japonicus* MATSUMOTO, 1947, *P. (N.) mokotibense* COLLIGNON, 1952, *P. (N.) obsoletiformis* JONES, 1963, *P. (N.) catarinae* (ANDERSON and HANNA, 1935) (*fide* MATSUMOTO, 1959, p. 41) and *P. (N.) gracilis* MATSUMOTO, 1979. These have an equidimensional whorl section, distant ribs on the nuclei and are smooth in middle and later growth.
A third group, long recognised (e.g. MATSUMOTO, 1959a, p. 41) has massive whorls with abundant ribs, most or all of which extend low on the flanks or branch from the umbilical shoulder, and reach a large size. In Europe, the earliest member of this group is *Pachydiscus duelmensis* (SCHLÜTER, 1872) of the Lower Campanian, while *P. launayi* DE GROSSOUVRE, 1894 and *P. colligatus* (BINKHORST, 1861) are other well-known Campanian representatives with, in the Maastrichtian, *P. epiplectus* (REDTENBACHER, 1873). Its origin lies, perhaps, in *Eupachydiscus* SPATH, 1922 (= *Mesopachydiscus* YABE and SHIMIZU, 1926) of the Coniacian to Campanian. Forms such as *Eupachydiscus jeani* (DE GROSSOUVRE, 1894) (p. 187, pl. 26, fig. 5) of the Santonian are possible ancestors. Compressed Upper Campanian forms with complex ribbing such as *Pachydiscus oldhami* (SHARPE, 1855) and *P. koeneni* DE GROSSOUVRE, 1894 seem unlikely ancestors for the *neubergicus* group, but the inner

whorls of Upper Campanian *Pachydiscus perfidus* DE GROSSOUVRE, 1894 (p. 213, pl. 34, fig. 1; KENNEDY and SUMMESBERGER, 1984, p. 160, pl. 3; pl. 6, fig. 6) show strong similarities to mature *Pachydiscus (Pachydiscus)* from low in the Maastrichtian (e.g. FAVRE, 1869, pl. 4, fig. 2), suggesting a paedomorphic origin for the subgenus.

OCCURRENCE

Campanian and Maastrichtian, world-wide.

*Pachydiscus (Pachydiscus) colligatus*
(BINKHORST, 1861)
Plate 1, figs. 1, 2; Plate 2, figs. 1, 2; Plate 3;
Plate 4, figs. 4, 5

BINKHORST, J. T., 1861, *Ammonites colligatus,* Nobis, p. 25 (*pars*), pl. 8 only.

non SEUNES, J., 1890a, *Pachydiscus colligatus,* BINKHORST, sp., p. 6, pl. 3 (2), fig. 4.

non SEUNES, J., 1891, *Pachydiscus colligatus,* BINKHORST, sp., p. 13, pl. 3 (12), fig. 3.

GROSSOUVRE, A. DE, 1894, *Pachydiscus colligatus* VON BINKHORST, sp. emend. A. DE GROSSOUVRE, p. 202 (*pars*), pl. 33, non pl. 24, figs. 1, 3.

GROSSOUVRE, A. DE, 1894, *Pachydiscus van den broecki* A. DE GROSSOUVRE, sp., p. 207.

non KOSSMAT, F., 1898, *Pachydiscus colligatus,* p. 101 (166).

non MARIANI, E., 1898, *Pachydiscus colligatus,* VON BINKHORST, sp., p. 63 (3), pl. 8 (1), fig. 2.

non PERVINQUIERE, L., 1907, *Pachydiscus (Pachydiscus) colligatus* VON BINKHORST, p. 175, pl. 7, fig. 12.

GROSSOUVRE, A. DE, 1908, *Pachydiscus colligatus* BINKHORST VAN DEN BINKHORST, sp. emend. DE GROSSOUVRE, p. 28, pls 7, 8, *non* pls. 4, 5, 6.

? PRUVOST, P., 1910, *Pachydiscus colligatus* VON BINKHORST, 1861, p. 368.

non NOWAK, J., 1913, *Pachydiscus colligatus* BINKHORST, sp., p. 361, pl. 43, fig. 30; pl. 44, fig. 39.

non SPATH, L. F., 1921, *Parapachydiscus* sp. nov. aff. *colligatus* BINKHORST, sp., p. 226, pl. 22, fig. 1.

DIENER, C., 1925, *Parapachydiscus colligatus* VON BINKHORST, p. 114 (*pars*).

non DIENER, C., 1925, *Parapachydiscus* non ex. aff. *colligato* (BINKHORST), SPATH, p. 115.

DIENER, C. 1925, *Pachydiscus van den Broecki* GROSSOUVRE, p. 109.

non BÖSE, E., 1928, *Parapachydiscus* cfr. *colligatus* BINKHORST, p. 305, pl. 15, fig. 11.

non BASSE, E., 1931, *Pachydiscus colligatus* BINKHORST, p. 28, pl. 3, figs. 6, 7.

non BASSE, E., 1931, *Pachydiscus* sp. indet. aff. *colligatus* BINKHORST, p. 29, pl. 4, fig. 8.

COLLIGNON, M., 1938, *Parapachydiscus colligatus* VON BINKHORST, p. 80 (30), pl. 5, fig. 1.

non MIKHAILOV, N. P., 1951, *Pachydiscus colligatus* BINKHORST, p. 56, pl. 5, figs. 28-30, text-figs. 20, 21.

non MIKHAILOV, N. P., 1951, *Pachydiscus colligatus* BINKHORST var *epiplecta* REDTENBACHER, p. 59, pl. 6, fig. 33.

non COLLIGNON, M., 1952, *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST, p. 79, pl. 26, fig. 2.

non COLLIGNON, M., 1955, *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST, p. 74, pl. 26, fig. 2.

non NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Pachydiscus colligatus* (BINKHORST), p. 186, pl. 11, fig. 4.

non BŁASZKIEWICZ, A., 1965, *Pachydiscus colligatus* (BINKHORST), p. 153, pl. 3, fig. 1.

non ATABEKIAN, A. A. and AKOPIAN, V. T., 1969, *Pachydiscus colligatus colligatus* (BINKHORST), p. 11, pl. 4, fig. 2; pl. 5, fig. 1.

non ATABEKIAN, A. A. and AKOPIAN, V. T., 1969, *Pachydiscus colligatus fresvillensis* SEUNES, p. 13, pl. 6, fig. 1.

non ATABEKIAN, A. A. and AKOPIAN, V. T., 1969, *Pachydiscus colligatus michailovi* subsp. nov., p. 14, pl. 5, fig. 2; pl. 6, fig. 2; pl. 7, figs. 1, 2.

non COLLIGNON, M., 1971, *Pachydiscus colligatus* VAN BINKHORST, p. 32, pl. 653, fig. 2409.

non BŁASZKIEWICZ, A., 1980, *Pachydiscus* cf. *colligatus latiumbilicatus* subsp. nov., p. 46, pl. 64, fig. 5; pl. 55, fig. 1.

non BŁASZKIEWICZ, A., 1980, *Pachydiscus colligatus latiumbilicatus* subsp. nov., p. 46, pl. 37, fig. 3; pl. 38, figs. 1-4; pl. 50, fig. 1.

non MARTINEZ, R., 1982, *Pachydiscus (Pachydiscus)* sp. gr. *Pachydiscus colligatus* BINKHORST, p. 83, pl. 7, fig. 2.

non TSANKOV, V., 1982, *Pachydiscus colligatus colligatus* (BINKHORST, 1861), p. 38, pl. 17, fig. 1; pl. 18, fig. 1.

TYPES

BINKHORST referred to a number of specimens in his account of this species. No previous valid lectotype designation has been made (see discussion below), and I here designate the original of BINKHORST, 1861, pl. 8, lectotype of the species, for reasons discussed below. The specimen is from the low Upper Campanian of Jauche, Brabant, Belgium. It is in the collections of the Museum für Naturkunde, East Berlin, and is reillustrated as Pl. 1, figs. 1, 2 and Pl. 2, figs. 1, 2. The paralectotype figured by BINKHORST as his pl. 6, figs. 3a-3f is from the Upper Maastrichtian of Benzerade near Kunrade, Limburg, The Netherlands. It cannot be recognised in the Berlin Collections. It is either a juvenile *Pachydiscus (Pachydiscus) jacquoti* SEUNES, 1890 or *Anapachydiscus fresvillensis* (SEUNES, 1890), probably the latter.

The paralectotype figured by BINKHORST as his pl. 7, figs. 1a-1c is from the Campanian of Slenaken, Limburg, The Netherlands. It is in the collections of the Museum für Naturkunde, East Berlin, and is reillustrated as Pl. 5, figs. 1, 2. It is a *Eupachydiscus* cf. *levyi* (DE GROSSOUVRE, 1894). It is not clear whether BINKHORST's pl. 7, figs. 2a-2e are based on one specimen or on several. What may be the basis of his pl. 7, figs. 2a, 2b is reillustrated here as Pl. 13, figs. 1, 2. What may be the original of his pl. 7, fig. 2c is reillustrated here as Pl. 15, figs. 4-6. Both specimens are in the collections of the Museum für Naturkunde, East Berlin, and are from the Upper Maastrichtian of Benzerade, near Kunrade, Limburg, The Netherlands. The possible original of BINKHORST's pl. 7, figs. 2a, 2b and the figures are both *Pachydiscus (Pachydiscus) jacquoti* SEUNES, 1890; the possible original of BINKHORST's pl. 7, fig. 2c and the figure are both *Anapachydiscus* cf. *fresvillensis* (SEUNES, 1890).

The original of BINKHORST's pl. 8a, figs. 1, 2 (parts of a single specimen) is in the collection of the Museum für Naturkunde, East Berlin, and is reillustrated here as Pl. 6, fig. 1 and Pl. 7, figs. 1, 2. It is from the Upper Maastrichtian of Benzerade, near Kunrade, Limburg, The Netherlands, and is the phragmocone of an adult *Anapachydiscus fresvillensis* (SEUNES, 1890).

The original of BINKHORST's pl. 8a, fig. 3a-e appears to be the specimen in the collections of the Museum für Naturkunde, East Berlin, shown in Pl. 15, figs. 1-3. It is a *Pachydiscus (Pachydiscus)* cf. *jacquoti* SEUNES, 1890, from the Upper Maastrichtian of Benzerade, near Kunrade, Limburg, The Netherlands.

The paralectotype from the Campanian of Folx-les-Caves, Brabant, Belgium, mentioned by BINKHORST on p. 29, is in the collections of the Museum für Naturkunde in East Berlin. It is indeterminate, but may be a *P. (P.) colligatus*.

MATERIAL

IRSNB 10256, from Folx-les-Caves, Brabant, Belgium (Doucet Collection).

| Dimensions | Lectotype at | IRSNB 10256 at |
|---|---|---|
| *D* | 260(100) | 223(100) |
| *Wb* | ~104(~40) | ~90(~40) |
| *Wh* | ~118(~45) | 101(45.3) |
| *Wb: Wh* | ~0.88 | ~0.89 |
| *U* | ~64.5(~24.8) | ~53.0(24) |

DESCRIPTION

The lectotype is a moderately well-preserved internal mould in quartzose calcarenite. One side is very well-preserved; the other is worn and corroded. The worn side shows small angular quartzite, chert and other pebbles, plus oysters debris. At one point (Pl. 1, fig. 1) a small area of external ornament 40 × 30 mm survives, where, after shell dissolution, loose sediment appears to have filled part of the external mould. The siphuncle is partially phosphatised.

Coiling is moderately involute, the umbilicus comprising an estimated 24,8% of the diameter. It is of moderate depth, with a rounded umbilical wall, undercut on the internal mould. The inner flanks are rounded, with the greatest breadth below mid-flank. The outer flanks are flattened and convergent with broadly rounded ventrolateral shoulders and venter. The expansion rate is relatively low.

Because of the irregular surface of the mould, little ornament is visible. Blunt umbilical bullae that merge into flank ribs are visible at a whorl height of 80-85 mm., but cannot be detected elsewhere. There are low folds and grooves on the surface of the flanks, but these may simply reflect the position of the sutures. The surface of the internal mould of the ventrolateral shoulder and venter are perfectly preserved for a distance of 90 mm. at a whorl height of approximately 85 mm. They are smooth, apart from faint undulations. In contrast, the patch where external shell surface is preserved (Pl. 1, fig. 1) shows narrow, low, transverse ribs one per 10 mm., 2-3 mm. wide, with 7-8 mm. interspaces. These interspaces bear delicate growth striae and, in one case, a median riblet and grooves.

BINKHORST's figure give a good idea of the expansion rate of the specimen and the relative proportion of the shell. It also shows, with a fair degree of accuracy, the ventral decoration of the shell.

In other respects, the figure is quite extraordinary, in that the side view shows the last part of the specimen to be body chamber, and shows shell covering all but the last half whorl. The shell is shown to be finely and evenly ribbed, the mould smooth. In contrast, the aperture view shows the specimen to be wholly septate, with shell covering only part of the outer whorl. The ribbing, as illustrated in BINKHORST, consists of fine primary ribs that extend to the umbilical wall, separated by broad interspaces and very fine riblets (or growth striae?) on the outer flank and venter between the ribs. The differences between the two views of the same specimen show that they are restored and in part imagination, as BINKHORST (1861, p. 26) noted.

The specimen from Folx-les-Caves that I refer to this species is shown in Pl. 3 and Pl. 4, figs. 4, 5. It has the same overall proportions as the lectotype, while the ornament is visible at the smallest diameter exposed. The inner flank is not preserved, but the mid- to outer flank shows low, broad, prorsiradiate ribs, concave on the outer flank and passing across the venter in a very broad convexity. There is an indication that the ribs are divided into

primaries separated by one or two intercalatories at the smallest diameter seen.
Flank ornament weakens around the last whorl, although the ventral ribbing persists although difficult to detect because of the poor preservation of the surface of the mould.
The sutures are typical for the genus.

DISCUSSION

No description of the type material has been published since BINKHORST's original study, and only DE GROSSOUVRE's (1908, pls. 7, 8) photographic illustration of the original of BINKHORST's pl. 8a provides accurate illustration of part of the material (note that DE GROSSOUVRE did not visit Berlin to see the types, he only obtained photographs (DE GROSSOUVRE, 1908, p. 28), and not a plaster cast as stated by ATABEKIAN and AKOPIAN (1969, p. 12).
SEUNES (1890a, p. 3) introduced *Pachydiscus fresvillensis* for an Upper Maastrichtian form from the Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France and the "Craie à *Stegaster*", "Craie à *Echinoconus sulcatus*" of the Pyrénées-Occidentales and the "Danien" of Aquitaine. He distinguished it from *Ammonites epiplectus* of REDTENBACHER because the Austrian form lacked umbilical tubercles, and from *Ammonites neubergicus* HAUER and *ootacodensis* STOLICZKA on this, and other criteria. He described a small (67 mm.) specimen as *Pachydiscus colligatus,* without discussion, comparing it with BINKHORST's pl. 7 and pl. 8a.
DE GROSSOUVRE (1894, p. 202) regarded *Ammonites colligatus* of BINKHORST (with the exception of the specimen shown in his pl. 6, fig. 3, pl. 7, figs. 1, 2 and pl. 8), *Ammonites epiplectus* of REDTENBACHER and *Pachydiscus fresvillensis* of SEUNES as synonyms. He pointed out that BINKHORST's fragments were of several different species and took the three fragments shown on BINKHORST's pl. 8a as "appartenant à un même type spécifique" (1894, p. 204). This is not a lectotype designation, as DE GROSSOUVRE clearly believed that more than one specimen was figured on BINKHORST's pl. 8a. DE GROSSOUVRE referred numerous specimens to *Pachydiscus colligatus* and figured a specimen from the Maastrichtian "Calcaires durs à Stegasters" between Gan and Rébénacq [Pyrénées Atlantiques (1894, pl. 24, figs. 1a, b, 3)] and another from Assise Q of ARNAUD (here regarded as Upper Campanian) at the falaise de Terrenègre, near Royan. They clearly belong to two different species. He also renamed the original of BINKHORST's pl. 8 *Pachydiscus vandenbroecki,* of which it is the holotype by monotypy. Under his discussion of *Pachydiscus neubergicus* (HAUER, 1858), DE GROSSOUVRE (1894, p. 209) clearly states that he adopts the original of HAUER's pl. 2, figs. 1-3 as type — which I take as a valid lectotype designation.
In 1908, DE GROSSOUVRE described the type material again. He maintained his view that the larger of the two figured specimens of *Ammonites neubergicus* HAUER, 1858 [p. 12 (*pars.*), pl. 3, figs. 1-2 only], *Ammonites epiplectus* and *Pachydiscus fresvillensis* were synonyms, but reproduced a photograph of the original of BINKHORST's pl. 8a (the holotype of *Pachydiscus vandenbroecki*) as his pls. 7 and 8. He describes BINKHORST's figures of this specimen as "fantaisiste" (as BINKHORST himself had observed), and regarded it as conspecific with specimens shown in BINKHORST's pl. 8a, figs. 1, 2 and 3a-e, which he "donc propose en 1893 de prendre comme types" (1908, p. 28).
MARIANI (1898), NOWAK (1913) and MIKHAILOV (1951) followed DE GROSSOUVRE in regarding *P. colligatus* and *P. fresvillensis* as synonyms. PERVINQUIÈRE (1907, p. 175 footnote) took valid exception to DE GROSSOUVRE's view:
"(1) Il ne me paraît pas possible d'exclure la figure de la Pl. VIII, ainsi que le fait DE GROSSOUVRE, car c'est évidemment là le type de l'espèce, puisque la description est faite presque uniquement d'après ce gros échantillon. Le caractère de la costulation, sur lequel se base DE GROSSOUVRE, n'a aucune valeur ici, puisque BINKHORST nous dit (p. 26): 'Elles (les côtes) ont été un peu trop restaurées par M. Hohe (le dessinateur), qui a supposé, ce qui peut être inexact, que ces côtes étaient toutes d'une égale longueur et couvraient toute la surface des tours. Ce fragment indique des côtes d'une longueur que cette partie corticale ne permet pas de préciser, et entre lesquelles nous remarquons des traces de côtes plus fines'.
Cette dernière phrase montre que la costulation est bien la même que celle des fragments de la Pl. VIIIa; nulle part le texte ne parle de côtes en S. Le caractère de la costulation, qu'invoque DE GROSSOUVRE pour la séparation, étant dû simplement au dessinateur, le nom de *Pach. Van den Broecki* DE GROSSOUVRE doit donc disparaître."
Again, this is not a lectotype designation, as PERVINQUIÈRE assumes the original of BINKHORST's pl. 8 is the type and does not designate it as such.
COLLIGNON (1938, p. 53) returned to the problem, and regarded *Pachydiscus fresvillensis* and *colligatus* as distinct species: in the juvenile he described *P. colligatus* as a form with a compressed whorl section and a finer ornament than *P. fresvillensis,* the ribs being more numerous. At a later growth stage, COLLIGNON considered *P. colligatus* to be more massive, with finer, more numerous ribs that are markedly concave and form a more pronounced ventral sinus than in *fresvillensis*. COLLIGNON furthermore regarded *P. fresvillensis* as Maastrichtian and *P. colligatus* as Campanian in Madagascar.
In 1952 (p. 79, pl. 26, fig. 2a, 2 b) (= 1955, p. 74,

pl. 26, fig. 2, 2a, 2b) COLLIGNON recorded what he termed *P.* aff. *colligatus* from the Maastrichtian of Madagascar, named his Campanian *P. colligatus Pachydiscus praecolligatus* COLLIGNON, 1952 (p. 66, pl. 21, figs. 1, 1a, 1b; pl. 25, figs. 2, 2a, 2b, 3, 3a, 3b) (= 1955, p. 64, pl. 21, figs. 1, 1a, 1b; pl. 25, figs. 2, 2a, 2b, 3, 3a, 3b) and renamed the original of HAUER, 1858, pl. 3 *Pachydiscus haueri* COLLIGNON, 1952 (p. 80, = 1955, p. 75).

ATABEKIAN and AKOPIAN (1969) provide a valuable discussion of *P. colligatus*. They believed that DE GROSSOUVRE (1894) selected the originals of BINKHORST's pl. 8a, figs. 1-3 lectotype, but point out that more than one specimen may be involved, and also draw attention to PERVINQUIÈRE's (1907) observations, attributing lectotype designation to that author. As already noted this is not the case, however. These authors describe two nuclei, from the upper part of the Maastrichtian 2 km. S.W. of the village of Sers in the Azizbek region of the Armenian SSR and the Upper Maastrichtian alveolitid limestones 3 km. S of the village of Khachik, in the Ekhegnadzor region. They regard REDTENBACHER's *Ammonites epiplectus* as a subspecies of *colligatus,* stating the former to be more involute with more ribs (60 vs. 40 on the outer whorl). *Pachydiscus fresvillensis* is also regarded as a subspecies of *colligatus,* while a fourth, Upper Maastrichtian subspecies, *P. colligatus michailovi* ATABEKIAN and AKOPIAN, 1969 was introduced (p. 14, pl. 5, figs. 2a, 2b; pl. 6, fig. 2; pl. 7, figs. 1a, b, 2). It was separated from *P. colligatus colligatus* on the basis of its coarser ribs (40 per whorl), arising in pairs from umbilical bullae in some cases, plus the more compressed whorl section. They compare it to *Pachydiscus subrobustus* (SEUNES, 1891).

The same authors recognise *P. haueri* as a separate Upper Maastrichtian species and introduce the subspecies *P. haueri sersensis* ATABEKIAN and AKOPIAN, 1969 (p. 17, pl. 8, fig. 2; pl. 10, fig. 1; pl. 11, fig. 1) for a further Upper Maastrichtian form.

A more recent account of this species that is relevant to the present discussion is that of BŁASZKIEWICZ, 1980. This author introduced yet a further subspecies, *P. colligatus latiumbilicatus* BŁASZKIEWICZ, 1980 (p. 46, pl. 37, fig. 3; pl. 38, figs. 1-4, pl. 50, fig. 1) for specimens from the Lower Maastrichtian *Belemnella lanceolata* Zone of Kamién in the Middle Vistula Valley, Poland. It was distinguished from the nominate subspecies by its "narrower section of whorls and slighter development of costulation in non-tuberculate stages. In addition its stratigraphic position seems to be lower" (BŁASZKIEWICZ, 1980, p. 47).

In summarising these divergent views, it will be seen that no lectotype has been designated for *P. colligatus,* that *Ammonites epiplectus, Pachydiscus fresvillensis* and the holotype of *Pachydiscus haueri* have been regarded as both synonyms of *colligatus* and as separate species or subspecies by various authors while two subspecies — *michailovi* and *latiumbilicatus* have also been recognised. *Pachydiscus colligatus* has been recorded from horizons ranging from Upper Campanian to Upper Maastrichtian.

How do the type specimens relate to these views? The lectotype designated above is the original of BINKHORST's (1861) pl. 8, the specimen refigured photographically by DE GROSSOUVRE (1908, pls. 7, 8). The justification for this designation is that of PERVINQUIÈRE mentioned above, plus the observation that DE GROSSOUVRE (1908) accepted it as a typical form, while it is the only specimen of which accurate illustrations have been available.

The age of this specimen has been assumed to be Maastrichtian by many authors. Jauche is, however, in Brabant, well away from Maastricht. DAIMERIES and VINCENT (1891, pl. 2) provide a detailed excursion guide to the area, and show an outcrop in an ancient ballast pit by the railway approximately 1 km. SW of Jauche, which is presumably the source of this specimen. In their account (p. 4) they record a sequence of Cretaceous tuffeau as follows:

| | |
|---|---|
| | Tuffeau altéré jaune brun |
| | Tuffeau jaunâtre graveleux à |
| ZONES | *Micrabacia* |
| FOSSILIFÈRES | Galets de tuffeau durci |
| | Tuffeau blanc |

*Belemnitella mucronata, B. quadrata?, Baculites faujasi* and *Ammonites colligatus* are recorded from the "zone à *Micrabacia*"; *Belemnitella mucronata* from the pebble bed. The belemnites suggest that the sequence is Campanian. However, early belemnite identifications are notoriously unreliable, and in consequence I submitted a suite of specimens from Jauche (IRSNB IG 5496, *ex* CORNET collection and labelled "Jauche" and specimens labelled: "Jauche, Excavation dans un talus gazonné montrant un gravier fossilifère paraissant être la base du Maestrichtien") to Dr. W. K. CHRISTENSEN of the Geologisk Museum, Copenhagen, who informs me (letter of 23 September 1983): "The collection consists of: (1) 13 specimens of *Belemnitella mucronata*; one of these may be referred to as *B. 'senior'* by authors; one specimen is relatively lanceolate in ventral view, but falls within the variation of *B. mucronata.* (2) 4 specimens of *Gonioteuthis*; one of these belongs to *G. quadrata.* (3) 1 specimen with a shallow pseudalveolus. It is either a Middle/Upper Santonian representative of *Gonioteuthis* or a pathological specimen of *G. quadrata* from the Lower Campanian.

Apart from the specimen mentioned under (3) the belemnites are rather similar to those I have found in Scania, i.e. at Ignaberga and Ivö Klack, from the uppermost Lower Campanian. ... *B. mucronata*

from the Lower Upper Campanian and uppermost Lower Campanian cannot be distinguished at present. Therefore, if the belemnites were not collected *in situ,* the locality may span the uppermost Lower Campanian - lower Upper Campanian".

Through the courtesy of Dr. H. JAEGER, I removed a small quantity of matrix from the lectotype of *P. colligatus* and submitted it to Professor M. B. HART of Plymouth Polytechnic for microfossil dating. In a letter 13 July 1984 Professor HART notes: "The tuffeau is a poor facies normally, but in this case there was a reasonable fauna that was quite diagnostic: *Spiroplectammina baudouiniana* (d'ORBIGNY), *Dorothia pupa* (REUSS), *Marssonella trochus* (d'ORBIGNY); *Bolivinoides laevigatus praelavigatus* BARR - *Bolivinoides laevigatus laevigatus* MARIE transitions, *Loxostomum eleyi* (CUSHMAN), *Archaeoglobigerina cretacea* (d'ORBIGNY), *Gavelinella* cf. *trochus* GOEL, *Gavelinella pertusa* (MARSSON), *Gavelinella lorneiana* (d'ORBIGNY), *Gyroidinoides nitidus* (REUSS), *Globorotalites conicus* (CARSEY)". Professor HART notes the absence of diagnostic Maastrichtian forms, and states that the assemblage indicates the middle of the *Belemnitella mucronata* Zone.

The belemnite dating of the Jauche locality plus the foram dating of the lectotype are thus in complete agreement, and the specimen is of low Upper Campanian date.

The large fragment from Folx-les-Caves (Brabant) mentioned by BINKHORST (1861, p. 29) also survives in the Museum für Naturkunde Collections (unregistered). It is an internal mould in the same preservation as the lectotype, and has a whorl height of 160 mm. It belongs to the same species as the lectotype. The age of this specimen is also Campanian. Dr. W. K. CHRISTENSEN (Copenhagen) informs me that his preliminary work on the belemnites shows that the sequence is probably a condensed one equivalent to most of the Lower Campanian.

The large paralectotype from Benzerade figured as BINKHORST's (1861) pl. 8a, figs. 1, 2, also survives in the Museum für Naturkunde (unregistered). As BINKHORST clearly states (p. 29), these figures are of but a single specimen, refigured here as Pl. 6 and Pl. 7, figs. 1, 2.

The dimensions are as follows:

| | *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|---|
| | 234(100) | 98.5(41.9) | 120(51.1) | 0.82 | 40.5(17.1) |
| at | 205(100) | 93.7(45.7) | 109(53.2) | 0.85 | 36.5(17.8) |

The specimen is wholly septate, moderately involute, with 70% of the previous whorl being covered. The umbilicus is small (17-18% of diameter), with a moderately high wall that is rounded and undercut on the mould. The outer whorls are markedly compressed (whorl breadth to height ratio is 0.82-0.85), with the greatest breadth low on the flanks. The inner flanks are markedly rounded and divergent, the outer flanks flattened and convergent; the ventrolateral shoulders are broadly rounded and the venter somewhat flattened. Small sharp umbilical bullae are visible on the inner whorls and are connected to strong primary ribs, of which there are 6-8 per half whorl.

Well-developed ornament can be detected to a diameter of 190 mm. on the outer preserved whorl; beyond this it is not easily visible on the internal mould but ventral ribs can be felt, if not seen, to the greatest preserved diameter. Low blunt bullae give rise to prorsiradiate primary ribs, singly or in pairs, that sweep forwards across the inner and middle flank, thereafter flexing forwards markedly and strengthening over the ventrolateral shoulder. They pass more-or-less straight over the central zone of the venter and weaken markedly over the siphonal line. These primaries are accompanied by shorter intercalated ribs that arise on the mid- to outer flank and have a comparable ventral development to the primary ribs.

The flank ornament declines markedly from 160 mm. onwards, although ventral and ventrolateral ornament persists.

BINKHORST's figures are accurate, if somewhat idealised.

This specimen is a typical large *Anapachydiscus fresvillensis,* comparing well with the original of SEUNES, 1890a, pl. 2 (1), figs. 1a, 1 b, from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France.

The smaller paralectotype from Benzerade figured as BINKHORST's pl. 8a, figs. 3a-3e survives in the Museum für Naturkunde Collections (unregistered) and is shown in Pl. 15, figs. 1-3. It consists of only two chambers, so that BINKHORST's figure is either heavily restored, or the specimen has suffered subsequent damage. The whorl section is compressed, with a low umbilical wall and an apparently rather shallow umbilicus. The inner flanks are rounded, the outer flanks flattened and convergent, the ventrolateral shoulders broadly rounded and the venter flattened. Broad primary ribs extend to the umbilical shoulder and bear feeble bullae; there are up to two shorter intercalated ribs developed between. The ribs are strongly developed over the ventrolateral shoulders and venter. This specimen is a *Pachydiscus (Pachydiscus),* best compared with *P. (P.) jacquoti* (SEUNES, 1890), resembling the specimen figured by SEUNES, 1890a, pl. 3 (2), figs. 2a, 2b, from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France.

I was unable to recognise the original of BINKHORST, 1861, pl. 6, figs. 3a-3e in the collection of the Museum für Naturkunde, although there are many fragments that might be the basis for the figure. The original is from Benzerade near Kunrade. The depressed whorl section and lack of

ornament suggest it is a juvenile *P. (P.) jacquoti* (SEUNES, 1890), comparable to the original of SEUNES, 1890a, pl. 3 (2), figs. 3a, 3b or perhaps a juvenile *Anapachydiscus fresvillensis*.

The original of BINKHORST's pl. 7, figs. 1a - 1c survives in the collections of the Museum für Naturkunde (unregistered), and is shown in Pl. 5, figs. 1, 2. It is from the "craie silicieuse glauconifère près de Slenaken" (BINKHORST, 1861, p. 29). Slenaken is close to the Dutch - Belgian border 15 km. SE of Maastricht, on the outcrop of the Vaals Formation, and the specimen is thus of Campanian date. It is a composite internal mould and is wholly septate. The original illustration appears to be a composite, based on both sides of the specimen, and gives only a generalised impression. The inner whorls and the whorl section shown in BINKHORST's pl. 7, fig. 1b are imaginary.

The specimen is slightly crushed. The maximum preserved whorl height is 93 mm. The whorl breadth 70 mm. Coiling appears to have been moderately involute. The umbilical wall is low and rounded. The whorl section of the inner whorl is reniform, that of the outer world is ovate. The greatest breadth is low on the flanks, which are broadly rounded; the outer flanks are flattened and convergent, the ventrolateral shoulders broadly rounded and the venter somewhat flattened. Rather distant primary ribs arise at the umbilical seam, strengthen into feeble bullae on the umbilical shoulder, are prorsiradiate, and pass straight across the inner and mid-flank, with minor flexure. They flex gently forwards across the ventrolateral shoulder, declining slightly in strength as they do so, and pass across the venter in a broad, shallow convexity. Between primaries are intercalated ribs that either extend to the umbilical seam as mere striae only, or very short ribs that are striae from umbilical shoulder to mid-flank, where they strengthen, matching the primary ribs in ventral development. There are thus four primary ribs with variably developed elongate bullae out of a total of 8 ribs on the fragment.

This fragment is, again, a *Pachydiscus (Pachydiscus)*; there is no recent revision of the Campanian ammonites of the region so that further identification is difficult, although the specimen shows some similarities to *Pachydiscus perfidus* DE GROSSOUVRE, 1894, (p. 213, pl. 34, fig. 1), especially the large examples figured by BŁASZKIEWICZ, 1980, pl. 29, figs. 3, 4; pl. 30, figs. 1, 3 and 4; pl. 31, figs. 1-3; pl. 32, figs. 1-3; pl. 33, figs. 3, 4 and pl. 37, figs. 1, 2, although all these specimens are compressed as a result of *post mortem* deformation. The type occurrence of this species at Tercis, Landes, France, is imprecisely dated. In Poland, BŁASZKIEWICZ (1980, p. 43) records it from the Upper Campanian.

The originals of BINKHORST's pl. 7, figs. 2a-2d present problems of recognition among the Berlin material. On p. 25, BINKHORST gives a diameter of 40 mm. for the original of pl. 7, fig. 2a. The figure shows a specimen 46.5 mm. in diameter, a juvenile which is septate to around 32 mm., appears to be body chamber — or is covered in shell — to 40 mm. followed by a further septate section to 46.5 m. No specimens corresponding to the measurements or the figure survive, but there is a specimen from Benzerade some 59 mm. in diameter (Pl. 13, figs. 1-2; Pl. 15, figs. 12-13) consisting of two thirds of a whorl, the last part of which is body chamber that resembles pl. 7, figs. 2a, 2 b. Coiling is moderately evolute, with a depressed, reniform whorl section. The phragmocone is smooth, due to poor preservation. On the body chamber, distant primary ribs extend to the umbilical shoulder (which is worn), with shorter, secondary ribs intercalated.

This specimen, and BINKHORST's pl. 7, figs. 2a-b are both the Upper Maastrichtian *Pachydiscus (Pachydiscus) jacquoti* (SEUNES, 1890) and match well with the specimen figured by DE GROSSOUVRE, 1894, pl. 26, fig. 3. It is not clear whether the original of BINKHORST's pl. 7, fig. 2c is a fragment of the same specimen as that shown in his pl. 7, figs. 2a, 2b from the original account. There is, however, a fragment in the Museum für Naturkunde (unregistered) that matches the figure (see Pl. 15, figs. 4-6). The maximum length is 43.5 mm; it is wholly septate, with a moderately high expansion rate and a very depressed, reniform whorl section, the whorl breadth to height ratio being 1.20. No ornament survives except for a trace of umbilical bullae.

This specimen is a juvenile *Anapachydiscus* cf. *fresvillensis* SEUNES, 1890.

I interpret *Pachydiscus (Pachydiscus) colligatus* as a Campanian species, and as will be seen from the synonymy believe that virtually all previous specimens referred to the species should be referred elsewhere. The notable exception is the fine specimen from the Falaise de Terrenègre near Royan figured by DE GROSSOUVRE (1894). This has the following dimensions (taken from the photographs)

| *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|
| 172(100) | 68.5(39.8) | 80(46.5) | 0.86 | 40(23.3) |

These correspond well with those of the lectotype, while the ornament matches what is visible on the smaller specimen from Folx-les-Caves. The Aquitaine specimen has not been traced (I have been unable to find it in the Sorbonne Collections (now in the Université Pierre et Marie Curie, Paris) that include many types described by DE GROSSOUVRE), but the age given by DE GROSSOUVRE is Assise Q of ARNAUD, that is to say Upper Campanian, lower part of the *Bostrychoceras polyplocum* Zone, approximately the same age as the lectotype

of *colligatus*. At the smallest diameter visible the ornament of the Aquitaine specimen consists of prorsiradiate primary ribs, straight on the inner flank and curving forwards and concave on the outer flank and ventrolateral shoulders, with a single intercalated rib inserted low on the flank. As size increases the flank ornament declines, with, however, persistent ribbing on the ventrolateral shoulders and venter.

If this interpretation of *P. colligatus* is accepted, a number of illustrated specimens belong here or are closely allied. The specimen of *Pachydiscus fresvillensis* from Tercis figured by SEUNES (1891, p. 14, pl. 12 (3), fig. 1) has a similar style of ornament, with rather more flexuous ribs and more intercalatories plus rather different proportions (at D = 139 mm., Wb = 51.7, Wh = 50, Wb:Wh = 1.03, U = 0.19). It is not a true *fresvillensis* and future study of the Tercis material may prove it to be within the limits of variation of the present species.

PERVINQUIÈRE's small specimen from the Campanian of Souk el Djemmaa, (1907, p. 175, pl. 7, fig. 12), and specimens from other Tunisian localities may belong here although the ribs of the figured specimen are distant and lack the forwards projection on the outer flank that distinguishes *colligatus*. Of Madagascan examples, the poorly preserved Campanian specimen illustrated by COLLIGNON in 1938 (pl. 5, fig. 1) seems to belong here, although Maastrichtian specimens referred to *colligatus* (see synonymy) belong elsewhere.

*Pachydiscus praecolligatus* COLLIGNON, 1952 (p. 66, pl. 21, fig. 1; pl. 25, figs. 2, 3; 1955, p. 64, pl. 21, fig. 1; pl. 25, figs. 2, 3; 1970, p. 40, pl. 624, fig. 2313) from the Campanian of Madagascar is a close ally. It has, according to COLLIGNON, the following proportions at a diameter of 131 mm.: Wb = 0.44; Wh = 0.47; U = 0.27 and a whorl breadth to height ratio of 0.95, with 26-32 ribs in total per whorl in most specimens, a single example having 36. It appears to be more sparsely ribbed than *P. colligatus,* but again, study of larger European collections is needed to clarify the limits of intraspecific variation.

HENDERSON and MCNAMARA (1985, p. 80) follow STOLICZKA (1865, p. 110) in regarding *P. colligatus* and *P. ootacodensis* as synonyms, but the two species are quite distinct and of very different ages.

OCCURRENCE

Upper Campanian, *Bostrychoceras polyplocum* Zone and correlatives of Jauche and Folx-les-Caves, Brabant, Belgium, Tercis (Landes) and Royan (Charente-Maritime), France and probably Upper Campanian of Madagascar.

*Pachydiscus (Pachydiscus) gollevillensis* (d'ORBIGNY, 1850)

Plate 12, figs. 4, 5; Plate 15, figs. 8, 9, 10, 11, 14, 15; Plate 22, figs. 1, 2, 3, 4, 5; Text-fig. 7A, C.

ORBIGNY, A. d', 1842, *Ammonites lewesiensis* MANTELL, p. 336 (*pars*), pl. 101, figs. 1-3, *non* pl. 102, figs. 1, 2.

ORBIGNY, A. d', 1850, *Ammonites gollevillensis* d'ORB., 1847, p. 212.

non SHARPE, D., 1854, *Ammonites gollevillensis* d'ORBIGNY, p. 48, pl. 17, fig. 2 (= *Pachydiscus sharpei* SPATH).

BINKHORST, J. T., 1861 *Ammonites exilis* Nobis, p. 31, pl. 6, fig. 4.

SEUNES, J., 1891, *Pachydiscus gollevillensis* d'ORBIGNY, sp., p. 10, pl. 14 (5), figs. 1-3.

GROSSOUVRE, A. DE, 1894, *Pachydiscus gollevillensis* d'ORBIGNY, sp., p. 214, pl. 29, fig. 4; pl. 31, fig. 9.

non KOSSMAT, F., 1897b, *Pachydiscus gollevillensis* ORB., p. 82, pl. 6, fig. 1 (= *Pachydiscus compressus* SPATH).

non KOSSMAT, F., 1897b, *Pachydiscus* sp. cf. *gollevillensis* ORB., pl. 6, fig. 3 (= *P.* sp. juv.).

non KOSSMAT, F., 1898, *Pachydiscus gollevillensis* ORB., p. 97 (162), pl. 15 (21), fig. 1 (= *Pachydiscus compressus* SPATH).

? WISNIOWSKI, T., 1907, *Pachydiscus gollevillensis* d'ORB., sp., p. 196.

GROSSOUVRE, A. DE, 1908, *Pachydiscus gollevillensis* d'ORBIGNY, sp., p. 32, pl. 9, figs. 1, 2.

non KILIAN, W. and REBOUL, P., 1909, *Pachydiscus* sp. ind. ex aff. *gollevillensis* (d'Orbigny), p. 43, pl. 19, fig. 3; pl. 20, fig. 1 (= *Pachydiscus* sp. nov.).

NOWAK, J., 1913, *Pachydiscus egertoni* FORBES, sp., p. 354, pl. 41, fig. 13; pl. 43, fig. 28; pl. 44, fig. 38.

COTTREAU, J., 1922, *Pachydiscus (Parapachydiscus) gollevillensis* (d'ORBIGNY), p. 181 (73), p. 17 (9), fig. 1.

SPATH, L. F., 1922a, *Parapachydiscus valognensis* nov., p. 122.

BÖHM, J., 1927, *Pachydiscus egertoni* FORBES sp. var. *gollevillensis* d'ORB., sp., p. 217 (*pars*), *non* pl. 13, fig. 2.

BARRABÉ, L., 1929, *Pachydiscus* cf. *gollevillensis* d'ORBIGNY, p. 181, pl. 22 (9), fig. 14.

BESAIRIE, H., 1930, *Pachydiscus gollevillensis* d'ORBIGNY, p. 566, pl. 26, fig. 4.

BASSE, E., 1931, *Pachydiscus gollevillensis* d'ORBIGNY, p. 31, pl. 4, fig. 1; pl. 11, fig. 4.

? COLLIGNON, M., 1938, *Parapachydiscus* nov. sp. aff. *Crishna* FORBES-*gollevillensis* d'ORBIGNY, p. 68 (18), pl. 1, fig. 6.

non SPATH, L. F., 1940, *Pachydiscus* aff. *gollevillensis* (d'ORBIGNY), p. 45, pl. 2, fig. 1.

MIKHAILOV, N. P., 1951, *Pachydiscus neubergicus* HAUER var. *nowaki,* var. nov., p. 65.

non MIKHAILOV, N. P., 1951, *Pachydiscus gollevillensis* d'ORBIGNY, p. 66, pl. 8, fig. 39.

NAIDIN, D. and SHIMANSKIJ, V. N., 1959, *Pachydiscus gollevillensis* d'ORBIGNY, p. 187, pl. 11, figs. 1-3.

non YOUNG, K., 1963, *Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'ORBIGNY), p. 56, pl. 8, fig. 5; pl. 17, fig. 5; text-figs. 10c, o.

non YOUNG, K., 1963, *Pachydiscus* sp. nov. 2 cfr. *P. gollevillensis* (d'ORBIGNY), p. 56, pl. 13, figs. 1, 2, 5; pl. 14, fig. 4; pl. 17, figs. 1, 8, text-figs. 10d, g.

non YOUNG, K., 1963, *Pachydiscus* sp. nov. 3 cfr. *P. gollevillensis* (d'ORBIGNY), p. 57, pl. 14, figs. 2, 3; text-fig. 7n, 8h.

TSANKOV, C. V., 1964, *Pachydiscus gollevillensis* (d'ORBIGNY), p. 160, pl. 6, fig. 3; pl. 7, fig. 4; pl. 9, fig. 1.

ATABEKIAN, A. A. and AKOPIAN, V. T., 1969, *Pachydiscus gollevillensis gollevillensis* (d'ORBIGNY), p. 4, pl. 1, fig. 1.

non ATABEKIAN, A. A. and AKOPIAN, V. T., 1969, *Pachydiscus gollevillensis armenicus* ATABEKIAN and AKOPIAN, subsp. nov., p. 8, pl. 1, fig. 2; pl. 3, figs. 1, 2.

COLLIGNON, M., 1971, *Pachydiscus gollevillensis* d'ORB., p. 24, pl. 649, figs. 2402, 2403; pl. 650, figs. 2404-2406.

BŁASZKIEWICZ, A., 1980, *Pachydiscus gollevillensis nowaki* MIKHAILOV, 1951, p. 45, figs. 2, 3 only (*non* pl. 35, figs. 1, 9).

TSANKOV, C. V., 1982, *Pachydiscus gollevillensis gollevillensis* (d'ORBIGNY, 1851), p. 36, pl. 15, fig. 2, ? figs. 1, 3; pl. 16, fig. 2.

non TSANKOV, C. V., 1982, *Pachydiscus gollevillensis armenicus* ATABEKIAN and HACOBJAN, 1969, p. 37, pl. 16, figs. 3, 4.

MARTINEZ, R., 1982, *Pachydiscus gollevillensis* (d'ORBIGNY), p. 82, pl. 7, fig. 1.

KENNEDY, W. J., 1986, *Pachydiscus (Pachydiscus) gollevillensis* (d'ORBIGNY), 1850, p. 28, pls. 1-3; pl. 4, figs. 4-6; pl. 5, figs. 12-14, 20-24; pl. 11, figs. 1-5, text-figs. 2, 3p, 3r, 4c.

TYPE

Neotype designated by KENNEDY (1986, p. 29) is BMNH C38179 from the Upper Maastrichtian, Calcaire à *Baculites* of Fresville, Manche, France (*ex* SOWERBY, *ex* DE GERVILLE Coll.).

MATERIAL

Nine specimens: MNB unregistered *ex* BINKHORST Collection, 3 specimens, IRSNB 9476 *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 9, fig. 2, all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; MNB unregistered, *ex* BINKHORST Collection, a fragment from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands; MNB unregistered, *ex* BINKHORST Collection from either Kunrade or Geulhem. MNB unregistered *ex* BINKHORST Collection, the lectotype, here designated, of *Ammonites exilis* BINKHORST, 1861, the original of his pl. 6, figs. 4a-e from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

| Dimensions | BMNH C38179 (neotype) | IRSNB 9476 | IRSNB 9477 |
|---|---|---|---|
| *D* | 112.7(100) | 48.5(100) | 93.5(100) |
| *Wb* | 33.6(29.8) | –(–) | 25.0(26.7) |
| *Wh* | 49.5(43.9) | 21.3(43.9) | 43.0(46.0) |
| *Wh:Wb* | 0.68 | – | 0.58 |
| *U* | 27.1(24.1) | 11.1(22.9) | 21.5(23.0) |

DESCRIPTION

IRSNB 9476 (Plate 22, figs. 2-4) is a very compressed juvenile, with a whorl breadth to height ratio of 0.65. Coiling is moderately involute, the umbilicus comprising 22.9% of the diameter, shallow, with an undercut umbilical wall on the internal mould. The inner flanks are broadly rounded, with the greatest breadth below mid-flank. The outer flanks are flattened, and converge to a narrowly rounded venter.

Ornament is poorly visible on the mould and is limited to weak umbilical bullae and a faint trace of ventrolateral and ventral ribbing. As size increases, as shown by IRSNB 9477 (Plate 22, figs. 1, 5) the ornament typical of middle growth consists of weak primary ribs, nine in the fragment preserved. These arise at the umbilical seam, sweep back across the umbilical wall and strengthen, curve forwards and are concave over the umbilical shoulder where they strengthen into a feeble bulla. The ribs remain concave on the innermost flank, thereafter continuing straight and prorsiradiate before declining and eventually effacing on the outer flank of the mould. Short intercalated ribs are present on the ventrolateral shoulders and venter; 33-34 are preserved on the fragment. They are rounded, prorsiradiate and approximately the same width as the interspaces.

The suture line is deeply dissected, and typical for the genus (Plate 22, fig. 2; Plate 15, fig. 11; text-fig. 7B).

DISCUSSION

*Ammonites gollevillensis* is a *Prodrome* species introduced by d'ORBIGNY in 1850 (p. 212) for *Ammonites lewesiensis* d'ORBIGNY, 1842, pl. 101, figs. 1-3, pl. 102, figs. 1, 2 *non* MANTELL, 1822 from the Upper Maastrichtian Calcaire à *Baculites* of Golleville and Fresville, Manche, France, and was based upon specimens from the DE GERVILLE Collection. No specimens corresponding to the figures are listed in the catalogue of, or survive in, the d'ORBIGNY Collection, (Muséum national d'Histoire naturelle, Paris) while the DE GERVILLE Collection, originally at Caen, was destroyed during

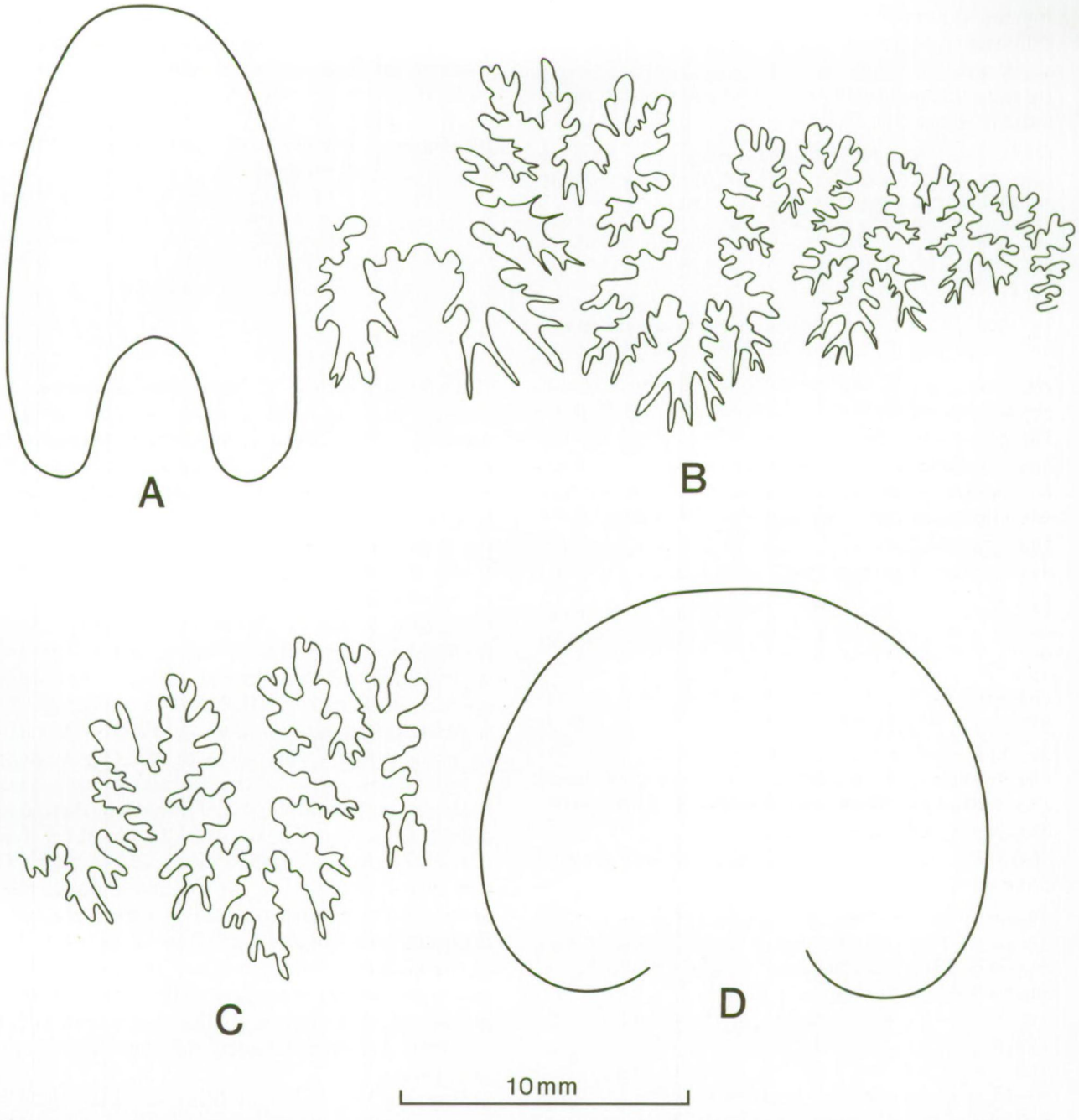


Fig. 7. *External sutures and whorl sections of: A, C,* Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) IRSNB 9476; B,* Pachydiscus (Pachydiscus) jacquoti *SEUNES, 1890 IRSNB 9481; D,* Saghalinites *sp. IRSNB IG 6521. Bar scale is 10 mm.*

1944. d'ORBIGNY's pl. 101, figs. 1-3 is schematised and could be either *P. gollevillensis* of authors or *P. valognensis* SPATH, 1922 a (p. 122) for those who believe the species distinct, while d'ORBIGNY's pl. 102, figs. 1, 2 is probably a juvenile *P. jacquoti* (SEUNES, 1890). The neotype BMNH C38179 agrees with the specimens of SEUNES (1891, pl. 14 (5), figs. 1-3) and DE GROSSOUVRE (1894, pl. 29, fig. 4; pl. 31, fig. 9) from the Calcaire à *Baculites*.

*Ammonites exilis* BINKHORST, 1861 (p. 31, pl. 6, figs. 4a, 4b, 4c, 4d) is based upon a juvenile fragment from the Upper Maastrichtian Calcaire de Kunraed of Kunrade shown here as Plate 12, figs. 4, 5 and is a synonym. The larger paralectotype (BINKHORST, 1861, p. 31) has not been recognised in the Museum für Naturkunde collections.

*Pachydiscus neubergicus* (HAUER, 1858) (p. 12, pl. 2, figs. 1-3 only) (see KENNEDY and SUMMESBERGER, 1986, for a revision of the type material) is a Lower Maastrichtian species that I believe to be the ancestor of *P. gollevillensis*. It has 50% more umbilical bullae (up to 17), ribs that extend across

the flank and bi- or trifurcate on the ventrolateral shoulder to give, with additional intercalatories, 47-60 ventral ribs versus up to 80 in *gollevillensis*. Evolution thus involved a decrease in primary ribs and an increase in secondaries, weakening of ornament and effacement at mid-flank plus increased involution and whorl compression. *Pachydiscus gollevillensis armenicus* ATABEKIAN and AKOPIAN, 1969 (p. 8, pl. 1, fig. 2; pl. 3, figs. 1, 2) from the Maastrichtian of Armenia has 16-20 umbilical bullae and 62-73 ventral ribs and may be an evolutionary link between the two.

The *Pachydiscus gollevillensis* of KOSSMAT (1897b, p. 82, pl. 6, fig. 1; see also KOSSMAT, 1898, p. 97 (162), pl. 15 (21), fig. 1) was renamed *Pachydiscus compressus* SPATH, 1921 (p. 122). It is from the Upper Maastrichtian *Trigonarca* Beds of Rautankupam, Pondicherry, southern India and differs from true *gollevillensis* in having coarse distant ventral ribs approximately 46 per whorl, 10 umbilical bullae and smooth flanks between. The *Pachydiscus* sp. ind. ex. aff. *gollevillensis* (d'ORBIGNY) of KILIAN and REBOUL (1909, p. 43, pl. 19, fig. 3; pl. 20, fig. 1) from the Maastrichtian of the Antarctic is a new form, more involute, compressed and high-whorled with a trigonal whorl section and fine crowded umbilical bullae.

*Pachydiscus valognensis* (SPATH, 1922) (p. 122), the holotype of which is BMNH 50135 from the Upper Maastrichtian Calcaire à *Baculites* of Valognes, Manche, France is simply a compressed variant of *gollevillensis* (at D = 101.5(100), Wb = –(–), Wh = 43.5(42.9), Wb:Wh = –, U = 26.0 (25.6) ).

*Pachydiscus neubergicus nowaki* MIKHAILOV, 1951, (p. 65), the holotype of which is the original of NOWAK, 1913, pl. 41, fig. 3, has somewhat coarser ventral ornament than French material, rather like the Limburg fragments shown here as Plate 15, figs. 8, 9, 10, 11, 14, 15 but is considered a synonym. BŁASZKIEWICZ's specimen of this form (1980, pl. 45, figs. 1-3, 9) bears little resemblance to the holotype.

OCCURRENCE

Where precisely localised and correctly identified this species is Upper Maastrichtian; it is known from the Calcaire à *Baculites* of Fresville, Golleville, "Valognes", Port Filiolet and Picauville in Manche, France, Hommes Morts, Lleida, Spain, Poland, north Germany, Austria, the Armenian SSR, northern Caucasus, Crimea, Bulgaria, the Bithynian Peninsula, Turkey and Madagascar as well as the present records from the Upper Maastrichtian of Kunrade and Geulhem, Limburg, The Netherlands.

*Pachydiscus (Pachydiscus) jacquoti* SEUNES, 1890
Plate 11, figs. 1, 2, 3, 4;
Plate 12, figs. 1, 2, 3, 8, 9, 10;
Plate 13, figs. 1, 2, 3, 4, 5;
Plate 14, figs. 4, 5, 6, 8, 9, 10;
Plate 15, figs. 1, 2, 3, 12-13; Text-fig. 7B.

ORBIGNY, A. d', 1841, *Ammonites lewesiensis* SOWERBY, p. 336 (pars), pl. 102, figs. 1, 2, only (non pl. 101).

ORBIGNY, A. d', 1850, *Ammonites gollevillensis* d'ORB., 1847, p. 212 (pars).

BINKHORST, J. T., 1861, *Ammonites colligatus* Nobis, p. 25 (pars), pl. 6, figs. 3a-f (?); pl. 7, figs. 2a, 2b only.

SEUNES, J., 1889, *Pachydiscus jacquoti* SEUNES, p. 803 (nom. nud.).

SEUNES, J., 1890a, *Pachydiscus jacquoti* SEUNES, 1888, p. 5, pl. 3 (2), figs. 1-3.

SEUNES, J., 1890b, *Pachydiscus jacquoti* SEUNES, p. 237, pl. 9, figs. 1-4.

SEUNES, J., 1891, *Pachydiscus jacquoti* SEUNES, p. 9, pl. 12 (3), fig. 4.

GROSSOUVRE, A. DE, 1894, *Pachydiscus neubergicus* F. VON HAUER, sp. emend. A. DE GROSSOUVRE, p. 207 (pars), pl. 26, fig. 3; pl. 38, fig. 3.

GROSSOUVRE, A. DE, 1908, *Pachydiscus neubergicus* V. HAUER, sp. emend. DE GROSS., p. 30, pl. 9, figs. 3-4.

DIENER, C., 1925, *Parapachydiscus jacquoti* SEUNES, p. 117.

COLLIGNON, M., 1938, *Parapachydiscus neubergicus* V. HAUER var. *Jacquoti* SEUNES, p. 98 (48), pl. 9, fig. 1.

? USHER, J. L., 1952, *Pachydiscus* sp. cf. *P. jacquoti* SEUNES, 1890, p. 72, pl. 11, figs. 1-3; pl. 31, fig. 1.

ATABEKIAN, A. A. and AKOPIAN, V. T., 1959, *Pachydiscus egertoni jacquoti* SEUNES, p. 9, pl. 1, fig. 3; pl. 2, fig. 2; pl. 4, fig. 1.

COLLIGNON, M., 1971, *Pachydiscus jacquoti* SEUNES, p. 36, pl. 455, figs. 2412-3.

KENNEDY, W. J., 1986, *Pachydiscus (Pachydiscus) jacquoti* SEUNES, 1890, p. 34, pl. 5, figs. 3-11, 15-19; pl. 6; text-figs. 2d, 2e, 3o, 3s, 4b.

TYPES

SEUNES (1890a, pl. 3 (2), figs. 1-3) figured three specimens from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France, mentioned specimens from the Upper Maastrichtian of the Pyrénées - Occidentales (now Pyrénées - Atlantiques) (possibly the specimens figured by him in 1890b, pl. 9, figs. 1-4) as well as a specimen from NW of Alcoy, Spain. All are syntypes of the species. Only the original of his pl. 3 (2), fig. 2, in the Collections of the École des Mines (now in the Université Claude Bernard) has been traced. It is immature. The original of SEUNES,

figured 3 specimens from the Carrière Bernes between Gan and Rébénacq (Pyrénées-Atlantiques) in a further paper (1890b). All four are syntypes of the species, as are further pyrenean specimens in the Sorbonne Collections (now in the Université Pierre et Marie Curie, Paris). The original of SEUNES 1890a, pl. 2 (1) has been designated lectotype by KENNEDY (1986, p. 44).

MATERIAL

More than 20 specimens plus numerous fragments, including the following. NMB unregistered, *ex* BINKHORST Collection, identified as *Anapachydiscus* cf. *fresvillensis,* the original of BINKHORST, 1861, pl. 7, fig. 2c, a paralectotype of *Ammonites colligatus* BINKHORST, 1861, from the Upper Maastrichtian Calcaire de Kunraed of Benzerade, near Kunrade, Limburg, The Netherlands; MNB unregistered, *ex* BINKHORST Collection, the original of BINKHORST, 1861, pl. 8a, figs. 1, 2, also a paralectotype of *P. colligatus* and from the same horizon and locality as the previous specimen; MNB, *ex* BINKHORST Collection, several fragments labelled "Maastricht", but from their preservation from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; IRSNB 9471 *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 4, fig. 3; IRSNB 9472, *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 4, fig. 2; IRSNB 9473, *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 4, fig. 1; IRSNB 9636, the original of DE GROSSOUVRE, 1908, pl. 5, fig. 1; IRSNB 9474, the original of DE GROSSOUVRE, 1908, pl. 6, fig. 1; IG 6521; IG 5521; IG 6521 plus numerous fragments, all *ex* UBAGHS Collection from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; IRSNB IG 8261 *ex* DE JAER Collection, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; NMM 1117, 3533 and 3537, all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; NMM 01014, 01089, 01878a-b and one unregistered specimen, all from the Upper Maastrichtian Nekum Chalk of St Pietersberg, Maastricht, The Netherlands; NMM 101638 from the Upper Maastrichtian of Valkenburg, Limburg, The Netherlands.

DESCRIPTION

The early whorls are depressed, with a reniform whorl section (Plate 15, figs. 4, 5, 6). At diameter of 14.5 mm, there is a deep, conical umbilicus (U = 24%). The umbilical wall is high and rounded, the whorl section depressed and reniform (whorl breadth to height ratio 1.4). As size increases the whorl section becomes somewhat less depressed; 1.23 at a whorl height of 20 mm. and 1.22 at a diameter of 42 mm. in IRSNB 9473. This specimen, an external mould, shows the juvenile ornament (Plate 10, figs. 1-3 shows casts from the natural mould). 60% of the previous whorl is covered. The umbilicus is deep, with a rounded wall, the umbilical shoulder rounded and the inner flanks strongly rounded, the greatest breadth being low on the flanks, the outer flanks and venter forming a broad continuous curve. Eleven primary ribs per whorl arise on the umbilical wall. They are weak and rursiradiate to the umbilical shoulder, where they strengthen markedly and develop into conical tubercles that are the bases of long septate spines.

Each tubercle/spine gives rise to one or two narrow, sharp primary ribs. These are straight and prorsiradiate, distant, and together with occasional intercalated short ribs decline markedly and virtually efface over the venter (Plate 10, fig. 2), where there are twice as many ribs as umbilical bullae. The last section of this specimen is an internal mould of body chamber (Plate 14, figs. 2, 3, 7) and shows only blunt bullae at the umbilical shoulder, the septate outer part of the spines being lost. The ribs are weak and rectiradiate on the inner flank, but strengthen and broaden over the ventrolateral shoulders and pass straight over the venter, weakening somewhat over the siphonal line. IRSNB 9472, also a natural mould shows the ontogeny to an estimated diameter of around 100 mm. Strong umbilical spines, 11-12 per whorl, are present up to a diameter of approximately 70 mm., thereafter declining into progressively weakening umbilical bullae (Plate 23, fig. 5). These give rise to one or two thin, distant straight, prorsiradiate primary ribs, while there are also shorter secondary ribs, inserted low on the flank to give more than twice as many ventral ribs as umbilical bullae at a diameter of 60-70 mm. The primary ribs are generally stronger than the secondaries on the inner to

| Dimensions | *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|---|
| EMP A1186, (Lectotype) | 148.0(100) | 72.0(48.6) | 77.0(52.0) | 0.94 | 31.0(21.1) |
| NMM 3533 | 150.0(100) | 72.3(48.2) | 74.5(49.7) | 0.97 | 30.4(20.3) |
| NMM unregistered | 180.0(100) | 79.1(43.9) | 89.5(49.7) | 0.88 | 36.5(20.3) |
| at | | | | | |
| MNB unregistered | 93.7(100) | 42.8(45.7) | 43.4(46.3) | 0.99 | 20.8(22.2) |
| (BINKHORST, 1861, pl. 8a, | 235.0(100) | 98.5(41.9) | 120.0(51.1) | 0.82 | 40.5(17.2) |
| figs. 1, 2) at | 205.0(100) | 93.7(45.7) | 109.0(53.1) | 0.86 | 36.5(17.8) |

middle flank, but all ribs are equally developed over the venter, where they sweep gently forwards. At the largest diameter, this specimen shows up to three secondary ribs intercalated between the primaries.

Internal moulds at this diameter are generally ill-preserved, with ornament poorly preserved. The whorl section becomes compressed, the whorls higher and coiling more involute. IRSNB 9636, the original of DE GROSSOUVRE, 1908, pl. 5, shown here in Plate 12, figs. 13, 14, has suffered *post-mortem* crushing into an ellipse. As a result, the apparent whorl breadth to height ratio is 1.2. There are approximately 40 ribs per whorl (preservation is defective) of which around 30% arise at the umbilical shoulder, singly or in pairs, the remainder intercalating low on the flank.

There are feeble umbilical bullae, the ribs are weak on the inner flank strengthening to their maximum development on the ventrolateral shoulders and venter, where they are interrupted by a striking siphonal groove (Plate 12, fig. 14) IRSNB 9471 (Plate 11, figs. 5, 6), the original of DE GROSSOUVRE, 1908, pl. 4, fig. 3 is an undeformed juvenile of comparable size and shows the progressive decline of umbilical bullae well. NMM unregistered (Plate 12, fig. 12; Plate 14, figs. 1, 11, 12) is a slender nucleus (Wb:Wh is 0.99 at 93.7 mm. diameter), again the presence of bullae (the bases of the septate spines) is obvious only at the smallest diameter preserved (Plate 14, fig. 1).

The largest fragment figured by DE GROSSOUVRE (1908, pl. 4, fig. 3, IRSNB 9474) is shown as Plate 13, figs. 6, 7. It extends to a diameter of 123 mm. and has a whorl breadth to height ratio of 0.87. MNB unregistered *ex* BINKHORST Collection is still septate at a diameter of 235 mm. The whorls become progressively more compressed and the umbilicus smaller, from 0.86 and 17.8 at 205 mm. to 0.82 and 17.2 at 235 mm. NMM unregistered shows the same progression; corresponding figures are 0.99 and 22.2 at 93.7 mm. and 0.88 and 20.3 at 180 mm. Ornament is poorly preserved on these individuals. Umbilical bullae are lost, flank ribs efface, and can be felt rather than seen (or photographed). The ribbing strengthens on the outer flanks, ventrolateral shoulders and venter (Plate 7, figs. 1, 2; Plate 9, figs. 1, 2). A differentiation of primaries, often mere striae, can still be seen on an exceptionnaly preserved Maastricht specimen (NMM 01014). The ribs are straight on the inner and middle flanks, prorsiradiate, strengthening markedly over the ventrolateral shoulder, projecting forwards to cross the venter in a broad convexity. These large specimens have in excess of 40 ribs per whorl on the venter.

The suture is complex, intrically subdivided, and typical for the genus.

DISCUSSION

Most authors refer this species to *Pachydiscus (Pachydiscus),* to which it bears little morphological resemblance. In contrast several *Anapachydiscus* species have massive whorls, septate umbilical spines (e.g. *Anapachydiscus peninsularis* (ANDERSON and HANNA, 1935) as illustrated by SAUL, 1979, text-figs. 4-6) or umbilical bullae that are obviously spine bases (e.g. the type species, *Anapachydiscus fascicostatum* (YABE, 1921) *in* YABE and SHIMIZU, plate 9 (2), fig. 2b), while the genus is characterised by ribs that spring singly or in pairs from umbilical bullae with additional intercalated ribs. Ornament is dense and more delicate in the type species, but coarser and sparser in *Anapachydiscus wittekindi* (SCHLÜTER, 1876) (p. 160, *nom. nov. prov. Ammonites robustus* SCHLÜTER, 1872, p. 67, pl. 21, figs. 1-8; pl. 22, figs. 1-3). The latter also has a smooth middle growth stage and coarse primary ribs when mature (SCHLÜTER, 1872, pl. 21, figs. 5, 6; pl. 22, figs. 1). *Anapachydiscus vistulensis* BŁASZKIEWICZ, 1980 (p. 49, pl. 42, figs. 3, 4; pl. 43, figs. 1, 3; pl. 48, figs. 1-2) is very coarsely ribbed, with few intercalatories. *Anapachydiscus arrialoorensis* (STOLICZKA, 1865) (pl. 63, figs. 2-4; pl. 64, fig. 1), which may well be a senior synonym of *vistulensis* is similarly distinguished in middle growth. KENNEDY and SUMMESBERGER, 1984 designated the original of STOLICZKA's pl. 64, fig. 1 lectotype. The smaller paralectotype shown in his pl. 63, fig. 2 is remarkably close to *A. fresvillensis* but has ribbing that is sharp and persists over the venter in the figure. It is from the Arrialoor Group in the neighbourhood of Arrialoor according to STOLICZKA and thus of Campanian age (SASTRY, RAO and MAMGAIN, 1968, pl. 4, figs. 7-8 provide a photograph of this specimen).

*Pachydiscus supremus* PETHÖ, 1906, p. 88, pl. 5, fig. 1 from the Maastrichtian of Fruska Gora, Yugoslavia is simply a large *P. fresvillensis*. The Upper Maastrichtian Quiriquina Island species *Pachydiscus quiriqinae* STEINMANN, 1895 (p. 74, pl. 6, fig. 3; text-fig. 5) is also a synonym of *fresvillensis*. The lectotype, designated by KENNEDY, 1986, p. 44, has the following proportions D = 285(100), Wb = 112(39.2), Wh = 14.5(50.9), Wb:Wh = 0.77, U = 51(17.9). 50 cm larger than the largest Limburg specimen, it shows the continuing trend to a compressed involute shell. The paralectotype with D = 239(100), Wb = 110(46), Wh = 120(50.2), Wb:Wh = 0.91, U = 40(16.7) overlaps with the present material. A beautiful nucleus of this species is figured by WETZEL, 1930, pl. 14, fig. 1. The sketchily illustrated Brazilian species *Parapachydiscus sumneri, P. poseidon* and *Canadoceras riogramense* of MAURY, 1930 may belong here but they are scarcely recognisable from the figures. All are of Maastrichtian age.

The poorly preserved *Pachydiscus colligatus michailovi* of ATABEKIAN and AKOPIAN (1969, p. 14, pl. 6, fig. 2; pl. 7, fig. 1; ? pl. 5, fig. 2) belongs here. The figured specimens are crushed composite moulds and their sharp ribbing is at first distinctive, yet it is identical to the Kunrade external mould IRSNB 9472, a cast from which is shown in Plate 23, fig. 5, while the holotype of the subspecies (pl. 7, fig. 1) has distinct bullae on the inner whorls (visible in the umbilicus in their pl. 7, fig. 1a). It might also be regarded as a coarsely ribbed form of *P. (P.) epiplectus* (REDTENBACHER, 1873).
The Lower Maastrichtian *Pachydiscus colligatus latiumbilicatus* BŁASZKIEWICZ, 1980 (p. 46, pl. 37, fig. 3; pl. 38, figs. 1-4, pl. 50, fig. 1) has as holotype a large specimen from the Lower Maastrichtian *Belemnella lanceolata* Zone of Kamién, Poland. It, and the paratypes are composite moulds, distorted by *post-mortem* crushing. (With U = 22-25% at diameters of 71-203 mm. it is unfortunately named; U = 24.8% in the lectotype of *colligatus*). There are 7 sharp bullae giving rise to pairs of sharp, prorsiradiate ribs with one or two intercalated ribs and a total of 32 ribs at D = 71.2 mm., while the flank ornament declines as size increases, leaving only ventrolateral and ventral ribs, 36 per whorl at a diameter of 108 mm. and 21 per half whorl at 203 mm. It is the closest ally of *Anapachydiscus fresvillensis,* and differs only in the coarse juvenile ornament and persistent coarse bullae. It is probably best regarded as no more than subspecifically distinct.
Several authors have regarded *Pachydiscus ootadensis* STOLICZKA, 1865 (p. 109, pl. 54, figs. 3, 4; pl. 56, *non* pl. 57) as a close ally of *Anapachydiscus fresvillensis*. The lectotype, here designated, of *ootacodensis* is the original of STOLICZKA's pl. 56, fig. 1. STOLICZKA himself introduced *ootacodensis* as a replacement name for *Ammonites colligatus* BINKHORST, 1861, due to the prior usage of HOENINGHAUS, 1830 (p. 447), but this is a *nomen nudum* and unavailable. It differs from *fresvillensis* in that juveniles lack strong umbilical bullae and indeed often have distant ventral ribs only, as do middle-aged and adult specimens (e.g. JONES, 1963, pl. 29, figs. 1-3, 13-15; pl. 32, fig. 1).

OCCURRENCE

Where well-dated the species is Upper Maastrichtian, as with occurrences in the Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France, the Pyrénées Atlantiques, France, the Limburg examples described here from the Calcaire de Kunraed of Kunrade, the Nekum Chalk of St Pietersberg, Maastricht, the Nekum or Meerssen Chalk of the same locality and the Nekum or Meerssen Chalk of Valkenburg, and specimens from Quiriquina Island and Western Australia. It also occurs in the Maastrichtian of Denmark, Yugoslavia, Armenia, Madagascar and perhaps Brazil. The closely allied *Pachydiscus colligatus latiumbilicatus* BŁASZKIEWICZ, 1980 is from the Lower Maastrichtian of Poland.

Superfamily ACANTHOCERATACEAE
DE GROSSOUVRE, 1894, p. 22
(*nom. correct.* WRIGHT and 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, p. 585
(= Libycoceratidae ZABORSKI, 1982, p. 306)
Genus *SPHENODISCUS* MEEK, 1871, p. 298
(= *Austrophenodiscus* OLSSON, 1944, p. 266)

TYPE SPECIES

*Ammonites lenticularis* OWEN, 1852, p. 579 (*non* PHILLIPS, 1829, pl. 6, fig. 5) by original designation, = *Ammonites lobatus* TUOMEY, 1856, p. 168.

DIAGNOSIS

Medium-sized to large, usually oxycone with a sharp venter on the phragmocone that may round on the later parts of the body chamber. Smooth or with feeble growth striae and riblets or feeble lateral and ventrolateral tubercles or riblets.
Suture with E/L subdivided into three with two distinct adventitious lobes. Auxiliary elements may be entire.

DISCUSSION

The most recent review of this genus is by ZABORSKI (1982), who points out the great difficulty in determining the relationship between the many records of this genus, often based on few specimens and poor material. From the relatively few specimens from the Maastricht area available for study I have been unable to determine how many of the smooth oxycone *Sphenodiscus* species merit distinction; the oldest available name for Lower Maastrichtian species is *Sphenodiscus siva* (FORBES, 1846) and for undoubted Upper Maastrichtian forms, *S. binkhorsti* BÖHM, 1898. The relative dating of most species within the Maastrichtian is, to say the least, tenuous, while as yet undocumented dimorphism means that individuals of the same size but at different ontogenetic stages are compared in the literature (*Sphenodiscus studeri* REYMENT, 1957, p. 63, pl. 10, fig. 2 seems to be an adult microconch; it has a phragmocone diameter of only 70 mm.; *Sphenodiscus lobatus* (TUOMEY, 1856) of ZABORSKI (1982) are up to 200 mm.

diameter and seem to be macroconchs in part). With limited material available, no exhaustive treatment is given here.

OCCURRENCE

*Sphenodiscus* ranges throughout the Maastrichtian. In Europe it is known as a rarity only fom the Maastrichtian of Maurens (Dordogne) and the Petites Pyrénées in southwestern France. It also occurs in the Upper Maastrichtian of The Netherlands, Poland and Bulgaria. In southern India *S. siva* (FORBES, 1846) is Lower Maastrichtian while it occurs throughout the Maastrichtian of the U.S. Western Interior, Gulf Coast and Mexico according to WAAGE (1968). In Madagascar it appears to be Lower Maastrichtian, and also occurs in the Maastrichtian in Peru, Brazil, Israel, Arabia, and Nigeria.

ZABORSKI (1982) has suggested that its association with *Libycoceras* in the Middle East, Nigeria and Peru indicates an Upper Campanian appearance. ZABORSKI has more confidence in our ability to recognise the Campanian-Maastrichtian boundary in these areas than I do. In Israel *Sphenodiscus* first occurs with a diverse heteromorph fauna in the upper part of the Mishash Formation. Included are *Nostoceras* like those known from the Lower Maastrichtian Navesink Formation of New Jersey (COBBAN, 1974) and this should not be taken as firm evidence of Campanian *Sphenodiscus*.

*Sphenodiscus binkhorsti* (BÖHM, 1898)
Plate 16, fig. 23; Plate 17, figs. 1, 2;
Plate 18, figs. 1, 2, 3, 4, 6, 7; Plate 19, figs. 5, 6;
Plate 20, figs. 1, 6, 7, 8; Plate 30, figs. 10, 11, 12;
Text-fig. 8A-C.

BINKHORST, J. T., 1861, *Ammonites pedernalis* VON BUCH, p. 21, pl. 5a1, fig. 2, *non* pl. 5a1, fig. 1; pl. 5d, fig. 5.

BÖHM, J., 1898, *Sphenodiscus binkhorsti* J. BÖHM, p. 197.

HYATT, A., 1903, *Sphenodiscus koninckі* n. sp. HYATT, p. 82, pl. 12, fig. 8.

HYATT A., 1903, *Sphenodiscus binkhorsti* J. BÖHM, p. 82.

GROSSOUVRE, A. DE, 1908, *Sphenodiscus binkhorsti* BÖHM, p. 16, pl. 1, fig. 1; pl. 2, figs. 1-3; pl. 3; text-figs. 9-11.

GROSSOUVRE, A. DE, 1908, *Sphenodiscus koninckі* HYATT, p. 19.

DIENER, C., 1925, *Sphenodiscus binkhorsti* J. BOEHM, p. 232.

DIENER, C., 1925, *Sphenodiscus koninckі* HYATT, p. 232.

SHELEV, St. T., 1934, *Sphenodiscus binkhorsti* J. BÖHM, p. 200, pl. 4, fig. 2.

JELETZKY, J. A., 1951, *Sphenodiscus binkhorsti* BÖHM, p. 18 et. seq.

POZARYSKA, K., 1953, *Sphenodiscus binkhorsti* BÖHM, p. 137, text-figs. 1, 2.

FELDER, W. M., 1968, *Sphenodiscus binkhorsti* BOEHM, p. 75 et seq., text-figs. 1-3, 6-11.

BŁASZKIEWICZ, A., 1980, *Sphenodiscus binkhorsti* BÖHM, p. 51.

TSANKOV, V. 1982, *Sphenodiscus binkhorsti* BÖHM, 1898, p. 53, pl. 26, fig. 2.

TYPES

BINKHORST illustrated three specimens that he referred to *Ammonites pedernalis* VON BUCH, 1848. BÖHM (1898, p. 197) renamed the originals of BINKHORST's pl. 5a1, fig. 2 and pl. 5d, figs. 5a-d *Sphenodiscus binkhorsti*. The lectotype here designated is MNB C412, the original of BINKHORST, 1861, pl. 5d, figs. 5a, 5b, 5c, 5d.

MATERIAL

MNB unregistered, 12 specimens *ex* BINKHORST Collection, from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands; all or in part paralectotypes. IRSNB IG 9470 *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 2, fig. 1; IRSNB 9475 *ex* LE HON Collection, the original of DE GROSSOUVRE, 1908, pl. 2, fig. 3; IRSNB IG 4285 *ex* BOSQUET Collection; IRSNB IG 6521 *ex* UBAGHS Collection; NMM, five unregistered specimens, all from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands; IRSNB 6521 *ex* UBAGHS Collection from the environs of Maastricht; NMM, three unregistered specimens, MK 733, 00821, 1084, all from the Meerssen Chalk at Geulhem, NMM 00780, NMM MK 718 and MK 2030 *ex* FELDER Collection from the top hardground of the Upper Maastrichtian Meerssen Chalk at Curfs Quarry, Geulhem; NMM MK 2872 from Curfs Quarry, Geulhem, below the top hardground; NMM 4995, 1081 and 1082, from the Upper Maastrichtian Meersen Chalk of St. Pietersberg, Maastricht, Limburg, The Netherlands.

| Dimensions | *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|---|
| Lectotype MNB C412 | 72.8(100) | 15.1(20.7) | 40.9(56.2) | 0.37 | –(–) |
| NMM MK 2872 | 100.0(100) | 19.5(19.5) | 57.6(57.6) | – | 3.0(3.0) |
| IRSNB 9470 | 112.0(100) | –(–) | 63.2(56.4) | – | –(–) |
| NMM MK 733 | 165.0(100) | –(–) | 108.0(65.5) | – | 3.5(2.1) |
| at | 158.0(100) | 28.5(18.0) | 95.5(60.4) | 0.30 | –(–) |

DESCRIPTION

The earliest stages are shown by IRSNB 9475, the original of DE GROSSOUVRE, 1908, pl. 2, fig. 3; only one flank is preserved of a specimen approximately 35 mm. in diameter. The shell is ornamented by faint prorsiradiate radial striae, and an estimated ten low ribs — or folds — per whorl. These strengthen into feeble outer lateral bullae, which connect to a low feeble radial rib that all but disappears by the venter. Larger specimens show the shell to have been an oxycone with a tiny umbilicus, 3% of less of the diameter, and a whorl breadth to height ratio of 0.37 in the lectotype at a diameter of 72.8 mm. and 0.3 in the largest specimen seen at a diameter of 158 mm. Most internal moulds are smooth, but some show faint radial striae and folds especially on body chambers (e.g. Plate 20, fig. 8; Plate 16, fig. 23), while there are occasional faint bullae on the outer flank (Plate 19, fig. 5) or even a suggestion of a concave crescentic fold (Plate 20, fig. 8). A number of specimens show a faint spiral angulation marking a change in slope in outer flank profile (Plate 16, fig. 23; Plate 17, fig. 1; Plate 20, fig. 8).
No complete body chambers are known.
The sutures of mature individuals (Plate 16, fig. 23; see text-fig. 8) follow an s-shaped course. There are two subequal adventive lobes dividing E/L into three elements plus at least 7 auxiliary lobes, which vary from moderately subdivided to entire.

DISCUSSION

*Sphenodiscus ubaghsi* DE GROSSOUVRE, 1894 (p. 141, pl. 9, figs. 4, 6; text-fig. 60), the types of which are before me, was originally described from Assise R of ARNAUD in the environs of Maurens (Dordogne). It also occurs in the Petites Pyrénées, southwestern France, and appears to be from a horizon low in the Maastrichtian. The whorl section is stouter than that of *S. binkhorsti,* and lanceolate, the external suture has the adventive lobes much smaller than the lateral so that the adventive saddles are rather small, with lesser incisions than the present species, even when individuals of the same size are compared. It appears to have been smooth.
The unique holotype of *Sphenodiscus rutoti* DE GROSSOUVRE, 1894, p. 143, text-fig. 61, is from the same locality, Maurens. I have been unable to trace the fragment and as only a part of the suture is figured, regard it as a *nomen dubium.*
*Sphenodiscus siva* (FORBES, 1846) (p. 110, pl. 7, fig. 6) is based on two small syntypes from the Lower Maastrichtian Valudayur Beds of Pondicherry, southern India (BMNH C51087 - 51088 *ex* Geological Society Collections). It is a smooth oxycone based on two juvenile specimens 66 and 76 mm. in diameter. Both are smooth, whereas at least some juvenile *S. binkhorsti* have ribs and tubercles, plus a marked spiral ridge on the outer flank. *S. siva* has five saddles with entire terminations and five with subdivided terminations so that smooth *binkhorsti* juveniles are probably inseparable from *siva.*
Better known is *S. lobatus* (TUOMEY, 1856) following the recent revision by ZABORSKI (1982, p. 316, figs. 21, 24, 25). The Nigerian population seems to include stouter individuals than those from Maastricht, while *S. lobatus costatus* ZABORSKI, 1982 (p. 320, figs. 22, 23, 26-35) which has flank ribs and tubercles in many individuals also seems to include stout forms.
ZABORSKI (1982) is probably correct in suggesting that the many smooth lenticular forms listed by him (p. 316) will probably fall into synonymy.
*Sphenodiscus koninckí* HYATT, 1903 (p. 82, pl. 12, fig. 8) is based on a specimen from near Maastricht in the DE KONINCK Collection in the Museum of Comparative Zoology, Cambridge, Massachusetts. The specimen could not be found in 1983. Only the suture was illustrated, and I take it to be a synonym of *binkhorsti,* in spite of sutural differences. No comparable specimens were seen by DE GROSSOUVRE (1908) or myself during the present study.

OCCURRENCE

This species is largely restricted to the upper part of the Meerssen Chalk in the Maastricht area. It is rare at Maastricht and Meerssen, commoner at Geulhem. Museum specimens labelled "Kunraed" are not from this locality but from Geulhem according to P. J. FELDER (personal communication, 1983). FELDER (1968) records a specimen from the Nekum Chalk; J. W. M. JAGT tells me he has a second specimen from just below the Laumont Horizon in the ENCI Quarry, Maastricht. The species is also recorded from the Upper Maastrichtian of Nasilow in the middle Vistula Valley, Poland, and Kajlâka, near Pléven, Bulgaria.

Suborder ANCYLOCERATINA WIEDMANN, 1966, p. 54
Superfamily TURRILITACEAE GILL, 1871, p. 3
(= Diplomoceratáceae BRUNNSCHWEILER, 1966, p. 14)
Family NOSTOCERATIDAE HYATT, 1894, p. 568
(= Jouaniceratidae WRIGHT, 1952, p. 218; Bostrychoceratinae SPATH, 1953, p. 16; Emperoceratinae SPATH, 1953, p. 17; Hyphantoceratinae SPATH, 1953, p. 16)
Genus *NOSTOCERAS* HYATT, 1894, p. 569

TYPE SPECIES

*Nostoceras stantoni* HYATT, 1894, p. 569, by original designation.

*Nostoceras* sp. juv.
not figured

TUUK, L. A. VAN DER and ZIJLSTRA, J. J. P., 1979, *Nostoceras* sp., pp. 116-120, 2 unnumbered figures.

DISCUSSION

This record is based on a tiny phragmocone only 18 mm. high. The apical angle is small, coiling fairly tight, with transverse ribs and no tubercles. The specimen compares most closely with *Nostoceras colubriformis* STEPHENSON, 1941 (p. 412, pl. 81, figs. 1-3) which has tiny tubercles and especially the non tuberculate *Turrilites saundersorum* STEPHENSON, 1941 (p. 416, pl. 83, figs. 6-8). The latter is from the base of the Palaeocene 12 miles southeast of Grenville, Texas, and is presumed to be derived from the underlying Kemp Clay, a unit regarded as mid-Maastrichtian by PESSAGNO (1969).

OCCURRENCE

Caster Horizon, Meerssen Chalk, Groeve Blom, Berg en Terblijt, Limburg, The Netherlands.

Family DIPLOMOCERATIDAE SPATH, 1926, p. 81
(= Neocrioceratinae SPATH, 1953, p. 17)
Subfamily DIPLOMOCERATINAE SPATH, 1926, p. 81
(= Scalaritinae WARD, 1976, p. 455)
Genus *GLYPTOXOCERAS* SPATH, 1925, p. 30
(= *Neohamites* BRUNNSCHWEILER, 1966, p. 48)

TYPE SPECIES

*Hamites rugatus* FORBES, 1846a, p. 117, by original designation by SPATH, 1926, p. 81.

DIAGNOSIS

Early whorls helicoid, followed by open elliptical coiling in one plane. Whorl section circular or oval. Ornament consists of straight sharp annular ribs, weakened on dorsum, closely or widely spaced. Periodic constrictions with flared collar ribs may be present. Suture relatively simple with bifid lobes and saddles.

DISCUSSION

SPATH (1925, p. 30) introduced *Glyptoxoceras* for "the Upper Senonian *'Hamites'*, the genotype to be *Hamites (Anisoceras) rugatus* (FORBES) KOSSMAT". The type species is thus *Hamites rugatus* FORBES, 1846 (p. 117, pl. 11, fig. 2), even though SPATH referred to KOSSMAT's pl. 19 (5), fig. 7, the original of which, BMNH C51111, has been taken as a typical *Glyptoxoceras indicum* (FORBES, 1846). Citation of the latter as type species (e.g. BRUNNSCHWEILER, 1966) is an error. The coiling of the type species, *N. rugatus* has yet to be demonstrated, but MATSUMOTO (1959a, pl. 41, figs. 2-6) and WARD (1976, text-fig. 3; pl. 1, figs. 1-5) have illustrated complete shells of closely allied forms that lead to the presumption that *rugatus* had a similar morphology. The great majority of "*Hamites*" described from the Coniacian-Maastrichtian are known as fragments only, and with only whorl section, ribbing strength and density and suture lines available for study, it is difficult to be sure of the true affinities of many forms. Even among the beautifully preserved material from the Lower Maastrichtian of southern India I have as yet failed to satisfy myself on the coiling mode and range of intraspecific variation present within the species named by FORBES (1846a). The present material, from the Upper Maastrichtian is even more problematic; it is all poorly preserved, and consists of short fragments, compared to the much older Indian species. A full account of these forms must await full revision of FORBES types.

OCCURRENCE

Species of *Glyptoxoceras* range with certainly from Upper Campanian to Upper Maastrichtian. I am uncertain of the affinities of Coniacian and Santonian material referred to the genus. The geographic range extends from northern Europe to Zululand, Madagascar, southern India, Japan, California and Washington in the U.S.A., and Brazil.

*Glyptoxoceras* cf. *subcompressum* (FORBES, 1846)
Plate 26, figs. 1-6, 8, 9, 13, 14, 19-21

compare:

FORBES, H., 1846a, *Hamites subcompressum,* sp. nov., p. 116, pl. 11, fig. 6.

BINKHORST, J. T., 1861, *Hamites rotundus* SOWERBY ?, p. 34 (*pars*), pl. 5b, figs. 4a, 4b; pl. 5c, figs. 1a, 1b only.

KOSSMAT, F., 1895, *Hamites (Anisoceras) subcompressus* FORBES, p. 145 (49), pl. 19 (5), figs. 10-12.

MATERIAL

More than 20 fragmentary internal moulds and 3 associated external moulds from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; IRSNB IG 6039 *ex* PIRLET Collection; IRSNB 10267 (IG 8261 DE JAER Collection); 10264, 10274 (IG 4285 *ex* BOQUET Collection, plus 5 other specimens); IRSNB 10263 (IG

6521 *ex* UBAGHS Collection, plus 6 other specimens); IRSNB IG 2738 *ex* NYST Collection. MNB unregistered the originals of BINKHORST, 1861, pl. 5b, figs. 4a, 4b and pl. 5c, fig. 1a-b plus several fragments, also from Kunrade.

DESCRIPTION

Coiling uncertain, with at least two open curved portions linking at least 3 straight shafts. Whorl height up to 18.5 mm., whorl section compressed, the whorl breadth to height ratio varying from 0.65 to 0.8, with most specimens 0.70 to 0.75. The greatest breadth is below mid-flank, with a somewhat flattened dorsum, strongly rounded dorsolateral area, convergent, somewhat flattened dorsoventral area and narrow rounded venter. The rib index varies from 5 to 5.5. On the shell exterior, seen in external moulds only (Plate 26, figs. 3, 6) the ribbing is sharp, the ribs separated by slightly wider interspaces. The ribs are straight, feebly prorsiradiate to rectiradiate on straight sections but distinctly rursiradiate on curved sections. They are weakest on the dorsum, strengthen across the flanks and are most prominent over the venter. Ribbing is blunt and rounded on internal moulds (e.g. Plate 26, figs. 1, 2, 4, 5, 8, 9, 19-21) and widely separated constrictions are present (e.g. plate 26, figs. 1, 2, 19, 20).

The sutures are poorly preserved but include moderately subdivided lobes and saddles. The individual chambers are relatively long.

DISCUSSION

These fragments are compared with *Hamites subcompressus* FORBES, 1846 (p. 117, pl. 11, fig. 6), from the Lower Maastrichtian Valudayur Beds of the Pondicherry district, southern India. The figures of FORBES (1846a, pl. 11, fig. 6) and KOSSMAT (1895, pl. 19 (5), fig. 10) are parts of one and the same specimen, now registered as BMNH C31100, while a second smaller syntype, BMNH C51103, was figured by KOSSMAT as his pl. 19 (5), fig. 11.

The Maastricht specimens are compared with this species because of their compressed whorl section, (Wb:Wh 0.65 to 0.8) and ribs index of 5 to 5.5 plus widely separated constrictions. BMNH C51100 has a whorl breadth to height ratio of 0.73, a rib index of 7-8 and sharper, narrower ribs than the present material and lacks obvious constrictions, although these are shown by the smaller syntype BMNH C51103. *G.* cf. *circulare* SHIMIZU, 1935, described below, has a near-circular whorl section, the whorl breadth to height ratio varying from 0.96 to 0.98, with a rib index of 4.5 and 5 and no constrictions. The *Glytoxoceras* sp., also described below, has very coarse ribbing indeed.

OCCURRENCE

Upper Maastrichtian, Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

*Glyptoxoceras* cf. *circulare* SHIMIZU, 1935
Plate 4, figs. 1-3; plate 26, figs. 7, 10, 11, 12, 15

compare:

BINKHORST, J. T., 1861, *Hamites rotundus* SOWERBY ?, p. 34 (*pars*), pl. 5b, figs. 2a, 2b, 2c, 3a, 3b only.

SHIMIZU, S., 1935, *Glyptoxoceras circulare,* p. 272, text-figs. 10-11.

MATERIAL

4 specimens, NMM 1083 is from the Upper Maastrichtian ? Nekum Chalk of St Pietersberg, Maastricht, Holland; IRSNB 10266 (IG 6521 *ex* UBAGHS Collection); IRSNB 10265, 10268, (IG 4285 *ex* BOSQUET Collection) plus one other specimen, all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade.

DESCRIPTION

The whorl breadth to height ratio varies from 0.96 to 0.98, the largest specimen having a whorl height of 13 mm. NMM 1083 is the largest fragment, 98 mm. long and slightly curved. There are 4.5 to 5 ribs in a distance equal to the whorl height. They are strong, blunt, weak on the dorsum but strenghtening across the flanks with maximum development on the venter. They are straight rectiradiate on straight fragments and feebly rursiradiate on curved sections of the shell.

The sutures are very widely spaced and are relatively simple, with moderately incised bifid lobes and saddles.

DISCUSSION

These specimens are compared with *G. circulare* SHIMIZU, 1935 (p. 272, text-figs. 10-11) on the basis of their near-circular whorl section and rib index of 4.5 to 5. The holotype of *circulare,* from the Lower Maastrichtian Valudayur Group of the Trichinopoly District, southern India, is BMNH 83624. It has an essentially circular whorl section and a rib index of 5-6. MATSUMOTO (1959a, p. 169) has suggested that *circulare* may be a synonym of *largesulcatum* FORBES, 1846; the available type material is too poor to be certain. *G.* cf. *circulare* differs from *G.* cf. *subcompressum,* described above, by its circular rather than distinctly compressed whorl section: *Glyptoxoceras* sp., described below, has much coarser ribs.

OCCURRENCE

Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; Upper Maastrichtian, ? Nekum Chalk of Maastricht, Limburg, The Netherlands.

*Glyptoxoceras* sp.
Plate 26, figs. 16-17

MATERIAL

IRSNB 10259 (IG 4285 *ex* BOSQUET Collection) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

DESCRIPTION

The only specimen is a slightly curved fragment 20 mm. long, with a compressed, oval whorl section, distorted by crushing. The fragment is ornamented by coarse, distant ribs; the rib index is 3, and the ribs are slightly effaced on the dorsum.

DISCUSSION

The ribbing is much coarser than that of the two species described above. It recalls that of *Hamites largesulcatus* FORBES, 1846 (p. 117, pl. 11, fig. 1) the type material of which comes from the Lower Maastrichtian Trichinopoly Group of the Pondicherry district of southern India, which has a rib index of 4.5 at much larger diameters.

OCCURRENCE

Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

Genus *DIPLOMOCERAS* HYATT, 1900, p. 571
(= *Eudiplomoceras* BRUNNSCHWEILER, 1966, p. 18)

TYPE SPECIES

*Baculites cylindracea* DEFRANCE, 1816, p. 160, by original designation.

DIAGNOSIS

Early whorls unknown, probably helicoid. Later whorls with three parallel shafts, close spaced, but not in contact. Whorl section depressed to compressed, oval, ovoid or circular, ornamented by fine, dense, crowded, generally recti- or feebly prorsiradiate ribs that are weakened on the dorsum. Internal moulds of phragmocone generally smooth or with very subdued ribbing. Occasional constrictions sometimes present. Aperture constricted.
Suture florid. May reach a large size.

DISCUSSION

WIEDMANN (1962) and KLINGER (1976) both regarded *Glyptoxoceras* as a subgenus of *Diplomoceras*. I incline to WARD's view (1976) that the markedly different adult coiling of the two supports generic separation while the curious rib development of *Diplomoceras* phragmocones is equally distinctive. *Eudiplomoceras* BRUNNSCHWEILER, 1966, has *E. raggati* BRUNNSCHWEILER, 1966, p. 18, pl. 8, fig. 7; text-figs. 4, 5 as type species. This falls within the variation range of *D. cylindraceum*, hence *Eudiplomoceras* is a synonym of *Diplomoceras*.

OCCURRENCE

Maastrichtian of western and central Europe, the transcaucasian region of the USSR, Greenland, British Columbia, Brazil, Chile, Antarctica, Zululand, Madagascar, southern India, Japan, New Zealand and western Australia.

*Diplomoceras cylindraceum* (DEFRANCE, 1816)
Plate 17, fig. 3; Plate 18, fig. 5;
Plate 21, figs. 2, 3, 5, 6; Plate 22, fig. 6;
Plate 23, figs. 1, 2; Plate 24, figs. 1, 2, 3;
Plate 25, figs. 1-8; Plate 26, fig. 18; Plate 33, fig. 16;
Plate 36, fig. 6; Text-figs. 9, 10.

DEFRANCE, M. J. L., 1816, *Baculites cylindracea,* p. 160.

DESMAREST, A. G., 1817, *Baculites gigantea,* p. 47, pl. 1, figs. 1, 2.

BLAINVILLE, H. DE, 1825, *Hamites cylindricus,* p. 382, pl. 23, fig. 1.

ORBIGNY, A. d', 1842, *Hamites cylindraceus,* p. 551, pl. 136, figs. 1-4.

? FORBES, E., *in* DARWIN, C., 1846, *Hamites elatior,* p. 265.

HAUER, F. VON, 1847, *Hamites hampeanus,* p. 75.

WOODWARD, S. P., 1851-1856, *Hamites ...,* p. 69, fig. 58.

HAUER, F. VON, 1858, *Hamites cylindraceus,* DEFR., sp., p. 8, pl. 1, figs. 3-6.

BINKHORST, J. T., 1861, *Hamites cylindraceus* d'ORBIGNY, p. 36, pl. 5b, figs. 5, 6, 7 (with additional synonymy).

FAVRE, E., 1869, *Hamites cylindraceus,* DEFRANCE, sp., p. 26, pl. 7, fig. 1 (with additional synonymy).

SCHLÜTER, C., 1872, *Hamites* cf. *cylindraceus* DEFR., sp., p. 103, pl. 31, figs. 10-14; pl. 29, figs. 8, 9 (with synonymy).

REDTENBACHER, A., 1873, *Hamites cylindraceus* DEFR., sp., p. 130.

WHITEAVES, J. F., 1879, *Hamites cylindraceus* ? DEFRANCE, p. 113, pl. 14, fig. 2.

? WHITE, C. A., 1890, *Hamites elatior* FORBES ?, p. 13, pl. 2, figs. 1, 2.

BÖHM, J., 1891, *Hamites cylindraceus* DEFR., sp. p. 51.

? KOSSMAT, F., 1894, *Hamites (Anisoceras) indicus* FORBES, p. 129 (33) (*pars*), pl. 19 (5), fig. 8 only.

STEINMANN, G., 1895, *Hamites* cf. *cylindraceus* DEFR., sp., p. 89.

MARIANI, E., 1898, *Pachydiscus,* sp., p. 56 (6), pl. 8 (1), figs. 5.

MARIANI, E., 1898, *Hamites* cf. *cylindraceus* DEFR., sp., p. 57.

? IMKELLER, H., 1901, *Hamites* aff. *cylindraceus* DEFRANCE, sp., p. 53.

RAVN, J. P. J., 1902, *Hamites cylindraceus* DEFRANCE, sp., p. 249.

WELLER, S., 1903, *Hamites elatior* FORBES, p. 418, pl. 2, fig. 3.

WELLER, S., 1903, *Hamites,* sp., p. 418, pl. 2, fig. 4.

WHITEAVES, J. F., 1903, *Diplomoceras notabile,* p. 335, pl. 44, fig. 4.

non WISNIOWSKI, T., 1907, *Hamites cylindraceus* DEFR., sp., p. 198, pl. 17, fig. 7.

? BOULE, M., LEMOINE, P., and THÉVENIN, A., 1907, *Hamites* cf. *cylindraceus,* p. 34 (54), pl. 6 (13), fig. 14.

KILIAN, W., and REBOUL, P., 1909, p. 15, pls. 2, 3, ?, 4, pl. 6, fig. 1.

NOWAK, J., 1911, *Hamites cylindraceus* DEFRANCE, sp., p. 382, pl. 41, fig. 10; pl. 43, fig. 35.

DIENER, C., 1925, *Anisoceras* (an *Diplomoceras*) *notabile* WHITEAVES, p. 72.

DIENER, C., *Diplomoceras cylindraceum* DEFRANCE, p. 74.

DIENER, C., 1925, *Diplomoceras* cf. *cylindraceum* (DEFR.), p. 75.

? DIENER, C., 1925, *Diplomoceras* sp. ind. aff. *cylindraceo* (DEFR.), p. 75.

WETZEL, W., 1930, *Diplomoceras* cf. *notabile* WHITEAVES, p. 89, text-fig. 4.

? MAURY, C. J., 1930, *Glyptoxoceras parahybense,* p. 185, pl. 11, fig. 2.

WOLANSKY, D., 1932, *Hamites cylindraceus* DEFR., p. 10.

SHELEV, St. T., 1934, *Hamites cylindraceus* DEFR., sp., p. 196, pl. 4, fig. 8.

COLLIGNON, M., 1938, *Diplomoceras cylindraceum* DEFRANCE, p. 56.

MIKHAILOV, V. P., 1951, *Diplomoceras* cf. *cylindraceum* (DEFRANCE), p. 41, pl. 2, figs. 9, 10; text-fig. 10.

MIKHAILOV, V. P., 1951, *Diplomoceras cylindraceum* DEFR. var. *lvovensis* var. nov., p. 42, pl. 2, figs. 7, 8; text-figs. 11a-b.

USHER, J. L., 1952, *Diplomoceras notabile* WHITEAVES, 1903, p. 109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26, 27.

PETKOVIČ, K., 1953, *Hamites cylindraceus* DEFRANCE, p. 33, pl. 6, figs. 1, 4-6.

SPATH, L. F., 1953, *Diplomoceras lambi,* sp. nov., p. 17, pl. 2, figs. 1-3; pl. 3, fig. 1.

SPATH, L. F., 1953, *Diplomoceras cylindraceum* (DEFRANCE in d'ORBIGNY), p. 17.

SPATH, L. F., 1953, *Diplomoceras notabile* WHITEAVES, p. 17, pl. 2, fig. 4.

? WRIGHT, C. W., 1957, *Diplomoceras,* sp., p. 806.

? ANDERSON, F. M., 1958, *Diplomoceras jimboi* ANDERSON, n. sp., p. 199, pl. 68, fig. 5.

? ANDERSON, F. M., 1958, *Diplomoceras o'shaughnessyi* ANDERSON, n. sp., p. 201, pl. 56, fig. 2.

NAIDIN, D. P., and SHIMANSKIJ, V. N., 1959, *Diplomoceras cylindraceum* (DEFRANCE), p. 181, pl. 3, fig. 2.

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JONES, D. L., 1963, *Diplomoceras notabile* WHITEAVES, p. 32, pl. 21, fig. 1; text-fig. 15.

TSANKOV, C. V., 1964, *Diplomoceras cylindraceum* (DEFRANCE), p. 152, pl. 4, fig. 2.

? BIRKELUND, T., 1965, *Diplomoceras,* sp., p. 67, pl. 16, figs. 1, 2.

BRUNNSCHWEILER, R., 1966, *Eudiplomoceras raggati,* sp. nov., p. 18, pl. 8, fig. 7; text-figs. 4, 5.

BRUNNSCHWEILER, R., 1966, *Diplomoceras* cf. *D. notabile* (WHITEAVES, 1903), p. 20, pl. 7, fig. 3; text-fig. 6.

BRUNNSCHWEILER, R., *Diplomoceras notabile* (WHITEAVES, 1903), text-fig. 7.

? HENDERSON, R. A., 1970, *Diplomoceras notabile* WHITEAVES, p. 11, pl. 644, figs. 2377-2379.

DUNDO, O. P., 1971, *Diplomoceras* cf. *notabile* WHITEAVES, pl. 1, fig. 12.

LAHSEN, A. and CHARRIER, R., 1972, *Diplomoceras notabile* (WHITEAVES, 1879), p. 528, pl. 2, figs. 1, 2.

DEL VALLE, R. A. and RINALDI, C. A., 1976, *Diplomoceras lambi* SPATH, p. 6, pls. 1-10.

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KLINGER, H. C., 1976, *Diplomoceras* gr. ex. *lambi* SPATH, p. 82.

KLINGER, H. C., 1976, *Diplomoceras* gr. ex. *cylindraceum* DEFRANCE, p. 82.

KLINGER, H. C., 1976, *Diplomoceras (Diplomoceras) notabile* WHITEAVES, 1903, p. 82, pl. 34, figs. 2, 4.

BIRKELUND, T., 1979, *Diplomoceras cylindraceum* (DEFRANCE, 1816), p. 55.

BŁASZKIEWICZ, A., 1980, *Diplomoceras cylindraceum lvovensis* MICHAILOV, 1951, p. 30, pl. 54, fig. 4.

BŁASZKIEWICZ, A., 1980, *Diplomoceras cylindraceum cylindraceum* (DEFRANCE, 1916) (*sic*), p. 30, pl. 54, fig. 2; pl. 55, figs. 6, 7.

TSANKOV, C. V., 1982, *Diplomoceras cylindraceum* (DEFRANCE, 1822), p. 22, pl. 6, figs. 1-3.

? MARTINEZ, R., 1982, *Diplomoceras notabile* ? WHITEAVES, p. 168, pl. 29, fig. 6.

KENNEDY, W. J., 1986, *Diplomoceras cylindraceum* (DEFRANCE, 1816), p. 51, pl. 4, figs. 1, 2; pl. 9, figs. 8-10; pl. 10; text-figs. 3i, 3l, 7g-m.

KENNEDY, W. J. and SUMMESBERGER, H., 1986, *Diplomoceras cylindraceum* (DEFRANCE, 1816), p. 194, pl. 15, figs. 1, 2, 5; pl. 16, figs. 14, 15; text-fig. 6.

KENNEDY, W. J. and SUMMESBERGER, H., *in prep.*, *Diplomoceras cylindraceum* (DEFRANCE, 1816).

TYPES

DEFRANCE's material has not been traced, and is presumed lost. Most authors have taken d'ORBIGNY's descriptions and figures as a basis for interpreting this species, but his surviving material is inadequate (KENNEDY, 1986, p. 52) and DEFRANCE's original description is adequate: "Cette espèce est cylindrique. Ses cloisons sont très profondément découpées. Son test est sillonné transversalement, et l'on voit à l'extérieur une trace longitudinale qui est sans doute celle du siphon. Le plus grand morceau de cette espèce que j'ai vu, a dix-neuf centimètres (sept pouces) de long sur quarante milimètres (dix-huit lignes) de diamètre à sa base, et il est tronqué par les deux bouts. Elle se trouve avec la précédente mais elle est beaucoup plus rare". (DEFRANCE, 1816, p. 160).
"La précédente" in the Supplement to volume 3 of the *Dictionnaire des Sciences Naturelles* in which *Baculites cylindraceus* is described is "La Baculite vertebrale, foss. de Maëstricht."

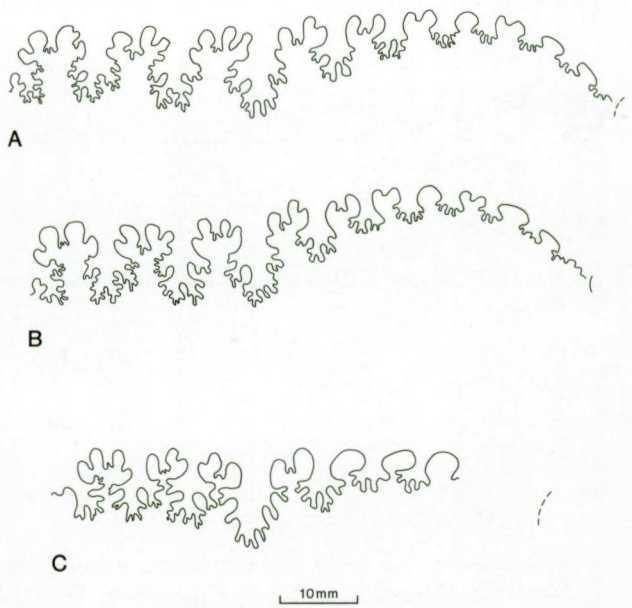


Fig. 8. *External sutures of* Sphenodiscus binkhorsti *(BÖHM, 1898) based on: A, B, NMM MK 733; C, NMM unregistered. Bar scale is 10 mm.*

DEFRANCE's specimens, or those he studied have never been recognised. His observation that it co-occurs with *Baculites vertebralis* at Maastricht confirms its age and provenance, while the figure in the volume of Plates (DE BLAINVILLE, 1816-1830, pl. 23, fig. 1, 1a) shows a specimen in what is obviously typical Maastricht preservation. In the interests of nomenclatural stability I here designate IRSNB 10511 shown in Plate 24, figs. 1-3 neotype of the species. It is from the Upper Maastrichtian Nekum or Meerssen Chalk of St. Pietersberg, Maastricht, The Netherlands.

MATERIAL

More than 70 specimens and numerous fragments including the following: from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands: IRSNB IG 6521 - 26 specimens plus fragments, *ex* UBAGHS Collection; IRSNB IG 4285 - 20 specimens plus fragments, *ex* BOSQUET Collection; IRSNB IG 6039 - 6 specimens, *ex* PIRLET Collection; MNB unregistered, one specimen *ex* BINKHORST Collection; NMM 3543 plus one unregistered specimen; from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands, MNB unregistered *ex* BINKHORST Collection; from the Upper Maastrichtian of Valkenburg, Limburg, The Netherlands, MNB unregistered *ex* BINKHORST Collection, the original of BINKHORST, 1861, pl. 5b, fig. 6a; from the Upper Maastrichtian Nekum Chalk of St. Pietersberg, Maastricht, The Netherlands NMM, two unregistered specimens; from the Upper Maastrichtian Nekum or Meerssen Chalk of the same locality; NMM 1076, 1087 and 1090; MNB, eight unregistered specimens; IRSNB IG 5997 *ex* UBAGHS Collection; IRSNB IG 4285, two specimens *ex* BOSQUET Collection.

DESCRIPTION

The material consists of fragmentary internal moulds of phragmocones, external moulds and a few body chamber fragments plus one fine silicified specimen with replaced shell (Plate 21, figs. 5, 6; Plate 22, fig. 6).
Coiling is diplomoceratid, with three parallel shafts linked by broadly curved sections. The early whorls are unknown, the smallest specimen is a curved fragment with a whorl height of 23 mm. and a whorl breadth to height ratio of 0.67 (Plate 25, figs. 5, 6). Straight shafts have whorl heights of as little as 26.5 mm.; the largest phragmocone fragment seen has a whorl height of 73.5 mm. The largest septate shaft is 260 mm. long. Body chamber fragments are uncommon; the largest is only 110 mm. long and has a maximum whorl height of 88.5 mm. The expansion rate is low.

The whorl section is variable, with a whorl breadth to height ratio of from 0.77 to 1.02. Most specimens are slightly compressed (Text-fig. 10); that this is not wholly due to post-mortem crushing is clear from well preserved material as shown in Plate 17, fig. 3, Plate 18, fig. 5 and Plate 25, figs. 7 and 8. There is a general tendency towards increasing compression as size increases. The section is circular to oval to ovoid, with the dorsum sometimes broader than the venter, the maximum breadth commonly lying below mid-flank.

Internal moulds of phragmocones are smooth to very feebly ribbed (Plate 23, figs. 1, 2; Plate 25, figs. 1-8) internal moulds of body chambers are ribbed (Plate 26, fig. 18) while external moulds and the silicified example shown in Plate 21, figs. 5-6 and Plate 22, fig. 6 demonstrate that the shell exterior was strongly ribbed. The ribs are sharp, narrower than the interspaces, annular and effaced slightly on the dorsum. On straight portions they are transverse or feebly convex on the dorsum, flex back over the dorsolateral region and pass straight across the flanks. They vary from almost rectiradiate to prorsiradiate. On hooks (Plate 21, fig. 5; plate 22, fig. 6) the ribs crowd and vary from prorsi- to rectiradiate in direction. One body chamber fragment shows flexuous ribs (Plate 26, fig. 18). Relatively few specimens (10) are well-enough preserved to determine the rib index which varies from 15 to 17 at whorl heights of 55-60 mm. but is 20 or more in the largest fragment (Plate 26, fig. 18), and there is a suggestion that the rib index increases as diameter increases.

Some internal moulds show distinct rugations corresponding to the apertural end of the sutures.

No specimens show the adult aperture. There are no constrictions in the material studied.

The suture is deeply and intricately subdivided (Text-fig. 9).

DISCUSSION

The neotype is the largest fragment seen and is very typical, with a whorl breadth to height ratio of 0.84. It is an internal mould, but shows traces of ribbing. It is within the commonly accepted concept of the species. Text-fig. 10 shows that most specimens are compressed, and that there is an overlap with well-preserved material from the Calcaire à *Baculites* of the Cotentin, although most of this is smaller and in consequence slightly less depressed.

*Diplomoceras cylindraceum lvovense* MIKHAILOV, 1951 (p. 42, pl. 2, figs. 7, 8; text-fig. 11), the holotype of which is the original of NOWAK, 1913, p. 382, pl. 41, fig. 10 is regarded as a synonym. MIKHAILOV's figure (1951, text-fig. 11a, b) shows a distinctly ovoid section with a whorl breadth to height ratio of 0.55 to 0.58, far less than typical *cylindraceum,* but due to *post-mortem* crushing. (This is confirmed from a study of other material from the environ of Lvov, including the original of FAVRE, 1869, pl. 7, fig. 1, the original of which is in the Collections of the Naturhistorisches Museum, Vienna). The rib index of 16-17 is within that of the Limburg material.

The Antarctic species *Diplomoceras lambi* SPATH, 1953 (p. 17, pl. 2, figs. 1-3) was separated from *D. cylindraceum* by virtue of its circular whorl section. As Text-fig. 10 shows, the whorl breadth to height ratio varies from 0.95 to 1.06 in the type series; the rib index measured on three specimens only is 13, 14 and 17. It is regarded as a synonym of *cylindraceum.*

*D. notabile* WHITEAVES, 1903 from the Maastrichtian of British Columbia (p. 335, pl. 44, fig. 4) has


Fig. 9. *Suture line of* Diplomoceras cylindraceum *(DEFRANCE, 1816). Based on IRSNB 10257 (IG 6521). Bar scale is 10 mm.*

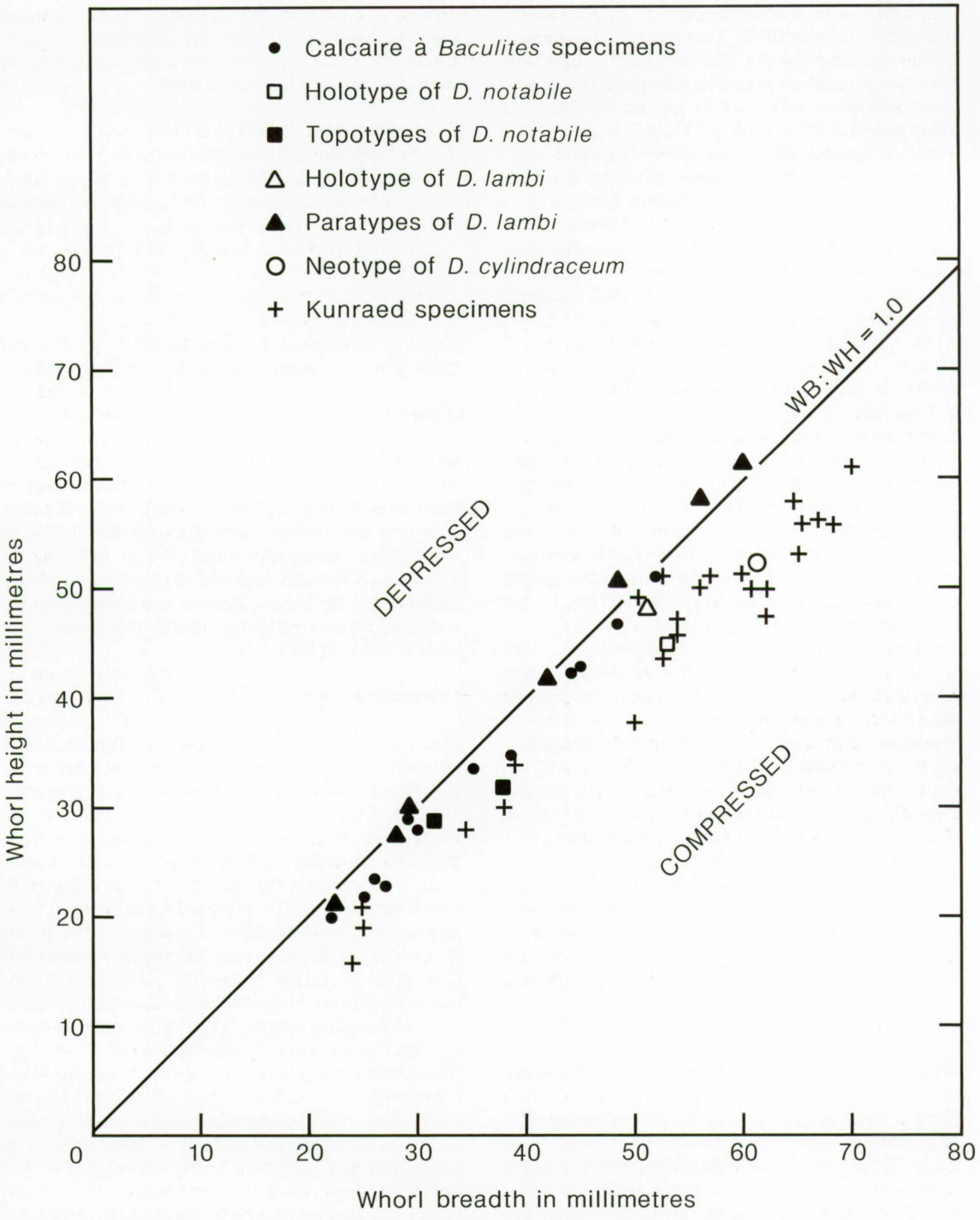


Fig. 10. *Scatter plot of whorl breadth versus whorl height in* Diplomoceras cylindraceum *(DEFRANCE, 1816).*

a holotype with a whorl breadth to height ratio of 0.9 and a rib index of 15. Two additional specimens in the British Museum (Natural History) (C3486, C41424) have whorl breadth to height ratios of 0.87 and 0.9 and rib indices of 14 and 12. The Alaskan examples of JONES (1963, p. 32, pl. 21, fig. 1) have ratios of 0.8 to 0.89 and rib indices of 11-12.

There is thus a clear overlap with the Limburg material and I regard it as a further synonym.

The poorly known South American *Hamites elatior* FORBES, 1846 may be a synonym; *Hamites hampeanus* HAUER, 1847, p. 45 (holotype figured by HAUER, 1858, pl. 1, fig. 3) is a crushed specimen of *cylindraceum* as HAUER acknowledged (1858, p. 8). WHITES' *Hamites elatior* (1890, pl. 2, figs. 1, 2) has a distinctive whorl section with parallel flanks. It is said to be distorted and thus may well belong here.

Large Indian fragments (e.g. KOSSMAT, 1894, p. 129 (33) (*pars*), pl. 19 (5), fig. 8 only) from the Maastrichtian Trichinopoly Group probably belong here.

The *Pachydiscus* sp. of MARIANI (1898, p. 56 (6), pl. 8 (1), fig. 5) from the Maastrichtian of Brenno, Lombardy, Italy I interpret as a crushed *D. cylindraceum,* as is the inadequately illustrated Brazilian species *Glytoxoceras parahybense* MAURY, 1930 (pl. 11, fig. 2). Again, the age is Maastrichtian.

*Eudiplomoceras raggati* BRUNNSCHWEILER, 1966 (p. 18, pl. 8, fig. 7; text-figs. 4, 5) from the Upper Maastrichtian of Western Australia has a circular whorl section and rib index of 15-16; it is also a synonym. *Diplomoceras jimboi* and *D. oshaughnessyi* of ANDERSON (1958) are poorly illustrated, but appear to be Californian representatives of the species. *D. australe* of HÜNICKEN (1965, p. 67, pl. 4, figs. 1-4) has a whorl breadth to height ratio of 1.6 and may be a distinct form.

It will be seen from the above that I treat *D. cylindraceum* as a variable species in which predominantly depressed populations such as the Antarctic *D. lambi* and the Australian *D. raggati* are regarded as just this, and not as distinct species or subspecies.

OCCURRENCE

Where well-dated this species is always Maastrichtian. The precise records from the Danish Chalk show it ranging from low in the *Belemnella lanceolata* Zone to high in the *Belemnella casimiroversis* Zone. It has a world-wide distribution, with records from north-west France, northern Spain (?), Italy, The Netherlands, Denmark, north Germany, Poland, Austria, the USSR, southern India (?), Zululand, Madagascar, western Australia, the Antarctic, South America, California, British Columbia and Greenland (?).

In Limburg it is the commonest ammonite in the collections from the Upper Maastrichtian Calcaire de Kunraed of Kunrade after *Baculites.* It also occurs at Geulhem and Maastricht, with definite records from the Upper Maastrichtian Nekum Chalk and some specimens from either the Nekum of the overlying Meerssen Chalk.

Family BACULITIDAE GILL, 1871, p. 3
(= Eubaculitinae BRUNNSCHWEILER, 1966, p. 4)
Genus *BACULITES* LAMARCK, 1799, p. 80
(= *Homaloceratites* HUPSCH, 1768, p. 110
(*non binomen*);
*Euhomaloceras* SPATH, 1926, p. 80)

TYPE SPECIES

*Baculites vertebralis* LAMARCK, 1801, p. 103, by subsequent designation by MEEK, 1876, p. 391.

DIAGNOSIS

Shell straight or slightly curved when adult, dorsal side concave, ventral side convex. Ornament varies from growth striae that pass straight across the dorsum and are strongly projected on the flanks to forms with strong crescentic ribs or dorsolateral tubercles. Tubercles and ribs may be separated by weaker ribs or riblets. Aperture with long dorsal rostrum. Sutures variable, usually only moderately incised. Dimorphic.

DISCUSSION

*Baculites* reaches a very large size (up to 2 m.) (STEPHENSON, 1941, plate 1) and adults are commonly curved. As discussed elsewhere (KENNEDY, 1984, p. 142) *Euhomaloceras* SPATH, 1926, shows no criteria that can be used to separate it from *Baculites sensu stricto. Sciponoceras* of the Cenomanian - Turonian is the ancester of *Baculites* from which it differs in the presence of prominent constrictions. *Pseudobaculites* COBBAN, 1952 is an endemic U.S. Western Interior genus of Coniacian date with a rapidly expanding shell and broad, deeply subdivided asymmetric saddles in the suture line. *Eubaculites* SPATH, 1926, with acute or tabulate keel is immediately distinguishable.

The taxonomy of European Upper Cretaceous baculitids is in a state of chaos. Most species are based on poor, often deformed and distorted fragments, while the wide intraspecific variation — from smooth to strongly ribbed and even feebly constricted — has not been appreciated by many workers. In particular, the names *vertebralis* LAMARCK, 1801 and *anceps* LAMARCK, 1822 have been applied to specimens of Campanian to Maastrichtian age, often without illustration, so that the identity of many records is uncertain. The Upper Maastrichtian of the Maastricht area is the source of the type material of *vertebralis,* the type species of *Baculites,* and clearly demonstrates this wide variability.

OCCURRENCE

Turonian to Maastrichtian, world-wide.

*Baculites vertebralis* LAMARCK, 1801
Plate 19, figs. 1, 2, 3, 4, 7, 8, 9, 10;
Plate 20, figs. 3, 4, 5;
Plate 28, figs. 2, 7, 8, 9, 10, 14, 15, 16;
Plate 29, figs. 1-15; Plate 30, figs. 1-9;
Text-figs. 11A, B, 12.

BOURGUET, L., 1742, *Spendylolitte,* p. 74, pl. 49, figs. 313-316.

HUPSCH, J. W. C. A. F., 1768, *Homaloceratites,* p. 110, pl. 4, figs. 11, 15, 18, 19 (*non binomen*).

FAUJAS - SAINT-FOND, B., 1799, Corne d'ammon droite ..., p. 140, pl. 21, figs. 2, 3.

LAMARCK, J. B. P. A. DE M. DE, 1801, *Baculites vertebralis,* n., p. 103.

DESMAREST, A. G., 1817, *Baculites dissimilis,* p. 49, pl. 2, figs. 4-6.

LAMARCK, J. B. P. A. DE M. DE, 1822, *Baculites faujasii* LAMARCK, p. 647.

non BLAINVILLE, H. M. D. DE, 1827, *Baculites vertebralis* LAMARCK, p. 380, pl. 12, figs. 1-3.

? ALTH, A., 1850, *Baculites faujassi* LAMARCK, p. 208, pl. 10, figs. 33-36.

BINKHORST, J. T., 1861, *Baculites faujasi* LAMARCK, p. 40, pl. 5d, figs. 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h (with extensive synonymy).

SCHLÜTER, C., 1876, *Baculites vertebralis* LAM., p. 143 (*pars*), pl. 39, figs. 12, 13; *non* pl. 13, fig. 11; pl. 40, figs. 4, 5 *non* pl. 40, fig. 6.

? MOBERG, J. C., 1885, *Baculites vertebralis* LAMARCK, p. 38, pl. 4, figs. 8, 9.

? IMKELLER, H., 1901, *Baculites vertebralis* LAM. (SCHLÜTER), p. 54.

RAVN, J., 1902, *Baculites vertebralis* LAMARCK, p. 250.

PERVINQUIÈRE, L., 1907, *Baculites vertebralis* LAMARCK, p. 92 (*pars*) non pl. 4, fig. 9.

NOWAK, J., 1908, *Baculites vertebralis* LAMARCK, p. 346, pl. 14, fig. 8.

DIENER, C., 1925, *Baculites vertebralis* LAMARCK, p. 64.

NALIVAJKO, L., 1936, *Baculites vertebralis,* p. 37.

MIKHAILOV, N. P., 1951, *Baculites vertebralis* LAMARCK, p. 48, pl. 1, figs. 4-6; text-fig. 15a, b, 16a, b.

HOWARTH, M. K., 1965, *Baculites vertebralis* LAMARCK, p. 363, 368.

BIRKELUND, T., 1979, *Baculites vertebralis* LAMARCK, 1801, p. 53.

KENNEDY, W. J., 1986, *Baculites vertebralis* LAMARCK, 1801, p. 57, pl. 11, figs. 6-11; pl. 12, figs. 1-6; text-figs. 3a-d, 7d-f, 8.

TYPES

*Baculites vertebralis* was introduced by LAMARCK in 1801 without description, but with reference to the figures of FAUJAS - SAINT-FOND (1799, p. 141, pl. 21, figs. 2, 3) and BOURGUET (1742, pl. 49, figs. 313-316). The original of FAUJAS-SAINT-FOND's pl. 21, figs. 2, 3 is designated lectotype by KENNEDY (1986, p. 57). It is also the holotype, by monotypy, of *Baculites faujasii* LAMARCK, 1822 (p. 647).

MATERIAL

Several hundred specimens from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands: IRSNB IG 6521 *ex* UBAGHS Collection; IRSNB IG 4285 *ex* BOSQUET Collection; IG 8261 *ex* DE JAER Collection. NMM 001106 (1186) *ex* BOETZKES Collection; NMM 00205 *ex* BOETZKES Collection; NMM 1080, 1128, 2837, 3538-3540, 3546; NMM KK17, 18, 41, 66 *ex* FELDER Collection (from the Kunderberg Quarry). From the Upper Maastrichtian of Maastricht, Limburg, The Netherlands: IRSNB IG 5185 *ex* UBAGHS Collection (labelled 'Mont St. Pierre'); IRSNB IG 3354 *ex* CANTRAINE Collection, 5 specimens; IRSNB IG 9144 *ex* WOOT DE TRIXHE Collection, 1 specimen; MNB *ex* BINKHORST Collection: numerous fragments; NMM 7108-7110, 38 specimens, *ex* MEYER Collection, (labelled 'St. Pietersberg'); IRSNB IG 6521 *ex* UBAGHS Collection (labelled 'Mont St. Pierre'); IRSNB IG 4285 *ex* BOSQUET Collection, 55 fragments. From the Upper Maastrichtian of Geulhem NMM 003704. From the base of the Upper Maastrichtian Valkenburg Chalk at Blankenberg Quarry, Cadier en Keer, Limburg, The Netherlands NMM MK 554 *ex* FELDER Collection, 60 fragments. From the Upper Maastrichtian of Vroenhoven, tranchée du Canal Albert, on the Dutch-Belgian border: IRSNB IG 9849. From the Upper Maastrichtian of Eben-Emael, Liège, Belgium, IRSNB IG 9708, 19 fragments, IRSNB IG 9745, IRSNB IG 9476, 7 phosphatic fragments, IRSNB IG 9712 (Drops Quarry); IRSNB IG 9489 (between Eben-Emael and Lanaye, tranchée du Canal; IRSNB IG 20.720, numerous specimens labelled 'Mb Eben-Emael (Eben); IRSNB IG 20.319 labelled Kanne-Eben-Emael, tranchée de Caster. From the Upper Maastrichtian of Valkenburg, Limburg, Holland, IRSNB IG 6521 *ex* UBAGHS Collection, 40 specimens. From the Upper Maastrichtian of Lanaye, Liège, Belgium, IRSNB IG 9708. From the Upper Maastrichtian of Craubeek, Limburg, The Netherlands IRSNB IG 4285 *ex* BOSQUET Collection. From the Upper Maastrichtian of Lanaye (Petit), Point 19, Limburg, Belgium couche à *Pyrgopolon,* IG 20193.

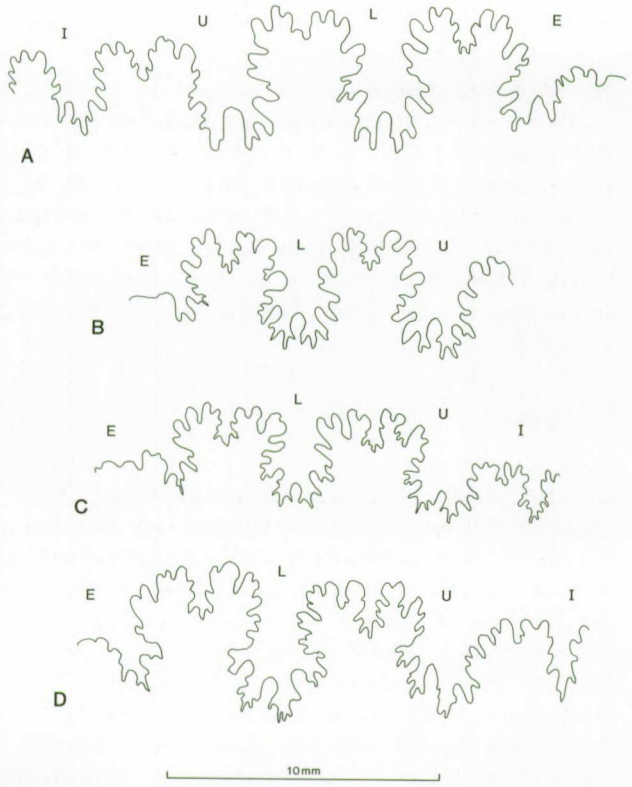


Fig. 11. *Suture lines of: A, B,* Baculites vertebralis *LAMARCK, 1801 based on A, IRSNB 10278 (IG 6521); B, IRSNB 10258 (IG 6521). C, D,* Baculites anceps *LAMARCK, 1822 based on C, SMC F2823; D, SMC F2822. Bar scale is 10 mm.*

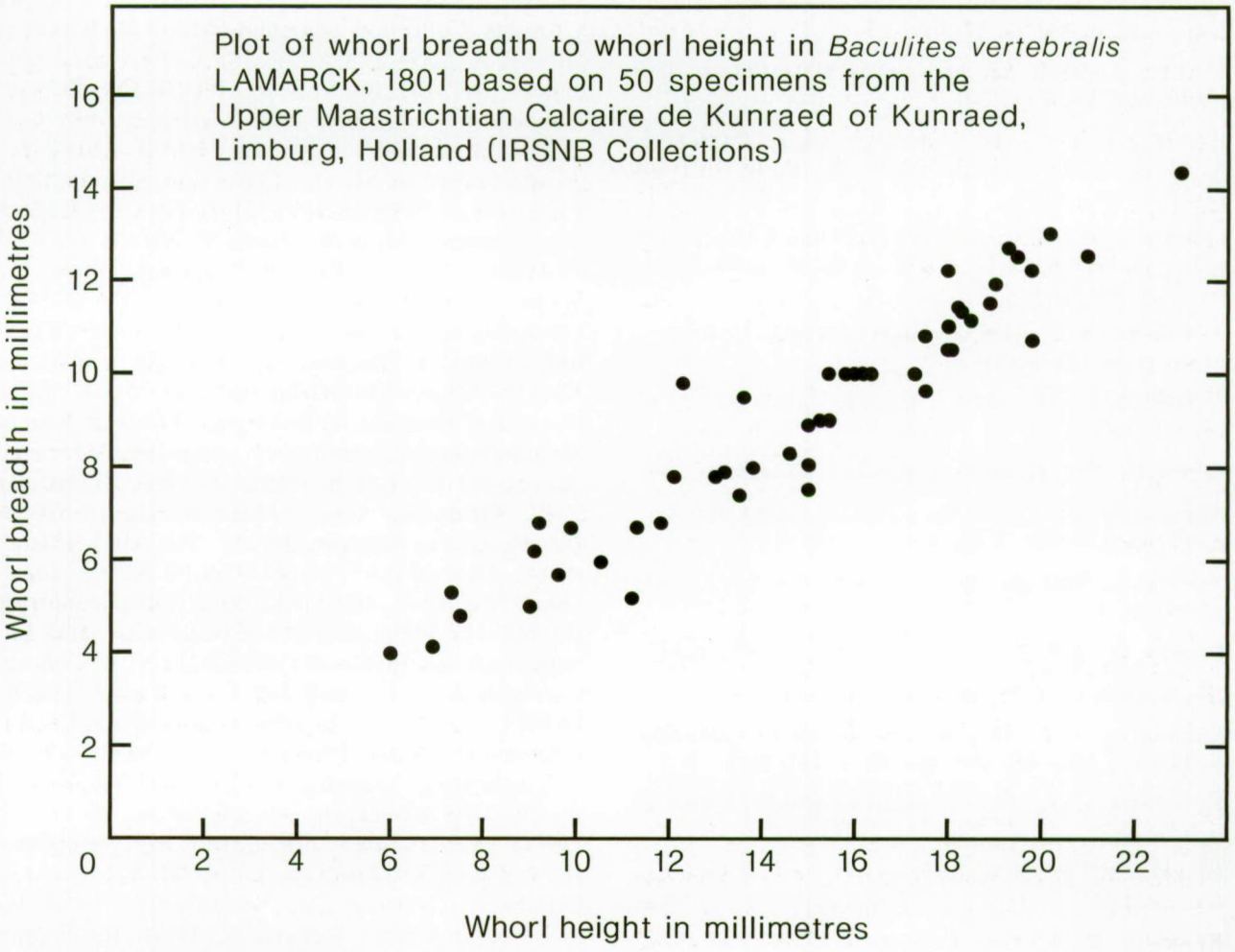


Fig. 12. *Scatter plot of whorl breadth versus whorl height in* Baculites vertebralis *LAMARCK, 1801.*

| DIMENSIONS | *Wb* | *Wh* | *Wb:Wh* |
|---|---|---|---|
| IRSNB IG 6521 (AD 83-56(2)) | 12.0 | 19.5 | 0.62 |
| IRSNB IG 6521 (AD 83-56(2)) | 14.5 | 21.5 | 0.67 |
| IRSNB IG 6521 (AD 83-24(4)) | 12.8 | 19.2 | 0.67 |
| IRSNB IG 6521 (AD 83-24(4)) | 10.2 | 18.0 | 0.57 |
| IRSNB IG 6521 (AD 83-30a) | 10.5 | 20 | 0.53 |
| IRSNB IG 6521 (AD 83-30b) | 17.3 | 24.8 | 0.70 |

DESCRIPTION

Medium sized, the largest specimen seen has a whorl height of 25 mm. Straight, slowly expanding, compressed, with whorl breadth to height ratios varying between 0.41 and 0.8 (see Text-fig. 12). Whorl section oval to piriform, with dorsum more broadly rounded than venter. Sides markedly flattened. Most specimens are smooth (Plate 20, figs. 3-5) but specimens may bear ornament, especially obvious on body chambers. There are weak to strong striae in some specimens (Plate 29, figs. 4-6, 13-15; Plate 30, figs. 7-9). These are most obvious on the outer flank, where they are strongly projected, intersecting the line of the venter at an angle of approximately 30°. They strengthen markedly over the venter, which they cross in a broad convexity (Plate 29, figs. 6, 15; plate 30, fig. 9). Some specimens bear distant constrictions on the later parts of the phragmocone (Plate 29, figs. 1-3) and the body chamber (Plate 19, figs. 8-10; plate 29, figs. 10-12; plate 30, figs. 1-6). These are broad and deep on the dorsum and dorsolateral area, where they are markedly concave. They sweep forwards and decline on the outer flank, running parallel to growth lines (Plate 30, fig. 5), and may disappear on the dorsoventreal area (Plate 29, fig. 1) or cross the venter (Plate 29, fig. 12). In a few specimens the constrictions have a raised lip on the dorsolateral region of the apertural side.

The suture line is moderately complex with deeply incised narrow, bifid elements. E/L and L/U are tall, L narrow, U broad and U/I squat (Text-fig. 11A, B).

DISCUSSION

*Baculites vertebralis* populations from Kunrade form the basis of the description and the scatter diagram, Text-fig. 12. The variation in ornament and constrictions is a distinctive feature of the assemblage, while the whorl section, with rounded venter and dorsum immediately distinguish it from *B. anceps,* which is also much rarer in Limburg. Sutures and the angle of intersection of growth striae and venter are also distinctive.

*Baculites faujasi* LAMARCK, 1822, is an objective synonym of *vertebralis,* both having the same type specimen. *Baculites knorrianus* DESMAREST, 1817 (p. 48, pl. 1, fig. 3) is a somewhat problematic species. DESMAREST figured a whorl section only, taken from KNORR. The name has been widely applied to the large, smooth, ill-preserved *Baculites* of the European Chalks, most recently by BIRKELUND (1979) who regards it as a diagnostic Lower Maastrichtian form. Although the provenance of the type specimen figured by KNORR and DESMAREST is unfortunate — it is from Pleistocene deposits near Danzig, the size and whorl section is that of the Lower Maastrichtian form well-known from Denmark and Galicia, and the name *knorrianus* is, in my view a valid one. On the basis of material from Galicia the species is large, with a whorl height of up to 80 mm., a broadly rounded — or even flattened dorsum — strongly convergent flanks and a complex suture.

*Baculites leopoliensis* NOWAK, 1908, (p. 328, pl. 14, figs. 1-5, 10; text-figs. 1-10) is based on more than a hundred fragments from the environs of Lvov, Galicia, and was proposed as a replacement name for *knorrianus* and regarded as a subspecies of *B. anceps.* In the interests of nomenclatoral stability I have designated the original of NOWAK's pl. 14, fig. 2, from Porszna, lectotype of the species. It differs from *B. vertebralis* in its large size, pyriform whorl section and strong primary ribs that split up into secondaries on the dorsoventral area.

*Baculites hochstetteri* LIEBUS, 1902 (p. 119, pl. 6, figs. 4-6, text-fig. 2) is based upon a series of tiny specimens, imprecisely dated. If NAIDIN's large specimen (1974, p. 164, pl. 53, figs. 6, 7) is conspecific, as it appears, then it is a Campanian form. All described specimens are ornamented by fine striae and riblets and lack constrictions.

OCCURRENCE

The precisely localised specimens from the White Chalks of Denmark show this species to be restricted to the Upper Maastrichtian *Belemnella casimirovensis* Zone there. It is abundant in the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands, while occurring widely in the Maastricht area, ranging from the base of the Valkenburg Chalk to the Meerssen Chalk, although commonest in the Nekum Chalk. It is rare in the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France and the Upper Maastrichtian of the Petites Pyrénées (Haute Garonne), France, and also occurs in Limburg, southern Sweden, north Germany, Poland, the southern USSR and Tunisia.

*Baculites anceps* LAMARCK, 1822
Plate 20, fig. 2;
Plate 28, figs. 3, 11, 12, 13, 19, 20, 21, 22, 23;
Text-fig. 11C, D.

DEFRANCE, M. J. L., 1816, *Baculites vertebralis* LAMARCK, p. 60, pl. 22, figs. 1-3.

LAMARCK, J. B. P. A. DE M., 1822, *Baculites anceps,* p. 648.

BLAINVILLE, H. M. D. DE, 1825, *Baculites vertebralis* LAMARCK, p. 380, pl. 12, figs. 1-3.

DESHAYES, M. G. P., 1831, *Baculites anceps* LAMARCK, p. 224, pl. 6, fig. 2.

BRONN, H. G., 1837, *Baculites anceps* LAMARCK, p. 372, pl. 33, fig. 5.

ORBIGNY, A. d', 1842, *Baculites anceps* LAMARCK, p. 565, pl. 139, figs. 1-7.

non KNER, R., 1850, *Baculites anceps* ?, p. 13, pl. 3, figs. 1, 1a.

non ROEMER, F., 1852, *Baculites anceps,* p. 36, pl. 2, fig. 3.

non BINKHORST, J. T., 1861, *Baculites anceps* LAMARCK, p. 42, pl. 5d, figs. 5a, 5b, 5c, 5d.

? SCHAUFHÄUTL, K. E., 1863, *Baculites anceps* LMK. (1863), p. 219, pl. 66, fig. 5.

SCHLÜTER, C., 1876, *Baculites anceps* LAM., d'ORB., *non* p. 145; pl. 40, figs. 2, 6 only.

MÖBERG, J. C., 1885, *Baculites anceps* (AUCTORUM) (LAMARCK, d'ORBIGNY, SCHLÜTER, etc.), p. 37, pl. 4, figs. 11, 12.

MÖBERG, J. C., 1885, *Baculites schluteri* ? MÖBERG, p. 40, pl. 4, fig. 13 only.

PRESTWICH, J., 1888, *Baculites anceps* LAMARCK, pl. 12, fig. 16.

non GRIEPENKERL, O., 1889, *Baculites anceps* LAMARCK var. *sublaevis,* p. 408 (106), pl. 44, fig. 2.

BÖHM, J., 1891, *Baculites valognensis,* sp. n., p. 50, pl. 1, fig. 13.

non QUAAS, A., 1902, *Baculites anceps* LAMK., p. 307, pl. 29, figs. 12-14.

RAVN, J. P. J., 1902, *Baculites valognensis* JOH. BÖHM, p. 250.

non BOULE, M., LEMOINE, P. and THÉVENIN, A., 1907, *Baculites anceps* LAMARCK, p. 44 (64).

non WEGNER, T., 1905, *Baculites* cf. *anceps* LAM., p. 207.

non PAULCKE, W., 1906, *Baculites* cfr. *anceps* LAM., p. 176, pl. 16, fig 6; text-fig. 1.

non SCHMIDT, W., 1908, *Baculites* cf. *anceps* LAM., p. 245.

NOWAK, J., 1908, *Baculites anceps* varietas *valognensis,* p. 335, figs. 1-4 (on p. 331), figs. 6, 7, 9, 12 (on p. 337); pl. 14, figs. 6, 7.

? LOPUSKI, C., 1911, *Baculites anceps* LAM., p. 138, pl. 4, fig. 4.

? LOPUSKI, C., 1911, *Baculites anceps* LAM. var. *angustisellata,* p. 139.

? LOPUSKI, C., 1911, *Baculites anceps* LAM. var. *latisellata,* p. 139.

? ZHELEV, Sh., 1934, *Baculites anceps,* p. 198, pl. 4, fig. 3.

? MIKHAILOV, N. P., 1951, *Baculites anceps* LAMARCK, p. 44, pl. 2, figs. 11, 12; text-fig. 13.

non YOUNG, K., 1963, *Baculites* cfr. *anceps* LAMARCK, 1799, p. 42, pl. 2, figs. 18, 20-22.

HOWARTH, M. K., 1965, *Baculites anceps* LAMARCK, p. 363, pl. 4, fig. 4; pl. 5, figs. 4, 5; pl. 6, figs. 1-5; text-figs. 2, 3, 5-12.

NAIDIN, D. P., 1974, *Baculites anceps anceps* LAMARCK (*sic*), p. 163 (*pars*), pl. 53, fig. 1, ? *non* figs. 2, 3, 4?

non ATABEKIAN, A. A. and KHAKHIMOV, F. KH., 1976, *Baculites anceps* LAM., p. 94, pl. 2, figs. 3-4; pl. 11, figs. 8-10.

BIRKELUND, T., 1979, *Baculites valognensis* BOEHM, 1891, p. 53.

? MARTINEZ, R., 1982, *Baculites anceps* LAMARCK, p. 169, pl. 30, figs. 1, 2.

KENNEDY, W. J., 1986, *Baculites anceps* LAMARCK, 1822, p. 58, pl. 11, fig. 12-14; pl. 12, figs. 7-11; text-figs. 3e-h, 7a-c.

TYPE

Neotype, designated by HOWARTH, 1965, p. 36 is BMNH 32573 from the Upper Maastrichtian Calcaire à *Baculites* of "Normandy" (ex MANTELL Collection).

MATERIAL

IRSNB IG 4285 *ex* BOSQUET Collection from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands. NMM 00265, two specimens from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands. Sedgwick Museum Cambridge F2822-3 from "Maastricht", Limburg, The Netherlands. MNB unregistered *ex* BINKHORST Collection from "Maastricht", Limburg, The Netherlands.

DESCRIPTION

Slowly tapering, compressed, with whorl breadth to height ratios of 0.69 to 0.73. The dorsum is broadly rounded, the dorsolateral area rounded, the flanks converging to an acute venter.

All specimens bear crescentic flank ribs; the rib index is 3. The ribs are weak and feebly convex over the dorsum, sweep back over the dorsolateral area, strengthening into broad crescentic ribs, strong on the inner two thirds of the flank, but weakening into mere striae over the outer third of the flank where they are strongly projected, intersecting the line of the venter at an angle of 21°. In some cases the rib breaks down into groups of striae near the venter, which they cross in an acute chevron. In some specimens, feeble constrictions are present, notably on the dorsum.

The adult aperture is preserved in one specimen (Plate 20, fig. 2) and has a short dorsal projection and a long ventral rostrum. The suture is relatively simple, with moderately incised rectangular elements (text-fig. 11C, D).

DISCUSSION

HOWARTH (1965, p. 363) provides a lengthy discussion of this species and a description of specimens from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula. This material varies from smooth to ribbed to constricted, with smooth forms dominant. It is therefore curious that the few specimens from Limburg are all ribbed.
The diagnostic features of this species are the shape of the ribs, where present, and the angular venter. This alone serves to distinguish it from all the other species of *Baculites* from the Maastricht area.
The *Baculites anceps* of BINKHORST, 1861, p. 40, pl. 5d, figs. 3a, 3b, 3c, 3d, is a *Eubaculites,* described further below (p. 195).
*Baculites valognensis* BÖHM, 1891 (p. 501, pl. 1, fig. 13) from the Maastrichtian of Siegsdorf, Oberbayern, Germany may be a smooth variant of this species. *B. sublaevis* GRIEPENKERL, 1889 [p. 409 (107)], referred to as *B. anceps sublaevis* elsewhere in the work is from the Upper Campanian of Koenigslütter, Braunschweig, Germany, only the suture was illustrated, although reference is also made to d'ORBIGNY's illustrations (1842, pl. 139, figs 1-7). Under these unsatisfactory conditions I regard it as a *nomen dubium.* Specimens referred to as *Baculites anceps valognensis* by NOWAK (1908, p. 335, figs. 1-4, 6, 7, 9, 12; pl. 14, figs. 6-7), are smooth variants of the present species.
*Baculites anceps leopoliensis* NOWAK, 1908 [p. 328, pl. 14, figs. 1-5, 10; text-figs. 1-4 (p. 329), 5-10 (p. 331)] differs from *B. anceps* in its large size and a pyriform whorl section with broadly rounded dorsum and narrowly rounded, rather than sharp venter. Both smooth and ribbed forms occur; the latter have a strong development on the dorsolateral area, with fine secondary ribs on the venter, retained to a large size. The rib index is 2.5 - 3.
*Baculites hochstetteri* LIEBUS, 1902 (p. 119, pl. 6, figs. 4-6, text-fig. 2) has been regarded as a subspecies of *B. anceps* by NAIDIN (1974, p. 164, pl. 53, figs. 6, 7) but it has an oval whorl section and lacks the acute venter of true *anceps.* The type specimens are small, but NAIDIN's large specimen, of Campanian age has the same fine ornament.
*Baculites anceps pacificus* MATSUMOTO and OBATA, 1963 (MATSUMOTO, 1959b, p. 130, pl. 34, fig. 3; pl. 35, fig. 1; see also MATSUMOTO and OBATA, 1963, p. 59, pl. 20, fig. 3; WARD, 1978, p. 1152, pl. 2, figs. 1-4, 8; text-fig. 6a-c) is a Campanian form with an elliptical whorl section, the venter only slightly narrower than the dorsum and rounded, not sharp. HOWARTH (1965, p. 368) regards it as a synonym of *Baculites subanceps* HAUGHTON, 1925.
As is clear from the synonymy, there are many citations of *B. anceps* that are based on poor material of Campanian age. They are mostly indeterminate or belong to other species.

OCCURRENCE

Where precisely dated the species is Upper Maastrichtian. The careful records from the expanded Danish Chalk sequences show it to be restricted to the Upper Maastrichtian *Belemnella casimirovensis* Zone [BIRKELUND, 1979, p. 53 (as *B. valognensis)].* It is reported from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, where it is abundant. It is very rare in Limburg, occurring in the Upper Maastrichtian Calcaire de Kunraed of Kunrade, at Geulhem and Maastricht. It occurs in Denmark, the USSR and possibly in northern Spain and elsewhere.

*Baculites* sp.
Plate 28, figs. 1, 4, 5, 6

BINKHORST, J. T., 1861, *Baculites carinatus,* Nobis, p. 43, pl. 5 d, figs. 2a, 2b, 2c, 2d (*non* MORTON, 1834).

IMKELLER, H., 1901, *Baculites carinatus* BINKHORST, p. 54, pl. 3, fig. 6.

DIENER, C., 1925, *Baculites carinatus* MORTON, p. 59 (*pars*).

MATERIAL

NMM MK 594 *ex* FELDER Collection, a phosphatic mould from the base of the Upper Maastrichtian Valkenburg Chalk of Cadier en Keer, Blankenburg, Limburg, The Netherlands.

DESCRIPTION

The only specimen seen is a phosphatic fragment, an internal mould of three camerae and part of the body chamber. The maximum preserved whorl height is 14.5 mm., the whorl breadth to height ratio is 0.48. The dorsum is broadly rounded, the inner to mid-flanks subparallel, with the greatest breadth close to mid-flank. The outer flanks converge markedly to a narrow arched venter which is separated from the flanks by a shallow longitudinal groove (Plate 28, fig. 5). Ornament is restricted to feeble growth striae and riblets markedly concave on the inner flank but strongly projected on the outer flank to intersect the line of the venter at an angle of approximately 20°. They strengthen over the venter into rounded riblets visible only at the apertural end of the fragment.
Suture poorly exposed, but typical of genus.

DISCUSSION

I was unable to find BINKHORST's holotype of *B. carinatus* in the collections of the Museum für Naturkunde, Berlin but the figure is sufficiently close to the present specimen as to suggest they may be the same form.
This may be no more than an atypical *Baculites vertebralis,* some specimens of which have an incipient ventrolateral groove, while others develop a rather similar ventral ribbing (e.g. Plate 29, fig. 15; Plate 30, fig. 9). With only one specimen the form is best left in open nomenclature.
*Baculites carinatus* MORTON, 1834, p. 44, pl. 13, fig. 1, from the Lower Maastrichtian Prairie Bluff Chalk of Alabama (*teste* STEPHENSON, 1941, p. 407) has strong crescentic flank ribs in MORTON's figure.

OCCURRENCE

BINKHORST's specimen is said to be from "Maastricht". The specimen described here is from the base of the Upper Maastrichtian Valkenburg Chalk of Cadier en Keer, Blankenberg, Limburg, The Netherlands.

*Baculites* sp. 2
Plate 27, figs. 19, 20

MATERIAL

Two specimens, NMM GK 809-810 *ex* FELDER Collection, from the base of the Lower Maastrichtian Vijlen Chalk of Vijlenerbosch, Limburg, The Netherlands.

DESCRIPTIONS

These two large, crushed composite moulds are illustrated to demonstrate the presence of indigenous *Baculites* in the Vijlen Chalk. More and better material is needed before any proper description is possible. GK 809 (Plate 27, fig. 20) is a large, smooth specimen resembling *Baculites knorrianus* of authors. GK 810 (Plate 27, fig. 19) is badly distorted, but appears to have been a ribbed form.

OCCURRENCE

As for material.

*Baculites* sp. 3

MATERIAL

Numerous phosphatic fragments from at or above the belemnite graveyard level at the base of the Lower Maastrichtian Vijlen Chalk at Cottessen, Limburg, The Netherlands, NMM GK 236, 690, 867 and 945, *ex* FELDER Collection.

DESCRIPTION

Most fragments are poorly preserved. The whorl section is oval, with dorsum narrower than venter. Whorl breadth to height ratios are 0.56 to 0.63. The shell appears to have been smooth.

DISCUSSION

These fragments are indeterminate. Being phosphatised, they may be derived from the Zeven Wegen Chalk and Campanian in age, or may be Lower Maastrichtian.

OCCURRENCE

As for material.

Aptychi of *Baculites*
*Rugaptychus rugosus* (SHARPE, 1857)
Plate 16, figs. 1-22

SHARPE, D., 1857, *Aptychus rugosus,* p. 57, pl. 24, figs. 8, 9.

MATERIAL

IRSNB IG 5496 *ex* CORNET Collection, 11 fragments including the original of DE GROSSOUVRE, 1908, pl. 10, figs. 7-13, from the Campanian of Folx-les Caves, Brabant, Belgium; IRSNB IG 5621 *ex* UBAGHS Collection, 10 fragments, also from Folx-les-Caves.

DISCUSSION

These beautifully preserved Aptychi agree closely with SHARPE's specimens (BMNH 3078-3079; Norwich Castle Museum no. 3519 *ex* KING Collection). SCHLÜTER (1876, pl. 39, fig. 16) figured a similar specimen associated with a large *Baculites* from the Mucronatenkreide of Lüneburg, demonstrating the association of this type of jaw apparatus with *Baculites*. The range of the form genus is Campanian to Maastrichtian; where well-dated, *rugosus* seems to be Campanian.

Genus *EUBACULITES* SPATH, 1926, p. 80
(= *Giralites* BRUNNSCHWEILER, 1966, p. 33;
*Eubaculiceras* BRUNNSCHWEILER, 1966, p. 33;
*Cardabites* BRUNNSCHWEILER, 1966, p. 38).

TYPE SERIES

*Baculites vagina* var. *Ootacodensis* STOLICZKA, 1866, p. 199, pl. 90, fig. 14, ? 15, by original designation.

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: "*Eubaculites* gen. nov. for the carinate forms of the group of *E. vagina* (Forbes) and *otacodensis* Stoliczka sp. (Kossmat, 'untersuch. Südind. Kreideform': *Beitr. Pal. Geol. Oesterr. Ung.*, vol. ix, 1895, p. 157, pl. 19, figs. 15*a, b*) genotype". A genotype (SPATH's term for a type species) is a species. As he clearly regarded *ootacodensis* as a species, it is the type species of *Eubaculites,* while I here designate the original of STOLICZKA, 1866, pl. 90, fig. 14, from the Maastrichtian Arrialoor Group "in the white gritty sandstone, north of Ootacod, near Arrialoor", lectotype of this species. A cast of this specimen, Geological Survey of India Collections no. 406, 407, is before me. SPATH obviously intended to include both species with a fastigiate venter and a tabulate venter in *Eubaculites.* In 1940 (p. 49) he further referred KOSSMAT's var. *simplex* (1895, p. 156 (60), pl. 19 (5), figs. 13a-b, 14a-b) to *Eubaculites* and regarded it as a separate species "because it is a passage form between *Eubaculites* and *Baculites* s.s."
WRIGHT, (1957, p. 218) diagnosed the genus as "Section pear-shaped, with flat venter; ribs normally faint towards venter but on inner part form prominent long curved bullae; row of lower lateral tubercles may be present. Suture with plump, minutely frilled elements". He reproduced KOSSMAT's (1895), pl. 19 (5), figs. 16a, 16b (*ootacodensis*) and pl. 19 (5), fig. 17 (*vagina*) as illustrations of the genus.
MATSUMOTO (1959b) gave a further review in which he stressed the flat venter, flattened dorsum, pear-shaped section, ornament of ribs and in some, indistinct tubercles, plus broad and massive sutures with numerous frills. He also suggested the origin of the genus lay in *Baculites occidentalis* MEEK, 1857, and described, as *E. ootacodensis,* Californian and west Australian specimens with exclusively tabulate venters.
BRUNNSCHWEILER (1966) adopted a somewhat different approach, after study of Upper Maastrichtian material from the Miria Marl of Western Australia. He erected a subfamily Eubaculitinae for "forms with a ventral keel which appears in very early growth stages. The keel is either acute or tabulate, never rounded". To *Eubaculites* he referred costate forms with a ratio of shell height to width of 1.8 to 1 or less and a ventral keel that is distinctly tabulate and set off from the flanks by longitudinal grooves, including *E. ootacodensis; E. vagina; E. kossmati* BRUNNSCHWEILER, 1966 (p. 31, pl. 2, figs. 15-17, pl. 3, figs. 1-7, text-fig. 15) to which he referred the syntype of *Baculites vagina* var. *simplex* KOSSMAT, 1895, pl. 19 (5), fig. 14 only and *E. multicostatus* BRUNNSCHWEILER, 1966 (p. 32, pl. 3, figs. 8-12; text-fig. 16). *Giralites* BRUNNSCHWEILER, 1966 (p. 33; type species *G. latecarinatus* BRUNNSCHWEILER, 1966, p. 33, pl. 3, figs. 13, 14; pl. 4, figs. 1-5; text-figs. 17, 18) was diagnosed as a non-costate genus with a ratio of height to width of cross section of less than 1.8 to 1. Included species were *G. latecarinatus, G. simplex* (KOSSMAT, 1895) (including the syntype figured on KOSSMAT's pl. 19 (5), fig. 13; this specimen, GSI 14819, a cast of which is before me, is here designated the lectotype of *simplex*) and *G. quadrisulcatus* BRUNNSCHWEILER, 1966 (p. 35, pl. 4, figs. 11-14; text-fig. 20). *Eubaculiceras* BRUNNSCHWEILER, 1966 (type species *E. compressum* BRUNNSCHWEILER, 1966, p. 36, pl. 4, figs. 15-17; pl. 5, figs. 1-3; text-fig. 21) was diagnosed as a ribbed form with a very compressed section, the ratio of whorl height to width being 2.1 or more. In addition to the type species, *E. fastigiatum* BRUNNSCHWEILER, 1966 (p. 37, pl. 5, figs. 7-9; text-fig. 22) was referred to the genus.
The genus *Cardabites* BRUNNSCHWEILER, 1966 (type species *C. tabulatus* BRUNNSCHWEILER, 1966, p. 38, pl. 5, figs. 12-15; text fig. 23) was proposed for unribbed, very compressed forms with a ratio of whorl height to width of 2.1 or more. Apart from the type species, *C. scimitar* BRUNNSCHWEILER, 1966 (p. 38, pl. 5, figs. 16-21; text-fig. 24) was referred to the genus.
BRUNNSCHWEILER thus divided up *Eubaculites* of authors on the basis of the degree of whorl compression and the presence or absence of ornament. *Eubaculites* was restricted to those forms that had a tabulate venter, as in the type species; *Giralites* are compressed, smooth with tabulate of fastigiate venter; *Eubaculiceras* are compressed and ribbed with tabulate or fastigiate venter; *Cardabites* very compressed with tabulate or fastigiate venter.
KLINGER (1976) regarded all BRUNNSCHWEILER's genera as synonyms, and diagnosed the genus as follows: "whorl section more or less pear-shaped with flattened dorsum and tabulate venter in typical specimens; it may become extremely laterally compressed with Wb:Wh 2 or more and with rounded dorsum and fastigiate venter. Ornament, if present, may be either lateral and dorsolateral tubercles or simple crescentic ribs. Ornament very variable and

different types often indistinguishable. Suture with broad, minutely frilled elements" (KLINGER, 1976, p. 83).

KLINGER provides valuable information on the occurrence of *Eubaculites* in Zululand, and confirms wide intraspecific variability, describing *E. vagina* in some detail on the basis of the FORBES' material, as well as pointing out that STOLICZKA's figure of *ootacodensis* has a fastigiate, not tabulate venter (he refers to this specimen as the holotype; it is actually a syntype).

I here propose a different approach. All the taxa discussed have a rather distinctive suture with broad, frilled elements, have a compressed whorl section with a broad, flattened dorsum. All large collections appear to show wide variation in strength of ornament, yet there appear to be forms with a fastigiate and a tabulate venter. The latter has always been taken as the most character feature of *Eubaculites,* yet the lectotype of the type species has a fastigiate venter, clearly shown in STOLICZKA's figure, although the text speaks of the siphuncle often lying nearer to one edge than the other (p. 199) suggesting STOLICZKA included specimens with a tabulate venter as well.

I recognise the following groups:

1. With fastigiate venter and flattened dorsum, ribbed or smooth; the following nominate species are included. *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,* possibly a corroded fragment of *B. rioturbioensis*).
2. With tabulate venter and flattened dorsum, ornamented individuals with dorsal and dorsolateral tubercles, some individuals smooth; *Baculites vagina* FORBES, 1846; *Baculites ornatus* d'ORBIGNY, 1847.
3. With tabulate venter and flattened dorsum, ornamented by flank ribs, some individuals in populations may be smooth: *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.

An extensive synonymy of *E. vagina* is given by KENNEDY and HENDERSON (*in press*), that of *E. lyelli* is given below, as is that of the most confused species, *E. ootacodensis,* although it does not occur in the Maastricht fauna.

It is more than unfortunate that the tabulate dorsum which is such a distinctive feature of the *vagina* and *lyelli* groups is absent in the *ootacodensis* group. Indeed, *simplex* of KOSSMAT, here regarded as a synonym of *ootacodensis,* was placed in *Baculites* by COLLIGNON (1971). The whorl section is, however, different from *B. vertebralis,* described above, as is the suture. Greater difficulty arises with the other well-known Maastrichtian species *B. anceps,* for this has the fastigiate venter of *ootacodensis* and only the flat dorsum and distinctive suture of the latter separates them.

Given the immediately distinctive tabulate venter of the *vagina* and *lyelli* groups, a case can be made for recognising *Giralites* BRUNNSCHWEILER, 1966 as a subgenus of *Eubaculites,* as the lectotype of *ootacodensis* indeed has the fastigiate venter shown in STOLICZKA's figure.

MATSUMOTO (1959b, p. 154) saw the origin of *Eubaculites* in late Campanian *Baculites,* pointing out that juvenile *Baculites occidentalis* MEEK, 1857, are close to *Eubaculites* and a paedomorphic origin was possible.

The first species to appear is *Eubaculites vagina,* known from southern India, Zululand, Madagascar and the Ukrainian SSR. In southern India this species appears in the Pondicherry district associated with *Pachydiscus neubergicus,* while *E. lyelli* occurs above with *Pachydiscus ootacodensis. E. ootacodensis* also appears after *vagina.* In Zululand, KLINGER's records show *E. vagina* appearing first thereafter accompanied briefly by *E. latecarinatus,* thereafter *E. compressus,* a brief overlap of these with *E. ootacodensis,* which persists. Some of KLINGER's *ootacodensis* appear to *E. lyelli,* however.

I can find no Campanian records of *Eubaculites.*

OCCURRENCE

Maastrichtian. Southern India, Assam, western Australia, Zululand, Mozambique, Madagascar, Peru, Chile, Patagonia, Argentina, California, southwestern France (University of Toulouse Collections), Austria, The Netherlands and the Ukrainian SSR (WISNIOWSKI, 1907, pl. 17, fig. 9). Records from New Zealand (WOODS, 1917) and Yugoslavia (PETHÖ, 1906) are doubtful.

*Eubaculites ootacodensis* (STOLICZKA, 1866)
not figured

STOLICZKA, F., 1866, *Baculites vagina* FORBES var. *Ootacodensis* STOLICZKA, p. 199, pl. 90, fig. 14, ? 15.

KOSSMAT, F., 1895, *Baculites vagina* FORBES n. var. *simplex,* p. 156 (60), pl. 19 (5), figs. 13a, b, *non* 14a, b.

? KOSSMAT, F., 1895, *Baculites vagina* var. Otacodensis STOL., p. 157 (61) (*pars*) ? pl. 19 (5), fig. 15, *non* 16.

? PETHÖ, J., 1906, *Baculites* aff. *vagina* FORBES, p. 87, pl. 6, fig. 1.

SPENGLER, E., 1923, *Baculites vagina* FORBES, p. 54, pl. 41, fig. 9.

COTTREAU, J., 1922, *Baculites vagina* FORBES var. *otacodensis* STOL., p. 180 (72), pl. 17 (9), fig. 11.

DIENER, C., 1925, *Baculites vagina* FORBES var. *otacodensis* KOSSMAT, p. 63 (*pars*).

DIENER, C., 1925, *Baculites vagina* var. *simplex* KOSSMAT, p. 63.

non SPATH, L. F., 1940, *Eubaculites otacodensis* (STOLICZKA), p. 49, pl. 1, fig. 3; text-fig. 1b.

non WRIGHT, C. W. 1957, *Eubaculites otacodensis* (STOLICZKA), p. L218, text-figs. 245, 6a-b.

non MATSUMOTO, T., 1959b, *Eubaculites otacodensis* (STOLICZKA), p. 166, pl. 43, fig. 6; pl. 44, figs. 1-3; text-figs. 84a, b; 85a, b.

non BRUNNSCHWEILER, R., 1966, *Eubaculites ootacodensis* (STOLICZKA, 1866), p. 27, pl. 1, figs. 9-14; text-figs. 9-11.

COLLIGNON, M., 1971, *Baculites simplex* KOSSMAT, p. 15, pl. 645, figs. 2388-2389.

COLLIGNON, M., 1971, *Eubaculites otacodensis* STOL., p. 18, pl. 645, fig. 2395.

non RICCARDI, A. C., 1974, *Eubaculites ootacodensis* (STOLICZKA), p. 388, pl. 1, figs. 1-7; pl. 2, figs. 1-4, 6; pl. 3, figs. 1-6; pl. 4, figs. 1-7; text-fig. 2.

KLINGER, H. C., 1976, *Eubaculites ootacodensis* (STOLICZKA), 1865, p. 90, pl. 39, figs. 1, 3; pl. 42, figs. 3, 8; pl. 41, figs. 1, 2; *non* text-fig. 11c.

TYPES

Lectotype designated herein (p. 193) is the original of STOLICZKA, 1866, pl. 90, fig. 14a-c. The lectotype, herein designated (p. 193), of *Baculites vagina* var. *simplex* KOSSMAT is the original of KOSSMAT, 1895, pl. 19 (5), fig. 13.

DISCUSSION

The synonym of *E. ootacodensis* is given to clarify the limits of the species as interpreted in the discussion of the genus above. The lectotype is from "the white gritty sandstone, north of Ootacod, near Arrialoor" according to STOLICZKA. The paralectotype, of which only the suture is figured (pl. 90, fig. 15) is from Pondicherry according to the plate explanation, and on p. 199 STOLICZKA records it as being "abundant in bluish calcareous sandstone near Pondicherry". The latter may thus be from another horizon. At Ootacod he also records *Pachydiscus ootacodensis,* a form occuring above *E. vagina* in Pondicherry.
The lectotype of *E. simplex* is from Ariyalur.

OCCURRENCE

Maastrichtian of southern India, Assam, Madagascar and Zululand. There is a doubtful record from Yugoslavia (PETHÖ, 1906).

*Eubaculites lyelli* (d'ORBIGNY, 1847)
Plate 27, figs. 5, 6, 7, 8; Plate 32, figs. 13, 14.

DARWIN, C., 1846, *Baculites vagina* E. FORBES, p. 126.

FORBES, E., 1846b, *Baculites vagina,* pl. 5, fig. 3.

ORBIGNY, A. d', 1847, *Baculites lyelli* d'ORB., pl. 1, figs. 3-7.

ORBIGNY, A. d', 1850, *Baculites lyelli* d'ORB., 1846, p. 215.

BINKHORST, J. T., 1861, *Baculites anceps* LAMARCK, p. 42, pl. 5d, figs. 3a-d.

GABB, W. M., 1864, *Baculites chicoensis,* p. 80 (*pars*), pl. 14, figs. 29, 29a, *non* pl. 17, figs. 27, 27a; *non* pl. 14, fig. 27b.

KOSSMAT, F., 1895, *Baculites vagina* FORBES n. var. *simplex,* p. 156 (60) (*pars*), pl. 19 (5), figs. 14a, b, only.

KOSSMAT, F., 1895, *Baculites vagina* var. *Otacodensis* STOL., p. 157 (61) (*pars*), pl. 19 (5), fig. 16, ? *non* 15.

STEINMANN, C., 1895, *Baculites vagina* FORBES, p. 89, pl. 6, fig. 4; text-figs. 8-10.

KOSSMAT, F., 1897, *Baculites vagina* FORBES, pl. 6, fig. 4.

WILKENS, O., 1904, *Baculites vagina* FORBES, p. 188.

non PAULCKE, W., 1906, *Baculites vagina* FORBES var. *cazadoriana* PAULCKE, p. 11, pl. 16, figs. 5a, 5b, 5c.

DIENER, C., 1925, *Baculites vagina* FORBES, p. 63 (*pars*).

non DIENER, C., 1925, *Baculites vagina* var. *Cazadoriana* PAULCKE, p. 63.

DIENER, C., 1925, *Baculites vagina* FORBES var. *otacodensis* STOLICZKA, p. 63 (*pars*).

WETZEL, W., 1930, *Baculites vagina* FORBES, p. 90, pl. 10, figs. 3, 4.

SPATH, L. F., 1940, *Eubaculites otacodensis* (STOLICZKA), p. 49, pl. 1, fig. 3; text-fig. 1b.

? SPATH, L. F., 1940, *Eubaculites* aff. *vagina* FORBES, p. 50.

? OLSSEN, A. A., 1944, *Baculites lyelli* d'ORBIGNY, pl. 16, figs. 3-5, text-fig. 1.

SPATH, L. F., 1953, *Eubaculites lyelli* d'ORBIGNY, pp. 46-47.

WRIGHT, C. W., 1957, *Eubaculites otacodensis* (STOLICZKA), p. L218, text-fig. 245, 6a-b.

MATSUMOTO, T., 1959b, *Eubaculites ootacodensis* (STOLICZKA), p. 166, pl. 43, fig. 6; pl. 44, figs. 1-3; text-figs. 84a, b, 85a, b.

MATSUMOTO, T. and OBATA, I., 1963, *Eubaculites lyelli* d'ORBIGNY, p. 97.

LEANZA, A. F., 1964, *Eubaculites argentinicus* (WEAVER), p. 95, pl. 1, figs. 1-5; text-fig. 1.

BRUNNSCHWEILER, R., 1966, *Eubaculites ootacodensis* (STOLICZKA, 1866), p. 27, pl. 1, figs. 9-14; text-figs. 9-11.

BRUNNSCHWEILER, R., 1966, *Eubaculites vagina* (FORBES, 1846), p. 29, pl. 1, fig. 7; pl. 2, figs. 1-14; text-figs. 12-14.

BRUNNSCHWEILER, R., 1966, *Eubaculites kossmati,* sp. nov., p. 31, pl. 2, figs. 15-17; pl. 3, figs. 1-7; text-fig. 15.

BRUNNSCHWEILER, R., 1966, *Eubaculites multicostatus,* sp. nov., p. 32, pl. 3, figs. 8-12; text-fig. 16.

RICCARDI, A. C., 1974, *Eubaculites ootacodensis* (STOLICZKA), p. 388, pl. 1, figs. 1-7; pl. 2, figs. 1-4, 6; pl. 3, figs. 1-6; pl. 4, figs. 1-7; text-fig. 2.

HÜNICKEN, M. A. and COVACEVICH, V., 1975, *Eubaculites lyelli* (d'ORBIGNY), p. 149, pl. 1, figs. 5-12; pl. 2, figs. 4-9; pl. 3, figs. 1-8; pl. 4, figs. 1-8; pl. 5, figs. 1-4; text-figs. 6-28.

KLINGER, H. C., 1976, *Eubaculites ootacodensis* (STOLICZKA), 1865, p. 90 (*pars*), pl. 39, fig. 1, *non* 3; pl. 41, figs. 1, 2; pl. 42, figs. 3, 8; ? *non* pl. 43, fig. 1; text-fig. 11c.

KENNEDY, W. J. and SUMMESBERGER, H., 1986, *Eubaculites lyelli* (d'ORBIGNY, 1850), p. 197, pl. 14, figs. 1-5, 9-14.

TYPES

The catalogue of the d'ORBIGNY Collections lists three specimens of *Baculites lyelli* from Concepción, under the number 7206. All survive in the collections of the Muséum National d'Histoire Naturelle in Paris, recatalogued as no. R1020a-c. I have designated MNHP R1020a the specimen shown in Plate 32, figs. 13, 14 lectotype of the species. It should be noted that d'ORBIGNY gives the locality of the species as Quiriquina Island in the *Prodome* (1850, p. 215).

MATERIAL

MNB unregistered *ex* BINKHORST Collection, the original of BINKHORST, 1861, pl. 5d, figs. 3a, 3b, 3c, 3d, from the Upper Maastrichtian of "St. Pierre et dans les environs de Fauquemont" (BINKHORST, 1861, p. 43).

DESCRIPTION

The Limburg specimen is a fragment of body chamber with a maximum whorl height of 17 mm. and a whorl breadth of 11 mm. the whorl breadth to height ratio being 0.65. The dorsum is broad and flattened, the dorsolateral area rounded, with the greatest breadth below mid-flank. The outer flanks are convergent, while a marked longitudinal sulcus runs close to the angular/narrowly rounded ventrolateral shoulder. The venter is narrow, flat and smooth.

Parts of five broad flank ribs are present. These arise at the dorsolateral shoulder and are low and markedly concave across the inner to mid-flank. The decline is strength and sweep forwards on the outer flank, disappearing at the outer lateral groove which they intersect at a high angle.

DISCUSSION

The Limburg specimen is shorter than shown in BINKHORST's figure, and is body chamber, not showing the septal face of his pl. 5d, fig. 3d. The differences I attribute to artistic licence. The specimen shows the same characters as the lectotype of *B. lyelli,* and an extensive suite of specimens from Quiriquina Island that I have studied in the Museum für Naturkunde Berlin and in the STINNESBECK Collection at Bonn and the extensive suite of material described and illustrated by HÜNICKEN and COVACEVICH (1975). The *Baculites vagina* of FORBES (1846) and DARWIN (1846) are from Quiriquina Island, and are synonyms. The Californian fragments of GABB (1864), discussed by MATSUMOTO (1959b) belong here, as does the ribbed paralectotype of *Baculites vagina* var. *simplex* of KOSSMAT [1895, p. 156 (60) (*pars*) pl. 19 (5), fig. 14a-c only], a cast of which is before me, and South American specimens referred to *vagina* by WILKENS, WETZEL and others.

The *Baculites vagina* var. *otacodensis* of KOSSMAT (1895) present problems. His pl. 19 (5), fig. 15a, b, a cast of which is before me, lacks the venter and may be a *Eubaculites ootacodensis;* his fig. 16a-c with tabulate venter is a large specimen of the present form. The nearly smooth specimen from the *Trigonarca* Beds of Rayapudupakam figured by the same author in 1897 (pl. 6, fig. 4) also belongs here. I am unable to determine, from the illustrations whether the smooth examples from Pondicherry figured by STOLICZKA (1866, pl. 91, figs. 1, 2) belong here, of are smooth variants of *E. vagina.* The dorsum of his pl. 91, fig. 2a certainly recalls that of *lyelli.*

*Baculites vagina* var. *cazadoriana* of PAULCKE (1906) has a rounded dorsum and fastigiate venter, suggesting it is a *Baculites.*

The large specimen figured by OLSSEN (1944, pl. 16, figs. 3-5) is somewhat problematic as the figures show a rounded-fastigiate venter suggesting it might be a *Eubaculites ootacodensis.* In contrast, large specimens figured by RICCARDI (1974) from Argentina certainly belong here.

*Eubaculites vagina, kossmati* and *multicostatum* of BRUNNSCHWEILER fall within the range of variation of Quiriquina Island material I have studied. In contrast, the very compressed forms *Giralites latecarinatus* BRUNNSCHWEILER, 1966 (p. 33, pl. 3, figs. 13, 14; pl. 4, figs. 1-5; text-figs. 17, 18) with a whorl breadth to height ratio of 0.6, *G. quadrisulcatus* BRUNNSCHWEILER, 1966 (p. 35, pl. 4, figs. 11-14; text-fig. 20) with a whorl breadth to height ratio of 0.59, *Eubaculiceras compressum* BRUNNSCHWEILER, 1966 (p. 36, pl. 4, figs. 15-17; pl. 5,

figs. 1-3; text-fig. 21) with a whorl breadth of height ratio of 0.45, and *Cardabites tabulatus* BRUNNSCHWEILER, 1966 (p. 38, pl. 5, figs. 16-21; text-fig. 23) may represent a separate form or forms.
*E. lyelli* is easily separated from the great majority of *E. vagina* (FORBES, 1846a, p. 114, pl. 10, fig. 4), which have dorsolateral and lateral tubercles. The smooth variants are inseparable according to KLINGER (1976). *E. ootacodensis,* so commonly confused with *E. lyelli,* has a fastigiate rather than tabulate venter.

OCCURRENCE

Where well-dated, this is generally an Upper Maastrichtian species, but ranges lower as in the Lower Maastrichtian of Neuberg, Steiermark, Austria. The geographic distribution is Argentina, Chile, California, southern India, western Australia, southwestern France, The Netherlands and Austria.

Superfamily SCAPHITACEAE GILL, 1871, p. 3
(*nom. transl.* WRIGHT and WRIGHT, 1951, p. 13, *ex* Scaphitidae GILL)
Family SCAPHITIDAE GILL, 1871, p. 3
Subfamily SCAPHITINAE GILL, 1871, p. 3
(*nom. transl.* WRIGHT, 1953, p. 473, *ex* Scaphitidae GILL)
Genus *HOPLOSCAPHITES* NOWAK, 1911, p. 565
[= *Mesoscaphites* ATABEKIAN, 1979, p. 523 (*nom. nud.*)]

TYPE SPECIES

*Ammonites constrictus* J. SOWERBY, 1817, p. 189, pl. A, fig. 1, by original designation.

DIAGNOSIS

Small to large. Phragmocone involute, sides flat to convex ornamented by fine to coarse ribs. Shaft of body chamber short, compressed. Ventral tubercles appear on last part of phragmocone or not. Body chamber with umbilical bullae and ventral clavi or not. Feeble siphonal swellings or nodes on body chamber in some individuals and species. Aperture with weak ventral projection and short dorsal projection; constricted. Suture relatively simple.

DISCUSSION

*Hoploscaphites constrictus* always has tubercles at some stage in development, as does its contemporary *H. schmidi* (BIRKELUND, 1982) (p. 17, pl. 1, figs. 7-10; pl. 2, figs. 1-4). Also referred to *Hoploscaphites* are a series of species with compressed involute phragmocones and very fine ribs, in some cases mere striae. This group includes *Scaphites angulatus* (LOPUSKI, 1911, p. 136, pl. 3, figs. 8-10), and *Scaphites tenuistriatus* KNER, 1848, p. 10, pl. 1, fig. 5) which lack tubercles on the body chamber and forms in which they may or may not be present, even in the same species, e.g. *Scaphites greenlandicus* DONOVAN, 1953 [p. 7, pl. 2, figs. 5 only; text-fig. 1a-e; see also BIRKELUND, 1965, p. 110, pl. 28, figs. 2-3; pl. 29, fig. 2; pl. 30, figs. 1-3; pl. 31, figs. 1-2; pl. 32, fig. 1; pl. 33, fig. 1; text-figs. 64-66, 98-100, 121 (6)], *Scaphites (Hoploscaphites) ravni* BIRKELUND, 1965 [p. 106, pl. 26, figs. 2-4; pl. 27, figs. 1-4; pl. 28, fig. 1; pl. 29, fig. 1; text-figs. 94-97, 100, 121 (4, 5)] and *Scaphites (Hoploscaphites) ikorfakensis* BIRKELUND, 1965 [p. 102, pl. 24, figs. 1-4; pl. 25, figs. 1-2; pl. 26, fig. 1; text-figs. 59, 93, 121 (3)].
The variably tuberculate species suggest that all these late compressed involute scaphitids should be treated as a single genus.

OCCURRENCE

Upper Campanian to Upper Maastrichtian, France, northern Spain, Ireland, Belgium, The Netherlands, Germany, Switzerland, Denmark, Sweden, Poland, USSR, Israel, Canada, U.S. Western Interior, Greenland, Chile, Grahamland, Zululand.

*Hoploscaphites constrictus* (J. SOWERBY, 1817)
Plate 31, figs. 1, 8-26; Plate 32, figs. 1-12, 18-21

SOWERBY, J., 1817, *Ammonites constrictus,* p. 189, pl. A, fig. 1.

PUSCH, G. G., 1837 *Ammonites constrictus* SOW., p. 159, pl. 14, fig. 3.

ORBIGNY, A. d', 1842, *Scaphites constrictus* d'ORBIGNY, p. 522, pl. 129, figs. 8-11.

? KNER, R., 1848, *Scaphites compressus* d'ORB., p. 10, pl. 1, fig. 4.

ALTH, A., 1850, *Sc. constrictus* d'ORB., p. 207, pl. 10, figs. 29-30.

ORBIGNY, A. d', 1850, *Scaphites constrictus* d'ORB., p. 214.

LEYMERIE, M. A., 1851, *Ammonites monteleonensis,* p. 198, pl. 11 (c), figs. 3, 4.

KNER, R., 1852, *Scaphites constrictus* d'ORB. var. p. 300 (8), pl. 15 (1), figs. 7, 8.

HAUER, F. VON, 1858, *Scaphites multinodosus,* n. sp., p. 9, pl. 1, figs. 7-8.

BINKHORST, J. T., 1861, *Scaphites constrictus* d'ORBIGNY, p. 38, pl. 5d, figs. 6a-h (with additional synonymy).

GÜMBEL, C. W. VON, 1861, *Scaphites multinodosus* V. HAUER, p. 574.

GÜMBEL, C. W. VON, 1861, *Scaphites (?) falcifer* GUEMB., p. 574.

GÜMBEL, C. W. VON, 1861, *Scaphites ornatus* ROEM., p. 576.

FAVRE, E., 1869, *Scaphites constrictus* SOWERBY, sp., p. 18, pl. 5, figs. 1-4 (with additional synonymy).

SCHLÜTER, C., 1872, *Scaphites constrictus,* SOW., sp., p. 28, pl. 28, figs. 5-9 (with additional synonymy).

non REDTENBACHER, A., 1873, *Scaphites* spec. ind. cfr. *Scaphites constrictus* SOW., p. 130, pl. 30, fig. 12.

MÖBERG, J. C., 1885, *Scaphites constrictus* SOWERBY, sp., p. 27, pl. 3, figs. 3-5.

BÖHM, J., 1891, *Scaphites constrictus* SOW., sp., p. 48, pl. 1, fig. 10a.

GROSSOUVRE, A. DE, 1894, *Scaphites constrictus* SOWERBY, sp., p. 248, pl. 31, figs. 1, 2, 7, 8.

UHLIG, V., 1894, *Scaphites niedzwiedzkii,* n. sp., p. 220, fig. 2.

SEMENOW, W. P., 1899, *Scaphites constrictus* SOW., p. 134, pl. 5, fig. 8.

? IMKELLER, H., 1901, *Scaphites constrictus* SOW., sp., p. 59.

RAVN, J. P. J., 1902, *Scaphites constrictus* SOWERBY, sp., p. 254, pl. 3, fig. 9.

WISNIOWSKI, T., 1902, *Scaphites constrictus* SOW., sp., p. 301.

WISNIOWSKI, T., 1902, *Scaphites constrictus* SOW., p. 193, pl. 17, fig. 2b.

WISNIOWSKI, T., 1902, *Scaphites constrictus* var. *Niedzwiedzkii* UHL., pl. 17, fig. 2a.

GROSSOUVRE, A. DE, 1908, *Scaphites constrictus* SOWERBY, sp., p. 36, pl. 11, figs. 3-7.

NOWAK, J., 1909, *Scaphites constrictus* SOW., p. 773, pl. 1, fig. 1.

? BÖHM, J., *in* BÖHM, J. and HEIM, A., 1909, *Scaphites* cfr. *Niedzwiedzkii* UHLIG, p. 54, pl. 1, fig. 3.

YABE, H., 1910, *Scaphites constrictus* d'ORB., p. 161, text-fig. 2.

LOPUSKI, C., 1911, *Scaphites constrictus* SOW., p. 113, 133, pl. 2, figs. 3-4.

LOPUSKI, C., 1911, *Scaphites constrictus* SOW. var. *crassus* mihi, p. 115, 134, pl. 2, figs. 5-6; pl. 3, figs. 1-2.

? LOPUSKI, C., 1911, *Scaphites,* sp., p. 117, pl. 3, fig. 4.

? LOPUSKI, C., 1911, *Scaphites,* sp., p. 118, pl. 3, fig. 3.

LOPUSKI, C., 1911, *Scaphites,* sp., p. 118, pl. 3, fig. 5.

NOWAK, J., 1911, *Hoploscaphites constrictus* SOWERBY, p. 580, pl. 32, fig. 6; pl. 33, fig. 8-12, 19, 24, 30; text-figs. 15, 16, 18, 19.

NOWAK, J., 1911, *Hoploscaphites constrictus* SOWERBY *vulgaris,* p. 583, pl. 32, fig. 6, pl. 33, figs. 8-12.

NOWAK, J., 1911, *Hoploscaphites constrictus tenuistriatus* KNER, p. 585 (*pars*), pl. 33, fig. 14, *non* 13; text-fig. 17.

FRECH, F., 1915, *Scaphites constrictus* SOWERBY, p. 562 (*pars*), text-figs. 9, ? 10.

NOWAK, J., 1916, *Scaphites constrictus* SOW., p. 59.

DIENER, C., 1925, *Scaphites Niedzwiedzkii* UHLIG, p. 201.

? DIENER, C., 1925, *Scaphites* cf. *Niedzwiedzkii* (UHL.), p. 201.

DIENER, C., 1925, *Discoscaphites constrictus* SOWERBY, p. 210.

DIENER, C., 1925, *Discoscaphites constrictus* SOW., var. *crassa* LOPUSKI, p. 211.

DIENER, C., 1925, *Discoscaphites constrictus* var. *vulgaris* NOWAK, p. 211.

non DIENER, C., 1925, *Discoscaphites,* sp. ind. aff. *constricte* (SOW.), p. 211.

WOLANSKY, D., 1932, *Hoploscaphites constrictus* SOW., p. 10, pl. 1, figs. 10, 12.

SHELEV, St. T., 1934, *Scaphites constrictus* SOW., p. 200.

MIKHAILOV, V. P., 1951, *Discoscaphites constrictus* (SOWERBY), p. 90, pl. 17, figs. 77-80.

MIKHAILOV, V. P., 1951, *Discoscaphites constrictus* (SOW.) var. *niedzwiedzkii* (UHLIG), p. 93, pl. 15, fig. 65; pl. 17, figs. 81, 82; pl. 18, fig. 85.

NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Discoscaphites constrictus* (SOWERBY), p. 196, pl. 6, figs. 7, 8.

NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Discoscaphites constrictus* (SOWERBY) var. *niedzwiedzkii* (UHLIG), p. 197, pl. 6, fig. 1-4.

MAKOWSKI, H., 1963, *Scaphites constrictus* (SOWERBY), pl. 4; text-fig. 3.

BIRKELUND, T., 1966, *Scaphites (Hoploscaphites) constrictus* (SOWERBY), p. 141 et. seq.; text-fig. 1, figs. 7-8.

NAIDIN, D. P., 1974, *Hoploscaphites constrictus constrictus* (SOWERBY, 1818), p. 173, pl. 58, figs. 7-9; pl. 61, figs. 2-4.

NAIDIN, D. P., 1974, *Hoploscaphites constrictus niedzwiedzkii* (UHLIG, 1894), p. 174, pl. 58, figs. 10, 11.

BIRKELUND, T., 1979, *Hoploscaphites constrictus* (SOWERBY, 1817), p. 55, text-fig. 2 (*pars*), 3d-e.

BIRKELUND, T., 1979, *Hoploscaphites constrictus crassus* (LOPUSKI, 1911), p. 55.

ATABEKIAN, A. A., 1979, *Mesoscaphites grossouvrei* ATAB., sp. nov., p. 523.

ATABEKIAN, A. A., 1979, *Mesoscaphites kneri* ATAB., sp. nov., p. 523.

BŁASZKIEWICZ, A., 1980, *Hoploscaphites constrictus anterior,* subsp. nov., p. 36, pl. 17, fig. 5; pl. 18, figs. 4-10.

BŁASZKIEWICZ, A., 1980, *Hoploscaphites constrictus crassus* (LOPUSKI, 1911), p. 37, pl. 18, figs. 1-3, 11-14.

BIRKELUND, T., 1982, *Hoploscaphites constrictus* (SOWERBY, 1818), p. 19, pl. 3, figs. 1-14.

TSANKOV, C. V., 1964, *Hoploscaphites constrictus constrictus* (SOWERBY, 1817), p. 24, pl. 7, figs. 6-8.

? MARTINEZ, R., 1982, *Scaphites (Hoploscaphites) constrictus* J. SOWERBY, p. 172, pl. 30, fig. 6.

RICCARDI, A. C., 1983, *Hoploscaphites constrictus* J. SOWERBY, 1818, p. 8 et. seq.

KENNEDY, W. J., 1985, *Hoploscaphites constrictus* (J. SOWERBY, 1817), pl. 3, figs. 8, 9.

KENNEDY, W. J., 1986, *Hoploscaphites constrictus* (J. SOWERBY, 1817), p. 64, pl. 13, figs. 1-13, 16-26; pl. 14, figs. 1-38; pl. 15; text-figs. 9, 11a-h.

KENNEDY, W. J. and SUMMESBERGER, H., 1986, *Hoploscaphites constrictus* (J. SOWERBY, 1817), p. 198, pl. 16, figs. 1-5, 8-10, 13; text-fig. 7.

KENNEDY, W. J. and SUMMESBERGER, H., *in prep.*, *Hoploscaphites constrictus* (J. SOWERBY, 1817), ...

TYPES

The lectotype, by the subsequent designation of KENNEDY, (1986, p. 68) is BMNH C36733 *ex* SOWERBY Collection; paralectotypes are BMNH C43988 and C70645-7 *ex* SOWERBY Collection. All specimens are from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France.

MATERIAL

Numerous specimens, including the following: from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands, MNB *ex* BINKHORST Collection: numerous fragments; IRSNB IG 6521 *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 11, fig. 7; from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands: IRSNB IG 4285, 5 specimens, *ex* BOSQUET Collection; IRSNB IG 5496 *ex* CORNET Collection; IRSNB 9487 *ex* PIRLET Collection, the original of DE GROSSOUVRE, 1908, pl. 11, fig. 4; IRSNB 9489 *ex* BOSQUET Collection, the original of DE GROSSOUVRE, 1908, pl. 11, fig. 3; IRSNB 8490 *ex* BOSQUET Collection; the original of DE GROSSOUVRE, 1908, pl. 11, fig. 5 (DE GROSSOUVRE gives the locality as Maastricht); IRSNB 9491 *ex* BOSQUET Collection, the original of DE GROSSOUVRE, 1908, pl. 11, fig. 6; IRSNB unregistered; IRSNB 4285, 4 specimens, *ex* BOSQUET Collection; NMM 007325, 7329 are labelled "Geulhem, Mb-Mc"; NMM 002588 is labelled "Kalkgroeve Schunk, Geulhem"; NMM 001491 "Groeve Schunk, Guelhem"; more precisely localised are NMM 733 - MK 734 *ex* FELDER Collection, from the top of the Meerssen Chalk (*Sphenodiscus* level) at Curfs Quarry; NMM 2874 *ex* FELDER Collection is from the upper part of the Meersen Chalk at Curfs Quarry. IRSNB IG 10511 and IRSNB IG 8261 *ex* DE JAER Collection are from the Upper Maastrichtian in the environs of Maastricht; NMM 1491 and 7107 are from the Upper Maastrichtian Meerssen Chalk, St. Pietersberg, Maastricht, Limburg, The Netherlands; NMM MK 2842a-b *ex* FELDER Collection is from Blom Quarry, Berg en Terblyt, Limburg, The Netherlands, the horizon is the hardground at the top of IV f4, the middle of the Upper Maastrichtian Meerssen Chalk. NMM MK 1886 and MK 1888 *ex* FELDER Collection are from the terminal hardground of the Upper Maastrichtian Meerssen Chalk at Vroenhoven (Albert Canal section), Limburg, Belgium. There are also four specimens in the IRSNB Collections from the Upper Maastrichtian of Shaft 2 of the Houthalen Mine, Limburg, Belgium. Unlocalised specimens include NMM 001201 from the Meerssen Chalk, NMM 3329 and MNB unregistered *ex* BINKHORST Collection, some ten specimens.
Of specimens figured by BINKHORST, 1861, pl. 5d, figs. 6a-h, from either Geulhem or Kunrade, the original of fig. 6a may survive and is an external mould, as is suggested by the lack of sutures in the figure, while the original of 6b is in the Teaching Collections of the Museum für Naturkunde, East Berlin. I was unable to recognise the remainder when visiting the Museum in December 1983.

DESCRIPTION

The material from the Maastricht area is highly variable, with most of the specimens being microconchs. The phragmocone is very involute, with a tiny umbilicus. At one extreme are highly compressed individuals where the phragmocone is flat-sided with broadly rounded ventrolateral shoulders and a narrow flattened venter (Plate 32, figs. 1-4). These bear fine flexuous primary ribs that arise at the umbilical seam, vary from feebly concave (Plate 31, fig. 12; Plate 32, fig. 3) to almost straight (Plate 31, fig. 9) and prorsiradiate on the inner flank, convex at mid-flank and concave on the outer flank and ventrolateral shoulder and feebly convex over the venter (Plate 31, fig. 10; Plate 32, fig. 2). The primaries divide both low and high on the flank, and intercalatories are inserted on the inner to outer flank and may themselves subdivide. More inflated individuals also occur (Plate 31, fig. 23) and these generally have coarser ribs. Small ventrolateral tubercles may or may not appear at the end of the phragmocone of both compressed and more inflated individuals (Plate 31, fig. 23).
Body chambers vary widely. In compressed microconchs (Plate 31, figs. 8-14; Plate 32, figs. 1-2, 9-10) the ribs may develop unbilical bullae on the shaft (Plate 31, fig. 12) or not (Plate 32, fig. 1), with every intermediate (Plate 32, fig. 10). Shafts vary from finely (Plate 31, fig. 9; Plate 32, fig. 1) to quite coarsely ribbed (Plate 31, fig. 20; Plate 32, fig. 10), with variably developed ventral tubercles (Plate 31, fig. 11; Plate 32, fig. 9). In inflated forms (Plate 31, figs. 21-26) umbilical bullae are coarser,

as are ribs and ventral tubercles (Plate 31, fig. 26). All tubercles decline on the final hook before the aperture in compressed individuals (Plate 31, figs. 9, 12, 16; Plate 32, fig. 1, 10) and in some inflated ones (Plate 32, figs. 18, 19) but persist in some others (Plate 31, figs. 22, 24) although weakening.
Specimens interpreted as macroconchs have a pronounced umbilical bulge (Plate 31, fig. 1; Plate 32, fig. 21) and a high whorled body chamber with a convex umbilical shoulder. Microconchs (Plate 31, figs. 8-26; Plate 32, figs. 1-2, 5-12) have a slender body chamber and lack an umbilical bulge.
Suture lines (text-fig. 13A, B) are simple, and little incised.

DISCUSSION

*Scaphites compressus* of KNER, 1848 (p. 10, pl. 1, fig. 4) may be a poorly preserved *H. constrictus*.
*Scaphites multinodosus* (HAUER, 1858) (p. 9, pl. 1, figs. 7-8) from the Maastrichtian of Neuberg, Steiermark, Austria is a clear synonym and is based on a small macroconch of this species (*S. multinodosus* HAUER, 1866, p. 306, pl. 1, figs. 7-8 is, in contrast, a microconch *Trachyscaphites, fide* KENNEDY and SUMMESBERGER, 1984).
*Scaphites (?) falcifer* GÜMBEL, 1861 (p. 574) and *S. ornatus* GÜMBEL, 1861 (p. 576) both appear to be *constrictus*.
*Scaphites niedzwiedzkii* UHLIG, 1894 (p. 220, text-fig. 2) is a microconch of *H. constrictus*.
*Scaphites constrictus crassus* LOPUSKI, 1911 (p. 115, 134, pl. 2, figs. 5-6; pl. 3, figs. 1-2), with rather coarse body chamber ornament and tubercles extending to the adult aperture seems distinct enough, but study of material from the Calcaire à *Baculites* of the Cotentin Peninsula (KENNEDY, 1986) shows a gradation with the typical form. It is, however, restricted to the Upper Upper Maastrichtian *Belemnella casimirovensis* Zone (BIRKELUND, 1979, 1982; BŁASZKIEWICZ, 1980).
*Hoploscaphites constrictus vulgaris* NOWAK, 1911 (p. 583, pl. 32, fig. 6; pl. 35, figs. 8-12) is inseparable from the present form. *H. constrictus anterior* of BŁASZKIEWICZ, 1980 (p. 36, pl. 17, fig. 5; pl. 18, figs. 4-10), differentiated on the basis of a smaller apertural angle and "not so close contact of body chamber and phragmocone and a smaller degree of flattening of the ventral side" falls within the species as here conceived, being no more than a mid-Maastrichtian variant of the species. *Mesoscaphites grossouvrei* ATABEKIAN, 1979, a *nomen nudum* for lack of valid indication was introduced for the original of DE GROSSOUVRE, 1894, pl. 31, fig. 1, a macroconch of the *crassus* form of *constrictus*. *M. kneri* ATABEKIAN, 1979, also a *nomen nudum* has the original of KNER, 1852, pl. 1, fig. 13 as holotype and is also a *constrictus*.
*H. tenuistriatus* (KNER, 1848) (p. 10, pl. 1, fig. 5), discussed further below, is distinct enough. It lacks tubercles at any stage but has a phragmocone with rather coarse ribs, like some *H. constrictus,* plus exceedingly fine, dense and uniform body chamber ornament.

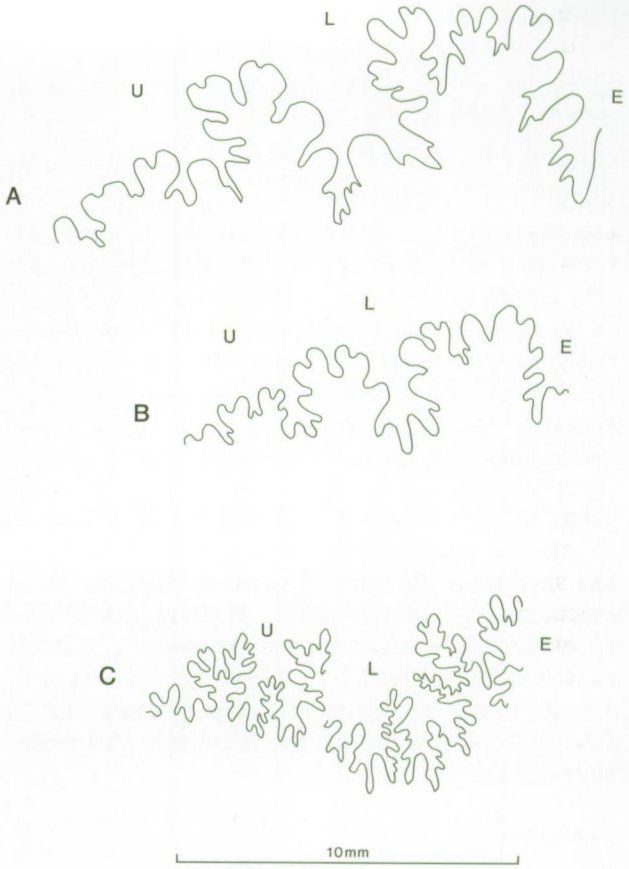


Fig. 13. *External sutures of: A, B,* Hoploscaphites constrictus *(J. SOWERBY, 1817) based on A, NMM MK 2874; B, NMM MK 734; C,* Hoploscaphites felderi *sp. nov. based on BMNH C75619. Bar scale is 10 mm.*

*Hoploscaphites elatensis* (LEWY, 1969) (p. 129, pl. 4, figs. 2a-c, text-fig. 5) closely resembles some individuals of *S. constrictus* (e.g. Plate 31, figs. 15-19) but shows details of body chamber ornament that find no precise match in either Limburg or Calcaire à *Baculites* material. It may well be a very early form of the species although the age is given as Upper Campanian.
Other European *Hoploscaphites* species and those described from Greenland are unlikely to be confused with *H. constrictus*. *Acanthoscaphites schmidi* BIRKELUND, 1982 (p. 17, pl. 1, figs. 7-10; pl. 2, figs. 1-4) is, I believe, a *Hoploscaphites*. It differs from *H. constrictus* in having a siphonal node on the body chamber with very fine ventral and ventrolateral ribbing. The lectotype of *H. constrictus* has a faint siphonal swelling, and *schmidi* seems to be a short-lived offshoot in which this feature is especially well-developed.

Most of the specimens from Limburg are fragments or nuclei only, but there are sufficient adults to show that microconchs were common and macroconchs rare. In Poland MAKOWSKI (1963) found a macroconch: microconch ratio of 2:1 in specimens from the Upper Maastrichtian of Kazimiérz on the Vistula, the former 47-68 mm. long, the latter 22-35 mm. (n = 32). The proportions in the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula are approximately the same as in Poland (KENNEDY, 1986): macroconchs (65%) range from 39-56 mm., microconchs (35%) from 25 to 34.5 mm. (n = 23). In contrast, the mid-Maastrichtian of Hemmoor yielded 260 specimens of which only one is a microconch (BIRKELUND, 1982, p. 20), the complete macroconchs ranging from 32 to 52 mm.
This progressive size increase through the Maastrichtian is supported by the Limburg material, for the specimens from the Meerssen Chalk include a macroconch 48 mm. long and microconchs up to 41 mm. long. The latter include forms with ventral tubercles that extend almost to the adult aperture and are very close to the *crassus* forms of *constrictus* that are limited to the *Belemnella casimirovensis* Zone.

OCCURRENCE

The species first occurs low in the Lower Maastrichtian. At Hemmoor, north Germany, the first known individual is from 3.5, to 5 m. above the base of the *Belemnella lanceolata* Zone while in Denmark it ranges to the top of the (incomplete) *Belemnella casimirovensis* Zone. The most southerly records are in the Upper Maastrichtian of the Petites Pyrénées (France) and northern Spain (Ernst Collection; ? the pre-Pyrenean region of Lleida (MARTINEZ, 1982). It also occurs in the Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France, in The Netherlands, Belgium, Switzerland, the Germanies, Denmark, Sweden, Poland, Austria, Bulgaria, the Ukrainian SSR, the Carpathians, Donbas, Transcaspia and Kopet Dag in the USSR.

*Hoploscaphites tenuistriatus* (KNER, 1848)
Plate 31, figs. 2-7

KNER, R., 1848, *Scaphites tenuistriatus,* m., p. 10, pl. 1, fig. 5.

ALTH, A., 1850, *Ammonites diversesulcatus,* m., p. 203, pl. 10, fig. 8.

PLACHETKO, S., 1863, *Ammonites tenuistriatus* KNER, p. 12.

FAVRE, E., 1869, *Scaphites tenuistriatus* KNER, p. 21, pl. 5, figs. 6, 7.

NOWAK, J., 1909, *Scaphites tenuistriatus* KNER, p. 775, pl. 1, figs. 2, 4, 5.

? LOPUSKI, C., 1911, *Scaphites,* sp., p. 117, pl. 13, fig. 6.

NOWAK, J., 1911, *Hoploscaphites constrictus-tenuistriatus* KNER, p. 585 (*pars*), pl. 33, fig. 13 (*non* 14).

NOWAK, J., 1916, *Hoploscaphites constrictus-tenuistriatus* KNER, p. 59.

DIENER, C., 1925, *Discoscaphites tenuistriatus* KNER, p. 212.

WOLANSKY, D., 1932, *Hoploscaphites constrictus* var. *tenuistriata* KNER, p. 10, pl. 1, fig. 6.

MIKHAILOV, V. P., 1951, *Discoscaphites constrictus* (SOW.) var. *tenuistriata* (KNER), p. 92.

NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Discoscaphites constrictus* (SOWERBY) var. *tenuistriata* KNER, p. 197, pl. 6, figs. 5, 6, 12, 13.

BIRKELUND, T., 1966, *Scaphites (Hoploscaphites) tenuistriatus* (KNER), p. 739, fig. 6.

NAIDIN, D. P., 1974, *Hoploscaphites constrictus tenuistriatus* (KNER, 1848), p. 173, pl. 58, fig. 12; pl. 60, figs. 5, 6.

BIRKELUND, T., 1979, *Hoploscaphites tenuistriatus* (KNER), p. 55, text-fig. 2 (*pars*).

BIRKELUND, T., 1982, *Hoploscaphites tenuistriatus* (KNER, 1848), p. 21, pl. 2, figs. 8, 10.

TYPE

KNER's specimen from Lemberg (Lvov) (1848, pl. 11, fig. 3) should be designated lectotype if still in existence.

MATERIAL

Four specimens: NMM 006541, NMM 006545a-c. All are from the Lower Maastrichtian Vijlen Chalk of Mesch, Limburg, The Netherlands.

DESCRIPTION

The specimens are all crushed internal moulds. NMM 006545a-c are fragmentary phragmocones, NMM 006541 a complete macroconch 28.5 mm. long. The phragmocones are all highly involute, with an umbilicus partially obscured by the body chamber shaft (Plate 31, fig. 7). Primary ribs arise in pairs at the umbilical shoulder. They are coarse, prorsiradiate and markedly flexuous on the outer flank. They branch once or twice, on the mid and outer flank, while shorter ribs intercalate. All coarsen markedly on the venter, which they cross in a marked convexity.
The body chamber of NMM 006541 is short, with a prominent umbilical bulge, indicating it to be a macroconch. The coarse ribbing of the phragmocone persists to the beginning of the shaft, but thereafter declines into fine dense prorsiradiate riblets that increase by branching and intercalation

such that there is a uniform density over the whole surface. The aperture appears to have been feebly constricted.

DISCUSSION

The phragmocone with coarse ornament and finely ribbed body chamber, both lacking tubercles distinguish this species from *H. constrictus*. NOWAK (1911, p. 585, pl. 33, fig. 14) referred specimens with ventral tubercles at the end of the phragmocone and on the first part of the body chamber to this species. As BIRKELUND (1982) notes, they are best referred to *H. constrictus*.

The best preserved specimen (Plate 31, fig. 7) shows a striking resemblance to KNER's figure (1848, pl. 1, fig. 5) and to specimens illustrated by NAIDIN (1974) (pl. 58, fig. 12; pl. 60, figs. 5, 6) and BIRKELUND (1982, pl. 2, figs. 8-10). A specimen from Lemberg is shown in Plate 31, figs. 2-3. Although much larger than the Limburg examples, it shows the same change in ornament. The very large size of this specimen throws some doubt, perhaps, on the view that NMM 006541 is a macroconch. The umbilical bulge and a relatively high body chamber are typical macroconch features in *H. constrictus*, suggesting it is simply a rather small adult.

OCCURRENCE

The type specimens are from Kieselka, Lemberg, Galicia, now Lvov in the Ukraine. The associated fauna, with *Didymoceras schloenbachi* (FAVRE, 1869) (= *Crioceras plicatilis* KNER, 1848, p. 9, pl. 2, fig. 3) indicates a Lower Maastrichtian horizon in Poland. In the southern USSR (MIKHAILOV, 1951; NAIDIN, 1974) it is recorded from both Lower and Upper Maastrichtian. The Rügen record is imprecisely located within the Maastrichtian, while in Denmark it occurs at imprecisely placed levels around the Lower-Upper Maastrichtian boundary. At Hemmoor, north Germany, there are definitely records of *in situ* specimens from the *Belemnella fastigata/Belemnella cimbrica* Zone boundary (e.g. high in the *Belemnella occidentalis* Zone of authors) high in the Lower Maastrichtian to low in the *Belemnella junior* Zone of the Upper Maastrichtian (1 specimen) with evidence that the species ranges down to the *Belemnella sumensis* Zone of the Lower Maastrichtian. The Limburg specimens, from the Vijlen Chalk and dated as probably *cimbrica* Zone are within the known range of the species.

*Hoploscaphites pungens* (BINKHORST, 1861)
Plate 23, figs. 3, 4; Plate 32, figs. 22, 23, 24, 25;
Plate 34, figs. 2, 3, 4, 5, 6, 10, 11, 18, 19;
Plate 35, figs. 1-11.

BINKHORST, J. T., 1861, *Ammonites pungens* NOBIS, p. 32, pl. 5a 3, figs. 1a-d.

SCHLÜTER, C., 1872, *Ammonites pungens,* BINKHORST, p. 88.

GROSSOUVRE, A. DE, 1908, *Scaphites pungens* BINKHORST, sp., p. 37, pl. 11, figs. 1, 2.

NOWAK, J., 1911, *Hoploscaphites pungens* BINKHORST, p. 566.

DIENER, C., 1925, *Discoscaphites pungens* V. BINKHORST, p. 212.

BIRKELUND, T., 1982, *Acanthoscaphites pungens* (BINKHORST, 1861), p. 18.

RICCARDI, A. C., 1983, *Scaphites pungens* BINKHORST, pp. 9, 32, pl. 11, figs. 22-23.

TYPE

Holotype, by monotypy, the original of BINKHORST, 1861, p. 32, pl. 5a 3, figs. 1a-d from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands, MNB C606a-b.

MATERIAL

18 specimens, all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands: MNB unregistered, 8 specimens; NMM 3329; IRSNB IG 4285, *ex* BOSQUET Collection, two body-chambers; IRSNB 9492 *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 11, fig. 1; IRSNB 9493 *ex* UBAGHS Collection the original of DE GROSSOUVRE, 1908, pl. 11, fig. 2; IRSNB IG 6521a-e.

DESCRIPTION

Early whorls poorly known. Dorsal impressed zones of outer phragmocone whorls suggest they were flat-sided with a broadly arched flattened venter ornamented by ribs only. The flanks are ornamented by primary ribs that branch on the outer flank and cross the venter accompanied by intercalatories of similar strength. On outer phragmocone whorls (Plate 34, figs. 2-6, 10, 11) which are up to 35 mm. in diameter, the coiling is involute, with a small conical umbilicus comprising 13.5 - 16.5% of the diameter. The umbilical wall is rounded, the flanks flattened and subparallel, with convergent shoulders and a somewhat flattened venter. The whorl breadth to height ratio is 0.58 - 0.66. There are an estimated six primary ribs per half whorl. These arise at the umbilical seam and strengthen across the umbilical wall and shoulder, where they are narrow and distant. A variably developed umbilical bulla is present on all ribs, and gives rise to one or two initially straight, prorsiradiate ribs which, together with occasional inter-

calated ribs, inserted low on the flank, flex back on the outer flank, where they terminate in bullate to conical inner ventrolateral tubercles. These are linked by a prominent rib or riblets to a prominent, high outer ventrolateral clavus (Plate 34, figs. 2-6). These strengthen markedly around the last whorl of the phragmocone (Plate 34, figs. 10, 11) rising high over the venter. These clavi are linked across the venter by 2-3 riblets, with additional intercalated riblets between tuberculate groups (Plate 34, figs. 3, 6, 10), in some cases extending down to the level of the inner ventrolateral tubercles. This style of ornament extends to the beginning of the adult body chamber.

Body chambers complete enough for measurement had the following dimensions: 52 mm. (holotype), 54 mm., 52.5 mm., 47.5 mm., 62 mm., 74.5 mm. They are all relatively slender with a concave umbilical wall. I cannot confidently separate them into macro- and macroconchs.

There are two phases of ornament. The initial phase is marked by the disappearance of the fine ventral ribbing, leaving a shell ornamented by strong umbilical bullae that give rise to groups of low weak, prorsiradiate convex ribs and striae (Plate, 35, figs. 1, 3, 6, 7, 9). Initially these link to an inner ventrolateral tubercle, but these rapidly decline, whereas the outer ventrolaterals strengthen markedly and a blunt siphonal clavus appears (Plate 34, fig. 19; Plate 35, figs. 2, 7).

The final phase of ornament extends over part of the shaft and the hook. The umbilical bullae rotate and eventually lie elongated parallel to the umbilical rim, thereafter declining and in some cases disappearing by the adult aperture (Plate 35, figs. 1, 3, 4, 6, 8, 9, 11), leaving a raised umbilical rim. The inner to mid-flank region is sunken and concave, while the venter broadens markedly (Plate 34, fig. 19; Plate 35, figs. 7, 10). Flank ornament is reduced to low, dense, irregular prorsiradiate ribs that arise in groups from the bullae and are feebly convex on the mid- to outer flank. The siphonal tubercles disappear abruptly (Plate 35, fig 7) and the outer ventrolaterals decline progressively (Plate 35, figs. 7, 10) so that the last part of the shell is ornamented by fine dense riblets and striae on ventrolateral shoulders and venter that have increased by subdivion and intercalation with flank ribs (Plate 35, figs. 6-11).

DISCUSSION

BIRKELUND (1982) referred *pungens* to *Acanthoscaphites,* but the overal shell form is quite unlike that of the giant recoiled forms referred to that genus, being that typical of *Hoploscaphites.* The species indeed bears blunt siphonal clavi at the beginning of the body chamber, but feeble tubercles of similar style occur even in the holotype of *H. constrictus.* It differs from *constrictus,* however, in the presence of an inner ventrolateral tubercle on the phragmocone and early body chamber, much stronger outer ventrolateral and siphonal clavi. Much closer to *pungens* is *Acanthoscaphites schmidi* BIRKELUND, 1982 (p. 17, pl. 1, figs. 7-10; pl. 2, figs. 1-4). This has a *Hoploscaphites* form and should also be referred to that genus in my view. It too has transient siphonal tubercles, but never develops the inner ventrolateral tubercles of *pungens* and has a very feebly ribbed final section to the body chamber. The siphonal and outer ventrolateral tubercles are also much stronger in *pungens.*

OCCURRENCE

Upper Maastrichtian, Calcaire de Kunraed of Kunrade only.

*Hoploscaphites felderi* sp. nov.
Plate 27, fig. 1; Plate 33, figs. 1-15;
Plate 34, figs. 7, 8, 9, 10, 11, 13, 14, 15, 16, 17;
Text-fig. 13c.

BINKHORST, J. T., 1861, *Ammonites Decheni* NOBIS, p. 30, pl. 5a, figs. 15a-e.

GROSSOUVRE, A. DE, 1908, *Scaphites* cf. *roemeri* d'ORBIGNY, p. 35, pl. 10, figs. 1, 2, 3.

TYPES

The holotype is IRSNB 9483 *ex* BOSQUET Collection, the original of DE GROSSOUVRE, 1908, pl. 10, figs. 1a-c from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands. Paratypes are IRSNB 9484 *ex* BOSQUET Collection, the original of DE GROSSOUVRE, 1908, pl. 10, fig. 2; IRSNB 9485a *ex* UBAGHS Collection, the original of DE GROSSOUVRE, 1908, pl. 10, figs. 3a, 3b; IRSNB 9485b *ex* UBAGHS Collection; IRSNB IG 4285 *ex* BOSQUET Collection; IRSNB IG 6039 *ex* PIRLET Collection; NMB unregistered *ex* BINKHORST Collection, NMM 3510 and 35145 all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; NMM MK 120, 463 and 464, all from the Upper Maastrichtian Meerssen Chalk of the Nekami Quarry, Bemelen, Limburg, The Netherlands; BMNH C75619 *ex* MORRIS and CLEEVELY Collection, from the Upper Maastrichtian Calcaire de Kunraed 0.5 km. S of Kunrade on the Ubachsberg Road, Limburg, The Netherlands.

MATERIAL

Apart from the types, numerous fragments in the MNB, unregistered *ex* BINKHORST Collection; IRSNB IG 2738 *ex* NYST Collection; IG 6039 *ex* PIRLET Collection; 144285 *ex* BOSQUET Collection

DIMENSIONS

| | | | | | |
|---|---|---|---|---|---|
| IRSNB 9843 | 42.8(100) | 10.1(23.6) | 23.9(55.8) | 0.42 | 3.6(8.4) |
| IRSNB 9485a | 42.9(100) | 11.0(25.6) | 23.5(54.8) | 0.47 | 4.2(9.8) |
| IRSNB 9485b | –(–) | 12.6(–) | 30.4(–) | 0.41 | |
| NMM MK 120 | 50.5(100) | 13.0(25.7) | 28.0(55.4) | 0.46 | –(–) |
| IRSNB 9484 | 56.0(100) | 14.0(25.0) | 32.0(57.1) | 0.44 | –(–) |
| NMM 003510 | 65.5(100) | 14.9(22.7) | 36.0(55.0) | 0.41 | 6.4(9.8) |

(4 fragments) all from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; IRSNB IG 10511 from the environs of Maastricht, Limburg, The Netherlands.

DESCRIPTION

Most specimens are internal moulds, a few external moulds showing details of the external ornament, while only phragmocones are known.

The phragmocones are large, up to 65 mm. diameter (Plate 33, figs. 1, 6, 7, 8) with a tiny umbilicus comprising less than 10% of the diameter. The whorl section is compressed, with a whorl breadth to height ratio of 0.41 - 0.47, the greatest breadth being at the umbilical shoulder, which is narrowly rounded. The inner flanks are flattened to feebly concave the mid-outer-flanks flattened and convergent. The ventrolateral shoulders and venter are broadly rounded.

Internal moulds are generally poorly preserved (Plate 33, figs. 1, 4, 5, 6, 7, 10, 13, 14, 15; Plate 34, figs. 7, 8, 9, 12, 13, 16, 17) but a few (Plate 27, fig. 1; Plate 34, fig. 15) show ornament, as do the external moulds (Plate 33, figs. 2, 3). Primary ribs arise at the umbilical shoulder, are concave on the inner flank, sweep forwards across the middle flank, and are concave on the outer flank.

The primary ribs are accompanied by very fine striae on the inner flank (Plate 33, figs. 2, 3) which strengthen on the outer flank, where the primary ribs subdivide, and the outer flank, ventrolateral shoulders and venter are covered in sharp, dense, fine ribs (Plate 33, figs. 2, 3, 9).

The suture line (Text-fig. 13c) is quite deeply dissected, with asymmetrically bifid elements.

DISCUSSION

Much confusion surrounds the nomenclature of *Hoploscaphites felderi* sp. nov. Original described by BINKHORST as *Ammonites decheni,* this name is preoccupied by *Ammonites decheni* ROEMER, 1841 (p. 85, pl. 13, fig. 1). I was unable to find BINKHORST's figured specimen in the Museum für Naturkunde in Berlin in December 1983, but the second syntype mentioned survives, and is shown here in Plate 33, fig. 10. SCHLÜTER (1872, p. 88) considered BINKHORST's *decheni* to be the inner whorls of *Scaphites gibbus* SCHLÜTER, 1872, but these are utterly distinct (see SCHMID and ERNST, 1975, p. 327, pl. 1, figs. 3-6 for a recent discussion of this species). DE GROSSOUVRE (1908, p. 36) referred BINKHORST's *decheni* to *Scaphites roemeri* of SCHLÜTER (1872, p. 89, pl. 27, figs. 1-4) *non* d'ORBIGNY, 1850 (p. 214, *nom. nov. pro Scaphites compressus* ROEMER, 1841, p. 91, pl. 15, fig. 1 *non Scaphites compressus* d'ORBIGNY, 1841, p. 517, pl. 128, figs. 4, 5). BIRKELUND (1965, p. 102) has shown that *Scaphites roemeri* d'ORBIGNY, 1850, is an objective synonym of *Scaphites tuberculatus* GIEBEL, 1849 (p. 20), both having been proposed as replacement names for ROEMER's *compressus* (see FRECH, 1915, text-fig. 14 for a photograph of ROEMER's original), and has referred SCHLÜTER's material to a new species, *Hoploscaphites ikorfakensis* BIRKELUND, 1965 (p. 102, pl. 24, figs. 1-4; pl. 25, figs. 1-2; pl. 26, fig. 1; text-figs. 59, 93, 121 (3) based on a large suite of beautifully preserved material from East Greenland. This may be a synonym of the Upper Campanian *Scaphites ornatissimus* d'ORBIGNY, 1850 (p. 214), which cannot be regarded as a *nomen dubium* following its redescription and illustration by SORNAY (1956).

*Hoploscaphites ornatissimus* and *ikorfakensis* differ from *H. felderi* in being less compressed and lacking the strong differention of inner-mid flank and outer flank-venter ornament, while some individuals of these two species have ventrolateral tubercles. Similar criteria differentiate *Hoploscaphites ravni* BIRKELUND, 1965 [p. 106, pl. 26, figs. 2-4; pl. 27, figs. 1-4; pl. 28, fig. 1; pl. 29, fig. 1; text-figs. 94-97, 100, 121 (4, 5)]. *Hoploscaphites greenlandicus* (DONOVAN, 1953) (p. 121, pl. 24, figs. 9-10); see also BIRKELUND 1965, p. 110, pl. 28, figs. 2-3; pl. 29, fig. 2; pl. 30, figs. 1-3; pl. 31, figs. 1, 2; pl. 32, fig. 1; pl. 33, fig. 1; text-figs. 64-66, 98-100, 121 (6) lacks tubercles on the phragmocone as does *H. felderi* sp. nov., but is a stouter form, with fine wiry ribs on the whole of the flanks, rather than the marked differentiation of the present species. All of these forms are much older than *H. felderi* sp. nov.

OCCURRENCE

Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands; Upper Maastrich-

tian Meerssen Chalk of the Nekami Quarry, Bemelen, Limburg, The Netherlands; Upper Maastrichtian of the environs of Maastricht and possibly Geulhem, Limburg, The Netherlands.

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

### TYPE SPECIES

*Scaphites tridens* KNER, 1848, p. 10, pl. 2, fig. 1, by the subsequent designation of DIENER, 1925, p. 205.

### DIAGNOSIS

Giant, strongly dimorphic scaphitids with whorls in contact throughout; microconchs with open umbilicus throughout, macroconchs with umbilicus partly occluded by early part of body chamber. Phragmocone with dense ribs arising singly or in pairs from umbilical shoulder with intercalatories of various lengths. Ribs sometimes branch. Later parts of phragmocone and early body chamber without tubercles or with some or all of umbilical, lateral, ventrolateral and siphonal tubercles on some ribs. End of body chamber with at least ventral and siphonal tubercles, the latter varying from a strong clavus to a mere elevation on the rib. Ribs loop between tubercles, and non tuberculate ribs intercalate between tuberculate groups on flank and venter. Aperture with marked constriction. Suture intricately subdivided.

### DISCUSSION

A full revision of the type species will be published elsewhere, on the basis of a large suite of topotypes from Nagorzany, Galicia. These show the species to be highly variable and strongly dimorphic. All specimens referred by previous authors to *Acanthoscaphites tridens trispinosus* (GEINITZ, 1850) and *Acanthoscaphites tridens bispinosus* NOWAK, 1911 are macroconchs, as is KNER's figured specimen (1848, pl. 2, fig. 1). The microconch corresponding to these includes forms referred to *Acanthoscaphites trinodosus* (KNER, 1848) and *Acanthoscaphites quadrispinosus* (GEINITZ, 1850). In the species there are umbilical, ventrolateral and siphonal tubercles on the late phragmocone and body chamber of almost all specimens, the umbilical tubercles migrating out to an umbilicolateral position on the outer whorl. Rare specimens show a delayed development of siphonal tubercles which are weak and restricted to the last part of the body chamber. Macroconchs have no umbilical tubercles or only feeble umbilical bullae on the phragmocone and, occasionally the early body chamber, with strong ventral and siphonal clavi present on the last part of the body chamber only, with some individuals showing delayed development of very weak siphonal tubercles. Only *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841) (p. 329, pl. 98, figs. 3-5), known from juvenile phragmocones only and *A. varians* (LOPUSKI, 1911) (p. 120, pl. 4, figs. 1-3) can be referred to the genus with any confidence (*Acanthoscaphites innodosus* NAIDIN, 1974, p. 178, pl. 62, fig. 1 is regarded as a synonym of *A. tridens*). *Scaphites pungens* BINKHORST, 1861 (p. 32, pl. 5a 3, figs. 1a-d) and *Acanthoscaphites schmidi* BIRKELUND, 1982 (p. 17, pl. 1, figs. 7-10; pl. 2, figs. 1-4) are both *Hoploscaphites*, as described above. The Upper Campanian *Acanthoscaphites praequadrispinosus* BŁASZKIEWICZ, 1980, p. 38, pl. 19, figs. 2, 3, 6-8; pl. 20, figs. 1-3, 6-8; pl. 21, figs. 1-6) lacks a siphonal tubercle but has flank ornament like the microconchs of the type species. BŁASZKIEWICZ regards it as ancestral to Maastrichtian *Acanthoscaphites;* it resembles the *Scaphites nodosus* OWEN, 1852 (p. 581, pl. 8, fig. 4) group, this North American form being the type species of *Jeletzkytes* RICCARDI, 1983.

*Acanthoscaphites* appears to be a hypermorphic giant in which the typically scaphitine phragmocone persists to a very large size. It seems to be a parallel development to *Rhaeboceras* MEEK, 1876, an equally large and recoiled form from the Upper Campanian and Maastrichtian of the North American Western Interior which generally lacks tubercles.

### OCCURRENCE

Maastrichtian, northern France, the Germanies, Denmark, Poland, the Ukrainian SSR, Donbass and elsewhere in southern European Russia.

## *Acanthoscaphites tridens* (KNER, 1848) Plate 37, figs. 1-5

KNER, R., 1848, *Scaphites tridens*, m., p. 10, pl. 2, fig. 1.

KNER, R., 1848, *Scaphites trinodosus*, m., p. 11, pl. 2, fig. 2.

GEINITZ, H. B., 1850, *Scaphites tridens* KNER (*Scaphites trispinosus* GEIN. litt.); p. 116, pl. 7, fig. 1.

GEINITZ, H. B., 1850, *Scaphites quadrispinosus*, p. 116, pl. 7, fig. 2; pl. 8, fig. 2.

GEINITZ, H. B., 1850, *Scaphites trinodosus* KNER, p. 116, pl. 8, fig. 1.

ALTH, A., 1850, *Scaphites tridens* KNER, p. 208.

FAVRE, E., 1869, *Scaphites trinodosus* KNER, p. 22, pl. 5, figs. 8, 9.

FAVRE, E., 1869, *Scaphites tridens* KNER, p. 24, pl. 6.

SCHLÜTER, C., 1872, *Scaphites tridens* KNER, p. 94, pl. 28, figs. 1-4 (with full synonymy).

HOLZAPFEL, E., 1888, *Scaphites tridens* KNER, p. 63, pl. 5, fig. 1.

? SEMENOV, V. P. [Benjamin], 1899, *Scaphites tridens* KNER, p. 135.

WOLLEMAN, A., 1902, *Scaphites tridens* KNER, p. 135.

NOWAK, J., 1912, *Acanthoscaphites tridens* KNER, p. 570, pl. 32, figs. 1-5, 7; pl. 33, figs. 25-29; text-figs. 8-11.

NOWAK, J., 1912, *Acanthoscaphites tridens-trinodosus* KNER, p. 576, pl. 32, figs. 5, 7; pl. 33, figs. 25-26; text-fig. 13.

NOWAK, J., 1912, *Acanthoscaphites tridens-quadrispinosus* GEINITZ, p. 577, pl. 33, fig. 28.

NOWAK, J., 1912, *Acanthoscaphites tridens-bispinosus* n.v., p. 577, pl. 32, figs. 1-3; text-fig. 14.

NOWAK, J., 1912, *Acanthoscaphites tridens-trispinosus* GEINITZ, p. 578, pl. 32, figs. 5, 7.

NOWAK, J., 1912, *Acanthoscaphites tridens-varians* LOPUSKI, p. 578 (*pars*), pl. 33, fig. 29.

DIENER, C., 1925, *Acanthoscaphites tridens* KNER, p. 207.

DIENER, C., 1925, *Acanthoscaphites tridens-bispinosus* NOWAK; DIENER, p. 208.

DIENER, C., 1925, *Acanthoscaphites tridens-quadrispinosus* GEINITZ, p. 208.

DIENER, C., 1925, *Acanthoscaphites tridens-trispinosus* GEINITZ, p. 208.

REESIDE, J. B., 1928, *Acanthoscaphites quadrispinosus* (GEINITZ), p. 33.

REESIDE, J. B., 1928, *Acanthoscaphites tridens* (KNER) NOWAK, p. 35.

REESIDE, J. B., 1928, *Acanthoscaphites tridens* (KNER) var. *bispinosus* NOWAK, p. 35.

REESIDE, J. B., 1928, *Acanthoscaphites trinodosus* (KNER) NOWAK, p. 35, pl. 11, fig. 2.

REESIDE, J. B., 1928, *Acanthoscaphites trispinosus* (GEINITZ) NOWAK, p. 35, pl. 11, fig. 1.

WOLANSKY, D., 1932, *Acanthoscaphites tridens* var. *quadrispinosus* NOWAK, p. 10, pl. 3, fig. 2.

MIKHAILOV, V. P., 1951, *Acanthoscaphites tridens* (KNER), p. 101, pl. 17, fig. 76; text-fig. 34.

MIKHAILOV, V. P., 1951, *Acanthoscaphites tridens* (KNER) var. *trinodosa* (KNER), p. 103, pl. 18, fig. 88; pl. 19, figs. 90, 91; text-fig. 35.

MIKHAILOV, V. P., 1951, *Acanthoscaphites tridens* (KNER) var. *quadrispinosa* (GEINITZ), p. 104, pl. 19, fig. 93.

MIKHAILOV, V. P., 1951 *Acanthoscaphites tridens* (KNER) var. *bispinosa* NOWAK, p. 104.

NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Acanthoscaphites tridens tridens* (KNER, 1848), p. 196, pl. 7, figs. 5.

NAIDIN, D. P. and SHIMANSKIJ, V. N., 1959, *Acanthoscaphites tridens bispinosus* NOWAK, 1911, p. 196, pl. 7, fig. 4.

NAIDIN, D. P., 1974, *Acanthoscaphites tridens tridens* (KNER, 1848), p. 176, pl. 60, figs. 2, 3.

NAIDIN, D. P., 1974, *Acanthoscaphites tridens bispinosus* NOWAK, 1911, p. 176, pl. 59, fig. 4, pl. 60, fig. 4.

NAIDIN, D. P., 1974, *Acanthoscaphites tridens trinodosus* (KNER, 1848), p. 177, pl. 59, fig. 3; pl. 61, fig. 1.

NAIDIN, D. P., 1974, *Acanthoscaphites innodosus* NAIDIN, sp. nov., p. 178, pl. 62, fig. 1.

BŁASZKIEWICZ, A., 1980, *Acanthoscaphites quadrispinosus* (GEINITZ, 1850), p. 39, pl. 22, figs. 1-10.

BŁASZKIEWICZ, A., 1980, *Acanthoscaphites bispinosus* NOWAK, 1911, p. 40, pl. 23, figs. 1-3, 5-7; pl. 24, figs. 1, 2, 4, 5.

TYPES

The whereabout's of KNER's material is not known. The original of his pl. 2, fig. 1 should be designated lectotype if found.

MATERIAL

An unregistered specimen in the Collections of the Geologisches und Paläontologisches Institut, Bonn, from the "Mucronaten-Schichten" of Vaals, the original of SCHLÜTER 1872, pl. 28, fig. 3. IRSNB 10255 from the "Craie Glauconifère" of Schneeberg near Vaals, Limburg, The Netherlands.

| DIMENSIONS | IRSNB 10255 |
|---|---|
| *D* | 103.0(100) |
| *Wb* | 24.5(23.8) |
| *Wh* | 62.0(60.2) |
| *Wb:Wh* | 0.40 |
| *U* | 9.5(9.2) |

DESCRIPTION

Both specimens are highly distorted composite internal moulds of microconchs. IRSNB 10255 (Pl. 37, figs. 1, 2) has been crushed laterally; the GPIB specimen (Pl. 37, figs. 3-5) has been crushed into an ellipse with a maximum diameter of 91 mm. The first specimen preserves the flank ornament well. Coiling is involute, with a very small umbilicus. Primary ribs arise at the umbilical seam of the spire and strengthen across the umbilical wall and shoulder. They broaden markedly on the inner flank, are strong and prorsiradiate, and bear rounded to bullate umbilicolateral tubercles that migrate progressively outwards around the outer whorl. Narrower ribs arise in groups of two or three from these tubercles or intercalate, to give a total of 90-100 ventral ribs on the specimen. Ventrolateral tubercles are present from the smallest diameter visible, and increase irregularly in strength when traced around the phragmocone and onto the body-chamber. They link groups of up to three ribs, while a similar number of ribs loop over the venter

to connect with the corresponding tubercle on the opposite flank. There are up to three non tuberculate ribs between tuberculate ribs. Occasional siphonal tubercles, weak and effaced by distortion, are present at diameters below 90 mm. Beyond this strong siphonal nodes appear between the ventral tubercles, to which they are linked by groups of three ribs.
Ribbing coarsens and becomes more widely spaced on the youngest preserved section of the body chamber.
The flank ornament of the second specimen is poorly preserved (Pl. 37, figs. 1, 2) but of similar style. Dorsum and venter show, however, well-developed siphonal tubercles extending over all of the body chamber and a part of the phragmocone.
Neither specimen shows the sutures.

DISCUSSION

The two specimens described here are both microconchs, as is the specimen from Schneeberg figured by HOLZAPFEL (1888, pl. 5, fig. 1). On the basis of these records from the "Craie-Glauconifère" or "Mucronaten-Mergel" I recorded *Acanthoscaphites trinodosus* from the Zeven-Wegen Chalk (KENNEDY, 1984, Table 6). The matrix of the specimens suggests that although they are undoubtedly from the Gulpen Formation they are more likely to be from a higher horizon, probably the Beutenaken Chalk.
Study of a large suite of *Acanthoscaphites* from Nagorzany, near Lvov (formerly Lemberg) in the Ukranian SSR (formerly Galicia) shows that the various forms named *tridens, trispinosus* and *bispinosus* are macroconchs and *trinodosus* and *quadrispinosus* are microconchs of what I believe to be a single variable species. Full discussion of the variation is deferred to a future occasion.
The present specimens are easily differentiated from *Acanthoscaphites varians* (LOPUSKI, 1911) (p. 120, pl. 4, figs. 1-3) which has an additional row of tubercles on each side making a maximum of seven versus five in the present species.

OCCURRENCE

Lower Maastrichtian of the Germanies, Denmark, Poland, the Ukrainian SSR, Donbass and elsewhere in southern European Russia.

*Acanthoscaphites* cf. *verneuilianus*
(d'ORBIGNY, 1841)
Plate 34, fig. 1

compare:

ORBIGNY, A. d', 1841, *Ammonites verneuilianus* d'ORBIGNY, p. 329, pl. 98, figs. 3-5.

ORBIGNY, A. d', 1850, *Ammonites verneuilianus* d'ORB., 1840, p. 212.

GROSSOUVRE, A. DE, 1894, *Scaphites verneuili* d'ORBIGNY, sp., p. 253, pl. 36, fig. 2.

DIENER, C., 1925, *Scaphites verneuili* d'ORBIGNY, p. 204.

KENNEDY, W. J., 1986, *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841); p. 74, pl. 16, figs. 15-17; text-fig. 10c.

TYPE

Holotype, by monotypy is the unregistered specimen in the École des Mines Collections (now in the Université Claude Bernard, Lyon) figured by d'ORBIGNY, 1841, pl. 98, figs. 3-5 and DE GROSSOUVRE, 1894, pl. 36, fig. 2, from the Upper Maastrichtian Calcaire à *Baculites* of Fresville, near Valognes, Manche, France (*ex* DE GERVILLE Collection).

MATERIAL

IRSNB IG 6521f *ex* UBAGHS Collection from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

DESCRIPTION

The specimen is a fragment only of the flank and dorsum of a phragmocone plus part of the body chamber. The whorl section was compressed, with flattened inner flanks, convergent outer flanks and a relatively broad flattened venter. Ornament is rather worn, but two orders of ribbing can be differentiated. The primary ribs are prorsiradiate and bear a weak, rounded inner ventrolateral tubercle. This gives rise to a rib or a pair of riblets that link it to a small, conical outer ventrolateral tubercle. The secondary ribs are much finer, and are inserted in twos and threes between the tuberculate groups.
The venter of the specimen is abraded, with only a faint suggestion of a siphonal tubercle on the main ribs.
The sutures are corroded, but E is deep and narrow, E/L deeply incised.

DISCUSSION

Although poorly preserved, the ornament of this fragment strongly recalls that of *Acanthoscaphites verneuilianus* (d'ORBIGNY, 1841) (p. 329, pl. 98, figs. 3-5) from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France (KENNEDY, 1986). When compared with *H. pungens,* with which it co-occurs, the differentiation of ornament into primary and secondary ribs and the tuberculation of *verneuilianus* is immediately distinctive.

OCCURRENCE

The holotype of *Acanthoscaphites verneuilianus* is from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France. The Limburg specimen is from the Upper Maastrichtian Calcaire de Kunraed of Kunrade.

*Acanthoscaphites* sp.
Plate 32, figs. 15, 16, 17

GROSSOUVRE, A. DE, 1908, *Scaphites*, sp., p. 37 (*pars*), pl. 10, fig. 4.

MATERIAL

IRSNB 9486 *ex* BOSQUET Collection, the original of DE GROSSOUVRE, 1908, pl. 10, fig. 4, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

| DIMENSIONS | IRSNB 9486 |
|---|---|
| *D* | 45.5(100) |
| *Wb* | 11.9(26.2) |
| *Wh* | 18.0(39.5) |
| *Wb:Wh* | 0.66 |
| *U* | 4.8(10.5) |

DESCRIPTION

The specimen is an internal mould of half a whorl, most of which is phragmocone. Coiling is very involute, the small, shallow umbilicus comprising 10.5% of the diameter. The umbilical wall is low and rounded, the whorl compressed (whorl breadth to height ratio 0.66) with flat, subparallel sides and an arched and narrowly rounded venter. The fragment bears 10-11 primary ribs. These arise at the umbilical seam, pass across the umbilical wall in a concave rectiradiate course, strengthening as they do so. They are markedly prorsiradiate and flexuous as they cross the flanks, strengthening markedly as they do so. The ribs increase by intercalation and occasional bifurcation, so that there are 19/20 ribs at the juncture of flank and ventrolateral shoulder, where they are strengthened into a weak incipient inner ventrolateral tubercle. The primary ribs flex forwards from this point, and most bear a small, conical outer ventrolateral tubercle. Some ribs bifurcate at the inner ventrolateral tubercle and other fine ribs are intercalated over the ventrolateral shoulders and venter to give approximately 40 ribs on the venter.

DISCUSSION

There is no indication of a siphonal tubercle, but preservation of the later parts of the venter is defective. The species differs from the other *Acanthoscaphites* from the Limburg Maastrichtian in the flexuosity of the flank ribs, presence of only a single order of flank ribs (separating it from *A. verneuilianus*) and no umbilical bullae (separating it from *H. pungens*). At a comparable size, *Hoploscaphites constrictus* lack inner ventrolateral tubercles.

OCCURRENCE

Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.

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PLATE 1

Figs. 1, 2. – Pachydiscus (Pachydiscus) colligatus *(BINKHORST, 1861) the lectotype, the original of BINKHORST, 1861, pl. 8, from the Upper Campanian of Jauche, Brabant, Belgium (MNB unreg.* ex *BINKHORST Coll.).*
*Fig. 1 is natural size and shows the only surviving area of external shell surface. Note that the internal mould is smooth.*
*Fig. 2 is reduced × 0.65; the original is 270 mm. in diameter.*


PLATE 2

Figs. 1, 2. – Pachydiscus (Pachydiscus) colligatus *(BINKHORST, 1861) the lectotype, the original of BINKHORST, 1861, pl. 8, from the Upper Campanian of Jauche, Brabant, Belgium (MNB unreg.* ex *BINKHORST Coll.).*
*Both figures are reduced × 0.7; the original is 270 mm. in diameter.*
*Arrow indicates are where surface of shell exterior, shown in Pl. 1, fig. 1, is preserved.*

PLATE 3

Pachydiscus (Pachydiscus) colligatus *(BINKHORST, 1861) from the Upper Campanian of Folx-les-Caves, Brabant, Belgium (IRSNB 10256* ex *DOUCET Coll.).*
*Reduced × 0.8; the specimen is 220 mm. in diameter.*

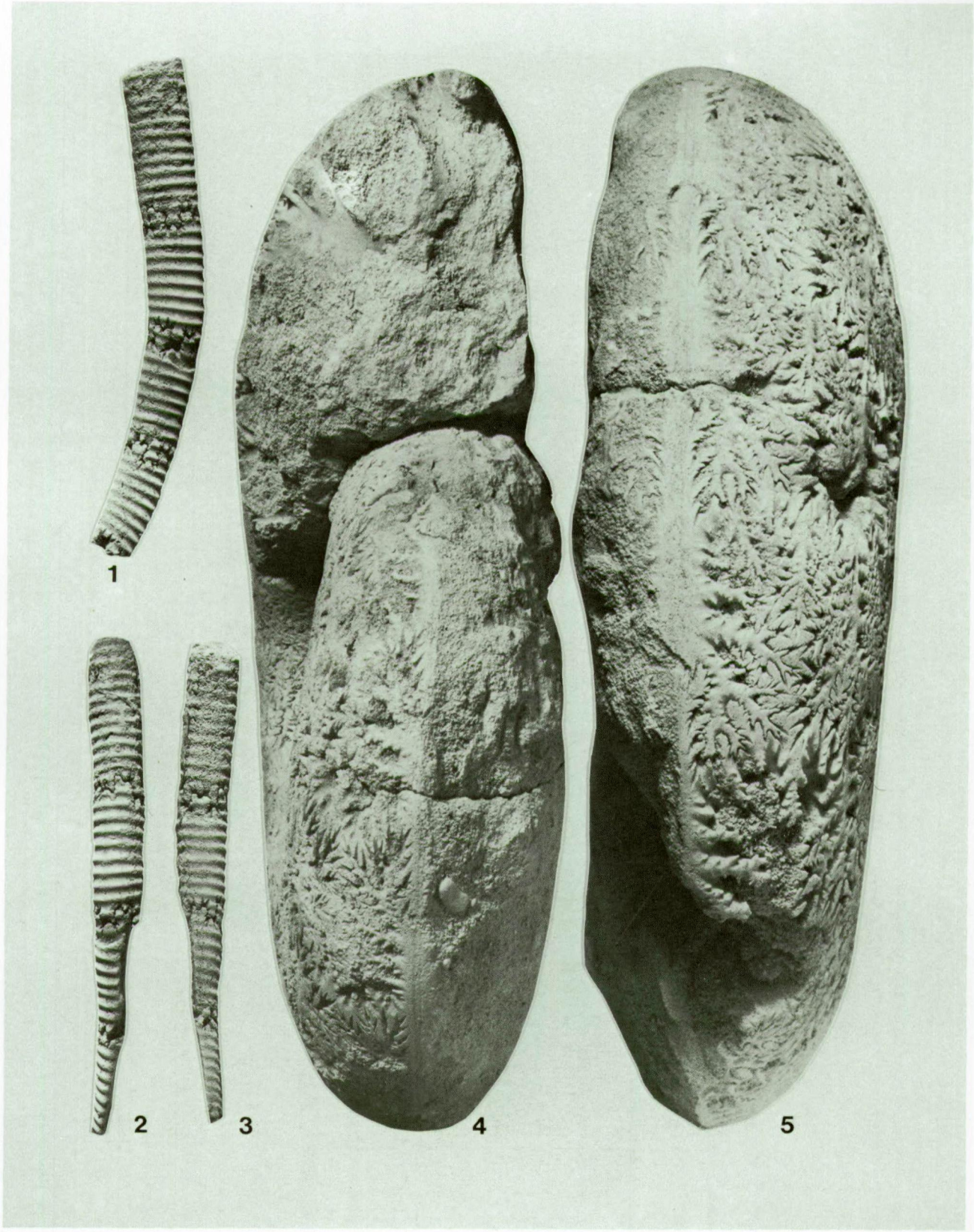



PLATE 4

Figs. 1-3. – Glyptoxoceras *cf.* circulare *SHIMIZU, 1935, Upper Maastrichtian, ? Nekum Chalk, St. Pietersberg, Maastricht, Limburg, The Netherlands (NMM 1083).*

Figs. 4, 5. – Pachydiscus (Pachydiscus) colligatus *(BINKHORST, 1861) from the Upper Campanian of Folx-les-Caves, Brabant, Belgium (IRSNB 10256* ex *DOUCET Coll.) same specimen as that shown in Plate 3, with an additional part of the outer whorl added.*

*Figs. 1-3 are natural size: figs. 4-5 are reduced × 0.75, the specimen is 250 mm in diameter.*

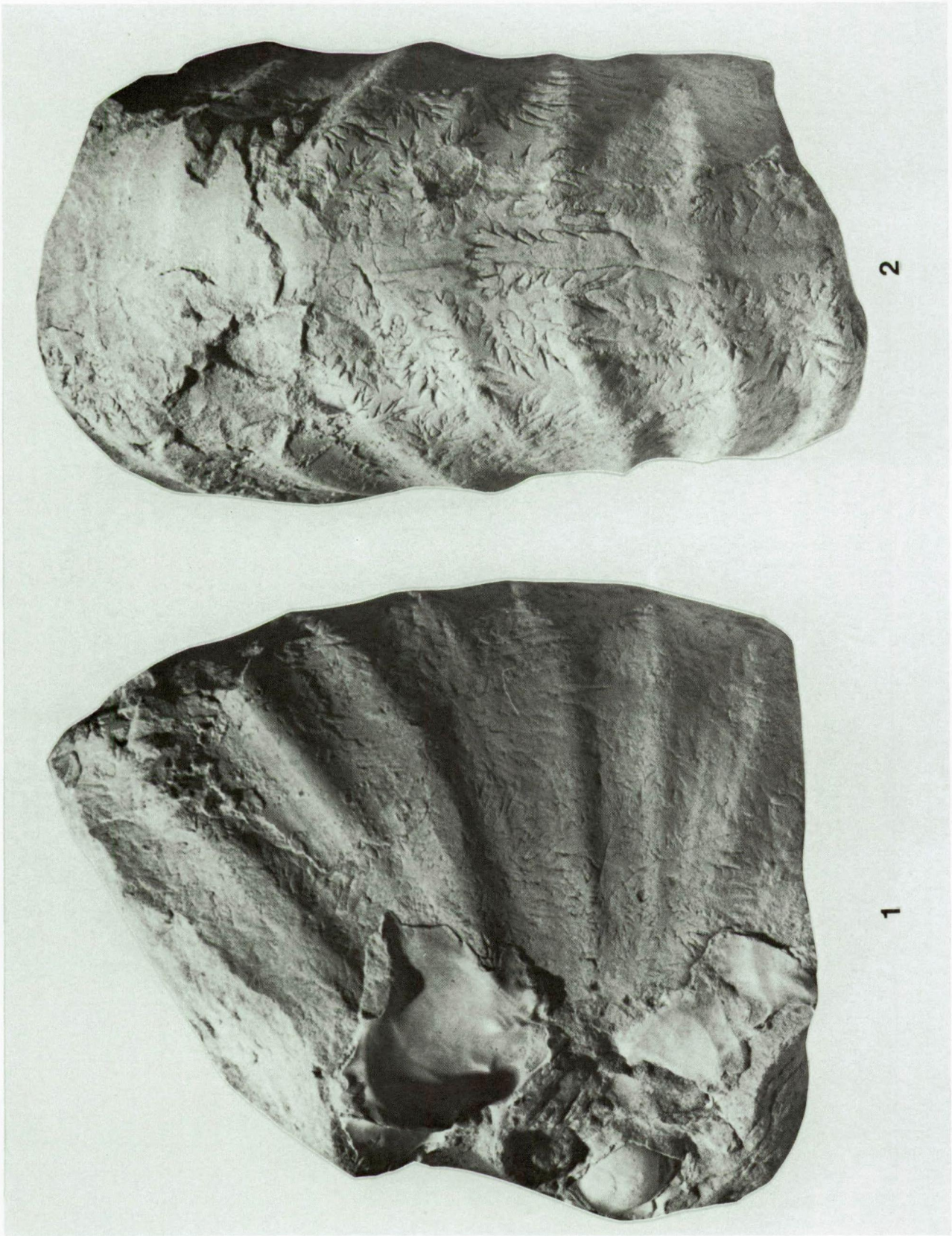



PLATE 5

Figs. 1, 2. – Eupachydiscus *cf.* levyi *(DE GROSSOUVRE, 1894) from the Lower Campanian Vaals Formation of Slenaken, Limburg, The Netherlands (MNB unreg.* ex. *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 7, fig. 1, and a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861).*
*Both figures are natural size.*

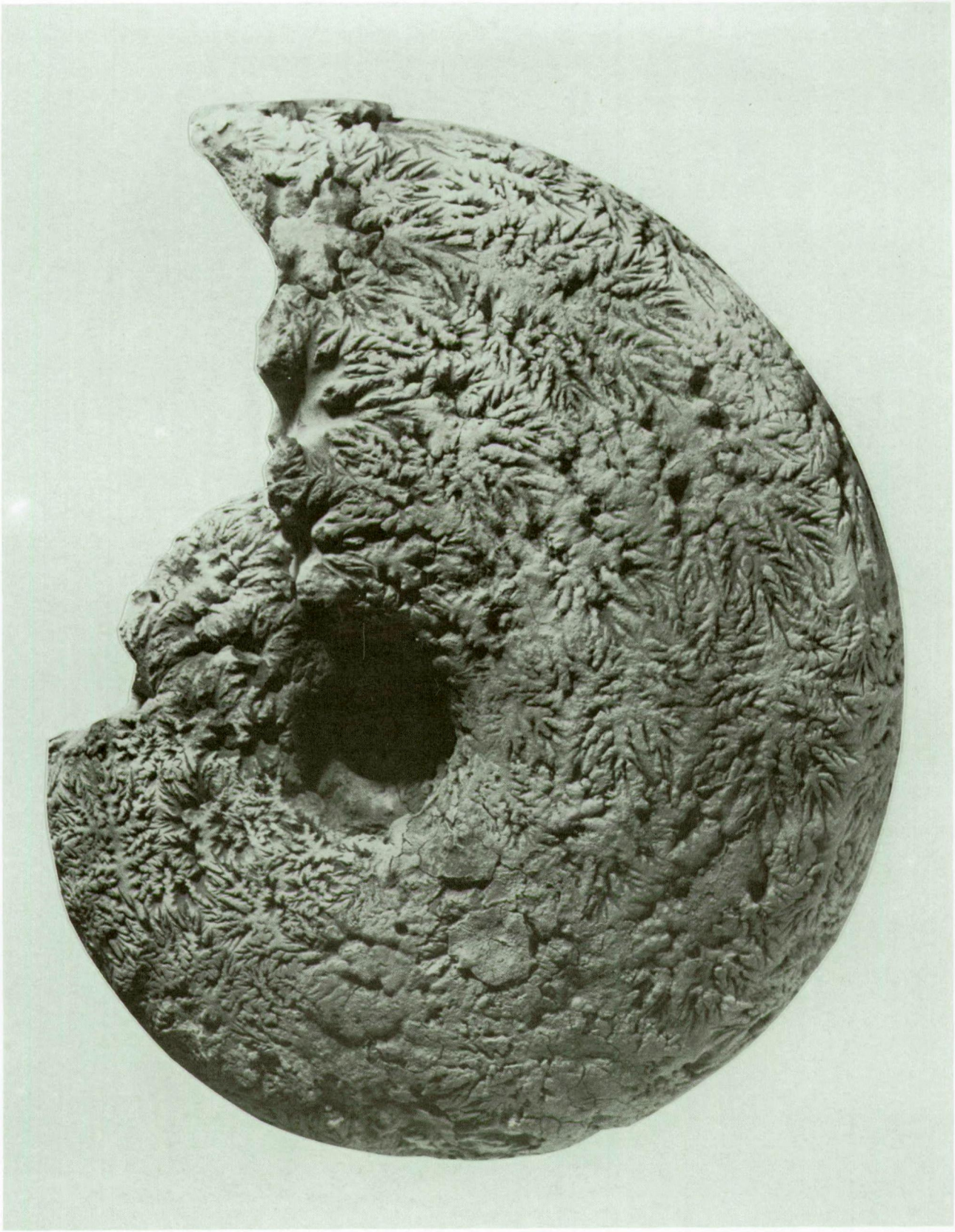


PLATE 6

Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade, near Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 8a, figs. 1, 2, and a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861).*
*Reduced × 0.83, the specimen is 235 mm. in diameter.*


PLATE 7

Figs. 1, 2. – Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade, near Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 8a, figs. 1, 2, and a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861). Reduced × 0.83, the specimen is 235 mm. in diameter.*

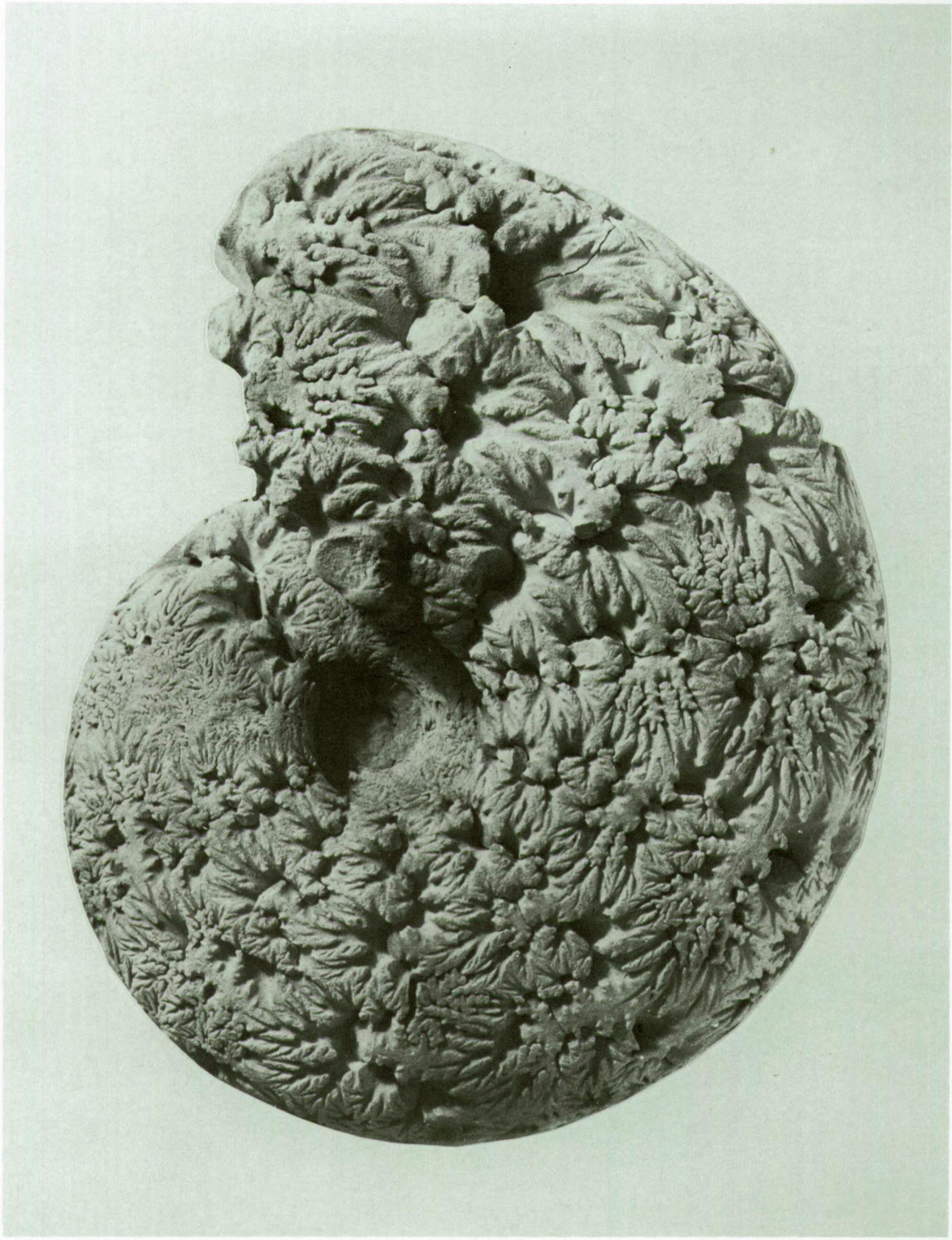


PLATE 8

Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unregistered).*
*Reduced × 0.95, the original is 200 mm. in diameter.*


PLATE 9

Figs. 1, 2. – Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unregistered).*
*Reduced × 0.95, the original is 200 mm. in diameter.*

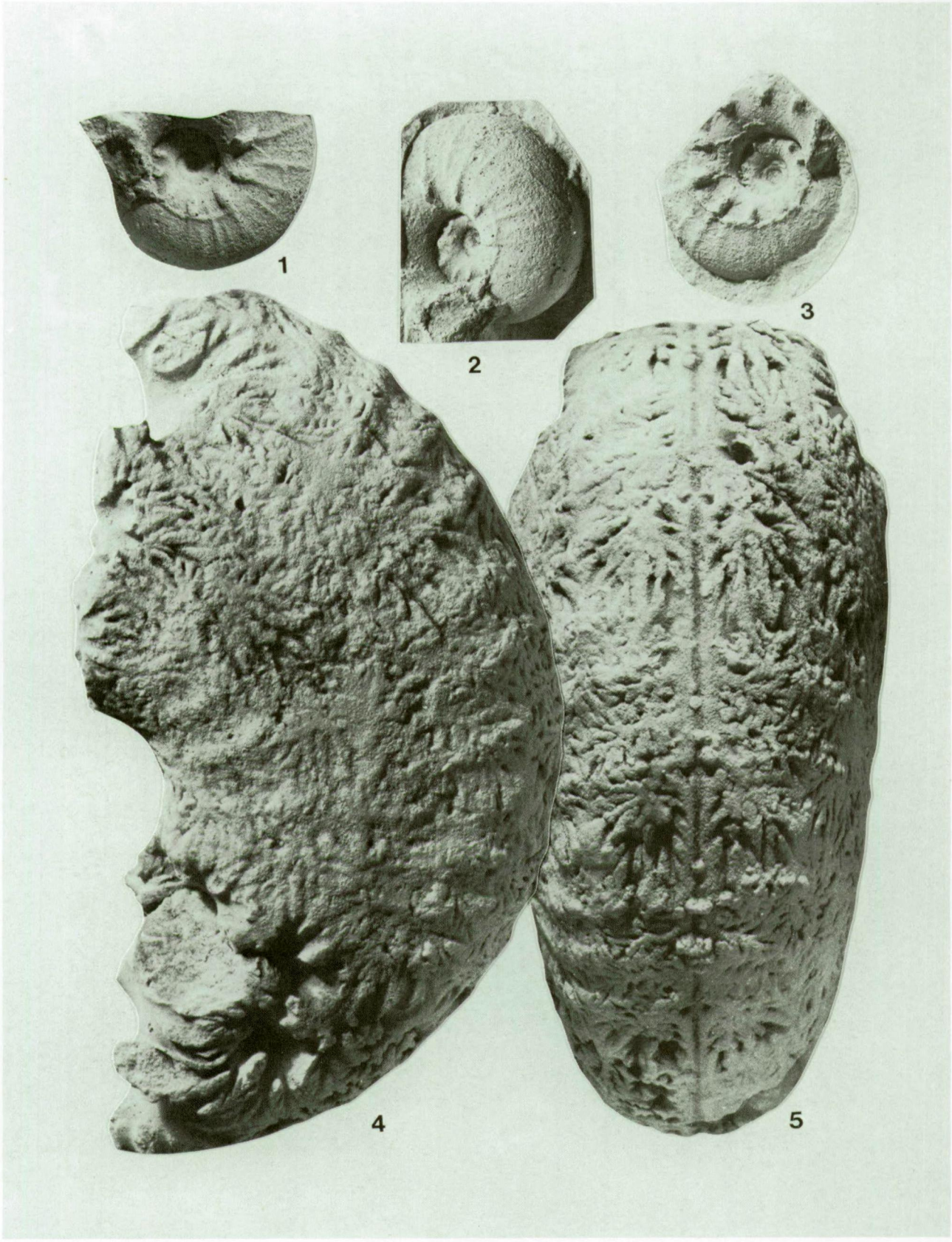



PLATE 10

Figs. 1-3. – Anapachydiscus fresvillensis *(SEUNES, 1890) plaster cast taken from an external mould from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9473,* ex *UBAGHS Coll.), a cast of the same specimen was figured by DE GROSSOUVRE, 1908, pl. 4, figs. 1a, 1b.*

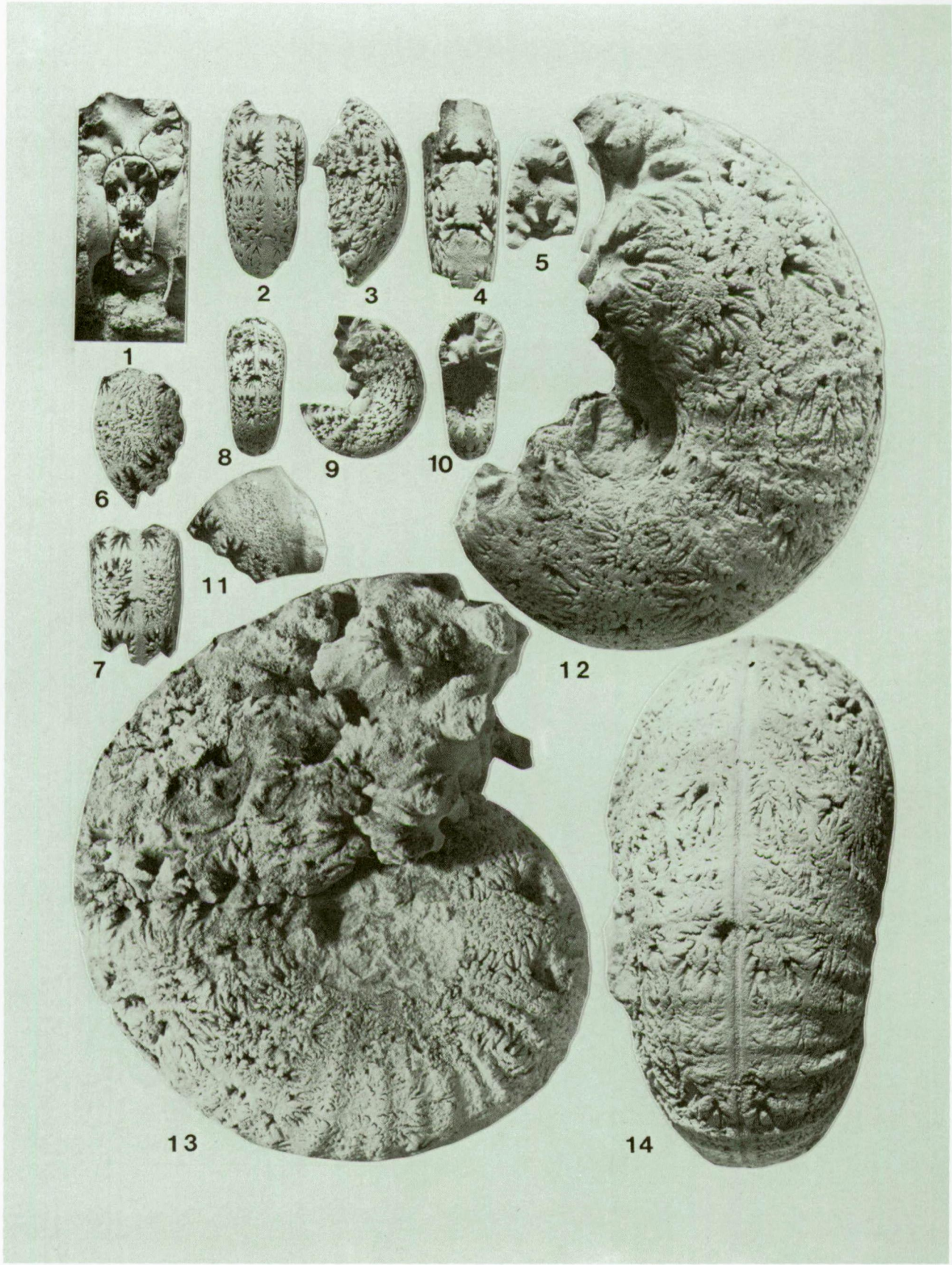
Figs. 4-5. – Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade near Kunrade, Limburg, The Netherlands (NMM 3533).*
*All figures are natural size.*


PLATE 11

Figs. 1-4. – Pachydiscus (Pachydiscus) jacquoti *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands. 1-3 internal mould; 4 squeeze from external mould (IRSNB 9480-81* ex *UBAGHS Coll.). The original of DE GROSSOUVRE, 1908, pl. 9, figs. 4.*

Figs. 5-6. – Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9471* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 4, fig. 3.*

*All figures are natural size.*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## PLATE 12

Figs. 1-3. – Pachydiscus (Pachydiscus) jacquoti *(SEUNES, 1890), juvenile labelled Maastricht, but probably from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 4-5. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850), the lectotype of* Ammonites exilis *BINKHORST, 1861, p. 51, pl. 6, fig. 4a-f, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

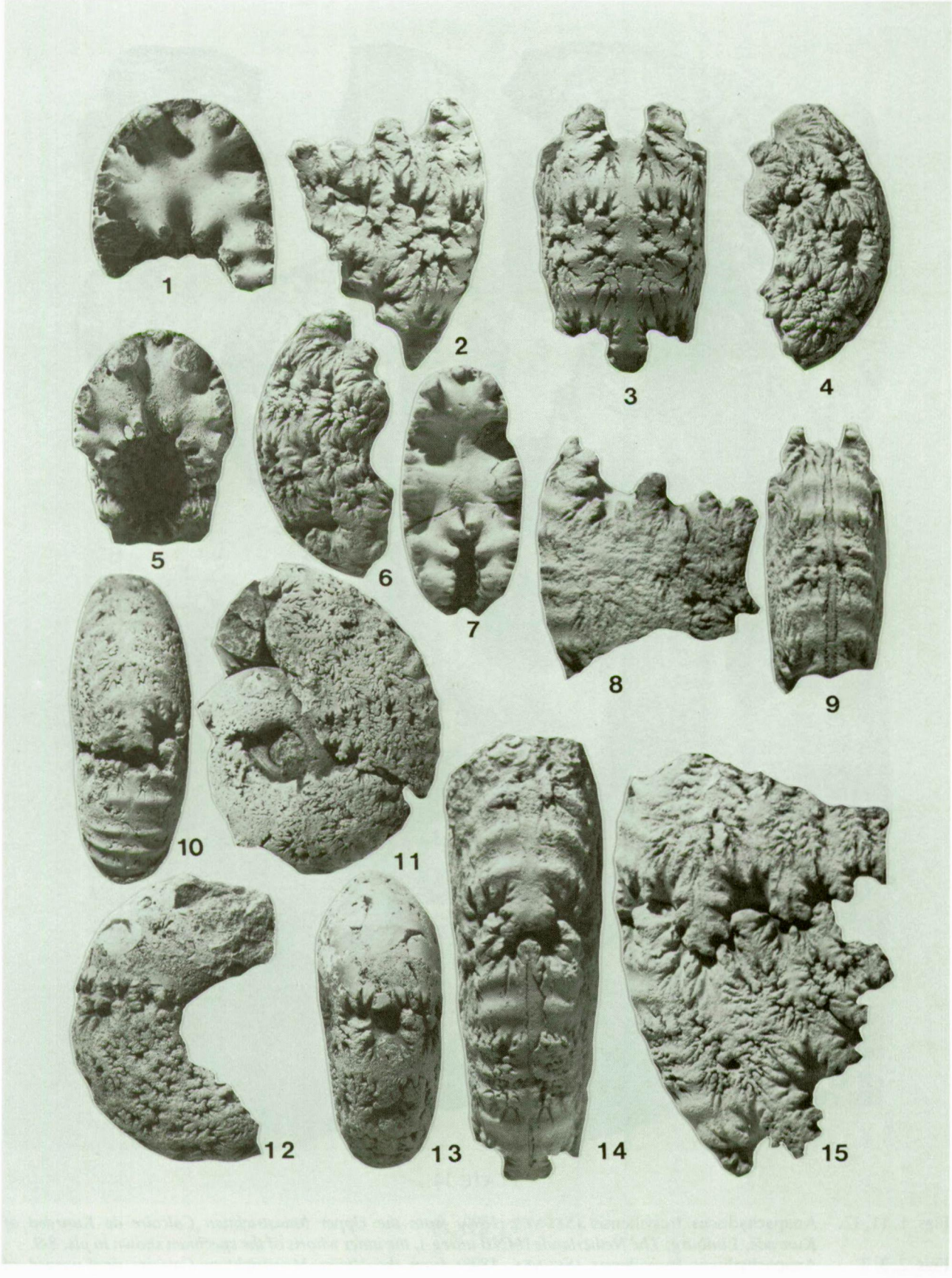
Figs. 6-7. – Pachydiscus (Pachydiscus) *sp. juv. cf.* jacquoti *(SEUNES, 1890), labelled Maastricht, but probably from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 8-10. – Pachydiscus (Pachydiscus) jacquoti *(SEUNES, 1890), labelled Maastricht, but probably from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Fig. 11. – Pachydiscus (Pachydiscus) *sp. juv. cf.* jacquoti *(SEUNES, 1890), labelled Maastricht, but probably from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Fig. 12. – Anapachydiscus fresvillensis *(SEUNES, 1890), from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.); inner whorl of specimen shown in Pls. 8-9.*

Figs. 13-14. – Anapachydiscus fresvillensis *(SEUNES, 1890), from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRNSB 9636* ex *UBAGHS Coll.). The original of DE GROSSOUVRE, 1908, pl. 5, fig. 1.*
*All figures are natural size.*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## PLATE 15

Figs. 1-3. – Anapachydiscus *cf.* jacquoti *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade near Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 8a, fig. 3, a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861).*

Figs. 4-6. – Anapachydiscus fresvillensis *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade near Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 7, fig. 2b, a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861).*

Figs. 7-9. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 10-11. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 12-13. – Pachydiscus (Pachydiscus) jacquoti *(SEUNES, 1890) from the Upper Maastrichtian Calcaire de Kunraed of Benzerade near Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), this may be the original of BINKHORST, 1861, pl. 7, figs. 2a-b, and thus a paralectotype of* Pachydiscus colligatus *(BINKHORST, 1861).*

Figs. 14-15. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*
*All specimens are natural size.*

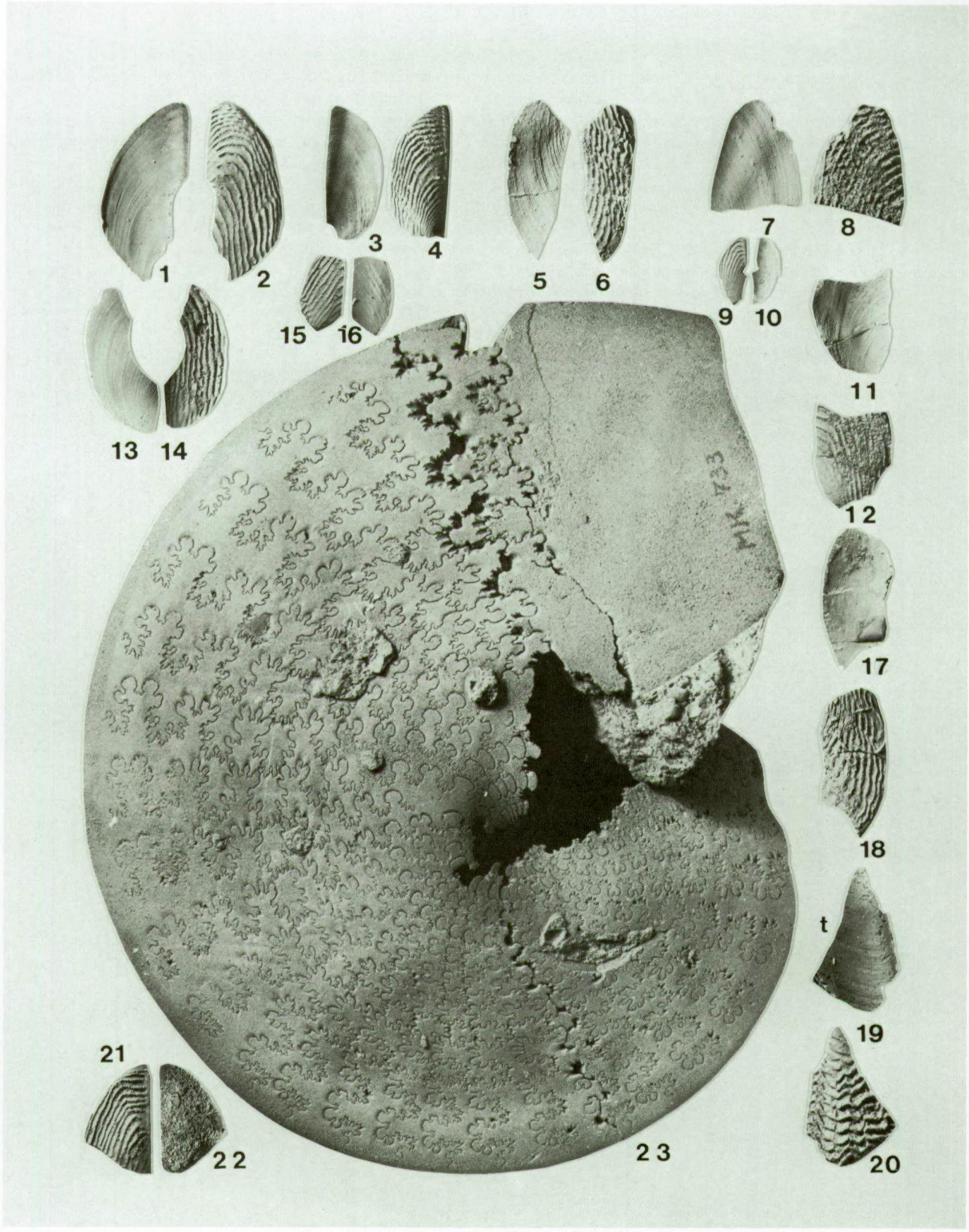



PLATE 16

Figs. 1-22. – Rugaptychus rugosus *(SHARPE, 1857), a series of specimens from Folx-les-Caves, Brabant, Belgium, including the specimens figured by DE GROSSOUVRE, 1908, pl. 10, figs. 7-13 (IRSNB 10288a-u* ex *CORNET Coll.).*

Fig. 23. – Sphenodiscus binkhorsti *(BÖHM, 1898) from the top of the Upper Maastrichtian Meerssen Chalk of Geulhem, Limburg, The Netherlands (NMM MK 733* ex *FELDER Coll.).*

*All figures are natural size.*

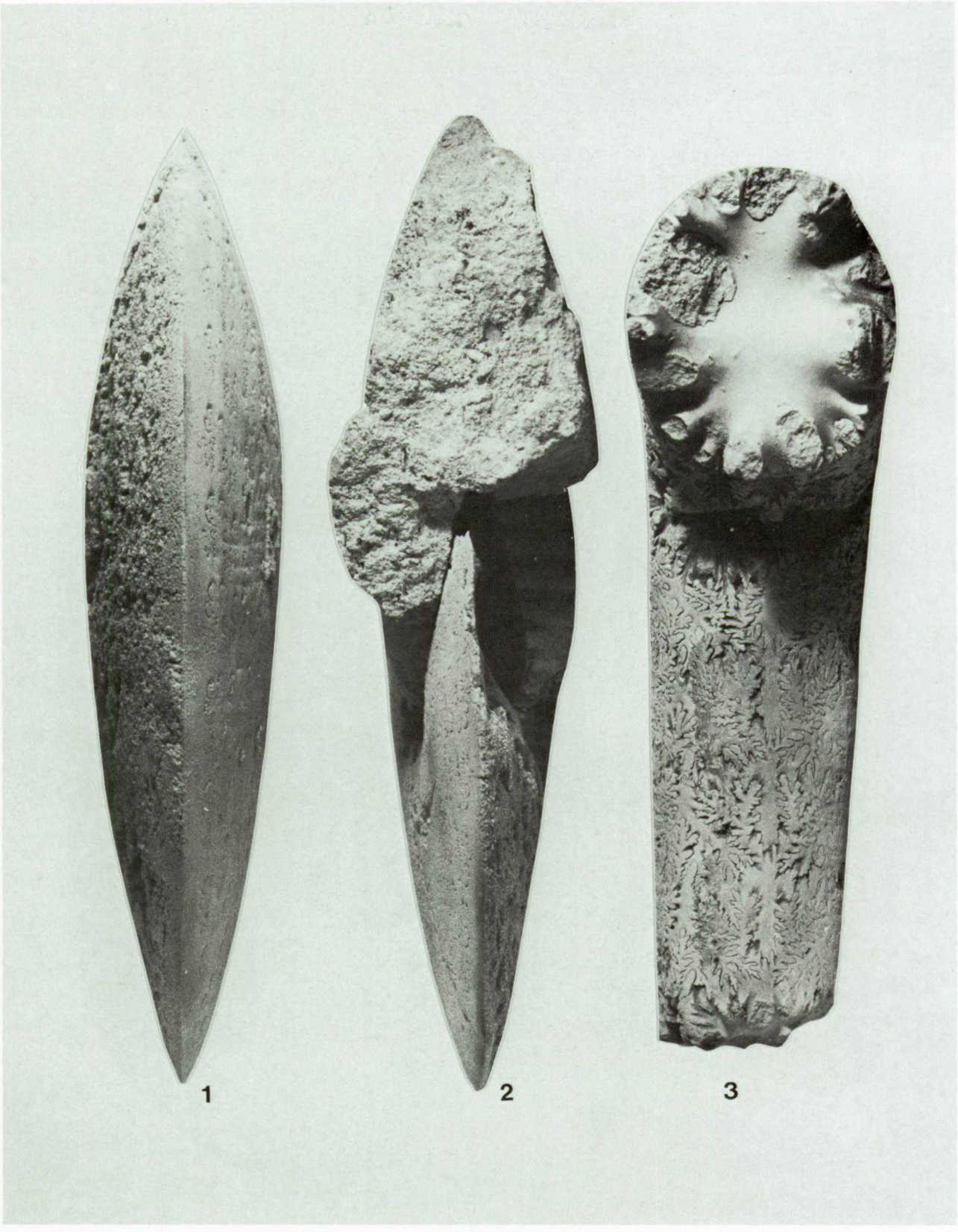
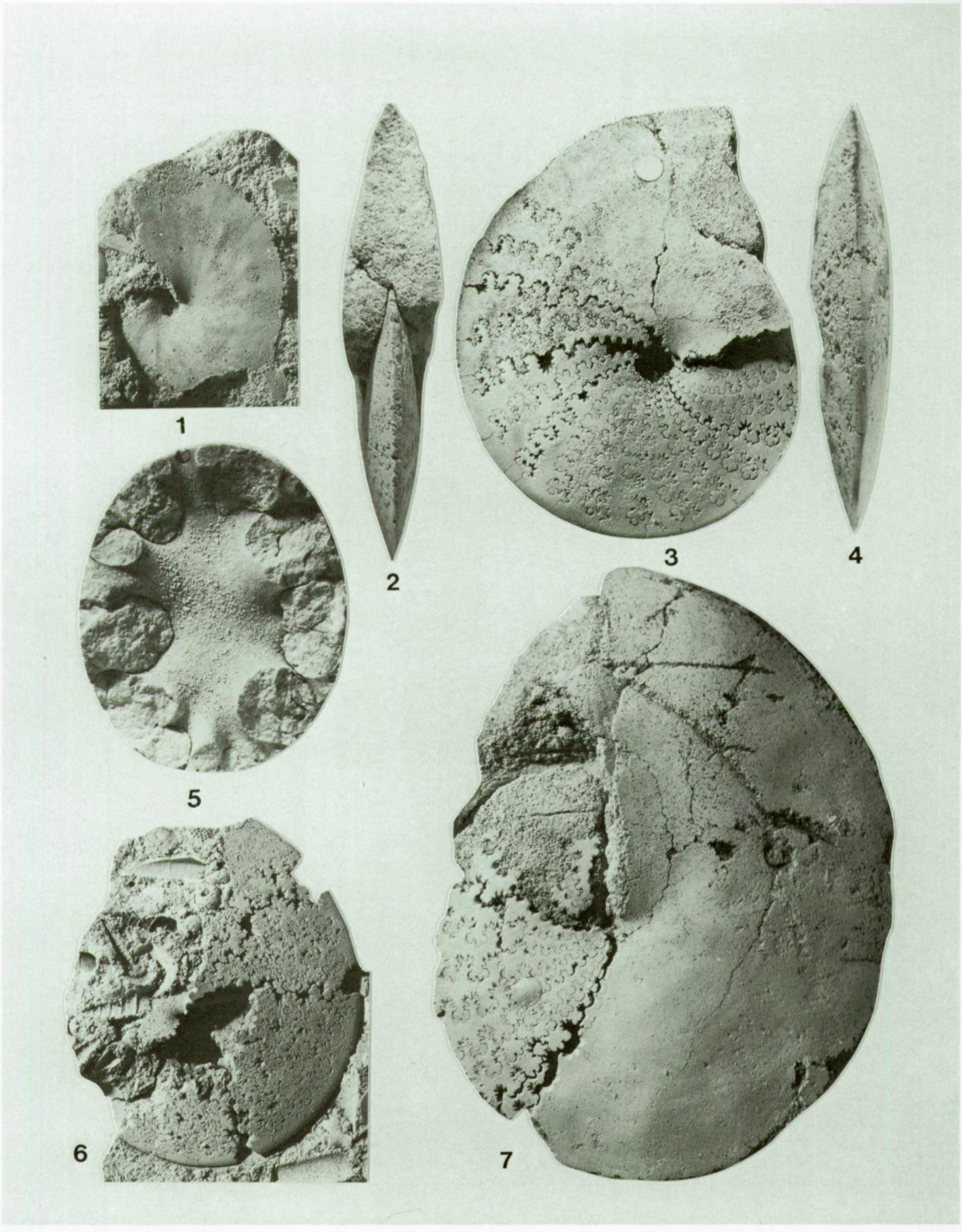



PLATE 17

Figs. 1, 2. – Sphenodiscus binkhorsti *(BÖHM, 1898) from the top of the Upper Maastrichtian Meerssen Chalk of Geulhem, Limburg, The Netherlands (NMM 733* ex *FELDER Coll.).*

Fig. 3. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10289* ex *UBAGHS Coll.).*

*All figures are natural size.*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## PLATE 18

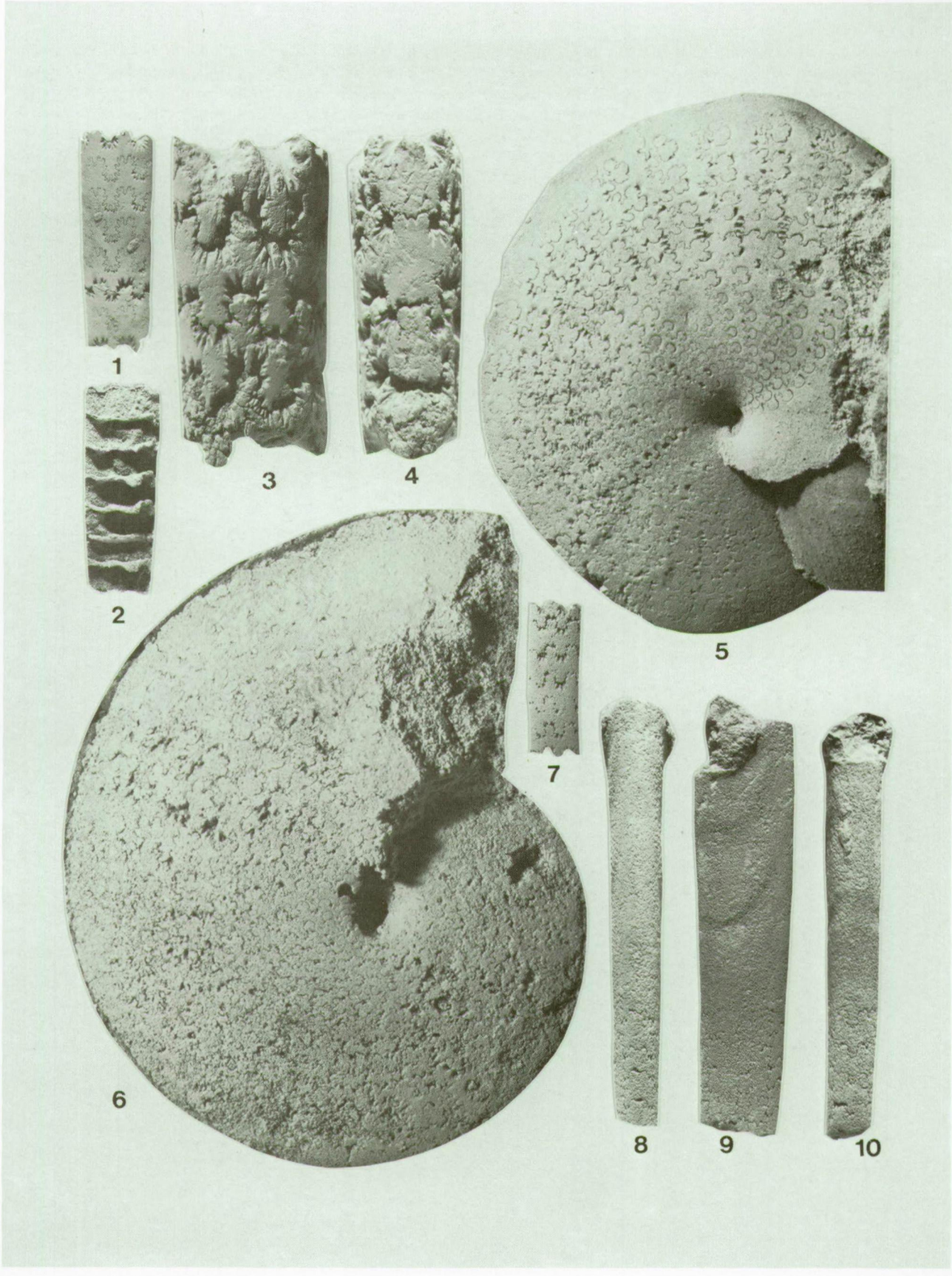
Fig. 1. – Sphenodiscus binkhorsti *(BÖHM, 1898) from the Upper Maastrichtian (Meerssen Chalk inferred) of Geulhem, Limburg, The Netherlands (IRSNB 9475* ex *LE HON Coll.), the original of DE GROSSOUVRE, 1908, pl. 2, fig. 3.*

Figs. 2-4. – Sphenodiscus binkhorsti *(BÖHM, 1898) the lectotype from the Upper Maastrichtian (Meerssen Chalk inferred) of "Geulhem bei Falkenberg", Limburg, The Netherlands (MNB C.412* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 5d, figs. 5a, 5b, ? 5c, and DE GROSSOUVRE, 1908, pl. 2, figs. 2a, 2b; pl. 3.*

Fig. 5. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10257 (IG 6521* ex *UBAGHS Coll.)], see Plate 25, figs. 7, 8 for other views of this specimen.*

Fig. 6. – Sphenodiscus binkhorsti *(BÖHM, 1898) a paralectotype from the Upper Maastrichtian (Meerssen Chalk inferred) of "Geulhem bei Falkenberg", Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Fig. 7. – Sphenodiscus binkhorsti *(BÖHM, 1898) from the Upper Maastrichtian (Meerssen Chalk inferred) of "Geulhem bei Falkenberg", Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*
*All figures are natural size.*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## PLATE 19

Figs. 1, 2. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10258 (IG 6521* ex UBAGHS *Coll.)], showing partial geopetal infilling like that shown by* BINKHORST*'s, 1861, pl. 5d, fig. 1f.*

Figs. 3, 4. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10259 (IG 6521* ex UBAGHS *Coll.).*

Fig. 5. – Sphenodiscus binkhorsti *(*BÖHM*, 1898) from the hardground at the top of the Upper Maastrichtian Meerssen Chalk of Curfs Quarry, Geulhem, Limburg, The Netherlands (NMM MK 2030* ex FELDER *Coll.).*

Fig. 6. – Sphenodiscus binkhorsti *(*BÖHM*, 1898) from the Upper Maastrichtian (Meerssen Chalk inferred) of Geulhem, Limburg, The Netherlands (IRSNB 9470* ex UBAGHS *Coll.), the original of* DE GROSSOUVRE*, 1908, pl. 2, fig. 1.*

Fig. 7. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Formation of "Maastricht", Limburg, The Netherlands (Geol. Pal. Inst. Univ. Bonn 81b* ex SCHLÜTER *Coll.), the original of* SCHLÜTER*, 1876, pl. 39, fig. 13.*

Figs. 8-10. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10260 (IG 4285* ex BOSQUET *Coll.)].*

*All figures are natural size.*

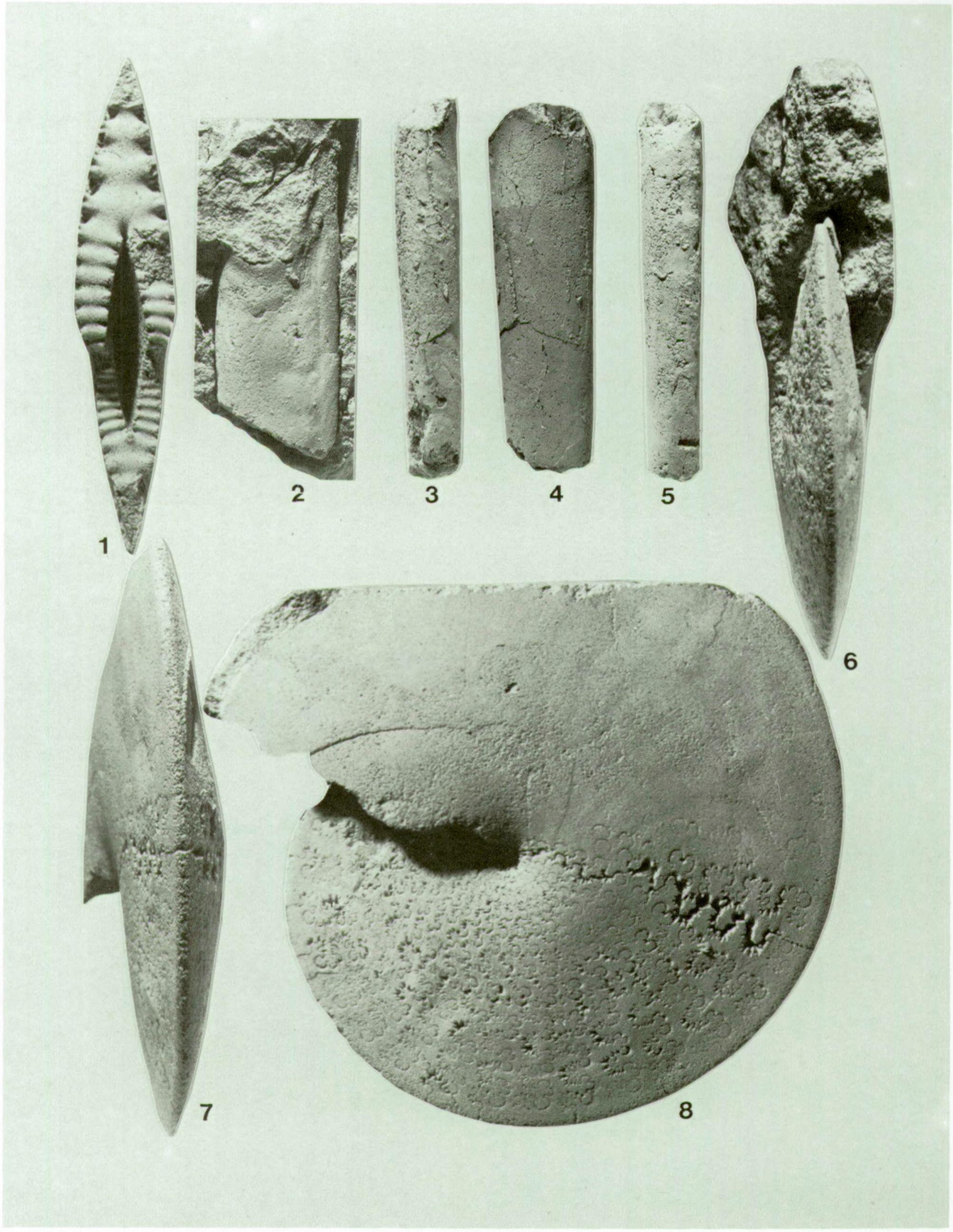



PLATE 20

Figs. 1, 6, 7, 8. – Sphenodiscus binkhorsti *(BÖHM, 1898) from the Upper Maastrichtian Meerssen Chalk of Curfs Quarry, Geulhem, Limburg, The Netherlands (NMM MK 2872* ex FELDER *Coll.).*

Fig. 2. – Baculites *cf.* anceps *LAMARCK, 1822, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (NMB unreg.* ex BINKHORST *Coll.).*

Figs. 3-5. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10261 (IG 6521* ex UBAGHS *Coll.)].*

*All figures are natural size.*

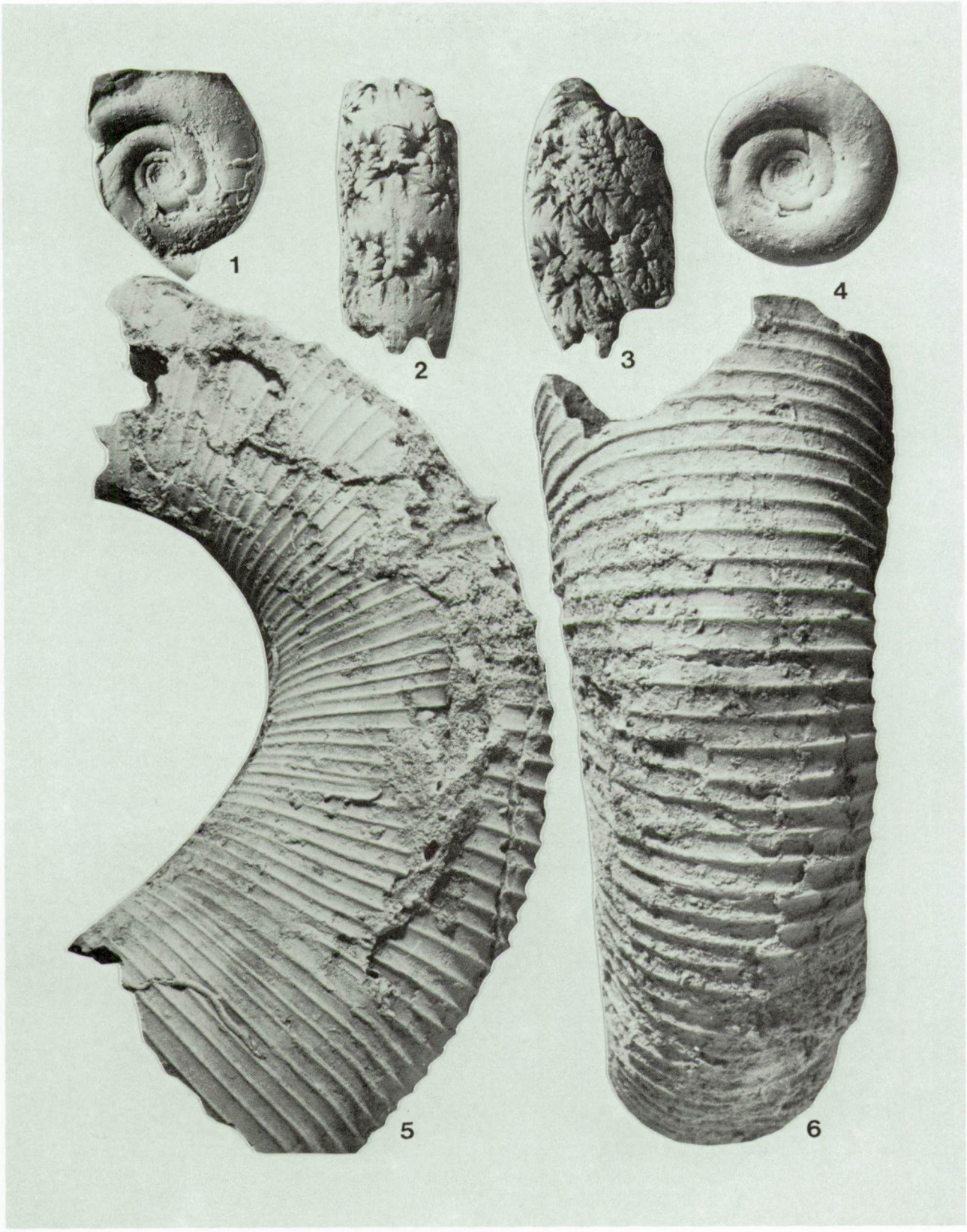



PLATE 21

Figs. 1, 4, – Saghalinites *sp. nov.* BIRKELUND, *1979. 1 is a silicone mould, 2 the original plaster mould figured by* DE GROSSOUVRE, *1908, pl. 10, fig. 5 as* Gaudryceras *cf.* kayei FORBES *sp., both taken from an external mould (IRSNB 9428* ex BOSQUET *Coll.) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands.*

Figs. 2, 3. – Diplomoceras cylindraceum *(*DEFRANCE, *1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB IG 6039* ex PIRLET *Coll.), this is one of the smallest fragments seen.*

Figs. 5, 6. – Diplomoceras cylindraceum *(*DEFRANCE, *1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10290* ex UBAGHS *Coll.), the specimen retains silicified shell. All figures are natural size.*

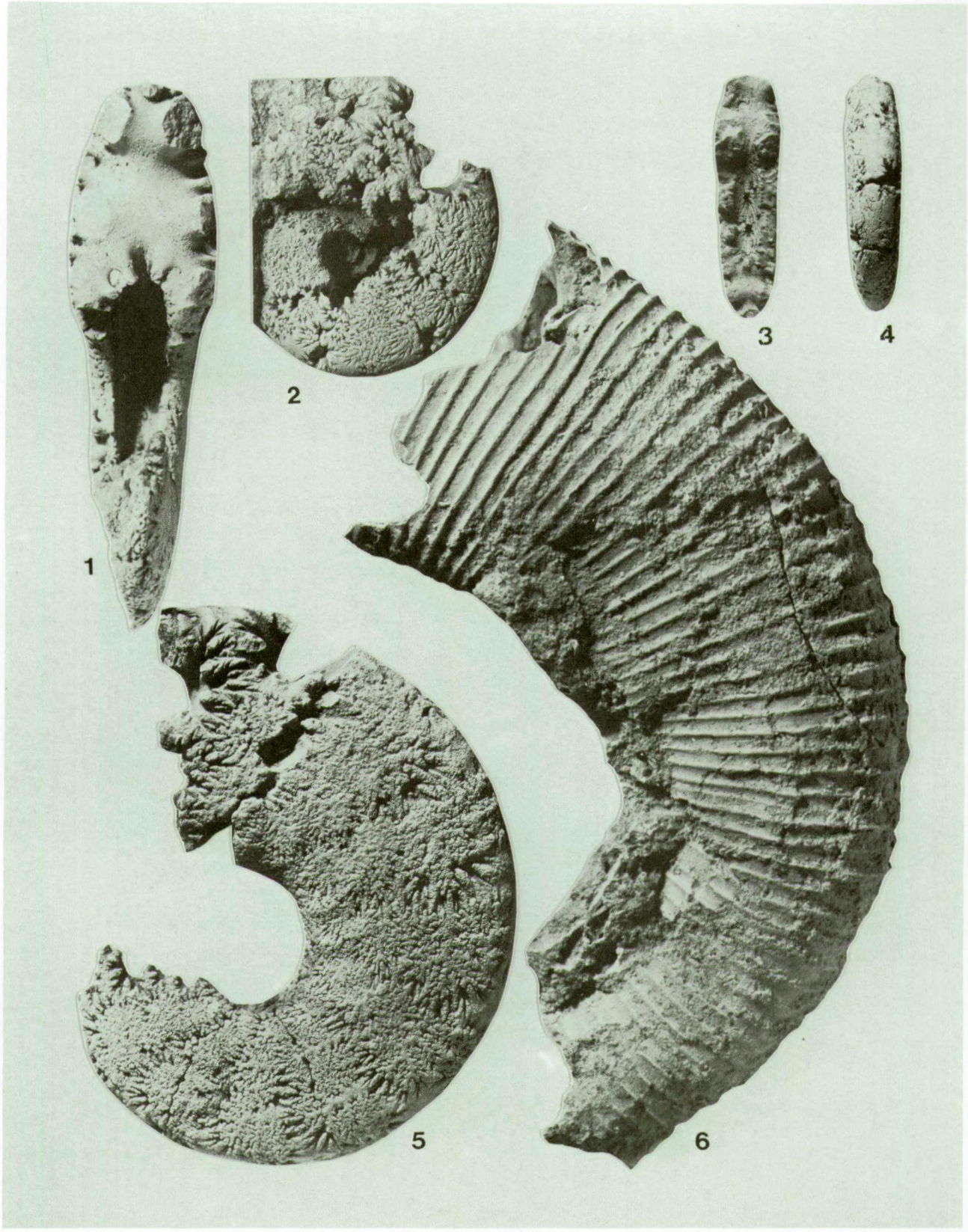



PLATE 22

Figs. 1, 5. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9477* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 9, fig. 2.*

Figs. 2, 3, 4. – Pachydiscus (Pachydiscus) gollevillensis *(d'ORBIGNY, 1850) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9476* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 9, fig. 1.*

Fig. 6. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10291* ex *UBAGHS Coll.), the specimen retains silicified shell. All figures are natural size.*


PLATE 23

Fig. 1. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10292* ex *UBAGHS Coll.).*

Fig. 2. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10262 (IG 8261* ex *DE JAER Coll.).*

Figs. 3, 4. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9493* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 11, figs. 2a, 2b.*

Fig. 5. – Anapachydiscus fresvillensis *(SEUNES, 1890) plaster cast taken from an external mould from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9472* ex *UBAGHS Coll.). All figures are natural size.*

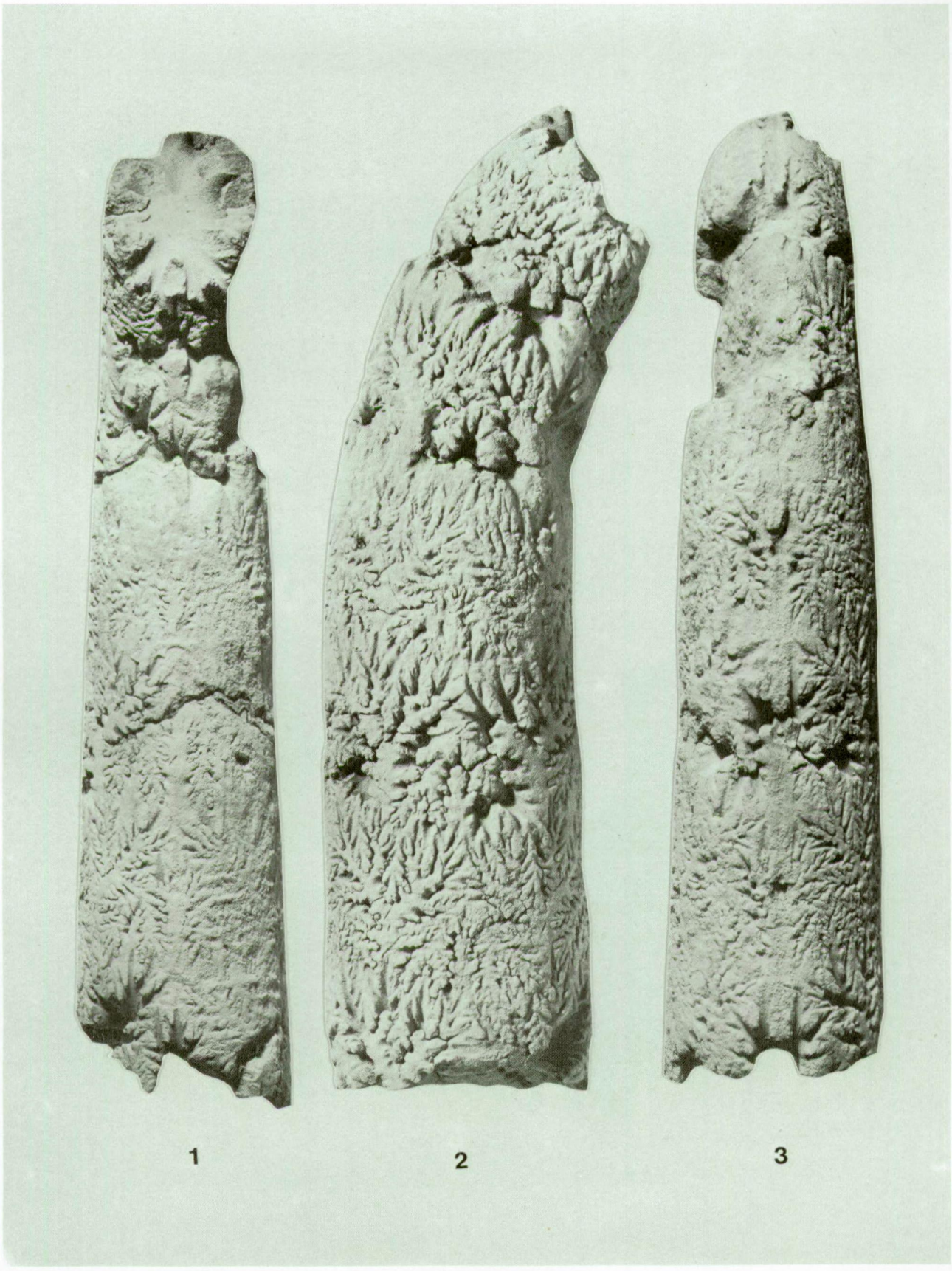



PLATE 24

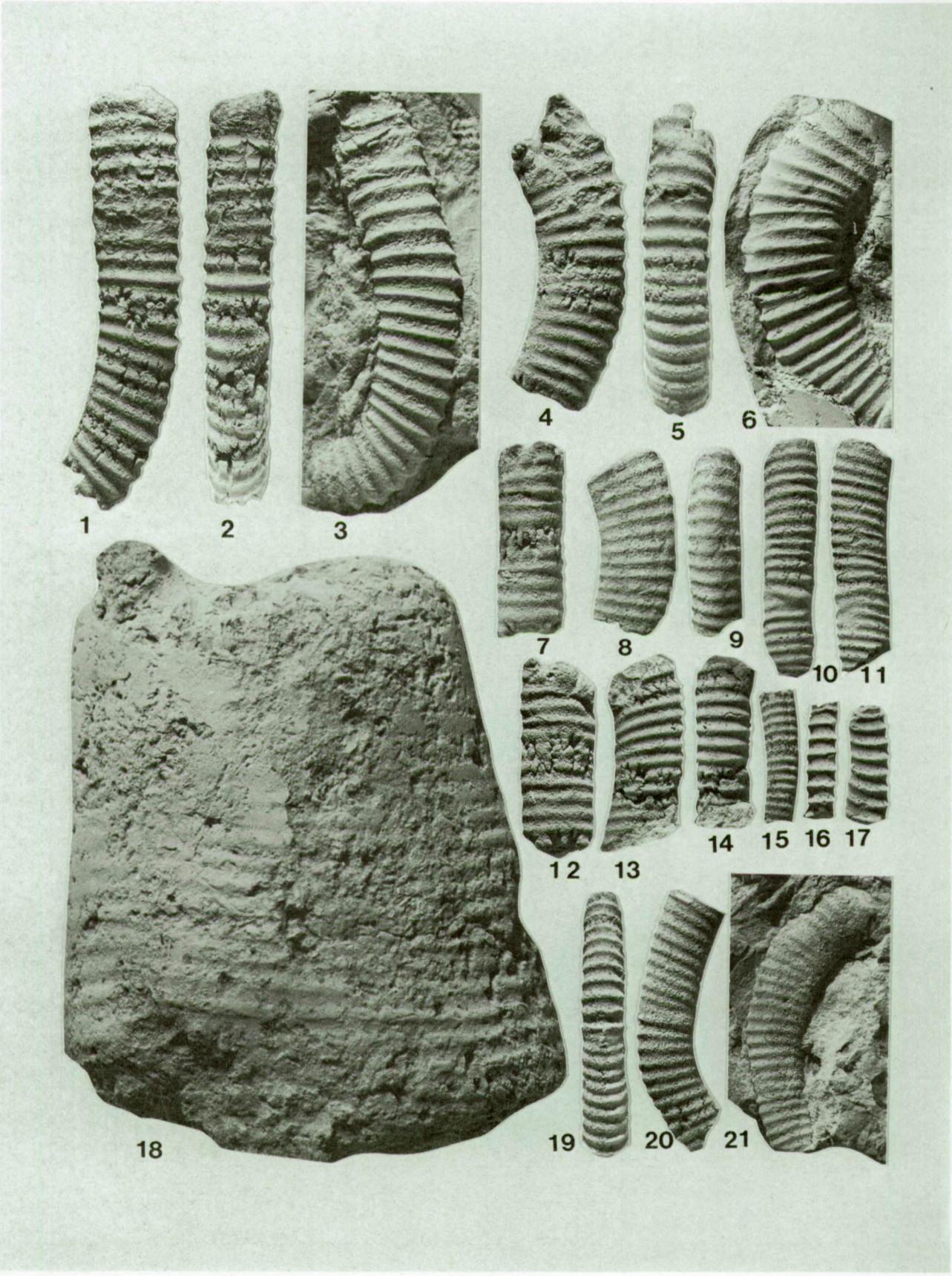
Figs. 1-3. – Diplomoceras cylindraceum *(DEFRANCE, 1816), the neotype, from the Upper Maastrichtian Maastricht Formation of St. Pietersberg, Maastricht, The Netherlands (IRSNB 10293).*
*All figures are reduced × 0.68; the fragment is 260 mm. long.*


PLATE 25

Figs. 1-4. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB IG 5185* ex *UBAGHS Coll.).*

Figs. 5-6. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB IG 6521* ex *UBAGHS Coll.).*

Figs. 7-8. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10257 (IG 6521* ex *UBAGHS Coll.)].*
*All figures are natural size.*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## PLATE 26

Figs. 1-3. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10263 (IG 6521* ex *UBAGHS Coll.)], 1, 2, internal moulds, 3 artificial cast from corresponding external mould.*

Figs. 4-6. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 102634(IG 4285* ex *BOSQUET Coll.)], 4, 5, internal moulds, 6 artificial cast from corresponding external mould.*

Figs. 7, 12. – Glyptoxoceras *cf.* circulare *SHIMIZU, 1935, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10265 (IG 4286* ex *BOSQUET Coll.)].*

Figs. 8, 9. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 5b, figs. 4a, 4b.*

Figs. 10, 11. – Glyptoxoceras *cf.* circulare *SHIMIZU, 1935, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10266 (IG 6521* ex *UBAGHS Coll.)].*

Figs. 13, 14. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10267 (IG 8261* ex *DE JAER Coll.)].*

Fig. 15. – Glyptoxoceras *cf.* circulare *SHIMIZU, 1935, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10268 (IG 4285* ex *BOSQUET Coll.)].*

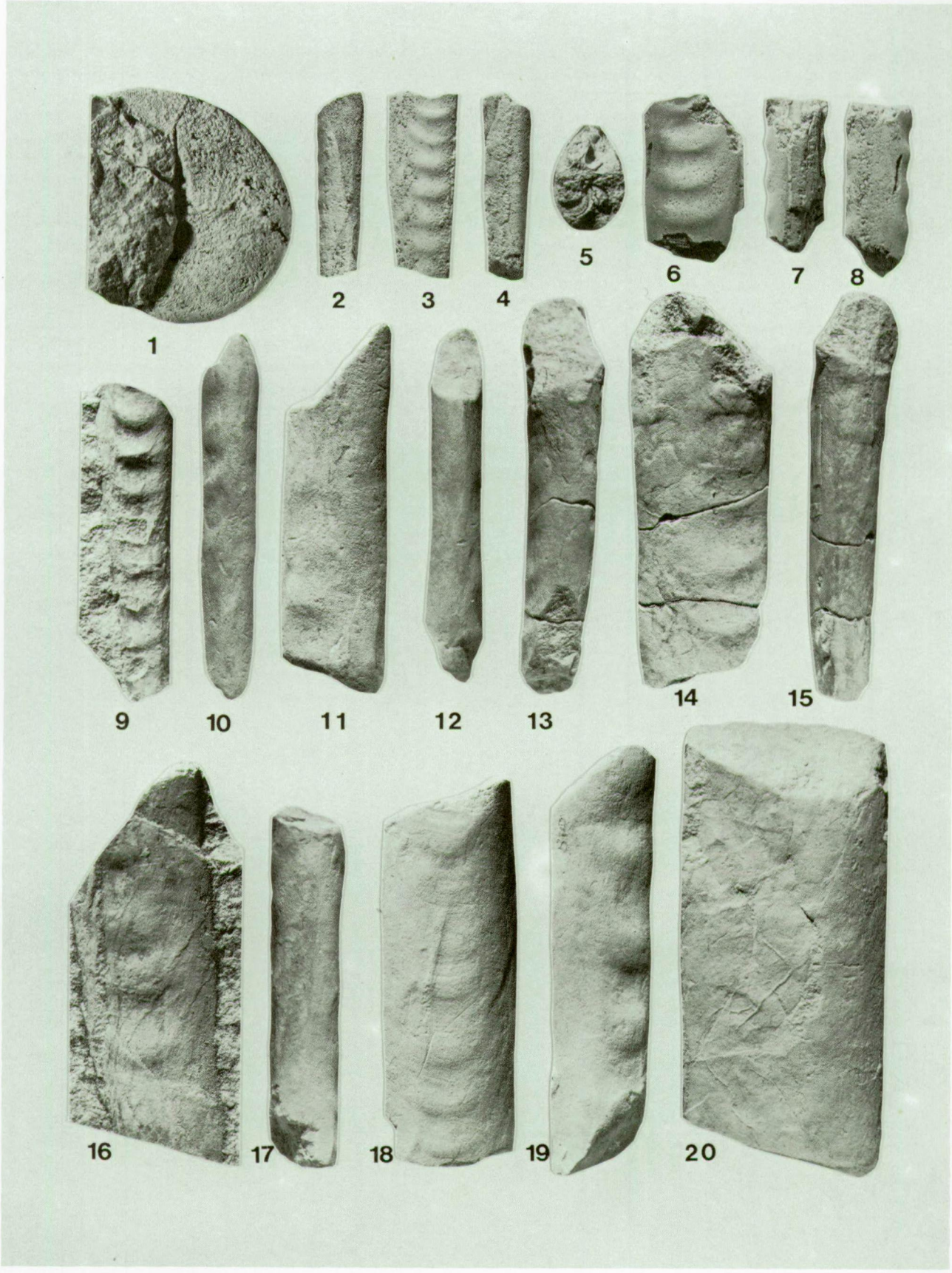
Figs. 16, 17. – Glyptoxoceras *sp. from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10269 (IG 4285* ex *BOSQUET Coll.)].*

Fig. 18. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10294* ex *UBAGHS Coll.), part of a body chamber, the largest specimen seen.*

Figs. 19, 20. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10270 (IG 4285* ex *BOSQUET Coll.)].*

Fig. 21. – Glyptoxoceras *cf.* subcompressum *(FORBES, 1846) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 5c, figs. 1a, b.*

*All figures are natural size.*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## PLATE 27

Fig. 1. – Hoploscaphites felderi *sp. nov. the holotype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9493* ex *BOSQUET Coll.), the original of DE GROSSOUVRE, 1908, pl. 10, figs. 1a, 1b, 1c.*

Figs. 2, 3, 4. – Baculites anceps *LAMARCK, 1822, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (NMM 00265* ex *BOETZKES Coll.).*

Figs. 5, 6, 7, 8. – Eubaculites lyelli *(d'ORBIGNY, 1847) from the Upper Maastrichtian of "St-Pierre et dans les environs de Fauquemont" (BINKHORST, 1861, p. 45) (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, p. 5d, figs. 3a, b, c, d.*

Fig. 9. – Baculites *sp. from the Upper Campanian Zeven Wegen Chalk of Cotessen, Limburg, The Netherlands (NMM GK 1101* ex *FELDER Coll.).*

Figs. 10, 11, 12. – Baculites *sp. from the Upper Campanian Zeven Wegen Chalk of Vijlenerbosch, Limburg, The Netherlands (NMM GK 611* ex *FELDER Coll.).*

Figs. 13, 14, 15. – Baculites *sp. from the Upper Campanian Zeven Wegen Chalk of Rarenbos, near Vaals, Limburg, The Netherlands (NMM GK 84* ex *FELDER Coll.).*

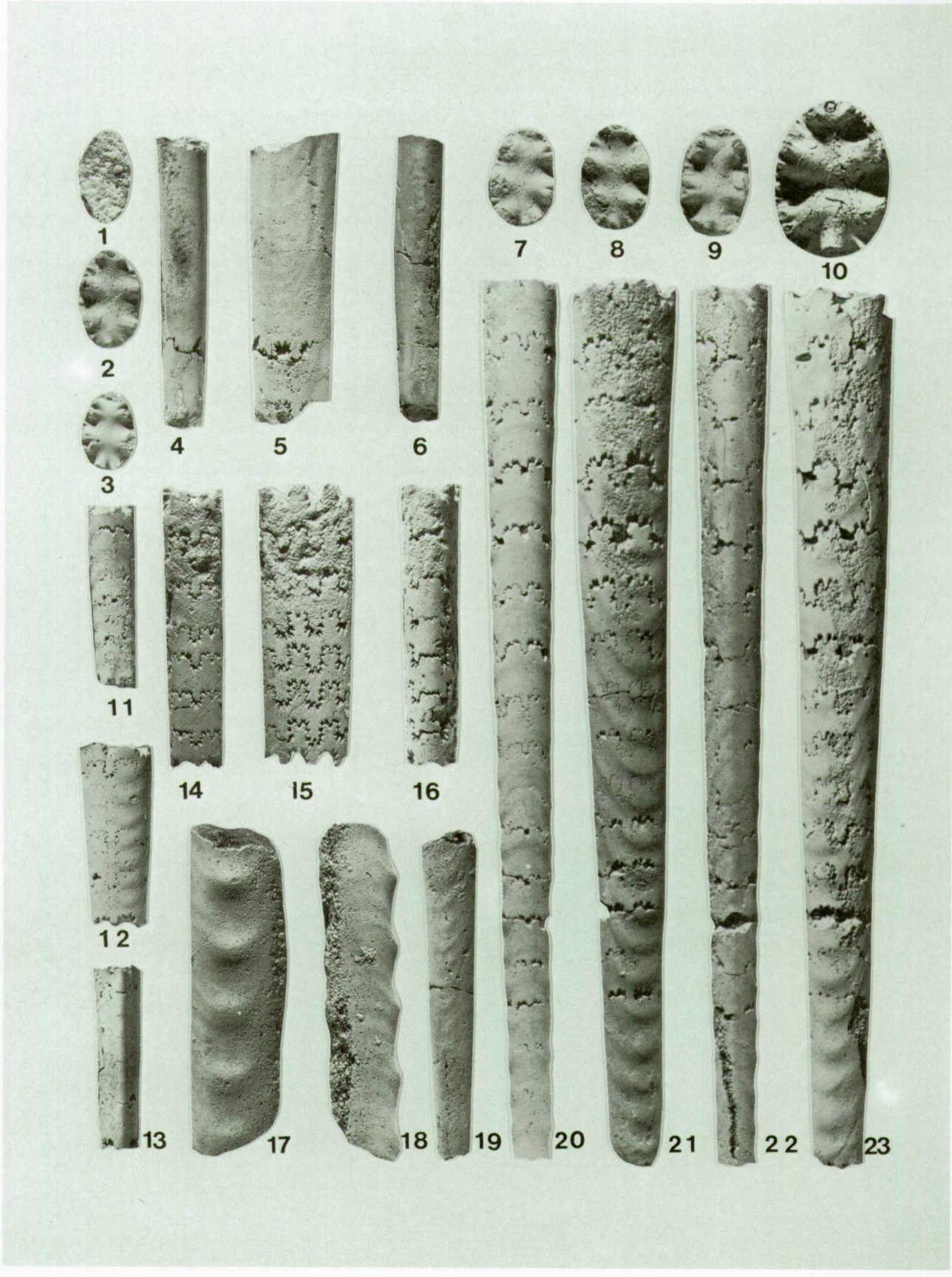
Fig. 16. – Baculites *sp. from the Upper Campanian Zeven Wegen Chalk of Rarenbos, near Vaals, Limburg, The Netherlands (NMM GK 46* ex *FELDER Coll.).*

Figs. 17, 18. – Baculites *sp. from the Upper Campanian Zeven Wegen Chalk immediately below the belemnite graveyard level, Vijlenerbosch, Limburg, The Netherlands (NMM GK 662* ex *FELDER Coll.).*

Fig. 19. – Baculites *sp. 2 from the Lower Maastrichtian Vijlen Chalk of Vijlenerbosch, Limburg, The Netherlands (NMM GK 810).*

Fig. 20. – Baculites *sp. 2 from the Lower Maastrichtian Vijlen Chalk just above the belemnite graveyard level at Vijlenerbosch, Limburg, The Netherlands (NMM GK 800).*

*All figures are natural size.*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## PLATE 28

Figs. 1, 4, 5, 6. – Baculites *sp. 1 a phosphatised specimen from the base of the Upper Maastrichtian Valkenburg Chalk at Blankenberg, Cadier en Keer, Limburg, The Netherlands (NMM MK 594* ex FELDER *Coll.).*

Fig. 2. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10271 (IG 4285* ex BOSQUET *Coll.)].*

Figs. 3, 11, 12, 13. – Baculites anceps LAMARCK, *1822, from the Upper Maastrichtian of "Maastricht" (Sedgwick Museum, Cambridge no. F2823).*

Fig. 7. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10277 (IG 4285* ex BOSQUET *Coll.)].*

Fig. 9. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10273 (IG 5185* ex UBAGHS *Coll.)].*

Fig. 10. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10259 (IG 6521* ex UBAGHS *Coll.)].*

Figs. 14, 15, 16. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10274 (IG 5185* ex UBAGHS *Coll.)].*

Figs. 17, 18. – Baculites *sp. indet. from the Campanian of Folx-les-Caves, Brabant, Belgium [IRSNB 10275 (IG 5496* ex CORNET *Coll.)].*

Fig. 19. – Baculites anceps LAMARCK, *1822, from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands [IRSNB 10276 (IG 4285* ex BOSQUET *Coll.)].*

Figs. 20, 21, 22, 23. – Baculites anceps LAMARCK, *1822, from the Upper Maastrichtian of "Maastricht", Limburg, The Netherlands (Sedgwick Museum, Cambridge no. F2822).*

*All figures are natural size.*

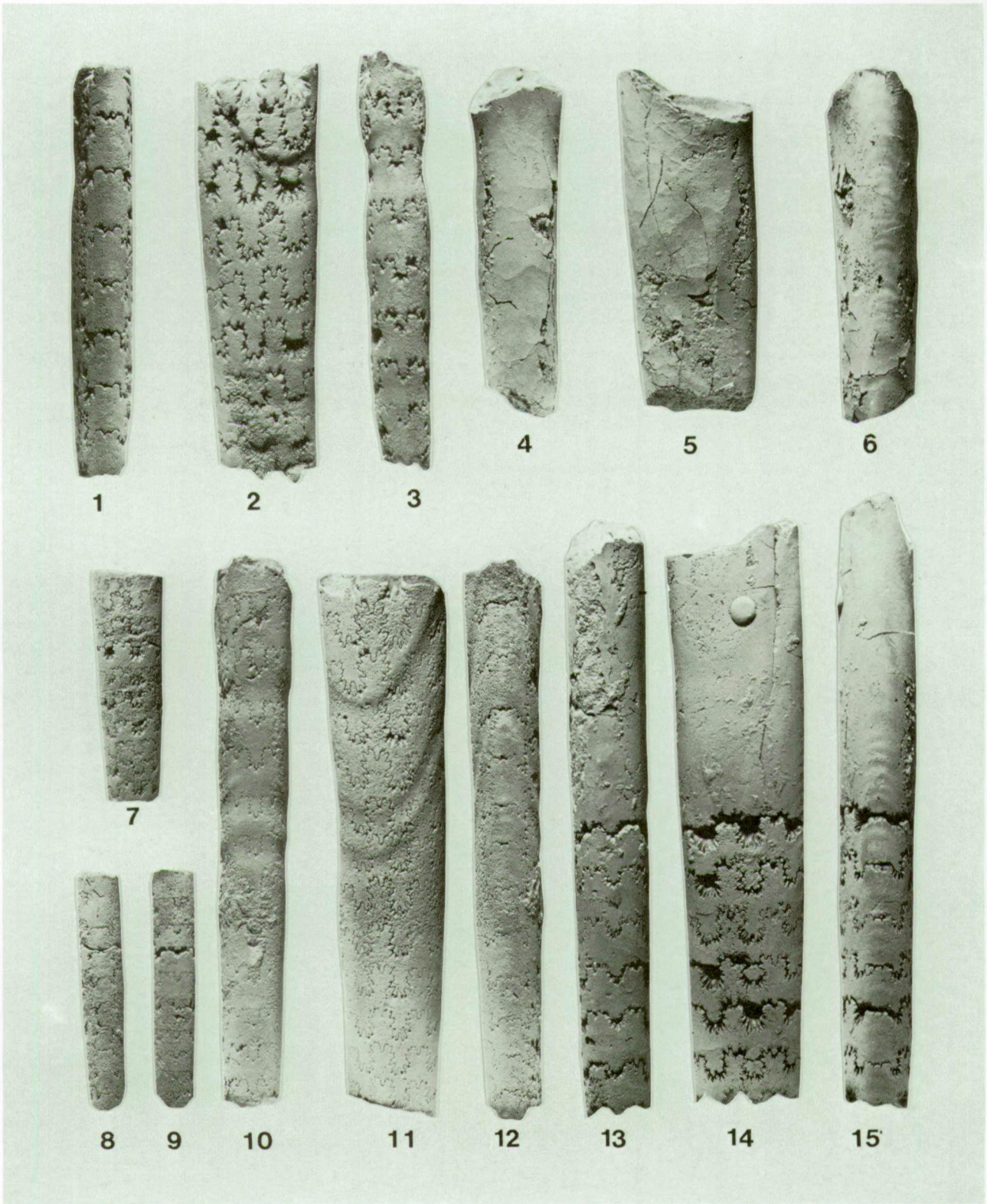



PLATE 29

Figs. 1, 2, 3. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10279 (IG 6521* ex *UBAGHS Coll.)].*

Figs. 4, 5, 6. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10280 (IG 6521* ex *UBAGHS Coll.)].*

Figs. 7, 8, 9. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian in the environs of Maastricht, Limburg, The Netherlands [IRSNB 10281 (IG 9144* ex *WOOT DE TRIXE Coll.)].*

Figs. 10, 11, 12. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10278 (IG 6521)].*

Figs. 13, 14, 15. – Baculites vertebralis *LAMARCK, 1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10282 (IG 6521* ex *UBAGHS Coll.)].*

*All figures are natural size.*


PLATE 30

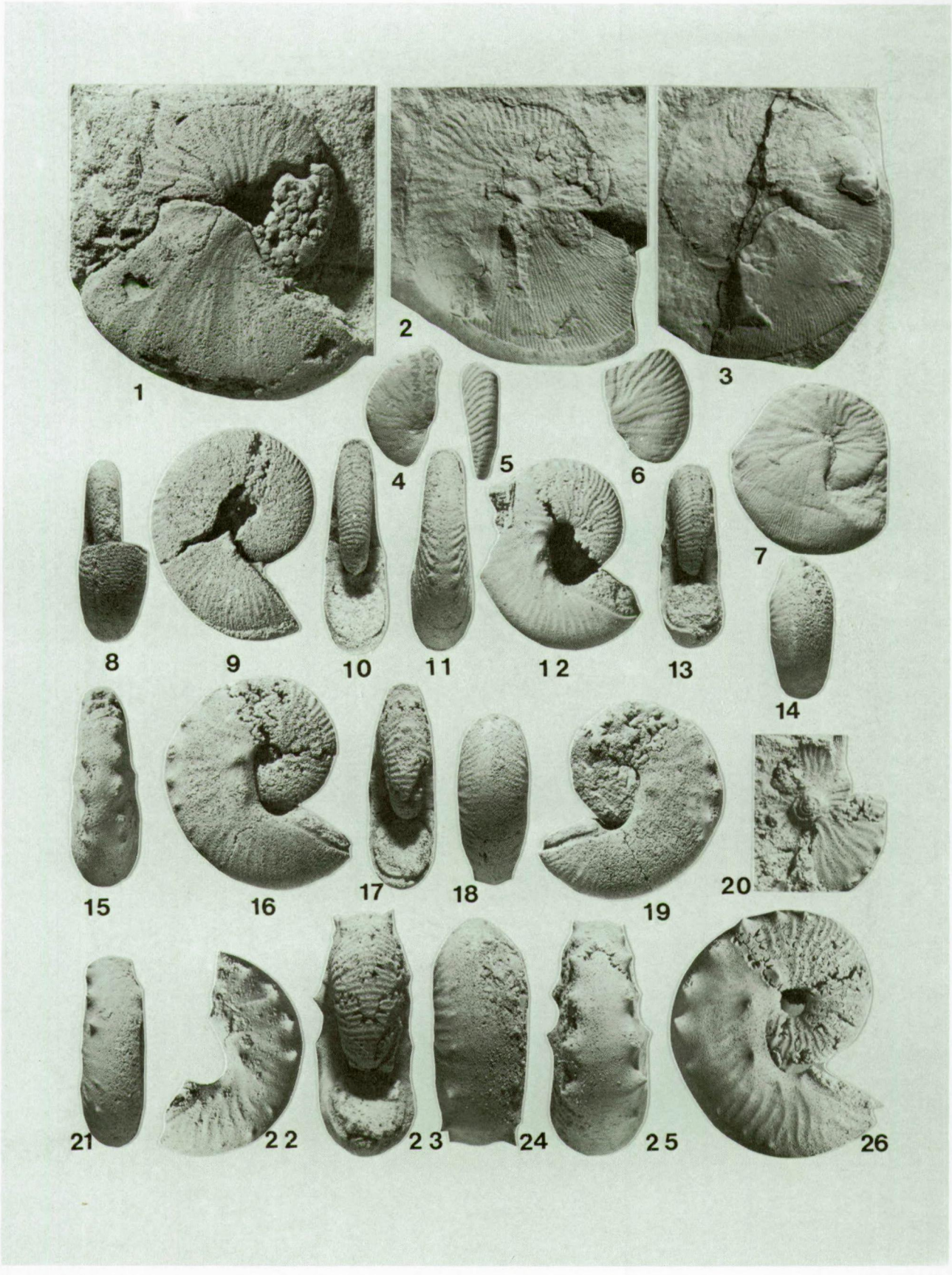
Figs. 1, 2, 3. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10283 (IG 4285* ex BOSQUET *Coll.)].*

Figs. 4, 5, 6. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10284 (IG 8261* ex DE JAER *Coll.)].*

Figs. 7, 8, 9. – Baculites vertebralis LAMARCK, *1801, from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands [IRSNB 10285 (IG 4285* ex BOSQUET *Coll.)].*

Figs. 10, 11, 12. – Sphenodiscus binkhorsti *(BÖHM 1898) from the Upper Maastrichtian Meerssen Chalk of Geulhem, Limburg, The Netherlands (NMM unregistered).*

*All figures are natural size.*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## PLATE 31

Fig. 1. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a macroconch from the Upper Maastrichtian of Kalkgroeve Schunk, Geulhem, Limburg, The Netherlands (NMM 2558).*

Figs. 2, 3. – Hoploscaphites tenuistriatus *(KNER, 1848) a macroconch from the Maastrichtian of Lemberg (Lvov), Galicia, Ukrainian SSR (MNB unreg.).*

Fig. 4. – Hoploscaphites tenuistriatus *(KNER, 1848) from the Lower Maastrichtian Vijlen Chalk of Mesch, Limburg, The Netherlands (NMM 006545a).*

Figs. 5, 6. – Hoploscaphites tenuistriatus *(KNER, 1848) from the Lower Maastrichtian Vijlen Chalk of Mesch, Limburg, The Netherlands (NMM 006545b).*

Fig. 7. – Hoploscaphites tenuistriatus *(KNER, 1848) from the Lower Maastrichtian Vijlen Chalk of Mesch, Limburg, The Netherlands (NMM 006545b).*

Figs. 8, 9, 10, 11. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian terminal hardground at the top of the Meerssen Chalk at Vroenhoven, Limburg, Belgium (NMM MK 1886a* ex *FELDER Coll.).*

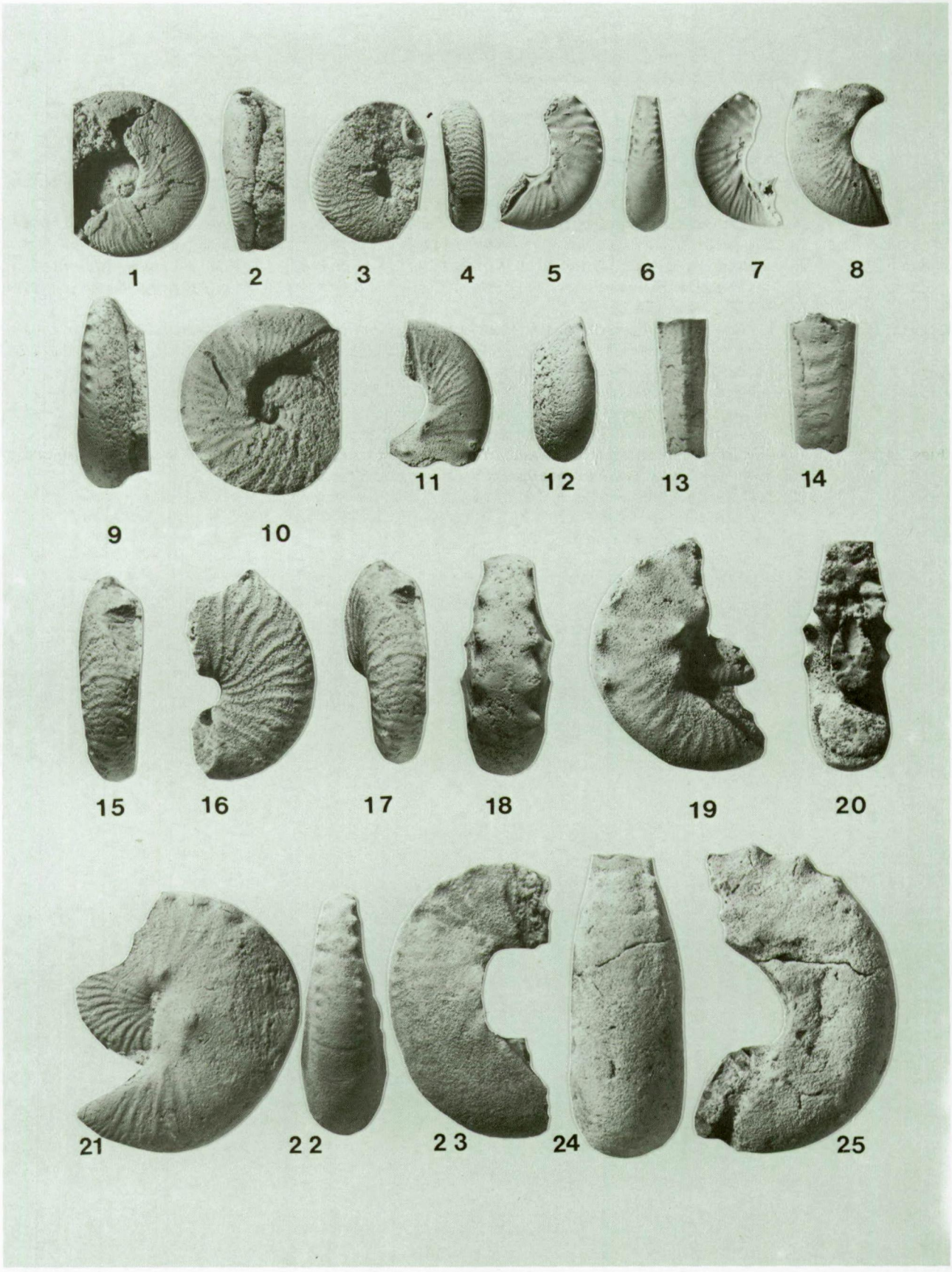
Figs. 15, 16, 17, 18, 19. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the terminal hardground at the top of the Meerssen Chalk at Vroenhoven, Limburg, Belgium (NMM MK 1886a* ex *FELDER Coll.).*

Fig. 20. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a juvenile from the Upper Maastrichtian Meerssen Chalk, hardground immediately below the Tertiary cover, Curfs Quarry, Geulhem, Limburg, The Netherlands (NMM 2030* ex *FELDER Coll.).*

Figs. 21, 22. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian of Groeve Schunk, Geulhem, Limburg, The Netherlands (NMM 1491).*

Figs. 23, 24, 25, 26. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian, upper part of the Meerssen Chalk at Curfs Quarry, Geulhem, Limburg, The Netherlands (NMM 2874* ex *FELDER Coll.).*

*All figures are natural size.*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## PLATE 32

Figs. 1, 2. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 9491* ex *BOSQUET Coll.), the original of DE GROSSOUVRE, 1908, pl. 11, fig. 6.*

Figs. 3, 4. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a juvenile from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10296* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 11, fig. 7.*

Figs. 8, 11, 12. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 10297* ex *BOSQUET Coll.).*

Figs. 9, 10. – Hoploscaphites constrictus *(J. SOWERBY, 1817) a microconch from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 9490* ex *BOSQUET Coll.), the original of DE GROSSOUVRE, 1908, pl. 11, fig. 5, who gave the locality as "Maastricht".*

Figs. 15, 16, 17. – Acanthoscaphites *sp. from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 9486* ex *BOSQUET Coll.).*

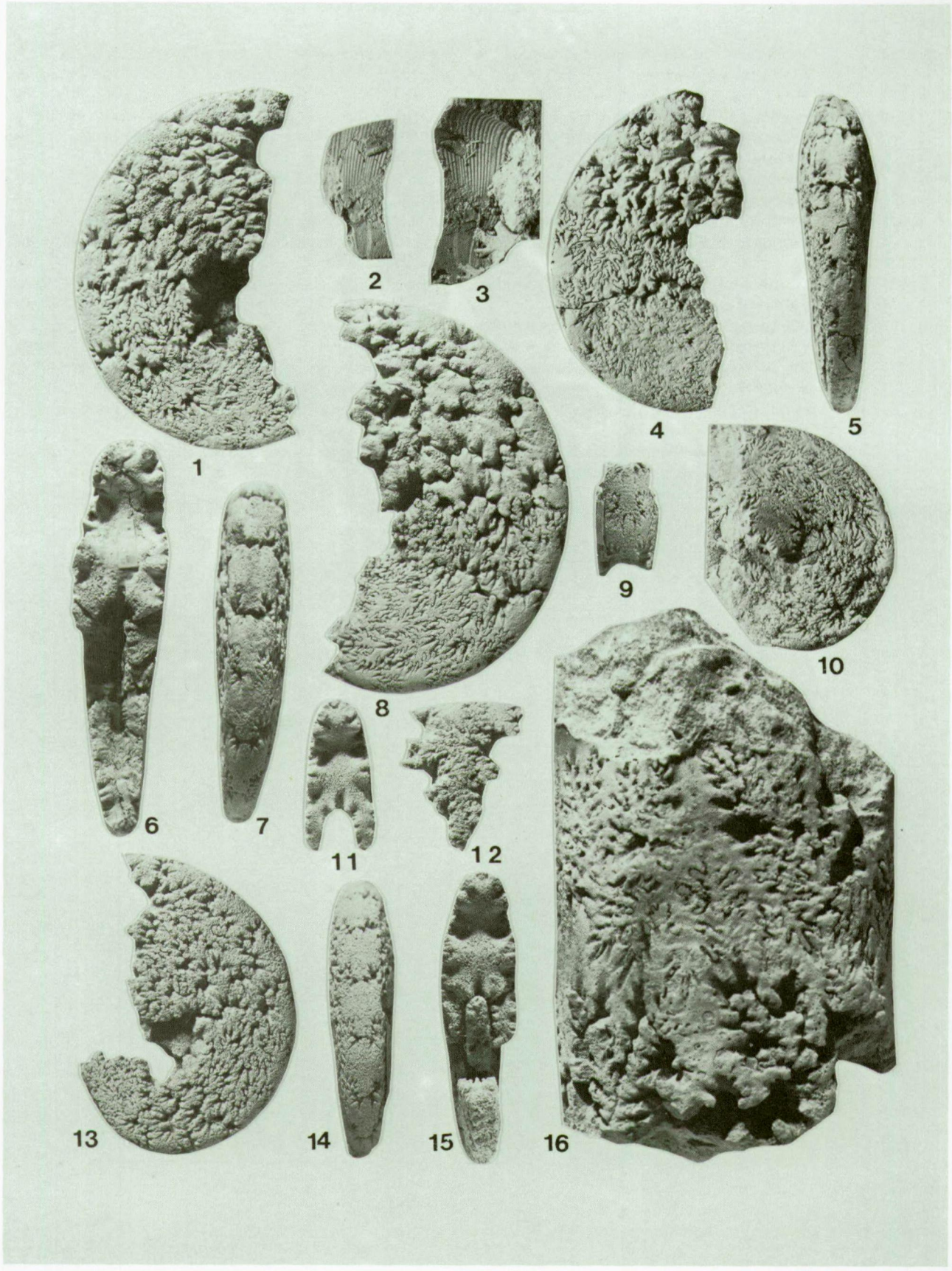
Figs. 18-20. – Hoploscaphites constrictus *(J. SOWERBY, 1817) from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 9487* ex *BOSQUET Coll.).*

Fig. 21. – Hoploscaphites constrictus *(J. SOWERBY, 1817) cast from an external mould from the Upper Maastrichtian of Geulhem, Limburg, The Netherlands (IRSNB 9489* ex *BOSQUET Coll.).*

Figs. 22, 23. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 24, 25. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

*All figures are natural size.*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## PLATE 33

Figs. 1, 6, 7, 8. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (NMM 3510).*

Figs. 2, 3. – Hoploscaphites felderi *sp. nov. paratype showing well-preserved ornament from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10298* ex *BOSQUET Coll.).*

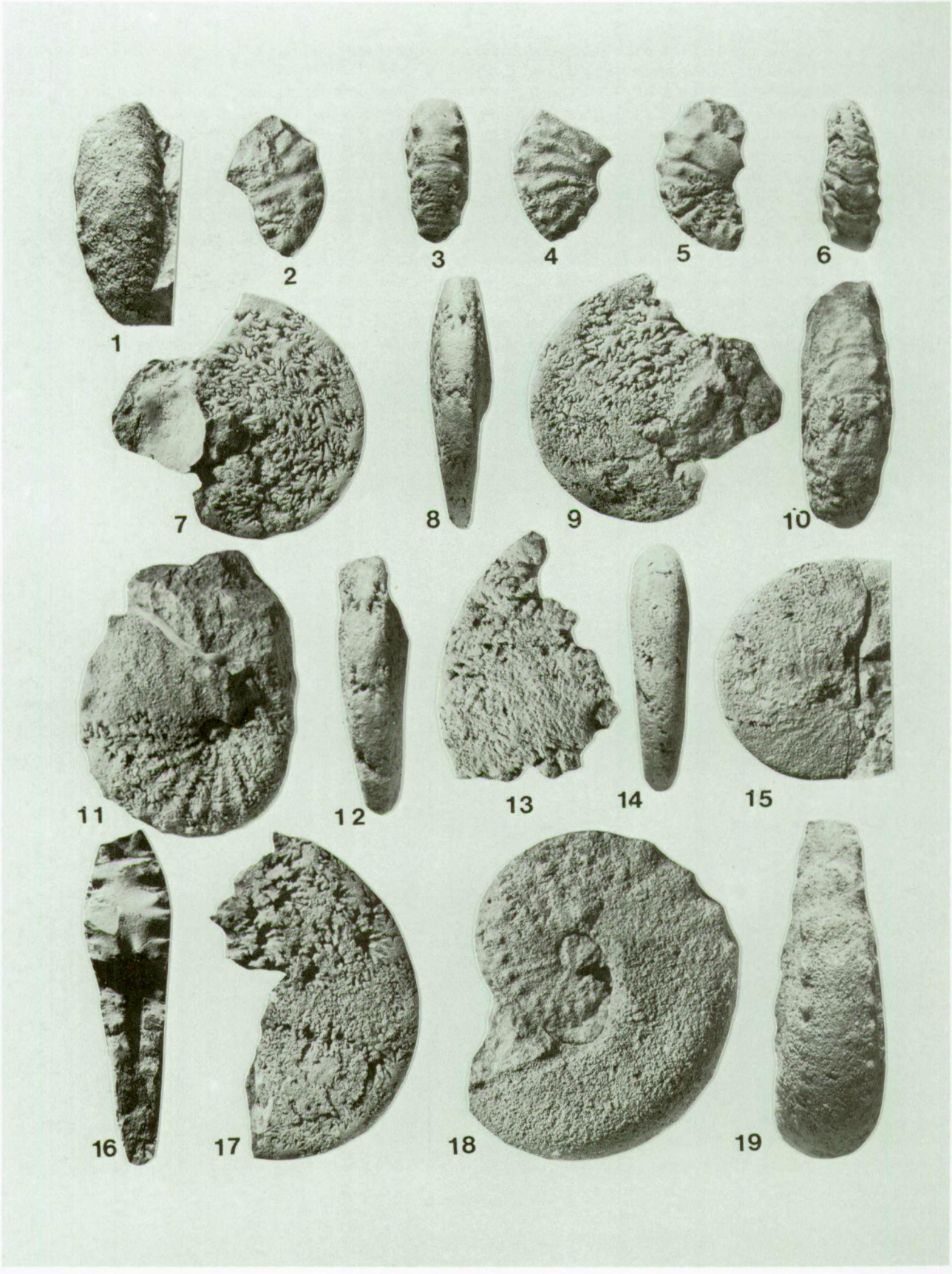
Figs. 4, 5. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9484* ex *BOSQUET Coll.), the original of DE GROSSOUVRE, 1908, pl. 10, fig. 2.*

Figs. 9, 11, 12. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian, Meerssen Chalk of the Nekami Quarry, Bemelen, Limburg, The Netherlands (NMM MK 463* ex *FELDER Coll.).*

Fig. 10. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the unfigured syntype of* Ammonites decheni *BINKHORST, 1861, p. 31.*

Figs. 13-15. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Meerssen Chalk of the Nekami Quarry, Bemelen, Limburg, The Netherlands (NMM MK 120* ex *FELDER Coll.).*

Fig. 16. – Diplomoceras cylindraceum *DEFRANCE, 1816) from the Upper Maastrichtian of Valkenburg, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 56, fig. 6a.*
*All figures are natural size.*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## PLATE 34

Fig. 1. – Acanthoscaphites *cf.* verneuilianus *(d'ORBIGNY, 1841) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10299* ex *UBAGHS Coll.).*

Figs. 2, 3, 4. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10300* ex *UBAGHS Coll.).*

Figs. 5, 6. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10301* ex *UBAGHS Coll.).*

Figs. 7-9. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9485a* ex *UBAGHS Coll.), the original of DE GROSSOUVRE, 1908, pl. 10, figs. 3a, 3b.*

Figs. 10, 11. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 12, 13. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9485b* ex *UBAGHS Coll.).*

Figs. 14, 15. – Hoploscaphites felderi *sp. nov. holotype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9483* ex *BOSQUET Coll.), the original of DE GROSSOUVRE, 1908, pl. 10, figs. 1a, 1b, 1c.*

Figs. 16, 17. – Hoploscaphites felderi *sp. nov. paratype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9848* ex *BOSQUET Coll.).*

Figs. 18, 19. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

*All figures are natural size.*

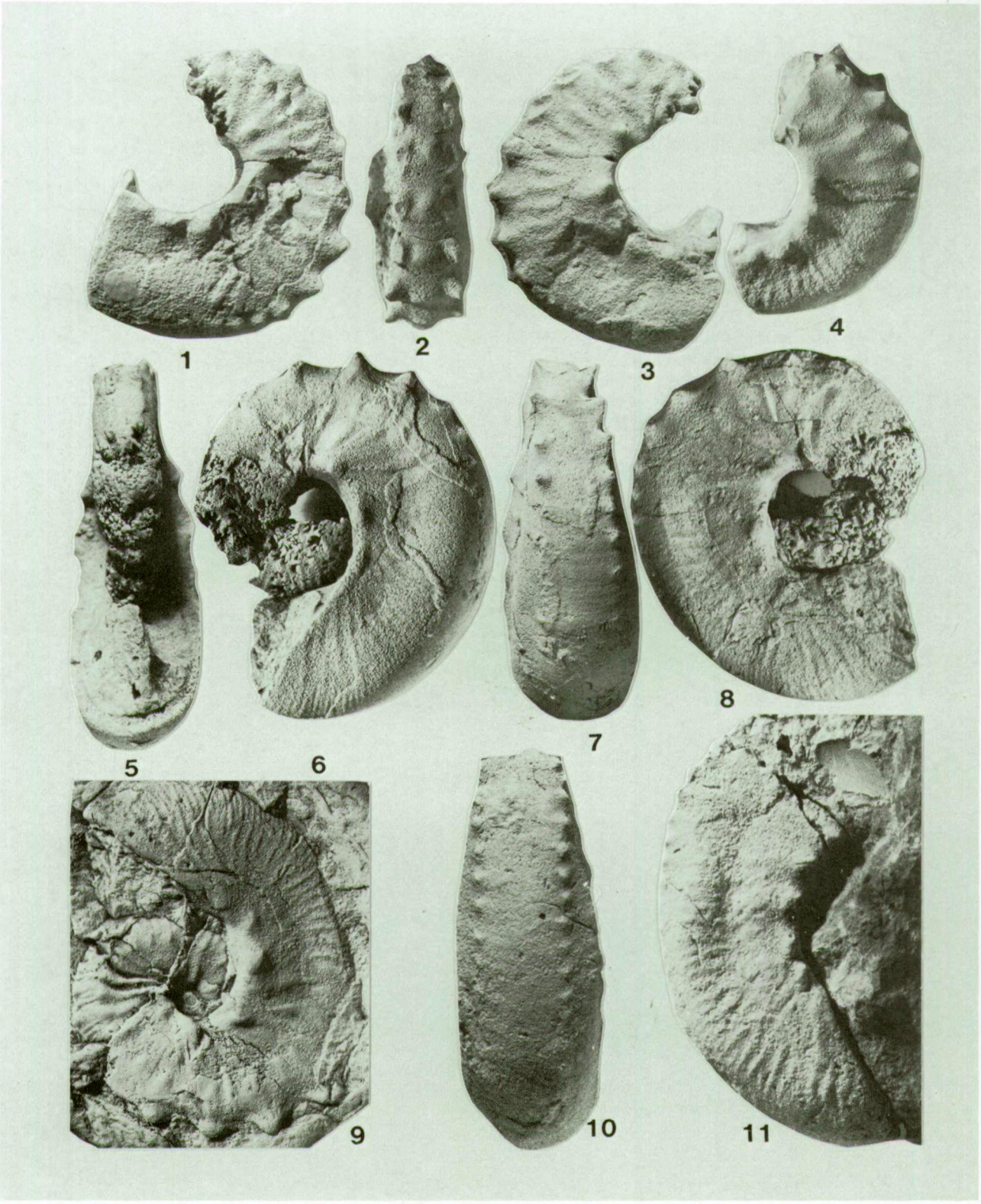


PLATE 35

Figs. 1-3. – Hoploscaphites pungens *(BINKHORST, 1861) holotype from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.), the original of BINKHORST, 1861, pl. 5a 3, figs. 1a, 1b, 1c, 1d, 1e.*

Fig. 4. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (MNB unreg.* ex *BINKHORST Coll.).*

Figs. 5-9. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 9492* ex *UBAGHS Coll.). Fig. 9 is a cast taken from an external mould.*

Figs. 10, 11. – Hoploscaphites pungens *(BINKHORST, 1861) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (NMM 3529), this is the largest specimen seen.*
*All figures are natural size.*

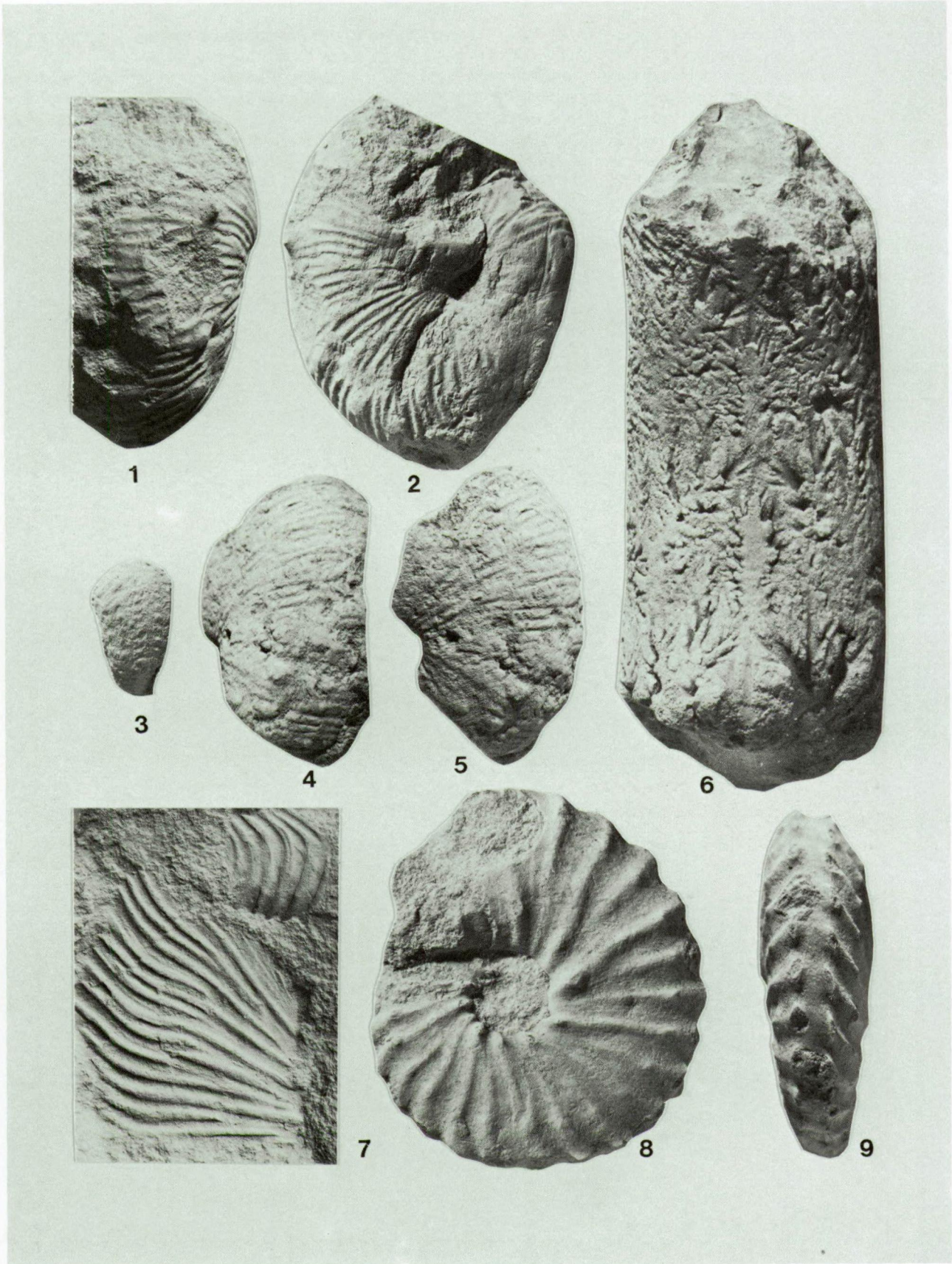


PLATE 36

Figs. 1, 2. – Trachyscaphites spiniger *(SCHLÜTER, 1872) from the Upper Campanian Zeven Wegen Chalk of Vijlenerbosch, Limburg, The Netherlands (NMM GK 965* ex *FELDER Coll.).*

Figs. 3, 4, 5. – Trachyscaphites spiniger *(SCHLÜTER, 1872) from the Upper Campanian Zeven Wegen Chalk of Vijlenerbosch, Limburg, The Netherlands (NMM GK 1116* ex *FELDER Coll.). Fig. 3 is a cast taken from the dorsum of the original of Figs. 4 and 5.*

Fig. 6. – Diplomoceras cylindraceum *(DEFRANCE, 1816) from the Upper Maastrichtian Calcaire de Kunraed of Kunrade, Limburg, The Netherlands (IRSNB 10262* ex *DE JAER Coll.), see also Pl. 23, fig. 2.*

Fig. 7. – Hoplitoplacenticeras coesfeldiense *(SCHLÜTER, 1867) from the Upper Campanian Zeven Wegen Chalk of Vijlenerbosch, Limburg, The Netherlands (NMM GK 840* ex *FELDER Coll.), corresponding to the original of SCHLÜTER, 1867, pl. 1, fig. 1a, 1b, 1c.*

Figs. 8, 9. – Hoplitoplacenticeras marroti *(COQUAND, 1859) from the Upper Campanian Vaals Formation by marker stone 7 at Vijlen, Cottessen on the Dutch/Belgian border (NMM VG 1312* ex *FELDER Coll.), the specimen corresponds to specimens figured by SCHLÜTER, 1867, pl. 1, figs. 2a, 2b, 3a, 3b (as* Ammonites vari*). All figures are natural size.*

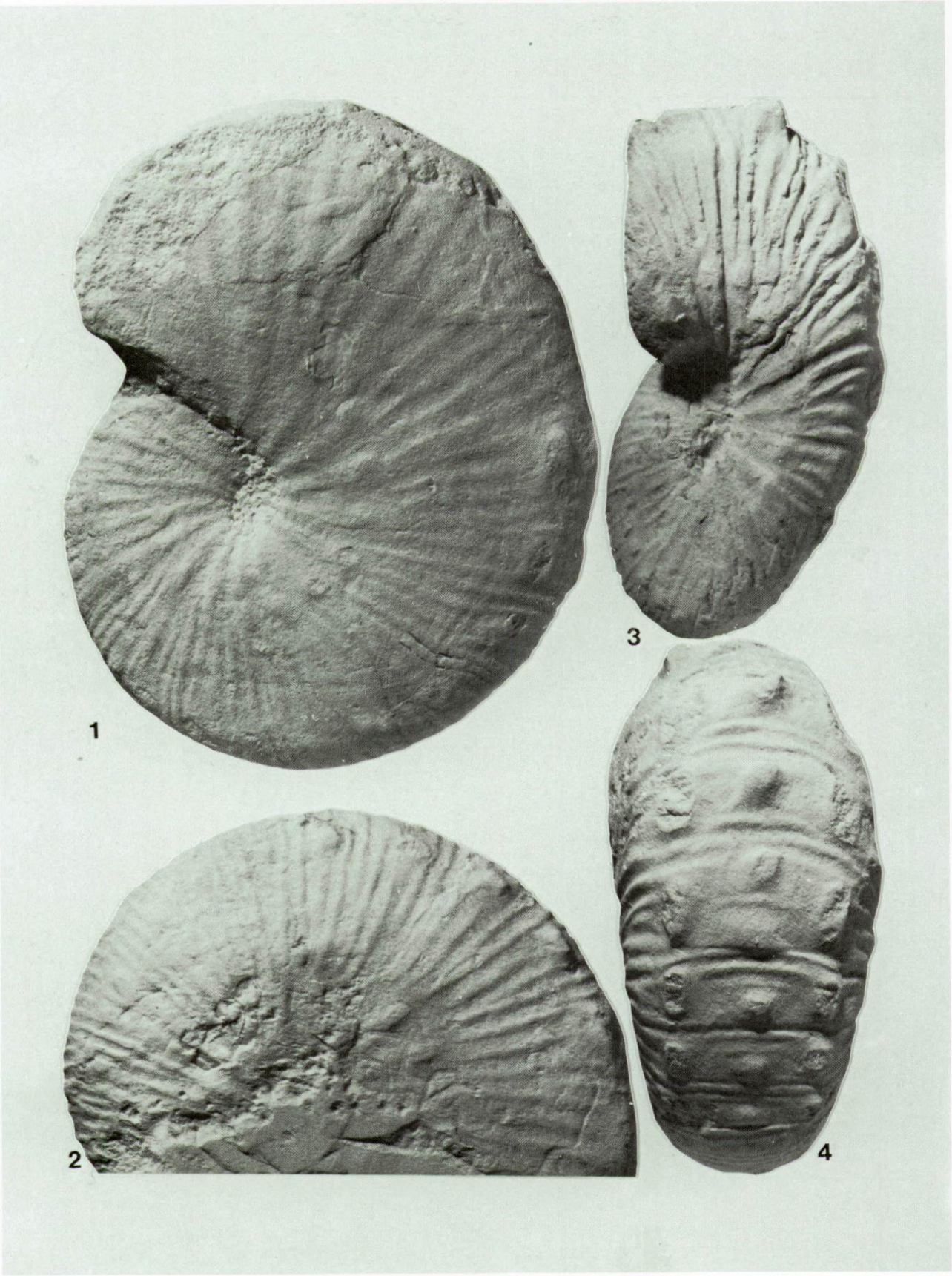


PLATE 37

Figs. 1, 2. – Acanthoscaphites tridens *(KNER, 1848) from the Gulpen Formation of Schneeberg, north of Vaals, German Federal Republic (IRSNB 10255).*

Figs. 3, 4. – Acanthoscaphites tridens *(KNER, 1848) from the "Mucronaten-Schichten von Vaals bei Aachen", the original of SCHLÜTER 1872, pl. 28, fig. 3 (Collections of the Geological and Palaeontological Institute of Bonn University, unregistered).*

*All figures are natural size.*