Beitr. Paläont. Österr. 12:181–242, Wien 1986

Lower Maastrichtian ammonites from Neuberg, Steiermark, Austria

Unter-Maastricht-Ammoniten von Neuberg in der Steiermark (Österreich)

by

W. J. KENNEDY* and H. SUMMESBERGER**

KENNEDY, W. J. & SUMMESBERGER, H., 1986: Lower Maastrichtian ammonites from Neuberg, Steiermark, Austria. – Beitr. Paläont. Österr. 12:181–242, Wien 1986.

SUMMARY

Revision of the celebrated Maastrichtian ammonite fauna from the Gosau Group of Neuberg, Steiermark, Austria revealed a diverse assemblage from a 20 m sequence of terrigeneous clastic sediments: *Partschiceras forbesianum* (D'ORBIGNY, 1850), *Anagaudryceras lueneburgense* (SCHLÜTER, 1872), *Anagaudryceras* sp., *Saghalinites wrighti* BIRKELUND, 1965, *Pseudophyllites* cf. *indra* (FORBES, 1846 a), *Pachydiscus (Pachydiscus) neubergicus* (VON HAUER, 1858), *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873), *Menuites costatus* sp. nov., *Diplomoceras cylindraceum* (DEFRANCE, 1816), *Diplomoceras* sp. indet., *Eubaculites lyelli* (D'ORBIGNY, 1847), *Hoploscaphites constrictus* (J. SOWERBY, 1817) and *Hoploscaphites* ? sp. The Neuberg fauna is in stratigraphic isolation and can be dated only by comparison with other Maastrichtian sequences. When compared with north-west European successions it can be shown to be lower but not lowest Maastrichtian in age. In terms of nannoplankton stratigraphy it is equivalent to the *Arkhangelskiella cymbiformis* Zone (CC 25 b). This is in terms of belemnite zonation middle *sumensis* Zone and/or younger.

The dominance of species with cosmopolitan distributions during the Maastrichtian (e. g. *Partschiceras forbesianum, Pachydiscus neubergicus, Diplomoceras cylindraceum, Eubaculites lyelli)* together with the occurrence of species that are widespread in the White Chalk facies of NW Europe (e. g. *Anagaudryceras lueneburgense, Saghalinites wrighti, Hoploscaphites constrictus)* shows the Neuberg area to have been in free marine communication with other areas, notably the north and north-west.

ZUSAMMENFASSUNG

Der Steinbruch in Krampen bei Neuberg (Steiermark) hat in der Mitte des 19. Jahrhunderts eine Reihe von Ammoniten geliefert, die von HAUER (1858) und REDTENBACHER (1873) beschrieben worden sind. Neuaufsammlungen sind eher unergiebig. Die Fauna wird in dieser Arbeit systematisch revidiert und eine stratigraphische Einstufung vorgelegt.

Die Revision ergab, daß die gesamte Fauna (14 Taxa) aus einem etwa 20 Meter mächtigen Schichtpaket stammt. Der kleine Steinbruch am Westende von Krampen existiert noch und schließt die gesamte Folge auch heute noch relativ gut auf. Es handelt sich um graue, sandig-siltige Sedimente terrigener Herkunft, die unter Bedingungen tieferen Wassers (Zoophycos Fazies) abgelagert worden sind. Die unterlagernde Serie heller, gröberer Sandsteine, Konglomerate und Brekzien (Textfig. 2) ergab keinerlei stratigraphische Anhaltspunkte. Überlagernde Gesteine sind nicht aufgeschlossen.

Mikrofauna fehlt weitgehend. Nannoplankton ist selten. Nur eine Probe ermöglicht eine Einstufung in das Nannoplankton-Zonenschema: CC 25 b. Dieses Ergebnis, umgesetzt in die Begriffe der Belemnitenstratigraphie der Schreibkreidefazies, ergibt für Neuberg eine Einstufung in die mittlere *sumensis*-Zone und/oder jünger. Dies ist der tiefere Teil des oberen Untermaastrichts. Die Auswertung der Ammoniten ergibt einen Schwerpunkt um die Wende vom unteren Untermaastricht zum oberen Untermaastricht *(B. lanceolata* Z./*B. occidentalis* Z.).

Die systematische Revision der Pachydisciden hat ergeben, daß der indischen Art *Pachydiscus (Pachydiscus) chrishna* (FORBES, 1846) Priorität über *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858) zukommt. Jedoch wurde ein entsprechender Antrag bei der Internationalen Kommission für Zoologische Nomenklatur eingebracht (KENNEDY & HENDERSON, im Druck), die Priorität des FORBES'schen Artnamens zugunsten des Artnamens *neubergicus* zurückzustellen.

Es zeigte sich ferner, daß der REDTENBACHER'schen Art *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873) Priorität über zahlreiche, zum Teil gut eingeführte Namen besitzt.

Überwiegend kosmopolitische Arten wie *Partschiceras forbesianum, Pachydiscus neubergicus, Diplomoceras cylindraceum, Eubaculites lyelli* und eine Reihe von Arten, die vor allem in der Weißen Kreide Nord- und Westeuropas verbreitet sind *(Anagaudryceras lueneburgense, Saghalinites wrighti, Hoploscaphites constrictus),* zeigen an, daß im Untermaastricht ganz allgemein gute Migrationsmöglichkeiten, besonders aber in den Norden und Westen des heutigen Europa bestanden haben müssen.

* Geological Collections, University Museum, Oxford. OX1 3PW, U. K.
** Naturhistorisches Museum Wien, A-1014 Wien, Austria.

INTRODUCTION

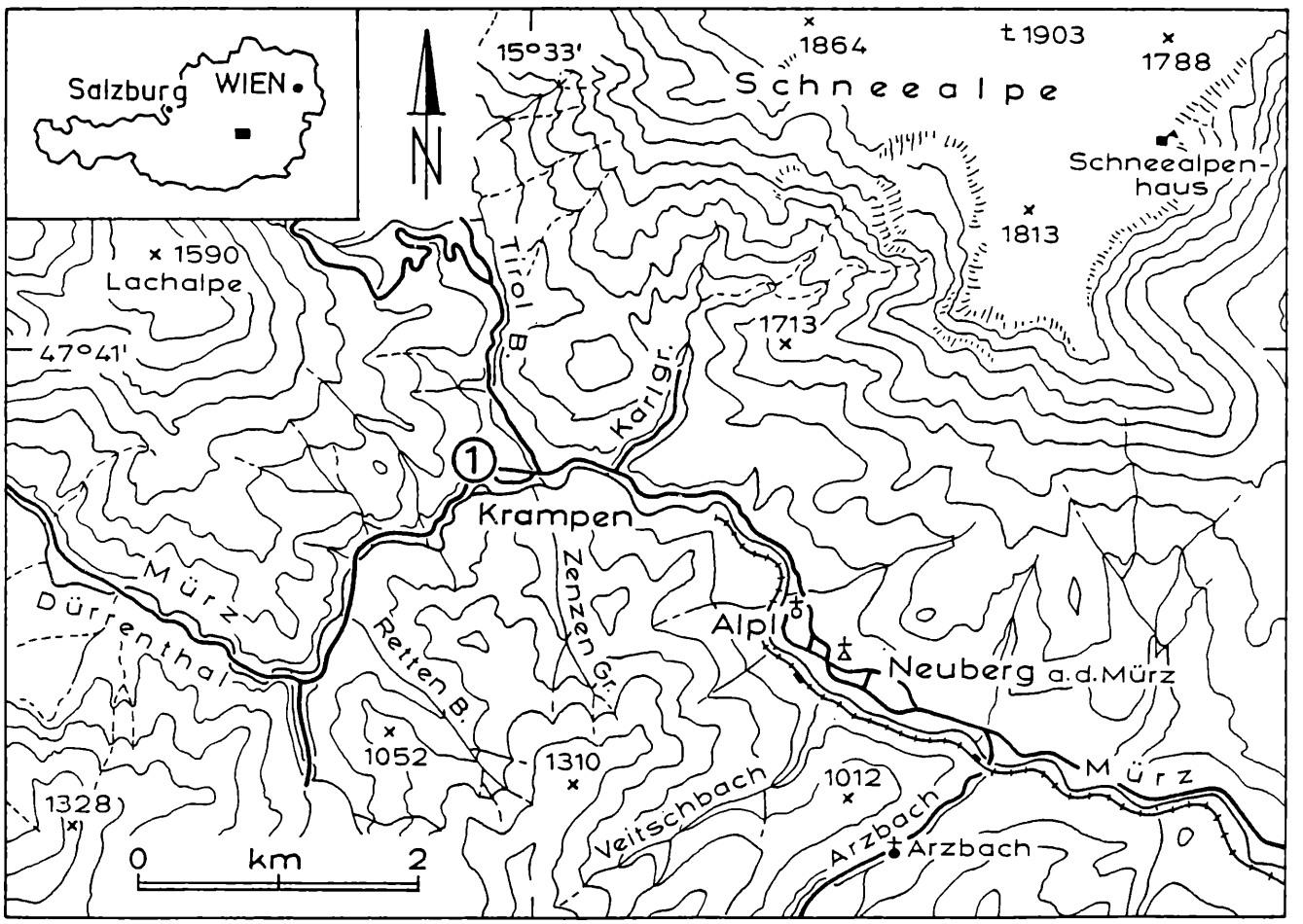
The fauna described in the present contribution is that of the classic Maastrichtian locality of Neuberg in Steiermark, Austria. This is the type locality of *Ammonites neubergicus* HAUER, 1858, a widely quoted Maastrichtian index fossil, and we illustrate and describe the type material and a series of topotypes of the species plus other elements of the ammonite fauna as a contribution to our understanding of Maastrichtian ammonite taxonomy and biostratigraphy.

All of the material mentioned in the literature or in museum collections is labelled 'Neuberg', 'Krampen' or 'Krampen bei Neuberg', Krampen is a small village west of, and now included in the community of Neuberg, in the Mürz valley (Text-fig. 1). There are no natural outcrops, and all the material came from a single quarry, now in the garden of a private house at the western end of the village.

The occurrence of ammonites at Neuberg was first noted by HAIDINGER (1846, p. 45). HAUER described a giant *'Hamites' (H. hampeanus)* from this locality in 1847 (p. 75); in 1858 he recognised this as a synonym of *Hamites cylindraceus* DEFRANCE, 1816, and also described three additional species, *Ammonites neubergicus* HAUER, 1858, *Scaphites multinodosus* HAUER, 1858 and *Scaphites equalis* J. SOWERBY, 1813. REDTENBACHER revised the Gosau ammonites in 1873, and pointed out that HAUER's *S. multinodosus* was a synonym of *Scaphites constrictus* J. SOWERBY, 1817 and that his *S. equalis* also belonged to that species. REDTENBACHER described two new forms, *Ammonites anaspastus* REDTENBACHER 1873 and *Ammonites epiplectus* REDTENBACHER 1873, as well as recording *Ammonites neubergicus, Ammonites* spec. indet. cfr. *Ammonites lünebergensis* SCHLÜTER, 1872 *Scaphites constrictus, Hamites cylindraceus* and *Baculites faujassi* LAMARCK, 1822. REDTENBACHER recognised that the Neuberg fauna was to be correlated with that of the Mucronatenkreide of north Germany (1873, p. 129).

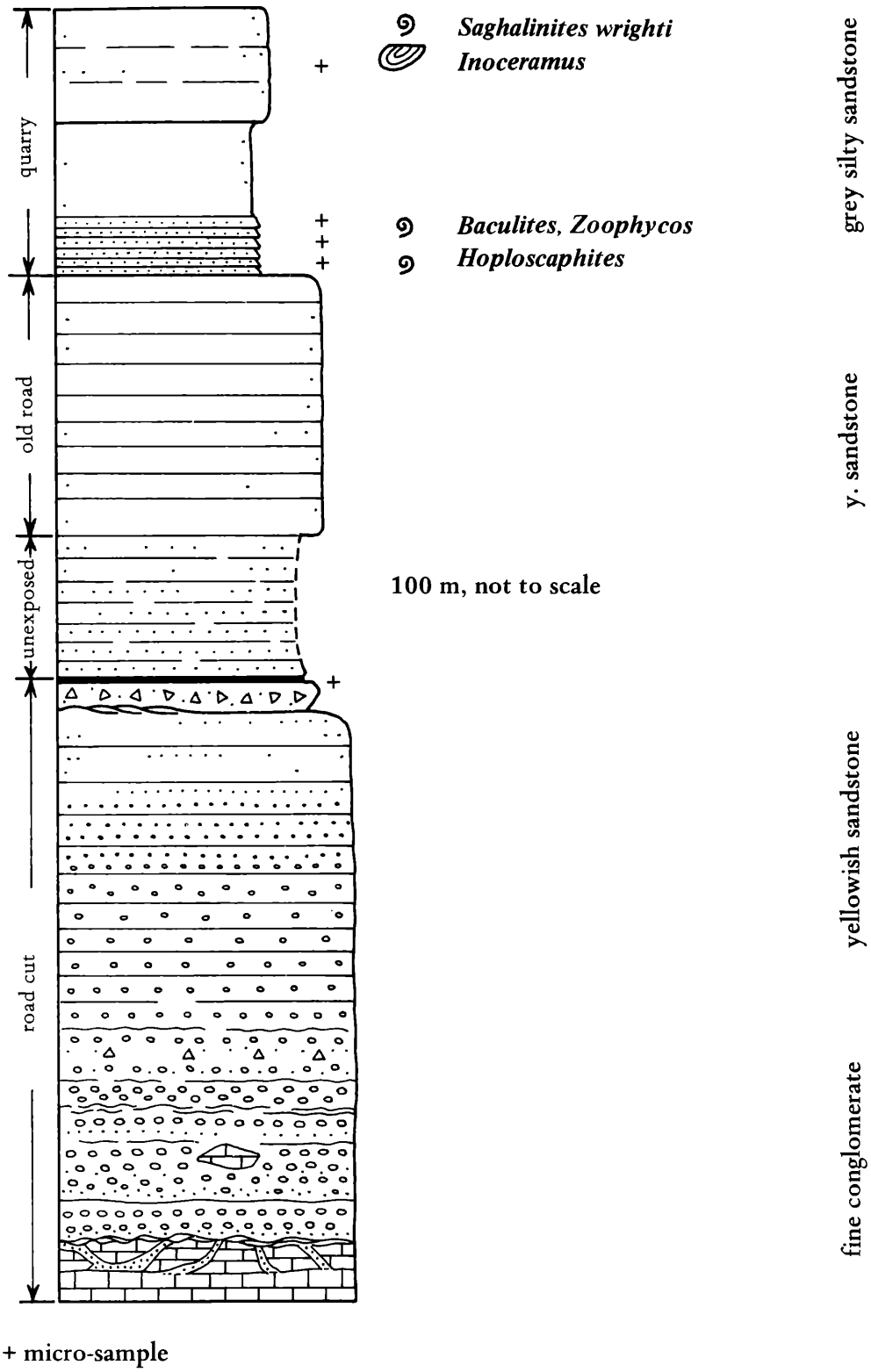
GEYER (1889) recorded a new species of *'Desmoceras'*, finer-ribbed than *'D' mite* (HAUER) from Neuberg, but the specimen has disappeared.

The most recent account of the Neuberg fauna is that of BRINKMANN (1935, p. 5) who recorded fourteen species, five of them pachydiscids, as well as an anomalous record of the Cenomanian *Forbesiceras largilliertianum* (D.ORBIGNY, 1841).



Text-fig. 1. Locality map of the Neuberg area.

The section of Neuberg, Steiermark, 1 500: Campanian – Lower Maastrichtian transgression series



Text-fig. 2. The lithostratigraphic sequence of Neuberg, Steiermark. The top is exposed in the old quarry of Krampen. The lower part and the transgression surface are roadside seen in exposures W of the quarry.

Latterly, REYMENT (1958, p. 32, pl. 11, fig. 1) reillustrated the holotype of *Ammonites anaspastus*, placing it in *Mesograudryderas* SPATH, 1927, and referring it to the Maastrichtian with a query. This remains the only Neuberg ammonite to be adequately illustrated.

LOCALITY DETAILS

The quarry at Krampen, although discused in HAUER's day, is in remarkably good condition, still showing a 20 m sequence of sediments. Neither upper nor lower boundaries are visible, while the whole sequence has been more-or-less tectonised. The succession consists of grey siltstones with argillaceous intercalations, and is locally carbonaceous, comparing with the 'Inoceramen-Schichten' of the Neue Welt basin to the north-east of Neuberg. A detailed section is shown in Text-fig. 2.

Collecting is now poor at Neuberg, although badly preserved bivalves (including *Inoceramus)*, gastropods and coral fragments occur. We feiled to find topotypes of *Pachydiscus neubergicus;* juvenile *Saghalinites* are relatively common, especially towards the top of the section, together with less frequent *Hoploscaphites constrictus.* Trace fossils include cylindrical burrows and *Zoophycos* MASSALONGO, 1885, the last suggesting, perhaps, a relatively deep water origon for the sequence.

LOCATION OF SPECIMENS

The following abbrevations are used to indicate the sources of material cited in the text:

NHMW – Department of Geology & Paleontology, Naturhistorisches Museum, Vienna.
GBA – Geologische Bundesanstalt, Vienna
PIUW – University of Vienna, Institute of Paleontology.
GIUW – University of Vienna, Institute of Geology.
GIG – Geologisches Institut, formerly Technische Hochschule, Graz.
BMNH – British Museum (Natural History), London.
JOAG – Steiermärkisches Landesmuseum Joanneum, Graz.

SUTURE TERMINOLOGY

The suture terminology of WEDEKIND (1916, see KULLMANN & WIEDMANN, 1970) is followed in the present work:

Is = Internal lobe with septal lobe
U = umbilical lobe
L = lateral lobe
E = external lobe

DIMENSIONS OF SPECIMENS

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

SYSTEMATIC PALAEONTOLOGY

Phylum MOLLUSCA; CLASS CEPHALOPODA CUVIER, 1797
Order AMMONOIDEA ZITTEL, 1884, pp. 355, 392
Suborder PHYLLOCERATINA ARKELL, 1950, p. 355
Superfamily PHYLLOCERATACEAE ZITTEL, 1884, p. 434
Family PHYLLOCERATIDAE ZITTEL, 1884, p. 434
Subfamily PHYLLOCERATINAE ZITTEL, 1884, p. 434

(= Hypophylloceratinae SPATH, 1927, p. 38; Calliphylloceratinae SPATH, 1927, p. 38)

Genus *PARTSCHICERAS* FUCINI, 1920, p. 95
(for synonymy see WIEDMANN, 1962 b, p. 257; 1964, p. 229)

Type species. *Ammonites partschi* STUR, 1851, p. 26, by the subsequent designation of SPATH, 1927, p. 38.

Discussion: WIEDMANN (1962 b, p. 257; 1964, p. 229) reviewed the genus at length. Only two specimens are before us, and we therefore follow him in regarding *Phyllopachyceras* SPATH, 1925 a, *Proclivicíceras* FUCINI, 1920, *Macrophylloceras* SPATH, 1927, *Hoplophylloceras* SPATH, 1927, *Partschiphylloceras* ROMAN, 1938 and ? *Calcaiceras* KOVACS, 1939 as synonyms. HENDERSON & MCNAMARA (1985, p. 43) afford *Phyllopachyceras* subgeneric status.

Occurrence: Sinemurian to Maastrichtian; in the Cretaceous species have a near world-wide distribution but are rare in the boreal region of north-west Europe and absent from the western interior of North America.

Partschiceras forbesianum (D'ORBIGNY, 1850)
Plate 1, figs. 2, 3, 6; Plate 15, figs. 3, 6

1846 a *Ammonites rouyanus* D'ORBIGNY; FORBES, p. 108, pl. 8, fig. 6 (non FORBES).
1850 *Ammonites forbesianum* D'ORBIGNY, p. 213.
1872 *Ammonites Velledaeformis* SCHLÜTER, p. 60, pl. 18, fig. 6 only.
1907 *Phylloceras* sp. WISNIOWSKI, p. 200 (10), pl. 17 (1), fig. 8.
1935 *Forbesiceras largilliertianum* BRINKMANN (non D'ORBIGNY), pp. 5, 10.
1970 *Phyllopachyceras forbesianum* (D'ORBIGNY); HENDERSON, p. 7, pl. 1, figs. 2, 4, 5 (with synonymy).
1971 *Phyllopachyceras forbesianum* (D'ORBIGNY); DUNDO, pl. 1, pl. 2, fig. 9.
1976 *Phyllopachyceras forbesianum* DEL VALLE & FOURCARDE, p. 14, pl. 3, fig. 6.
1985 *Partschiceras (Phyllopachyceras) forbesianum* (D'ORBIGNY, 1850); HENDERSON & MCNAMARA, p. 43, pl. 1, figs. 4–6; text-fig. 3 f.

Holotype: BMNH C51081, from the Valudayur Beds of Pondicherry, southern India, by monotypy.

Material: Two specimens, NHMW 1935. III. 14, and JOAG 60, the latter, labelled 'Gosau?' but, by its preservation, from Neuberg.

Description: The most complete specimen, NHMW 1935. III. 14, is a distorted and crushed body chamber fragment of an individual with an original estimated diameter of 80–90 mm (pl. 1, figs. 2, 3, 6). Coiling appears to have been very involute, the umbilicus tiny, but surrounded by a larger, funnel-shaped circumbilical depression. The whorl section appears to have been depressed and swollen, with rounded outer flanks, shoulders and venter.

Ornament consists of broad radial ribs on the outer flank and the venter, connected to the umbilicus by weak striae. On the flanks, the ribs and interspaces bear poorly preserved dense striae; on the venter, these strenghten into fine, dense, crowded sharp lirae over the siphonal line, particularly prominent on the ribs.

Discussion: The poorly preserved described specimen was determined by BRINKMANN (1935) as *Forbesiceras largilliertianum* (D'ORBIGNY, 1841). In fact, it appears to be the largest described Upper Cretaceous *Partschiceras*, matching in ornament with the Indian holotype at the largest diameter preserved on that specimen (FORBES 1846 a, pl. 8, fig. 6), material from British Columbia described by USHER (1952, p. 52, pl. 2, figs. 1–5; pl. 31, figs. 11, 12) and from Alaska described by JONES (1963, p. 24, pl. 41, figs. 2, 4–6; text-fig. 9).

According to HENDERSON (1970, p. 7), *P. ezoense* (YOKOYAMA, 1890) (p. 178, pl. 19, fig. 2), *P. minimum* (MARSHALL, 1926) (p. 138, pl. 19, fig. 8; pl. 26, figs. 5–9), *P. inflatum* (SHIMIZU, 1935) (p. 172), *P. marshalli* COLLIGNON, 1937 (p. 26) and *P. zelandicum* COLLIGNON, 1956, p. 31) are synonyms of *P. forbesianum;* the reader is referred to HENDERSON'S work for a full discussion on the species.

Occurrence: *P. forbesianum* is recorded, under various names, from southern India, Japan, British Columbia, Alaska, California, New Zealand, the sub-Antarctic Islands, Western Australia, Spain, North Africa, and Madagascar. One of SCHLÜTER'S specimens of *Ammonites velledaeformis* (1871, pl. 18, fig. 6 only) from Lüneburg, north Germany is also a *P. forbesianum* according to Dr. H. C. KLINGER (personal communication 1984), as is WISNIOWSKI'S specimen from the Flysch of Leszczyny, Galicia, now in the USSR. The species has not been previously recorded from the Gosau Beds. The age of *P. forbesianum* appears to be chiefly late Campanian to late Maastrichtian, although recorded from the early Campanian of Spain (WIEDMANN, 1962 a) and Santonian of Madagascar (COLLIGNON, 1956, 1966).

Suborder LYTOCERATINA HYATT, 1889, p. 7
Superfamily TETRAGONITACEAE HYATT, 1900, p. 568
Family GAUDRYCERATIDAE SPATH, 1927, p. 66

Genus *ANAGAUDRYCERAS* SHIMIZU, 1934, p. 67
(= *Paragaudryceras* SHIMIZU, 1934, p. 67; *Murphyella* MATSUMOTO, 1972, p. 208)

Type species: *Ammonites sacya* FORBES 1846 a, p. 113, pl. 14, fig. 9 by the original designation of SHIMIZU 1934, p. 67.

Diagnosis: Medium-sized gaudryceratids in which the early growth stages show an evenly rounded, circular to depressed whorl section which may become compressed in later growth stages. Ornament of early and middle growth stages typically consists of very fine radial lirae, often invisible to the naked eye, and periodic rounded, collar-like radial ribs. Internal moulds are typically smooth, save for radial constrictions corresponding to the site of the periodic ribs. Ornament frequently changes on the body chamber, where constrictions become closely spaced, and fold- or scale-like ribs develop between them. Suture line gaudryceratid, with deeply incised, bifid lobes and saddles and a retracted suspensive lobe.

Discussion: Nomenclatural problems associated with the erection of *Anagaudryceras* have been reviewed by WRIGHT & MATSUMOTO (1954, pp. 111–113) and the interpretation of the genus is discussed by MATSUMOTO (1959 a, p. 138, 1959 b, p. 73), WIEDMANN (1962 a, pp. 156–158), HOWARTH (1965, p. 357) and KENNEDY & KLINGER (1979, p. 144).

Occurrence: The known time range of *Anagaudryceras* is from Middle Albian to Upper Maastrichtian. The geographic distribution includes Antarctica, New Zealand, Zululand, Madagascar, Angola, North Africa, France, Germany, Austria, Roumania, southern India, Japan, Sakhalin, Kamchatka, Alaska, British Columbia, California and western Australia.

Anagaudryceras lueneburgense (SCHLÜTER, 1872)
Plate 3, fig. 6; Plate 15, fig. 4

1872 *Ammonites lüneburgensis* SCHLÜTER, p. 62, pl. 18, figs. 8–9.
? 1873 *Ammonites* spec. indet. cfr. *Ammonites Lüneburgensis* SCHLÜTER; REDTENBACHER, p. 126.
1894 *Gaudryceras Lüneburgense* SCHLÜTER sp.; DE GROSSOUVRE, p. 231.
1902 *Desmoceras lüneburgense* SCHLÜTER sp.; RAVN, p. 252.
1902 *Gaudryceras Lüneburgense* SCHLÜTER sp.; WOLLEMANN, p. 94.
1925 *Gaudryceras lüneburgense* SCHLÜTER; DIENER, p. 48.
1935 *Gaudryceras lüneburgense* SCHLÜTER; BRINKMANN, p. 5.
1979 *Gaudryceras lueneburgense* (SCHLÜTER); BIRKELUND, p. 53.
1979 *Anagaudryceras lüneburgense* (SCHLÜTER); KENNEDY & KLINGER, p. 146.
1982 *Anagaudryceras lueneburgense* (SCHLÜTER); BIRKELUND, p. 14, pl. 1, fig. 1.

Type: The lectotype, by the subsequent designation of BIRKELUND, 1982, p. 14 is the original of SCHLÜTER, 1872, pl. 18, fig. 8 from the Upper Campanian or Lower Maastrichtian Mucronatenkreide of Lüneburg, north Germany. The specimen is no. 65–4 in the Geologisch-Paläontologisches Institut, Universität Göttingen.

Material: Two specimens; one in the GBA collections, the other is JOAG. 55.514.

Description: The larger specimen is a crushed and deformed individual approximately 130 mm in diameter. Over half the last whorl appears to be body chamber, and traces of aragonitic test are present in many places.

Coiling appears to have been moderately evolute, the umbilicus comprising an estimated 35 % of the diameter. Because of crushing, it is not possible to determine the original whorl section. Ornament consists of fine, dense lirae. These arise at the umbilical seam, sweep strongly forwards across the shoulder, and are markedly prorsiradiate across the inner flank. The ribs flex backwards and are convex across the mid-flank, concave on the outer flank, and cross the venter with a distinct convexity. Parallel to the striae are numerous narrow, quite deep constrictions and associated collar-ribs, totalling 13–14 per whorl. The collars are particularly prominent across the umbilical shoulder.

The sutures are not exposed.

Discussion: Although crushed, the flexuous lirae and numerous constrictions of this species are quite distinctive, and separate the specimens from most *Anagaudryceras* known to us – the *A. sacya* group develop strong folds at the same diameter, whilst forms such as *A. politissimum* (KOSSMAT, 1895) (p. 128 (32), pl. 15 (1), fig. 7), *A. yamashitai* (YABE, 1903) (p. 38, pl. 4, fig. 7) and *A. mikobokense* COLLIGNON, 1956 (p. 59, pl. 8, fig. 1) lack such strinkingly flexuous constrictions. There are some similarities to the *Gaudryceras glaneggense* group, especially *Gaudryceras lauteli* COLLIGNON, 1956 (p. 57, pl. 7, fig. 1) but here, lirae are coarser, and constrictions do not appear to be either as numerous or as prominent. The lectotype of *A. lueneburgense* lacks, according to SCHLÜTER'S figure both lirae and collars, but a series of specimens from the White Chalk facies of Denmark kindly shown to us by Professor TOVE BIRKELUND link the lectotype to our material, the lack of lirae on the chalk specimens being a matter of preservation in our view. *Gaudryceras hamanakense* MATSUMOTO & YOSHIDA, 1979, p. 68, pl. 10, figs. 1–3; pl. 11, figs. 1–2; text-fig. 2 from the Maastrichtian of eastern Hokkaido, Japan, is a close ally. The constrictions and collars are a little less flexuous on the inner whorls and appear more distantly spaced on the outer.

Occurrence: According to BIRKELUND (1982, p. 14) precisely localised specimens from Hemmoor and Jylland range from the upper part of the Lower Maastrichtian to the lower part of the Upper Maastrichtian *Belemnitella junior* Zone. There are also records from Rügen (SCHLÜTER, 1874), Scania (MOBERG, 1885), the Carpathians (WISNOWSKI, 1907) and Tercis, Landes, France (DE GROSSOUVRE, 1894; Ecole des Mines and Sorbonne Collections).

Anagaudryceras sp.
Plate 2, figs. 3, 4

? 1935 *Gaudryceras mite* VON HAUER; BRINKMANN, p. 5.

Material: One specimen, GIUW unregistered (ex. Vienna High School Collections).

Description: This fragment is wholly septate, and originally had a whorl height of over 80 mm. It is of interest in showing a massive septal lobe, and a fine, dense liration, indicating the presence of a further species with delicate ornament.

Family TETRAGONITIDAE HYATT, 1900, p. 568
Genus *Saghalinites* WRIGHT & MATSUMOTO, 1954, p. 110

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

Discussion: KENNEDY & KLINGER (1977, p. 167) review the limits and members of this genus. In that work the range is given as Santonian to Lower Maastrichtian. It is now clear that the genus extends to the Upper Maastrichtian in western Europe (BIRKELUND, 1979, p. 53, text-fig. 1; 1982, p. 15). Poorly preserved *Saghalinites* have been recorded widely in the Maastrichtian of Europe, but have generally been overlooked, as with the records of MARIANI, 1898 (as *Hauericeras pseudo-gardeni* SCHLÜTER sp., p. 57 (7), pl. 8 (1), fig. 6) from Brenno, Lombardy, Italy; BÖHM (1909, p. 52, pl. 1, fig. 5, as *Tetragonites subepigonum* BÖHM) from Beerenbach, Switzerland, and WISNIOWSKI (1907, p. 201 (11), pl. 17 (1) figs. 5 a–c, as *Lytoceras (Tetragonites)* sp.) from Leszczyny, Galicia, now in the Ukrainian SSR.

Occurrence: Santonian to Upper Maastrichtian; Antarctica, south Patagonia, Zululand, Madagascar, southern India, Japan, Sakhalin, northern Spain, south-western France, Holland, Switzerland, Austria, north Germany, USSR and Denmark.

Saghalinites wrighti BIRKELUND, 1965
Plate 1, figs. 4, 5, 7; Plate 3, fig. 4; Text-fig. 3

1876 *Ammonites* sp. n. ?; SCHLÜTER, p. 161, pl. 42, figs. 6–7.
1902 *Ammonites* n. sp. ? SCHLÜTER; RAVN, p. 257, p. 3, fig. 1.
1965 *Saghalinites wrighti* BIRKELUND, p. 30, pl. 1, fig. 5; pl. 2, figs. 1–5; pl. 3, fig. 1; text-figs. 14–25.
1979 *Saghalinites* n. sp. aff. *wrighti* BIRKELUND; BIRKELUND, p. 53.
1982 *Saghalinites wrighti* BIRKELUND; BIRKELUND, p. 15, pl. 1, figs. 2–3.
non 1982 *Saghalinites* aff. *wrighti* BIRKELUND, 1965; IMMEL, KLINGER & WIEDMANN, p. 10, pl. 2, figs. 1–2.

Holotype: Mineralogical Museum, Copenhagen Collections, no. 9747, the original of Birkelund, 1965, pl. 2,

fig. 5, text-fig. 19, by original designation; Maastrichtian of Nugssuaq, west Greenland.

Material: NHMW 1977.1924.7; NHMW 1977.1924.8; NHMW 1985/69 a–c, GIG 487.

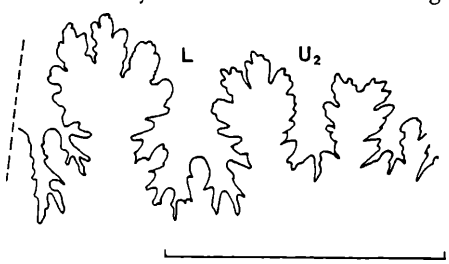
Description: The specimens are all distorted internal moulds retaining traces of partially recrystallised shell.

The dimensions of the best preserved specimen, GIG 487, are:

D	Wb	Wh	Wb:Wh	U
50.5(100)	–(–)	16.8(33)	–	22.8(45)

Coiling is very evolute, the umbilicus comprising 45 % of the diameter, broad and shallow, with a low, flattened umbilical wall. The whorl section is secondarily compressed, but appears to have originally been polygonal with an abruptly rounded umbilical shoulder, flattened flanks, rounded ventrolateral shoulders and a venter that is rounded on the inner whorls but flattened on the last half whorl.

There are poorly preserved prorsiradiate lirae, which parallel well-developed constrictions, of which there are four on the last half whorl of GIG 487 (Plate 1, fig. 7). They arise at the umbilical seam, pass forwards across the umbilical wall, and are markedly prorsiradiate across the flank, straight to mid flank, then flexed backwards to produce a marked convexity over outer flank and shoulder with a shallow concave sinus over the siphonal region. There are ventrolateral and a siphonal ridge, separated by grooves (Plate 1, fig. 5); one specimen (NHMW 1977.1924.7) shows additional ridges on the outer flank. The suture line (Text-fig. 3) is poorly exposed, but appears relatively simple, with a large E/L and smaller L/U_2, both of wich are irregularly trifid. The suspensive lobe is strongly retracted, with small auxiliary lobes and saddles. L is large and bifid.



Text.-fig. 3. External suture of *Saghalinites wrighti* BIRKELUND, 1965. GIG 487. Bar scale is 10 mm.

Discussion: These specimens are referred to *Saghalinites wrighti* on the basis of the shape and number of constrictions per whorl. This species (BIRKELUND, 1965, p. 30, pl. 1, fig. 5; pl. 2, figs. 1–5; pl. 3, fig. 1; text-figs. 14–25), originally described from East Greenland but subsequently recorded from low in the Upper Maastrichtian of north Germany and Denmark has straight constrictions rather than the flexuous constrictions of the type species, *S. cala* (FORBES, 1846) (see KENNEDY & KLINGER, 1977, p. 168, text-figs. 10A–B, 11A–B, 12D–G, 13A–B, E–K, ?C–D, 14A–F, 15A–F, for a full discussion of this species). The *Saghalinites* n. sp. discussed by BIRKELUND (1979, p. 53; 1982, p. 15) from the Upper Maastrichtian of Kunrade, Holland, and north Jylland, Denmark, was described by DE GROSSOUVRE (1908, p. 34, pl. 10, fig. 5) as *Gaudryceras* cf. *kayei* FORBES, 1846. It differs from *S. wrighti*, following BIRKELUND, in being more evolute and having much stronger constrictions.

We doubt that the specimens from the Santonian Gosau Beds of Brandenberg (Tirol) described by IMMEL, KLINGER & WIEDMANN (1982, p. 10, pl. 2, figs. 1–2) belong here.

Occurrence: According to BIRKELUND (1982, p. 16) the Greenland, north German and north Jylland (Denmark) occurrences are all around the Lower/Upper Maastrichtian boundary in belemnite terms.

Genus *PSEUDOPHYLLITES* KOSSMAT, 1895, p. 137(41)

Type species: *Ammonites indra* FORBES, 1846 a, p. 105, pl. 7, fig. 7, by original designation.

Discussion: For a recent review of this genus, see KENNEDY & KLINGER (1977).

Occurrence: Campanian and Maastrichtian: Antarctica, South Africa, Madagascar, southern India, New Zealand, western Australia, Japan, Sakhalin, southern and central Europe, west Greenland, British Columbia, United States, Gulf Coast, Brazil. Also recorded from the Upper Santonian of Madagascar (COLLIGNON, 1956).

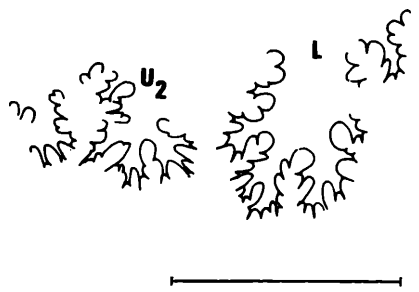
Pseudophyllites cf. *indra* (FORBES, 1846)
Plate 1, figs. 1, 8; Plate 3, fig. 5; text-fig. 4

1873 *Ammonites anaspastus* REDTENBACHER, p. 113, pl. 26, fig. 1.
1935 *Gaudryceras* sp. (= *anaspastus* REDT.); BRINKMANN, p. 5.
1958 *Mesogaudryceras anaspastum* (REDTENBACHER); REYMENT, p. 32, pl. 9, fig. 1.
1968 *Mesogaudryceras* cf. *anaspastum* (REDT.); SUMMESBERGER, p. A 62.

Material: GBA 1873.01.16, the holotype, by monotypy, of *Ammonites anaspastus* REDTENBACHER, 1873, pl. 26, fig. 1.

Description: The specimen is a crushed and distorted internal mould 75 mm in diameter, with almost three-quarters of the outer whorl body chamber. Coiling is involute, with a small umbilicus comprising approximately 20–23 % of the diameter. The umbilical wall appears to have been rounded and outward-sloping, the flanks gently inflated and the venter rounded. There are poorly preserved prorsiradiate lirae on one flank of the body chamber together with delicate spiral and transverse ridges. Such as can be deciphered of the suture line is shown in Text-fig. 4.

Discussion: *Ammonites anaspastus* was referred to the genus *Mesogaudryceras* SPATH, 1927 in REYMENT'S (1958) revision of some of REDTENBACHER'S types. WRIGHT & KENNEDY (1984) treat *Mesogaudryceras* as a subgenus of *Gaudryceras*, and show it to be an exclusively Cenomanian form which has well-developed distant flexuous lirae. Absence of constrictions in *Ammonites anaspastus* differentiate it from most genera of Tetragonitidae



Text-fig. 4. External suture of *Pseudophyllites* cf. *indra* (FORBES, 1846). Taken from the holotype of *Ammonites anaspastus* REDTENBACHER, 1873, GBA 1873.01.06. Bar scale is 10 mm.

and Gaudryceratidae, while the coiling and whorl profile, although distorted by crushing (Plate 1, fig. 1) are close to those of *Pseudophyllites*. The combination of fine radial and spiral ornament is seen in many individuals of this genus, including the lectotype of *P. indra* and some other specimens (e. g. USHER, 1952, pl. 3, figs. 11–13). The present specimen is compared with *P. indra* on the basis of the whorl section and form of umbilicus. KENNEDY & KLINGER (1977, p. 186) provide a full discussion of this, and other species; see also HENDERSON & MCNAMARA, 1985, p. 50, pl. 2, figs. 7, 8; pl. 3, figs. 4, 5; text-figs. 5a, d.

Occurrence: Campanian to Upper Maastrichtian. Southern India, Madagascar, Zululand, northern Australia, Japan, Sakhalin, British Columbia, Alaska, California, Brazil (?), south-eastern France, Poland and Austria. Also recorded from the Upper Santonian of Madagascar.

Suborder AMMONITINA HYATT, 1889, p. 7
Superfamily DESMOCERATACEAE ZITTEL, 1895, p. 426
(**nom. transl.** WRIGHT & WRIGHT, 1951, p. 18 ex Desmoceratidae ZITTEL, 1895).

Family PACHYDISCIDAE SPATH, 1922 a, p. 132
(**nom. transl.** SPATH, 1923, p. 39 for Pachydiscinae SPATH, 1922 a, 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 bullae or disappear completely at maturity. Many reach a large size.

Occurrence: Campanian to Maastrichtian, worldwide.

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 below. 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, 1922a), *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 & HANNA, 1935); fide MATSUMOTO, 1959 b, p. 41) and *P. (N.) gracilis* MATSUMOTO, 1979. These have an equidimensional whorl section, distant ribs on the nuclei and are near smooth in middle and later growth although striae and fine riblets develop in some.

A third group, long recognised (e. g. MATSUMOTO, 1959 b, 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, 1922a (= *Mesopachydiscus* YABE and SHIMIZU, 1926) of the Coniacian to Campanian. Forms such as *Eupachydiscus jeani* (DE GROSSOUVRE, 1894) (p. 127, 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 & SUMMESBERGER 1984 (p. 16, 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 these species.

Occurence: Campanian to Maastrichtian, world-wide.

Pachydiscus (Pachydiscus) neubergicus
(VON HAUER, 1858)

Plate 2, figs. 1–2; Plate 3, figs. 1–3; Plate 4, figs. 1–5; Plate 5, figs. 1, 4, 5; Plate 6, figs. 1, 2, 5; Plate 15, figs. 7, 8, Text-fig. 5A, B.

1846a *Ammonites chrishna* FORBES, p. 103, pl. 9, fig. 2.
1858 *Ammonites Neubergicus* HAUER, p. 12 (pars.), pl. 2, figs. 2, figs. 1–3 only (non pl. 3, figs. 1–2, = *Pachydiscus haueri* COLLIGNON)
1865 *Ammonites egertonianus,* FORBES; STOLICZKA, p. 104 (pars), pl. 53, fig. 4 only.
1869 *Ammonites Neubergicus* V. HAUER; FAVRE, p. 14, pl. 4, figs. 2–3.
1872 *Ammonites Neubergicus,* V. HAUER, SCHLÜTER, p. 59. pl. 18, figs. 1–3.
1873 *Ammonites Neubergicus* HAUER: REDTENBACHER, p. 120, pl. 27, fig. 5.
1891 *Pachydiscus neubergicus* (HAUER); BÖHM, p. 48.
1894 *Pachydiscus neubergicus* F. VON HAUER, sp. emend., A. DE GROSSOUVRE, p. 207 (pars) pl. 30, fig. 4 (non pl. 26, fig. 3, Pl. 38, fig. 3; text-fig. 80 = *Pachydiscus jacquoti* SEUNES, 1890).
1898 *Pachydiscus neubergicus* HAUER; KOSSMAT, p. 95 (160).
1901 *Pachydiscus neubergicus* HAUER sp.; IMKELLER, p. 56.
non 1901 *Pachydiscus neubergicus* V. HAUER sp. var. nov. *Stallauensis* IMKELLER, p. 57, pl. 3, fig. 5.
1902 *Pachydiscus neubergicus* (VON HAUER); WOLLEMANN, p. 102.
1902 *Pachydiscus neubergicus* V. HAUER sp. emend. DE GROSSOUVRE; LIEBUS, p. 117, pl. 6, fig. 1.
1908 *Pachydiscus neubergicus* (VON HAUER); SCHMIDT, p. 243.
non 1908 *Pachydiscus neubergicus* V. HAUER sp. emend. DE GROSS; DE GROSSOUVERE, p. 30, pl. 9, figs. 3, 4 (= *P. jacquoti* SEUNES, 1890).
non 1909 *Pachydiscus neubergicus* HAUER sp. emend. DE GROSS; NOVAK, p. 796, pl. 1, fig. 6.
1925 *Pachydiscus egertoni* FORBES –*neubergicus* HAUER; DIENER, p. 115 (pars).
1935 *Pachydiscus neubergicus* V. HAU.; BRINKMANN, p. 5.
non 1938 *Parapachydiscus neubergicus* V. HAUER; COLLIGNON, p. 95 (45), pl. 8, fig. 4.
non 1938 *Parapachydiscus neubergicus* V. HAUER var. *jacquoti* SEUNES; COLLIGNON, p. 98 (48), pl. 9, fig. 1.
1951 *Pachydiscus neubergicus* HAUER; MICHAILOV, p. 62, pl. 7, figs. 36, 37; text-figs. 22, 23.
non 1951 *Pachydiscus neubergicus* HAUER var. *nowaki* MICHAILOV, p. 65.
1951 *Pachydiscus gollevillensis* D'ORBIGNY; MICHAILOV, p. 66, pl. 8, fig. 39, text-fig. 24.
1959 *Pachydiscus neubergicus* (VON HAUER); NAIDIN & SHIMANSKIJ, p. 186, pl. 10, figs. 1–3; text-fig. 18 a.
1965 *Pachydiscus neubergicus* (HAUER); BLASZKIEWICZ, p. 151, pl. 1, figs. 1, 2; pl. 2, fig. 1.
1969 *Pachydiscus gollevillensis neubergicus* (V. HAUER); ATABEKIAN and AKOPIAN, p. 7, pl. 2, fig. 1.
non 1971 *Pachydiscus neubergicus* (VON HAUER); COLLIGNON, p. 28, pl. 651, figure 2407.
1976 *Pachydiscus* sp. juv. aff. *neubergicus* (HAUER); THIEDIG and WIEDMANN, p. 20, text-figs. 2A–B.
1980 *Pachydiscus neubergicus raricostatus* BLASZKIEWICZ, p. 43 (pars), pl. 36, figs. 1–4, 7–10; ? non pl. 35, figs. 6–8.
1980 *Pachydiscus neubergicus neubergicus* (HAUER, 1858); BLASZKIEWICZ, p. 44, pl. 35, figs. 4, 5; pl. 36, figs. 5, 6.
1982 *Pachydiscus gollevillensis neubergicus* (HAUER, 1858); TZANKOV, p. 36, pl. 16, fig. 1.
1985 *Pachydiscus (Pachydiscus) dossantosi* (MAURY, 1930); ZABORSKI, p. 20, figs. 17, 18, 20.

Lectotype: GBA 1858.01.6, the original of HAUER, 1858, p. 12, pl. 2, figs. 1–2. Designated by DE GROSSOUVRE, 1894, p. 209.

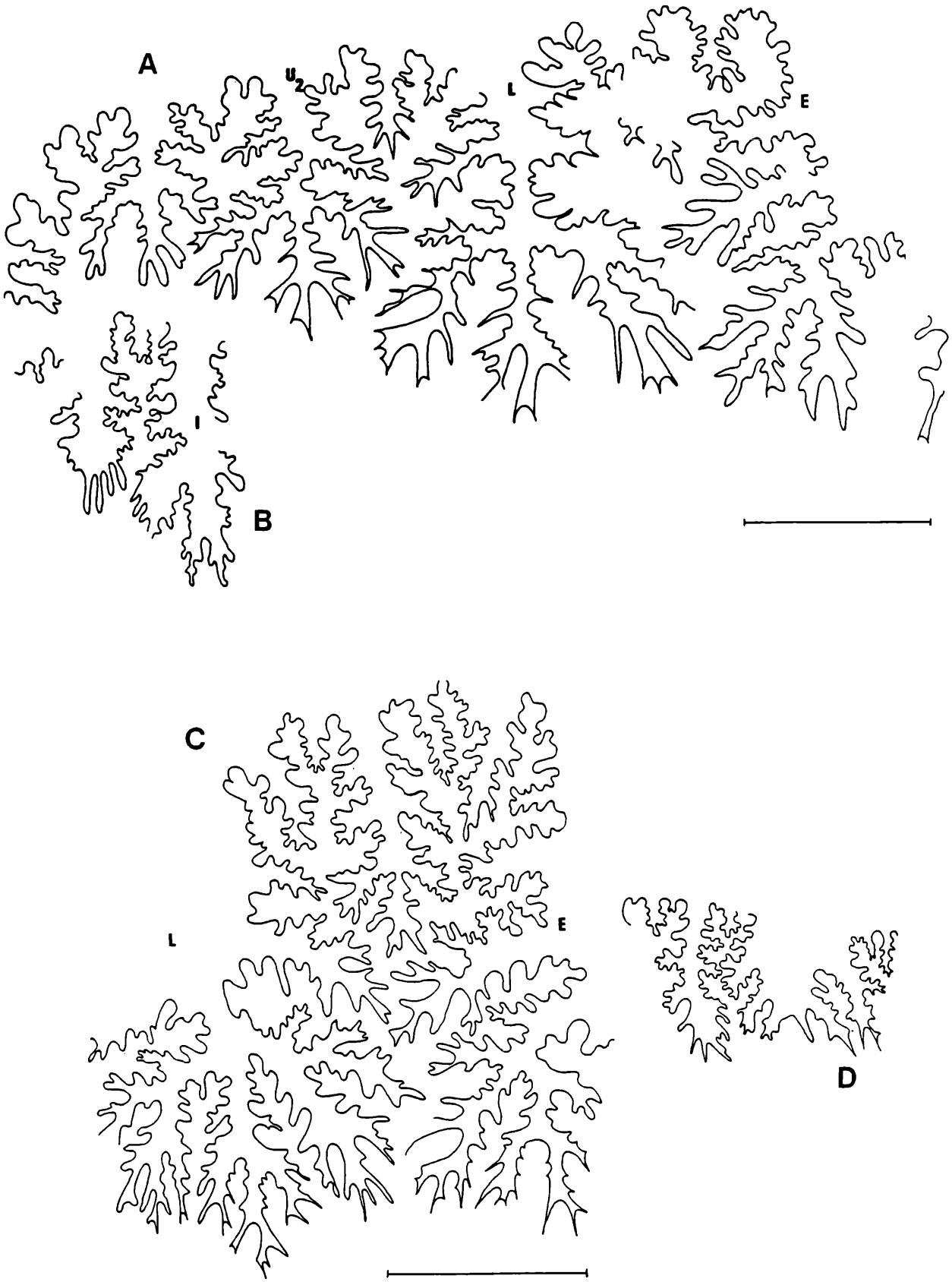
Material: Three paralectotypes, GBA 1858.01.6; and the following topotypes: GBA 1935.01.39 (= BRINKMANN 1935, p. 5) PIUW Coll. Vienna High School no. 1876.XV.6, 7; JOAG nos. 34, 6109 and 6110, 6112; GBA 1873.01.23 = REDTENBACHER 1873, p. 120, pl. 27, fig. 5 c; NHMW 1851.XXI.1880, NHMW 1852.XXI. 1881; GIUW. 1875.XXX.I.

Description: All the available specimens are distorted to varying degrees, and are preserved as internal moulds, most retaining traces of powdery aragonitic shell.

The lectotype is absolutely typical of the smallest individuals we have seen, and is distorted into an ellipse with a maximum diameter of 93 mm.

Coiling is relatively involute, approximately two thirds of the previous whorl being covered, the umbilicus comprising an estimated 28–30 % of the diameter, relatively shallow, with a low, rounded undercut wall on moulds. The whorl section appears to have been compressed, with rounded inner and convergent outer flanks, and a narrowly rounded venter. Ribs arise at the umbilical seam and sweep backwards and are concave across the umbilical wall. They strengthen on the umbilical shoulder, giving rise to sixteen long strong umbilical bullae which extend across the inner third of the flank and are straight at the smallest diameter visible, but become concave as size increases. From the bullae arise narrow primary ribs. These are straight and prorsiradiate on the inner two thirds of the flank in most cases and only occasionally concave. They bi- or rarely trifurcate at variable points on the outer flank, the secondary ribs passing slightly forwards across the venter, accompanied by occasional short intercalated ribs, so that there are a total of fifty ventral ribs corresponding to the sixteen umbilical bullae. Other specimens show some variability in rib density, strength, form and direction of bullae and ribs at the same diameter as the holotype; PIUW, Vienna High School 1876.XV.7 has seventeen bullae and fifty-six ventral ribs; in NHMW 1851.XXI.1880 the figures are fourteen and approaching sixty; in the PIUW specimen, the figures are seventeen and forty-eight.

As size increases, the bullae elongate in many specimens (Plate 5, figs. 4–5), and the ribbing weakens, so that the outer flanks and venter bear only very feeble, broad, rather distant ribs. The suture lines are well-exposed (if somewhat distorted) on several specimens, as shown in text-fig. 5.



Text-fig. 5: External suture of A, B *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858), taken from: A, GBA.1858.01.6; B, GBA. 1873.01.23. C, D *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873).. GBA 1873.01.24. C is the external, D the internal suture. Bar scale is 10 mm.

Discussion: As will be seen from the description, the quarry at Krampen yields specimens with an oval whorl section, 14–17 umbilical bullae and 48 to almost 60 ventral ribs. The Indian species *Pachydiscus chrishna* (FORBES, 1846a) (p. 103, pl. 9, fig. 2) (see Pl. 2, figs. 1, 2) with a comparable whorl section, 14–15 umbilical bullae on the outer whorl and 27 ventral ribs on the first half of the outer whorl is clearly the same species and has priority. HENDERSON and KENNEDY (in press) have asked the International Commission on Zoological Nomenclature to give the name *neubergicus* nomenclatural priority over *chrishna* for reasons set out in that application.

Pachydiscus gollevillensis (D'ORBIGNY, 1850) (p. 212) is an Upper Maastrichtian species from the Calcaire a *Baculites* of the Cotentin Peninsula, Manche, France. A revision of the species (KENNEDY, 1986) shows it to have the greatest breadth close to the umbilical shoulder, 9–11 umbilical bullae per whorl and approximately 80 ventral ribs. There are thus fewer umbilical and more ventral ribs than in typical *neubergicus,* while ornament is weaker. *Pachydiscus egertoni* (FORBES, 1846a) (p. 108, pl. 9, fig. 1) has U = 28–29 % with strongly convergent flanks, a whorl breadth to height ratio of 0.88, 12 umbilical bullae in the lectotype at a diameter of just over 100 mm, while the secondary ribs are restricted to the ventral region and do not persists beyond 65 mm diameter.

Pachydiscus jacquoti SEUNES, 1890 (p. 5, pl. 3 (2), figs. 1–3; for a recent revision see KENNEDY 1986). Is closely allied to, and probably an Upper Maastrichtian descendant of, *P. egertoni.* If differs from *P. neubergicus* in being evolute at maturity (U = 32 % at D = 122 mm) with a slowly expanding, subcircular whorl section (Wb:Wh = 0.91–1.14), fewer primary ribs and coarser, more distant ventral ornament. *P. jacquoti australis* HENDERSON & MCNAMARA, 1985 (p. 76, pl. 8, figs. 1, 2, 7, 8, 9, 10; text-figs. 12 a, 13 b, 15 a) is more depressed, and coarser ribbed and tuberculate.

Pachydiscus neubergicus stallauensis IMKELLER (p. 57, pl. 3, fig. 5), from the Pattenauer Mergel of the Bayerischen Alpen is a Campanian form. The figured specimen is crushed according to RIEDEL (1932), and appears to be closer to the *P. haldemsis* (SCHLÜTER, 1967) – *P. oldhami* (SHARPE, 1855) group.

Pachydiscus neubergicus nowaki MICHAILOV, 1951 (p. 65) is based on the original of NOWAK, 1913, p. 354, pl. 41, fig. 13 (= holotype) and FAVRE, 1869, p. 14, pl. 4, figs. 2, 3 (= paratypes). The holotype has feebler ornament and far more ventral ribs than *P. neubergicus,* being better referred to *P. gollevillensis.* NOWAK speaks of up to 8 primary ribs with up to 5 short ribs intercalated between. The larger paratype (FAVRE, 1869, pl. 4, fig. 2) is shown with fourteen umbilical and more than sixty ventral ribs, although FAVRE speaks of 40–50 ribs in the text; the smaller paratype has twelve umbilical ribs and coarser ventral ribs. We have not seen FAVRE'S specimens but place them in the synonymy of *P. neubergicus.*

Pachydiscus gollevillensis armenicus ATABEKIAN and AKOPIAN, 1969, p. 8, pl. 1, fig. 2; pl. 3, figs. 1–2, has 16–20 umbilical ribs and 62–73 ventral ribs. It thus has more umbilical and ventral ribs than typical *P. neubergicus* (14–17, 48–60) plus more umbilical but an equal or smaller number of ventral ribs than *P. gollevillensis* (9–11, up to 80).

Pachydiscus neubergicus raricostatus BLASZKIEWICZ, 1980 (p. 43, pl. 35, figs. 6–8; pl. 36, figs. 1–4, 7–10) is based on crushed material. According to its author it has an umbilical diameter of 27–29 %, eleven to fifteen primary ribs, some of which bifurcate, and 30–40 ventral ribs. There is thus little overlap of rib density with *neubergicus* sensu stricto, while the bifurcating ribs and ribs arising in pairs from bullae would place it close to the Upper Campanian *P. perfidus* DE GROSSOUVRE, 1894, as BLASZKIEWICZ notes. The holotype (BLASZKIEWICZ, 1980, pl. 36, figs. 3, 4, 8) has, however, 14 umbilical bullae and more than 40 venter ribs according to the photograph, with the rib bifurcations no more pronounced than is occasionally seen in topotypes of *neubergicus* (Plate 4, fig. 5). The small specimen figured by BLASZKIEWICZ (1980) as pl. 35, fig. 6 is sparsicostate when compared with the present material, so that more than one form may be present.

Fragmentary specimens from the Lower Maastrichtian Nkoporo Shale of Nigeria identified as *P. (P.) dossantosi* (MAURY, 1930) appear to belong, rather, to *neubergicus* (ZABORSKI, 1985, p. 20, figs. 17, 18, 20).

P. (P.) neubergicus from the lower Upper Maastrichtian of Western Australia belong to a distinctive subspecies *dissitus* HENDERSON & MCNAMARA, 1985 (p. 72, pl. 7; fig. 7; pl. 9, figs. 3, 4, 5, 6; text-figs. 11, 12c, 13c) that has nuclei like those of the present material but an outer whorl with fine ventral ribbing, as in *P. (P.) gollevillensis.*

Pachydiscus neubergicus of the Lower Maastrichtian and *P. gollevillensis* of the Upper Maastrichtian thus appear to represent the early and late members of a stock in which evolution involved an overall weakening of ornament, including effacement at mid-flank in middle growth, reduction in the number of umbilical bullae and primary ribs but increase in outer lateral and ventral ribs, with a range of specimens varying round this theme to which subspecific names such as *armenicus, nowaki* and *dissitus* have been applied. *P. neubergicus raricostatus* appears to be a distinctive early form, perhaps forming a link with the Campanian *Pachydiscus.*

Occurrence: Where well-localised, *P. neubergicus* is Lower Maastrichtian, as in Poland and the USSR, southeastern France, Nigeria and southern India. In north Germany the precise records of SCHULZ, ERNST, ERNST & SCHMID (1984) show it restricted to the upper part of the lower Lower maastrichtian, the *Belemnella obtusa* Zone, of Lüneburg.

In Poland, BLASZKIEWICZ (1980) records *P. neubergicus neubergicus* from his *Belemnella occidentalis* Zone only and *P. neubergicus raricostatus* from the underlying *B. lanceolata lanceolata* Zone, suggesting the restricted form appears some way above the base of the stage, although he records only 3 specimens of the former. In Denmark, BIRKELUND (1979, text.-fig. 1) reports, but does not discuss, specimens from the top of the Lower Maastrichtian *Belemnella occidentalis* Zone and the base of the Upper Maastrichtian *Belemnitella junior* Zone, with no *Pachydiscus* recorded from the *Belemnella lanceolata* Zone. In Western Australia, subspecies *dissitus* is Upper Maastrichtian. In summary, *P. neubergicus* appears in the lower Lower Maastrichtian, occurs in the upper Lower Maastrichtian, and is also recorded from the lower Upper Maastrichtian.

Pachydiscus (Pachydiscus) epiplectus
(REDTENBACHER, 1873)
Plate 6, figs. 3, 4; Plate 7, figs. 1, 2; Plate 8, figs. 1, 2; Plate 9; Plate 10, figs. 1–3; Plate 11, figs. 1–4; Plate 12; Plate 13, figs. 1–3.

1958 *Ammonites neubergicus* n. sp. VON HAUER, p. 12 (pars), pl. 3, figs. 1–2 only.
1873 *Ammonites epiplectus* REDTENBACHER, p. 121, pl. 28, figs. 1a–c.
1891 *Pachydiscus fresvillensis* SEUNES; SEUNES, p. 14, pl. 12 (3), fig. 1.
1894 *Pachydiscus colligatus* VON BINKHORST sp. emend. A. DE GROSSOUVRE; DE GROSSOUVRE, p. 202 (pars) non pl. 24, figs. 1, 3; non pl. 33.
1898 *Pachydiscus colligatus* VON BINKHORST sp.; MARIANI, p. 53, pl. 8, fig. 2.
1908 *Pachydiscus colligatus* BINKHORST VAN DEN BINKHORST sp. emend. DE GROSS.; DE GROSSOUVRE, p. 28 (pars) non pls. 4, 5, 6, 7, 8.
1913 *Pachydiscus colligatus* BINKHORST sp.; NOWAK, p. 361 (pars), ? pl. 43, fig. 30; pl. 44, fig. 39.
1925 *Pachydiscus colligatus* V. BINKHORST; DIENER, p. 114 (pars).
1935 *Pachydiscus colligatus* BINK.; BRINKMANN, p. 5.
1935 *Pachydiscus colligatus* BINK.; (= *epiplectus* REDT.); BRINKMANN, p. 6.
1951 *Pachydiscus colligatus* BINKHORST; MICHAILOV, p. 56, pl. 5, figs. 28–30.
1951 *Pachydiscus colligatus* BINK. var. *epiplecta* REDTENBACHER; MICHAILOV, p. 59, pl. 6, fig. 33.
1952 *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST; COLLIGNON, p. 79, pl. 26, fig. 2.
1952 *Pachydiscus haueri* COLLIGNON, p. 80.
1955 *Pachydiscus* sp. aff. *colligatus* VAN BINKHORST; COLLIGNON, p. 74, pl. 26, fig. 2.
1955 *Pachydiscus haueri* COLLIGNON; COLLIGNON, p. 75.
1959 *Pachydiscus colligatus* NAIDIN & SHIMANSKIJ, p. 186, pl. 9, fig. 4.
1969 *Pachydiscus colligatus colligatus* (BINKHORST); ATABEKIAN & AKOPIAN, p. 11 (pars), pl. 4, fig. 2; pl. 5, fig. 1.
1969 *Pachydiscus haueri haueri* COLLIGNON; ATABEKIAN & AKOPIAN, p. 16, pl. 8, fig. 1; pl. 9, fig. 1.
1969 *Pachydiscus haueri sersensis* ATABEKIAN & AKOPIAN, p. 17, pl. 8, fig. 2; pl. 10, fig. 1; pl. 11, fig. 1.
1982 *Pachydiscus colligatus colligatus* (BINKHORST); TZANKOV, p. 38, pl. 17, fig. 1; pl. 18, fig. 1.

Types: Lectotype, here designated is GIUW 1868.X.15, the original of REDTENBACHER 1873, pl. 28, fig. 1a, b from Muthmannsdorf. GBA 1873.01.24 from Grünbach appears to be the original of REDTENBACHER 1873, pl. 28, fig. 1c and is thus a paralectotype. We have been unable to recognise the third, Neuberg specimen cited by REDTENBACHER.

Material: GIUW unregistered; GIUW 1876.XV.8; GBA, HAUER collection.

Dimensions:	D	Wb	Wh	Wb;Wh	U
GIUW 1868 XI5* (lectotype)	165(100)	70.0(42.4)	78.5(47.5)	0.89	30.0(18.2)
at*	112(100)	53.0(47.3)	55.8(49.8)	0.95	24.5(21.9)
GIUW 1876.XV.8*	230.(100)	108(46.9)	110(47.8)	0,98	42.0(18.3)

(* all specimens are distorted by post-mortem crushing)

Description: All the Neuberg specimens studied are distorted to varying degrees, while the lectotype is also secondarily compressed. The earliest whorls are seen only in the dorsal impressed zones of GBA 1873.01.24 and GIUW unregistered where ornament is identical to that shown by the inner whorls of the lectotype, GIUW 1868.X.15 (Plate 10, figs. 1, 2). The whorl section varies from compressed to depressed, sometimes on the same specimen, due to post-mortem crushing, with a small deep umbilicus, the umbilical wall and shoulder rounded. The inner flanks are inflated, the outer flanks flattened and convergent, with a broadly rounded venter. The greatest breadth is below mid-flank. Primary ribs arise at the umbilical shoulder, singly or in pairs, from feeble bullae or not and are narrow, sharp and prorsiradiate, separated by wide interspaces. They forwards across the inner flank, while intercalated ribs are inserted at various positions high or low on the flank to give an estimated 20–22 bullae at the umbilical shoulder and a total of 50–55 ribs per whorl at a diameter of 100–150 mm. The ribs appear slightly flexuous in some specimens (due to post-mortem distortion?) but all sweep forwards over the ventrolateral shoulders where they are markedly concave, and pass across the venter in a broad convexity. The best-preserved of the larger specimens, GIUW 1876.XV.8 (Pl. 9; Pl. 10, fig. 3; Pl. 11, fig. 4) is distorted, with a major diameter of 220 mm. It shows the same style of ornament persisting to around 170 mm, beyond which it is poorly preserved, although flank ribs persist and there is strong ventral ribbing, the rib density being an estimated 60 per whorl. In the largest specimen (Pl. 12) the ribbing appears to be effacing on the mid-flank-region.

Suture line typical for genus (Text-fig. 6C, D).

Discussion: *Pachydiscus epiplectus* has been a neglected species, for authors from DE GROSSOUVRE (1894, p. 202) onwards have treated it as a synonym of *Pachydiscus colligatus* (BINKHORST, 1861). This latter species presents numerous problems. One of us was able to reexa-

mine the surviving types in the Museum für Naturkunde, East Berlin in 1984, and the results are published elsewhere (KENNEDY in press). The lectotype, by the subsequent designation of KENNEDY (in press) is the original of BINKHORST 1861, pl. 8. It is from the low Upper Campanian of Jauche, Brabant, Belgium and has been figured photographically by DE GROSSOUVRE (1908, pls. 7, 8) and KENNEDY (in press). It differs from *P. epiplectus* in being much more evolute with slower expanding whorls (dimensions are D = 260(100), Wb = 104(40), Wh = 118(45), Wb:Wh = 0.88, U = 64.5(24.8)), where *epiplectus* has a smaller umbilicus (U = 18.2 % in the distorted lectotype; less than 20 % in the large specimens) and more massive whorls. Little ornament survives on the lectotype of *colligatus* at a size where *epiplectus* retains ornament, including coarse ventral ribbing.

DE GROSSOUVRE (1894, p. 202) also placed *Pachydiscus fresvillensis* SEUNES, 1890 (p. 3, pl. 2(1), fig. 1) in the synonymy of his *colligatus,* together with *epiplectus.* As KENNEDY (1986) has shown, *fresvillensis* has strong umbilical spines and is an *Anapachydiscus.* The proportions recall, however, those of *epiplectus* (lectotype at D = 148.0(100), Wb = 72.0(48.6), Wh = 77.0(52.0), Wb: Wh = 0.94, U = 31.0(21.1)) while the whorls are similarly massive, with coarse persistent ventral ribs (see, for instance the huge specimen figured by PETHÖ (1906, p. 88, pl. 5, fig. 1) as *Pachydiscus supremus).* The two differ when young in the coarser ribs, 32–33 in total per whorl, with prominent rounded umbilical tubercles (the bases of septate spines) of *fresvillensis* while adults have fewer ribs (40 in topotypes) and flank ornament that completely effaces beyond a diameter of 120 mm, whereas it is strong in *epiplectus.*

There are also similarities to *Pachydiscus ootacodensis* (STOLICZKA, 1865) (p. 109, pl. 54, figs. 3, 4; pl. 56, non pl. 57) recently revised by JONES (1963) (p. 38, pl. 29, figs. 1–3, 13–16; pls. 30, 31; pl. 32, fig. 1).

A fine topotype in the Oxford University Museum Collections (OUM KY444) shows much coarser ribbing on the venter and inner flank ornament already effacing at a diameter of 120 mm, while juveniles figured by JONES (1963, pl. 29, figs. 1–3, 13–15) are utterly distinct.

Pachydiscus haueri COLLIGNON, 1952 (p. 80) has, as type specimen, the original of *Ammonites neubergicus* VON HAUER, 1858 (p. 12 (pars), pl. 3, figs. 1, 2 only), a specimen from Neuberg. COLLIGNON distinguished it from other species because of its "forme discoidale plate, a flancs peu bombees, presques plats au voisinage de la fosse ombilicale Ses cotes concaves en avant le mettre un peu plus a part. Je le considere, a condition que la figure de la Pl. III de V HAUER soit bien la reproduction exacte du fossile de Neuberg, comme une espece nouvelle" (1952, p. 80).

The holotype is missing, but the very compressed whorl section shown in HAUER'S figure is undoubtedly due to post-mortem crushing, as with so many Neuberg specimens. We believe the curious changes in ornament are due to artistic license, and place the species in synonymy with *epiplectus. P. haueri sersensis* ATABEKIAN & AKOPIAN, 1969 (p. 17, pl. 8, fig. 2; pl. 10, fig. 1; pl. 11, fig. 1) is probably a finely ribbed ally of *P. epiplectus.* It will also be seen that we regard some of the Maastrichtian records of *Pachydiscus colligatus* as being *epiplectus.* Most are poorly preserved and perhaps others should be added; the fine specimens from the USSR figured by MICHAILOV (1951) and ATABEKIAN & AKOPIAN (1969) certainly belong here. Other Maastrichtian specimens referred to *P. colligatus* seem to encompass a number of forms. *P. colligatus michailovi* of ATABEKIAN & AKOPIAN (1969, p. 14, pl. 5, fig. 2; pl. 6, fig. 2; pl. 7, figs. 1, 2) is more distantly and sparsely ribbed (40 per whorl) and may be *Anapachydiscus fresvillensis* (SEUNES, 1890) (fide KENNEDY in press). The *Pachydiscus* sp. aff. *colligatus* of COLLIGNON (1952, p. 79, pl. 26, fig. 2; 1955, p. 74, pl. 26, fig. 2) has inner whorls with ribs not unlike the present species and might belong here, to *A. fresvillensis* or some other form. In the absence of a fuller description it is difficult to be certain.

The *Pachydiscus colligatus* of COLLIGNON, 1971 (p. 32, pl. 453, fig. 2409; pl. 454, fig. 2409) is rather coarsely and distantly ribbed, with ornament comparable to that of *P. colligatus michailovi;* similar comments apply.

The *Pachydiscus colligatus latiumbilicatus* of BLASZKIEWICZ, 1980 (p. 46, pl. 37, fig. 3; pl. 38, figs. 1–4; pl. 50, fig. 1) and cf. *latiumbilicatus* of that author (1980, p. 46, pl. 54, fig. 5; pl. 55, fig. 1) have a much wider umbilicus than *P. epiplectus,* fewer, more distant ribs while the smaller paratype (BLASZKIEWICZ, 1980, pl. 38, fig. 3) appears to have umbilical spines and to be an *Anapachydiscus,* allied to *A. fresvillensis.*

Occurrence: The lectotype is from the Lower Maastrichtian of Muthmannsdorf in the Neue Welt Basin, and the Neuberg occurrence is also Lower Maastrichtian. It is described from the Lower Maastrichtian of the USSR and Bulgaria and may also occur in southern France and Madagascar.

Genus *MENUITES* SPATH, 1922 a, p. 123
(= *Besairieites* COLLIGNON, 1931, p. 19)

Type species: *Ammonites menu* FORBES, 1846 a, p. 111, pl. 10, fig. 1.

Discussion: *Menuites* is based on a microconch probably of *Anapachydiscus* YABE & SHIMIZU, 1926, over which it would thus have priority. We have seen undoubted macroconch microconch pairs of *Anapachydiscus/Menuites* from the Campanian, but have not as yet found the macroconch of the type species, *M. menu,* to prove the point beyond doubt. The microconch of *Anapachydiscus fascicostatus* (YABE, 1921) has been figured recently as *Menuites sanadai* MATSUMOTO, 1984 (p. 17, pl. 5, fig. 1; text-fig. 5). As a result we continue to use both names as a convenience. A single specimen from Neuberg represents a previously undescribed form, which we are unable to link conclusively with other, macroconch pachydiscids in the fauna.

Occurrence: Upper Santonian to Upper Maastrichtian, with a near world-wide distribution.

Menuites costatus sp. nov.
Plate 5, figs. 2, 3
1935 *Pachydiscus* ex. aff. *menu* FORBES; BRINKMANN, p. 5.

Holotype: GIUW 1876.XV.9 from Krampen, Neuberg, Styria.

Description: The holotype and only available specimen is a crushed body chamber retaining most of the original aragonitic shell. It is 70 mm in diameter. Coiling appears to have been relatively involute, with a small deep umbilicus and depressed, rounded whorl section. There are six umbilical bullae on the half whorl preserved, giving rise to one or two narrow ribs, with occasional non-bullae ribs extending to the umbilicus towards the aperture. The ribs are prorsiradiate and gently flexuous, and on the first part of the body chamber, most bear a prominent finger-like ventral tubercle. These tubercles are linked across the venter by single narrow convex ribs. Towards the aperture, all tubercles decline, and narrow ribs extend across the whole of the whorl.

Discussion: Although only a fragment, this specimen is immediately distinguished from all other *Menuites*. *M. menu* (FORBES, 1846a) (p. 111, pl. 10, fig. 1) has weaker bullae and lacks the distinctive ribs of our species. *M. japonicus* MATSUMOTO, 1955 (p. 158, pl. 31, figs. 1–3; pl. 33, figs. 2, 3; texts-figs. 4, 5) has stronger, sparser ribs, which are single, and do not branch from umbilical bullae, although they may loop between ventral tubercles. In *Menuites portlocki* (SHARPE, 1855) (p. 30, pl. 13, figs. 2, 3) the shell is larger, with much coarser bullae; although these do give rise to pairs of ribs as in our form, the ventral tubercles do not develop until a much greater diameter (SHARPE, 1855, pl. 13, fig. 2), and the ribs are blunter. *M. pusillus* (MATSUMOTO, 1955), *M. sturi* (REDTENBACHER, 1873) and *M. selbensis* (PERVINQUIÈRE, 1907) are much smaller species. The American *M. stephensoni* YOUNG, 1963 (p. 57, pl. 15, figs. 1–2; text-figs. 70, 9n) has a tabulate venter, and lacks umbilical bullae.

Occurrence: as for type.

Suborder ANCYLOCERATINA WIEDMANN, 1966, p. 54
Superfamily TURRILITACEAE GILL, 1871, p. 3
(= Diplomoceratacеae BRUNNSCHWELLER, 1966, p. 14)
Family DIPLOMOCERATIDAE SPATH, 1926, p. 81
(= Neocrioceratinae SPATH, 1953, p. 17)
Subfamily DIPLOMOCERATINAE SPATH, 1926, p. 81
(= Scalaritinae WARD, 1976, p. 455)
Genus *DIPLOMOCERAS* HYATT, 1900, p. 571
(= *Eudiplomoceras* BRUNNSCHWEILER, 1966, p. 18)

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

Discussion: We regard *Glyptoxoceras* SPATH, 1925 c, as a genus distinct from *Diplomoceras*, following WARD (1976). The adult coiling of the two is quite distinct. *Eudiplomoceras* was separated from *Diplomoceras* on the basis of a circular, rather than compressed whorl section. Many collections of *Diplomoceras/Eudiplomoceras* include compressed and near-circular forms; they are regarded as synonyms here.

Occurrence: Maastrichtian of western and central Europe, the transcaucasian region of the USSR, Greenland, Zululand, Madagascar, southern India, Japan, Alaska, British Columbia, California, Antarctica, South America, New Zealand and Western Australia.

Diplomoceras cylindraceum (DEFRANCE, 1816)
Plate 15, figs. 1, 2, 5; Plate 16, figs. 14, 15; text-fig. 6.

1816 *Baculites cylindracea* DEFRANCE, p. 160.
1842 *Hamites cylindraceus* D'ORBIGNY, p. 551, pl. 136, figs. 1–4.
1846b *Hamites elatior* FORBES in DARWIN, p. 265.
1847 *Hamites hampeanus* HAUER, p. 75.
1851–1856 *Hamites cylindraceus* WOODWARD, p. 96, fig. 58.
1858 *Hamites cylindraceus* DEFR. sp.: HAUER, p. 8, pl. 1, figs. 3–6.
1861 *Hamites cylindraceus,* D'ORBIGNY; BINKHORST, p. 36, pl. 5b, figs. 5–7 (with additional synonyny).
1869 *Hamites cylindraceus,* DEFRANCE sp.; FAVRE, p. 26, pl. 7, fig. 1.
1872 *Hamites* cf. *cylindraceus* DEFR. sp.; SCHLÜTER, p. 103, pl. 31, figs. 10–14; pl. 29, figs. 8, 9 (with synonymy).
1873 *Hamites cylindraceus* DEFR. sp.; REDTENBACHER, p. 130.
? 1890 *Hamites elatior* FORBES?; WHITE, p. 13, pl. 2, figs. 1, 2.
1895 *Hamites* cf. *cylindraceus* DFR. sp.; STEINMANN, p. 89.
1898 *Pachydiscus* sp., MARIANI, p. 56 (6), pl. 8 (1), fig. 5.
1898 *Hamites* cf. *cylindraceus* DEFR. sp., MARIANI, p. 57.
1903 *Hamites elatior* FORBES?; WELLER, p. 418, pl. 2, fig. 3.
1903 *Hamites* sp. indet. WELLER, p. 418, pl. 2, fig. 4.
1903 *Diplomoceras notabile* WHITEAVES, p. 335, pl. 44, fig. 4.
1909 *Anisoceras notabile* WHITEAVES; KILIAN and REBOUL, p. 15, pls. 2, 3, ?4; pl. 5, pl. 6, fig. 1.
1913 *Hamites cylindraceus* DEFRANCE sp.; NOWAK, p. 382, pl. 41, fig. 10; pl. 42, fig. 35; pl. 45, fig. 47.
1925 *Diplomoceras cylindraceum* DEFRANCE; DIENER, p. 74 (with synonymy).
1925 *Diplomoceras* cf. *cylindraceum* (DEFR.); DIENER, p. 75, (pars) (with synonymy).
1925 *D.* sp.; ind. aff. *cylindraceo* (DEFR.); DIENER, p. 75 (with synonymy).
1925 *Anisoceras* (an *Diplomoceras) notabile* WHITEAVES; DIENER, p. 72 (with synonymy).
? 1930 *Glyptoxoceras parahybense* MAURY, p. 185, pl. 1, fig. 2.
1951 *Diplomoceras* cf. *cylindraceum* (DEFRANCE); MICHAILOV, p. 41, pl. 2, figs. 9, 10; text-fig. 10.
1951 *Diplomoceras cylindraceum* DEFR. var. *Ivovensis* var. nov., MICHAILOV, p. 42, pl. 2, figs. 7, 8; text-figs. 11 a–b.
1952 *Diplomoceras notabile* WHITEAVES, 1903; USHER, p. 109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26, 27.
1953 *Hamites cylindraceus* DEFRANCE; PETKOVIĆ, p. 33, pl. 6, figs. 1, 4–6.
1953 *Diplomoceras lambi* SPATH, p. 17, pl. 2, figs. 1–3; pl. 3, fig. 1.
1953 *Diplomoceras notabile* WHITEAVES; SPATH, p. 17; pl. 2, fig. 4.
1953 *Diplomoceras cylindraceum* (DEFRANCE in D'ORBIGNY); SPATH, p. 17.

? 1957 *Diplomoceras* sp. WRIGHT, p. 806.
? 1958 *Diplomoceras jimboi* ANDERSON, p. 199, pl. 68, fig. 5.
? 1958 *Diplomoceras o'shaughnessyi* ANDERSON, p. 201, pl. 56, fig. 2.
1959 *Diplomoceras cylindraceum* (DEFRANCE); NAIDIN & SHIMANSKIJ, p. 181, pl. 3, fig. 2.
1962a *Diplomoceras (Diplomoceras)* cf. *notabile* WHITEAVES; WIEDMANN, p. 208.
1963 *Diplomoceras notabile* WHITEAVES; JONES, p. 32, pl. 21, fig. 1; text-fig. 15.
1964 *Diplomoceras cylindraceum* (DEFRANCE); TSANKOV, p. 152, pl. 4, fig. 2.
1965 *Diplomoceras* sp. BIRKELUND, p. 67, pl. 16, figs. 1, 2.
1966 *Eudiplomoceras raggati* BRUNNSCHWEILER, p. 18, pl. 8, fig. 7; text-figs. 4–5.
1966 *Diplomoceras* cf. *D. notabile* (WHITEAVES, 1903); BRUNNSCHWEILER, p. 20, pl. 7, fig. 3; text-fig. 6.
1966 *Diplomoceras notabile* (WHITEAVES); BRUNNSCHWEILER, text-fig. 7.
? 1970 *Diplomoceras* sp. HENDERSON, p. 27, pl. 3, fig. 5.
1971 *Diplomoceras notabile* WHITEAVES; COLLIGNON, p. 11, pl. 644, figs. 2377–9.
1971 *Diplomoceras* cf. *notabile* WHITEAVES; DUNDO, pl. 1, fig. 12.
1975 *Diplomoceras lambi* SPATH; DEL VALLE and RINALDI, p. 1, pls. 1–10.
1976 *Diplomoceras cylindraceum* DEFRANCE; KLINGER, p. 81 et. seq.
1976 *Diplomoceras* gr. ex. *lambi* SPATH; KLINGER, p. 82.
1976 *Diplomoceras* gr. ex. *cylindraceum* DEFRANCE; KLINGER, p. 82.
1976 *Diplomoceras (Diplomoceras) notabile* WHITEAVES, 1903; KLINGER, p. 82, pl. 34, figs. 2, 4.
1979 *Diplomoceras cylindraceum* (DEFRANCE, 1816); BIRKELUND, p. 55.
1980 *Diplomoceras cylindraceum lvoviense* MICHAILOV; BLASZKIEWICZ, p. 30, pl. 54, fig. 4.
1980 *Diplomoceras cylindraceum cylindraceum* (DEFRANCE, 1816); BLASZKIEWICZ, p. 30, pl. 54, fig. 2, pl. 55, figs. 6, 7.
1982 *Diplomoceras cylindraceum* (DEFRANCE, 1822); TZANKOV, p. 22, pl. 6, figs. 1–3.
? 1982 *Diplomoceras notabile* ? WHITEAVES; MARTINEZ, p. 168, pl. 29, fig. 6.
1986 *Diplomoceras cylindraceum* (DEFRANCE, 1816); KENNEDY, p. 51, pl. 4, figs. 1, 2; pl. 9, figs. 8–10; pl. 10; text-figs. 3 I–M, 6, 7 G–M.

Types: DEFRANCE'S specimens are lost. Most authors have taken D'ORBIGNY'S description as the basis for this species, but his surviving material is inadequate and is not from Maastricht, the only locality mentioned by DEFRANCE. Neotype designation must await revision of the Maastricht material.

Material: Three specimens: GBA 1858.01.1 a, the original of HAUER 1858, p. 8, pl. 1, fig. 4; GBA 1858.01.1 b, the original of HAUER 1858, pl. 1, fig. 6; GBA unregistered.

Description: Both specimens are crushed and retain the original shell material. It is impossible to determine whether the rounded whorl section was originally depressed or compressed. The available material suggests at least three sub-parallel shafts were present, although there is no trace of the earliest whorls. Ornament consists of strong sharp straight prorsiradiate ribs, 12–13 in a distance equal to the whorl height. They pass forwards across the flanks, straight across the venter (where they are at their maximum strength: Plate 15, fig. 1; Plate 16, fig. 14) and dorsum (where at their minimum strength: Plate 15, fig. 5).

Text-fig. 6. Suture of *Diplomoceras cylindraceum* (DEFRANCE, 1816) GBA 1858.01.1 b. Bar scale is 10 mm.

There is a tendency to crowd on the hooks. One specimen (Plate 15, figs. 1, 2) shows a prominent constriction at a whorl height of 16 mm; it runs parallel to the ribs. A fragment associated with this individual shows the intricately subdivided suture line, illustrated by VON HAUER (1858, pl. 1, fig. 6) and shown here as Text-fig. 7. Internal moulds are smooth (Plate 15, fig. 5).

Discussion: Better-preserved, uncrushed specimens from the Upper Maastrichtian Calcaire à *Baculites* of the Cotentin Peninsula, Manche, France (KENNEDY, 1986), have phragmocone whorl heights of 21.9 to 51 mm. The whorl breadth to height ratio varies from 0.89 to 0.99, the whorl section from ovoid/rounded subtrigonal to nearly circular. Internal moulds are virtually smooth to feebly ribbed. On straight shafts rib direction varies from near rectiradiate to markedly prorsiradiate, even in the same specimen. The rib density varies from 11–13 in a single specimen and between specimens where ornament is well-preserved. Occasional interspaces are strengthened into constrictions. The Neuberg specimens are inseparable from this material, differing only in their excellent preservation of shell material.

HAUER (1847, p. 75) introduced the name *Hamites hampeanus* for a Neuberg specimen. In 1858 he illustrated the specimen as plate 1, fig. 3. Since lost, it is a typical *cylindraceum*, as HAUER noted (1858, p. 8). He originally separated it from *cylindraceum* because it had an oval rather than circular section. Subsequently he found specimens with a circular section, like that figured by BLAINVILLE (1825, p. 382, pl. 23, fig. 1) and regarded the two as synonyms.

Diplomoceras notabile WHITAVES, 1903 (p. 335, pl. 44, fig. 4) is discussed in detail by USHER (1952), JONES (1963) and KLINGER (1976). Study of a cast of the holotype plus topotypes in the British Museum (Natural History) showed a whorl breadth to height ratio of 0.87–0.9 and

a rib index of 12–14. Alaskan examples have a whorl breadth to height ratio of 0.80 to 0.89 and a rib index of 11–12. All figured specimens have ribs that are prorsiradiate or both prorsiradiate and rectiradiate on the same specimen. Contrary to the view of WHITEAVES (1903), there are no major sutural differences between the two. *D. notabile* is, at most, a subspecies of *D. cylindraceum* and they are placed in synonymy here. *Diplomoceras lambi* SPATH, 1953 (p. 17, pl. 2, figs. 1–3; pl. 3, fig. 1) is also a synonym. Study of the type series in the British Museum (Natural History) shows internal moulds of phragmocones to be smooth or feebly ribbed, but internal moulds of body chambers are strongly ribbed. The rib direction varies as in *cylindraceum,* the whorl breadth to height ratio ranging from 0.95 to 1.06, with 5 specimens slightly compressed and 4 slightly depressed. The rib index, measurable on only 3 specimens, was 13, 14 and 17. *Hamites elatior* FORBES, 1846 b and *Glyptoxoceras parahybense* MAURY, 1930 (p. 185, pl. 11, fig. 2) are based on material that is too poor for satisfactory discussion. The latter is said to have a compressed oval whorl section, but from the account is obviously crushed. The rib index is 13, the ribs distinctly prorsiradiate.

The *Hamites elatior* of WHITE (1890, p. 13, pl. 2, figs. 1, 2) has an oval section with flattened, sub-parallel flanks (whorl breadth to height ratio 0.77) and a rib index of 20. WHITE states that it has been deformed by post-mortem compression. It resembles the finely ribbed specimens of KILIAN & REBOUL (1909, pl. 4) and WELLER (1903). *Diplomoceras cylindraceum lvoviense* MICHAILOV, 1951 (p. 42, pl. 2, fig. 7, 8; text-fig. 11), the holotype of which is the original of NOWAK, 1913, p. 382, pl. 41, fig. 10, has, according to MICHAILOV'S figure, a compressed, ovoid section, but this is due to post-mortem distortion. The rib index of 16–17 is higher than in specimens from Cotentin, but the sample is small, and specimens from Maastricht show a similar rib index (BINKHORST, 1861, p. 5 b, fig. 6 a). It too is regarded as a synonym. *Diplomoceras australe* HUNICKEN, 1965 (p. 67, pl. 4, figs. 1–4) has a whorl breadth to height ratio of 1.6 and a rib index of 12, this being beyond the limits of variation of material discussed here.

Diplomoceras species from California described by ANDERSON (1958) are said to range from Turonian to Maastrichtian. Figures and descriptions are inadequate, but *D. jimboi* and *D. oshaughnessyi* probably belong here.

Eudiplomoceras raggati BRUNNSCHWEILER, 1966 (p. 18, pl. 8, fig. 7; text-figs. 4–5) with, according to its author, a circular cross section and rib index of 13–15 appears inseparable from *D. cylindraceum.*

Occurrence: This species ranges throughout most of the Maastrichtian. The Danish records are the most precise (BIRKELUND, 1979, p. 55, text-fig. 1) and show the species first appearing very low in the Lower Maastrichtian *Belemnella lanceolata* Zone and ranging to the top of the Upper Maastrichtian *Belemnella casimirovensis* Zone. The species has a world-wide distribution, with records from north-west France, Holland, Denmark, north Germany, Poland, Austria, the USSR, southern India (?), Zululand, Madagascar, Western Australia, the Antarctic, south America, California, British Columbia and Alaska plus doubtful records from Greenland and New Zealand.

Diplomoceras sp. indet.

Material: NHMW 1935.III.16, 1935.III.23.

Description: These two specimens are fragments of a huge *Diplomoceras;* NHMW 1935.III.16 has a whorl height in excess of 70 mm. NHMW 1935.III.23 approaches 80 mm whorl height. Both are ornamented by strong, sharp crowded ribs, and the latter specimen appears to preserve an aperture associated with four much stronger ribs and a marked broad, deep constriction. Neither specimen shows the sutures.

Discussion: These huge specimens from Neuberg may be fragments of adults of the material described above as *D. cylindraceum.* They exceed in size the huge body chambers described by SPATH (1953, p. 17, pl. 3, fig. 1).

Family BACULITIDAE GILL, 1871, p. 3
(= Eubaculitidae BRUNNSCHWEILER, 1966, p. 4)

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

Type species: *Baculites vagina* var. *Ootacodensis* STOLICZKA, 1866, p. 199, pl. 90, fig. 14 by original designation.

Diagnosis: Large, curved or straight, with pyriform whorl section, venter fastigiate or narrow and tabulate with sharp ventrolateral shoulders. Dorsum flattened. Smooth or ornamented by crescentic ribs and riblets, with or without dorsolateral and lateral bullae. Venter smooth, ribbed or notched. Ribs may extend to 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. Österr. Ung., vol. IX, 1895, p. 157, pl. XIX, figs. 15 a, b, genotype)". A genotype is a species, not a specimen, and as KOSSMAT identifies his pl. 19(5), fig. 15a–b as "*Baculites vagina* FORBES var. *Otacodensis* STOL.", *ootacodensis* is the type species.

Most descriptions of *Eubaculites* have stressed the tabulate venter, yet STOLICZKA'S figure shows a specimen with a fastigiate venter although his description: "the dorsal edge is somewhat narrower than in many Pondicherry specimens; further, the siphuncle often lies nearer to one edge than to the other" (1866, p. 199) suggests it is actually tabulate. Further discussion of this point must await restudy of the type material. The most comprehensive reviews of the genus are those of BRUNNSCHWEILER (1966) and KLINGER (1976). The former recognised a subfamily Eubaculitinae plus genera *Eubaculites, Giralites* BRUNNSCHWEILER, 1966, *Eubaculiceras* BRUNNSCHWEILER, 1966 and *Cardabites* BRUNN-

SCHWEILER, 1966, with some 11 species referred to them. All are from a limited stratigraphic interval. KLINGER (1976) regarded all BRUNNSCHWEILER'S genera as synonyms of *Eubaculites,* and recognised only four species, rather than the 11 of BRUNSCHWEILER. KLINGER'S views are accepted here with minor modification.

Occurrence: *Eubaculites* is restricted to the Maastrichtian. In Europe it is known from the Lower Maastrichtian of Austria and the Ukraine, the upper Maastrichtian of south-western France and Holland. Records elsewhere suggest it ranges from very low in the Maastrichtian to near the top of the stage. It occurs in southern India, Assam, Mozambique, Zululand, Madagascar, western Australia, Chile, Peru, Argentina, Patagonia, California, southwestern France, Austria, Holland and the Ukrainian SSR. Records from New Zealand and Yugoslavia are doubtful.

Eubaculites lyelli (D'ORBIGNY, 1847)
Plate 14, figs. 1–5, 9–14

1846 *Baculites vagina* E. FORBES; DARWIN, p. 126.
1846b *Baculites vagina* FORBES; FORBES, pl. 5, fig. 3.
1847 *Baculites lyelli* D'ORBIGNY, pl. 1, figs. 3–7.
1850 *Baculites lyelli* D'ORB.; D'ORBIGNY, p. 215.
1861 *Baculites anceps* LAMARCK; BINKHORST, p. 42, pl. 5d, fig. 5a–d.
1864 *Baculites chicoensis* GABB, p. 80 (pars), pl. 14, fig. 29, 29a, non pl. 17, figs. 27, 27a; non pl. 14, fig. 27b.
1895 *Baculites vagina* FORBES n. var. *simplex* KOSSMAT, p. 156(60), pl. 19(5), figs. 14a, b only.
1895 *Baculites vagina* var. *Otacodensis* STOL.; KOSSMAT, p. 157(61) (? pars), pl. 19(5), fig. 16, ? non 15.
1895 *Baculites vagina* FORBES; STEINMANN, p. 89, pl. 6, fig. 4; text-figs. 8–10.
1897b *Baculites vagina* FORBES; KOSSMAT, pl. 6, fig. 4.
1904 *Baculites vagina* FORBES; WILCKENS, p. 188.
non 1907 *Baculites vagina* var. *cazadoriana* PAULCKE, p. 177, pl. 16, figs. 5a–b.
1925 *Baculites vagina* FORBES; DIENER, p. 63 (pars).
non 1925 *Baculites vagina* var. *cazadoriana* PAULCKE; DIENER, p. 63.
1925 *Baculites vagina* FORBES var. *otacodensis* STOLICZKA; DIENER, p. 63 (pars).
1930 *Baculites vagina* FORBES; WETZEL, p. 90, pl. 10, figs. 3, 4.
1940 *Eubaculites otacodensis* (STOLICZKA); SPATH, p. 48, pl. 1, fig. 3; text-fig. 1b.
1940 *Eubaculites* aff. *vagina* FORBES; SPATH, p. 50.
1944 *Baculites lyelli* D'ORBIGNY; OLSSON, p. 104, pl. 16, figs. 3–5; text-fig. 1.
1953 *Eubaculites lyelli* D'ORBIGNY; SPATH, pp. 46–47.
1957 *Baculites vagina* FORBES; HOFFSTETTER, FUENZALIDA & CECIONI, pp. 300, 302.
1957b *Eubaculites otacodensis* (STOLICZKA); WRIGHT, p. L218, fig. 245, 6.
1959c *Eubaculites otacodensis* (STOLICZKA); MATSUMOTO, p. 166, pl. 43, fig. 6; pl. 44, figs. 1–3; text-figs. 84a, b; 85a, b.
1963 *Eubaculites lyelli* D'ORBIGNY; MATSUMOTO & OBATA, p. 97.
1964a *Eubaculites argentinicus* (WEAVER); LEANZA, p. 95, pl. 1, figs. 1–5.
1966 *Eubaculites ootacodensis* (STOLICZKA, 1866); BRUNNSCHWEILER, p. 27, pl. 1, figs. 9–14; text-figs. 9–11.
1966 *Eubaculites vagina* (FORBES, 1846); BRUNNSCHWEILER, p. 29, pl. 1, fig. 7; pl. 2, figs. 1–14; text-figs. 12–14.
1966 *Eubaculites kossmati* sp. nov. BRUNNSCHWEILER, p. 31, pl. 2, figs. 15–17; pl. 3, figs. 1–7; text-fig. 15.
1966 *Eubaculites multicostatus* sp. nov.; BRUNNSCHWEILER, p. 32, pl. 3, figs. 8–12; text-fig. 16.
1974 *Eubaculites ootacodensis* (STOLICZKA); RICCARDI, 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.
1975 *Eubaculites lyelli* (D'ORBIGNY); HUNICKEN & COVACEVICH, 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.
1976 *Eubaculites ootacodensis* (STOLICZKA), 1865; KLINGER, p. 90 (pars), pl. 39, fig. 1, non 3; pl. 42, fig. 3, 8; pl. 41, figs. 1, 2; ? non pl. 43, fig. 1; text-fig. 11c.

Types: The catalogue of the D'ORBIGNY Collection lists 3 specimens of *Baculites lyelli* from "Concepcion" under the number 7206. All survive in the Collections of the Muséum National d'Histoire Naturelle in Paris, recatalogued as no. 1020a–c. It should be noted that D'ORBIGNY (1850, p. 215) gives the locality as Quiriquina Island.

Material: 8 specimens: NHMW 1852.II.215; NHMW 1935.III.18, 19, 19a; NHMW 1935.III.20; GBA 1873.01. 39a, b, c.

Description: The material is all crushed and distorted to varying degrees. Whorls slowly expanding, straight when young, becoming slightly curved when adult. Whorl section, best shown by NHMW 1935.III.19a (Plate 14, figs. 2–5), with broad flattened dorsum, narrowly rounded dorsolateral region, flanks flattened, slightly divergent dorsolaterally, maximum breadth above mid-flank, thereafter converging to narrow tabulate venter with sharp ventrolateral angulation. Ornament varies from weak to strong. Where well developed the dorsum is crossed by feeble riblets and striae. These strengthen into strong crescentic ribs on the flanks, concave across the inner to mid-flank but declining on the outer flank. The rib index, measured on crushed specimens, varies between 3 and 5. Some specimens also have short ventrolateral ribs. More numerous than the primaries, these arise on the outer flank and strengthen over the ventrolateral shoulder and venter, which may be markedly notched as a result (Plate 14, figs. 2–5, 10).

Sutures not seen.

Discussion: The Neuberg specimens agree very well with the extensive suite of topotypes illustrated by HUNICKEN & COVACEVICH (1975), which show well the strong flank ribs and distinctive ventrolateral and ventral ribbing seen on several of our specimens (Plate 14, figs. 2–5, 10–14), while it is not unreasonable to regard our almost smooth individual as probably merely a feebly ornamented variant of the species (Plate 14, figs. 6–8).

It will be seen from the synonymy that we regard spe-

cimens of *Eubaculites ootacodensis* with tabulate venters as synonyms of *lyelli,* but exclude those specimens with a fastigiate venter at this time, regarding *ootacodensis* as an independent species. STOLICZKA'S figure (1866, pl. 90, fig. 14) also shows the ribs to be very widely spaced, with a rib index of 1. The *Baculites vagina* var. *Otacodensis* of KOSSMAT (1895) is difficult to interpret as his pl. 19(5), fig. 15 lacks the venter. His fig. 16a–c with tabulate venter appears to be a large specimen of the present form. The *Baculites anceps* of BINKHORST (1861, p. 42, pl. 5d, figs. 5a–d) is a *Eubaculites* with a tabulate venter but lacking ventral and ventrolateral ornament on the mould; this is a variable feature in topotypes of *E. lyelli* and the Dutch specimen and comparable forms (e.g. *Baculites vagina* var. *simplex* KOSSMAT, 1895, p. 156(60) (pars), pl. 19(5), figs. 14a, b only, *Eubaculites ootacodensis* of MATSUMOTO, 1959c, *E. ootacodensis, vagina, kossmati* and *multicostatus* of BRUNNSCHWEILER, 1966) are also regarded as synonyms. It is far more difficult to place the moderately inflated smooth *Eubaculites* with tabulate venters that occur with these forms; they may be variants of *lyelli* or some other form. 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 to height ratio of 0.45 and *Cardabites tabulatus* BRUNNSCHWEILER, 1966 (p. 38, pl. 5, figs. 16–21; text-fig. 24) with a whorl breadth to height ratio of 0.43 seem to be a different species (or species) (fide KLINGER, 1976).

Eubaculites lyelli is easily separated from most specimens of *Eubaculites vagina* (FORBES, 1846a) (p. 114, pl. 10, fig. 4), which have dorsolateral and lateral tubercles, although as KLINGER (1976) notes, smooth variants may be indistinguishable.

Occurrence: The type material of *E. lyelli* is of Upper Maastrichtian date, as are Australian, French and Dutch occurrences. It appears to occur at a lower level in Zululand. The geographic range extends to Argentina, Chile, California, Holland, southern France, Zululand, Madagascar, southern India and western Australia.

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: See BIRKELUND, 1965, p. 102.

Occurrence; Upper Campanian to Upper Maastrichtian. Europe, Israel, Chile, Grahamland, U.S.A., Canada and Greenland.

Hoploscaphites constrictus (J. SOWERBY, 1817)
Plate 16, figs. 1–5, 8–10, 13; text-fig. 7

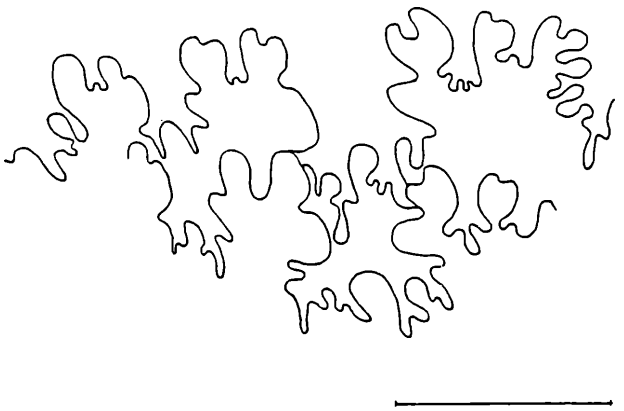
1817 *Ammonites constrictus* J. SOWERBY, p. 189, pl. A, fig. 1.
1858 *Scaphites multinodosus* HAUER, p. 9, pl. 1, figs. 7–8.
1872 *Scaphites constrictus* SOW. sp.; SCHLÜTER, p. 92, pl. 28, figs. 5–9 (with synonymy).
1873 *Scaphites constrictus* SOW. sp.; REDTENBACHER, p. 127.
non 1873 *Scaphites* spec. indet. cfr. *Scaphites constrictus* SOW.; REDTENBACHER, p. 130, pl. 30, fig. 12.
1894 *Scaphites niedzwiedzkii* UHLIG, p. 220, fig. 2.
1911 *Scaphites constrictus* var. *crassus* mihi; LOPUSKI, p. 115, 134, pl. 2, figs. 5–6; pl. 3, figs. 1–2.
1911 *Hoploscaphites constrictus* SOWERBY *vulgaris* NOWAK, p. 583, pl. 32, fig. 6; pl. 33, figs. 8–12.
1915 *Scaphites constrictus* SOWERBY; FRECH, p. 562 (pars), text-figs. 9, ? 10.
1925 *Discoscaphites constrictus* SOWERBY; DIENER, p. 210 (with synonymy).
1979 *Mesoscaphites grossouvrei* ATABEKIAN, p. 523.
1979 *Mesoscaphites kneri* ATABEKIAN, p. 523.
1980 *Hoploscaphites constrictus anterior* BLASZKIEWICZ p. 36, pl. 17, fig. 5; pl. 18, figs. 4–10.
1982 *Hoploscaphites constrictus* (SOWERBY, 1818); BIRKELUND, p. 19, pl. 3, figs. 1–14 (with synonymy).
1982 *Hoploscaphites constrictus constrictus* (SOWERBY, 1817); TZANKOV, p. 24, pl. 7, figs. 6–8.
1982 *Scaphites (Hoploscaphites) constrictus* J. SOWERBY; MARTINEZ, p. 172, pl. 30, fig. 6.
1986 *Hoploscaphites constrictus* (J. SOWERBY, 1817); KENNEDY, p. 64, pl. 13, figs. 1–13, 16–24; pl. 14, figs. 1–38; pl. 15, figs. 1–31; text-fig. 11, A–H.

Types: Much confusion surrounds the types of this species. SOWERBY obviously possessed several specimens and there are five surviving syntypes, BMNH 43988, C36733 and C70645–7. SPATH (1953, p. 13) referred to BMNH 43988 as the 'holotype', but as PHILLIPS (1977, p. 90) notes, BMNH C36733 closely resembles SOWERBY's figure. The syntypes are described elsewhere and a lectotype designated (KENNEDY, 1986); BMNH C367 33.

Material: 5 specimens: GBA 1858.01.2a (with counterpart), the lectotype, here designated, of *Scaphites multinodosus* HAUER, 1858; GBA 1858.01.2b–d, paralectotypes of *S. multinodosus;* GIG.166.G.S.

Description: The macroconch is represented by 3 specimens, GBA.1858.01.2a and b and GIG.166.G.S. The lectotype of *S. multinodosus* is the best preserved of these specimens. It is 34 mm long. The ribbing of the phragmocone appears to have been relatively coarse, but typical of the species. There is a prominent umbilical bulge at the beginning of the shaft, which is broad and short.

There are two, possibly three umbilical bullae. Ventral clavi appear at the end of the phragmocone, and there are



Text.-fig. 7. External suture of *Hoploscaphites constrictus* (J. SOWERBY, 1817), taken from GBA 1858.01.2a, the lectotype of *Scaphites multinodosus* HAUER, 1858, pl. 1, figs. 7, 8. Bar scale is 10 mm.

fourteen on the body chamber. These decline markedly in size around the hook (Plate 16, fig. 5) and disappear well before the aperture. Flank ornament is not well preserved. There are traces of broad primary ribs on the inner flank at the beginning of the body chamber, arising in pairs from the bullae and linking to the ventral clavi. They decline on the later part of the shaft; there are fine ribs on the venter linking the tubercles over the last part, while the venter and flanks immediately before the aperture are covered in fine riblets. The aperture is marked by a constriction; the aperture angle is 120°

There are two microconchs, GBA 1858.01.2c–d, one being an external mould only (Plate 16, fig. 13). Both are rather distorted, with lengths of 21 and 26 mm. They lack the umbilical bulge of the macroconchs, have a relatively slender body chamber, a coarsely ribbed phragmocone but very finely ribbed body chamber. Ventral clavi appear at the end of the phragmocone and persist to the beginning of the final hook (e. g. Plate 10, fig. 13) in both specimens. The final section of the hook bears very fine, delicate riblets. The aperture is constricted. The apical angle cannot be measured due to deformation.

Suture line simple, typical of species (Text-fig. 8).

Discussion: BIRKELUND (1982) discusses this species in detail and shows that *Scaphites niedzwiedzkii* UHLIG, 1894, *S. constrictus vulgaris* NOWAK, 1911, *S. constrictus crassus* LOPUSKI, 1911 and *Hoploscaphites constrictus anterior* BLASZKIEWICZ, 1980 do not merit separation. *Mesoscaphites grossouvrei* ATABEKIAN, 1979 (p. 523) a **nomen nudum** has *Scaphites constrictus* of DE GROSSOUVRE, 1894, pl. 31, fig. 1, as holotype and is a typical Upper Maastrichtian form of the species. *Mesoscaphites kneri* ATABEKIAN, 1979 (p. 523), also a **nomen nudum** has the original of KNER, 1852, pl. 11, fig. 13 as holotype. At first sight rather distinctive, with what appear to be outer lateral and ventral tubercles it is no more than a crushed example close to that figured by FAVRE, 1869, pl. 5, fig. 2, the original of which is before us.

Macroconchs from Neuberg are unmistakeably *H. constrictus*. The microconchs appear, at first sight, to be *H. tenuistriatus* (KNER, 1848), but this species lacks ventral tubercles (BIRKELUND, 1982, p. 22). NOWAK (1911, p. 585) referred forms with fine ribbing and ventral tubercles to *H. constrictus tenuistriatus*, but his specimens (NOWAK, 1911, pl. 33, fig. 14), are better referred to *H. constrictus*, for forms with very fine riblets on the body chamber occur within the type population from the Cotentin.

The best preserved Neuberg specimens most closely recall those from Nagoryanȳ, in particular FAVRE'S (1869) pl. 5, fig. 3. There is also a similarity to some of the specimens from Hemmoor (NW Germany) figured by BIRKELUND (1982, pl. 3, figs. 1–14).

Occurrence: *Hoploscaphites constrictus* extends through virtually the whole of the Maastrichtian. At Kronsmoor in north Germany the first specimen appears 3.5 to 5 m above the base of the *Belemnella lanceolata* Zone while in Denmark it ranges to the top of the *Belemnella casimirovensis* Zone (which is, however, incomplete). The most southerly records are from the Petite Pyrénées (south western France) and northern Spain (Ernst Collection). It occurs in the Calcaire à *Baculites* of the Cotentin Peninsula in north western France (the type locality) in the Maastrichtian area of Holland, the Germanies, Denmark, southern Sweden, Poland, Austria, Bulgaria and the Soviet Union (Donbas region, Transcaspia, Kopet Dag).

Hoploscaphites ? sp.
Plate 16, figs. 6, 7, 11, 12

Material: 3 specimens, NHMW 1852.2.803; NHMW 1977.1924.9 and NHMW 1985/70.

Description: Small; NHMW 1985/70 is adult at a diameter of 26 mm. Moderately evolute, whorls slowly expanding. All specimens are crushed, but the whorl section appears to have been compressed, with flattened sides and a narrow, tabulate venter. Phragmocone unknown. Body chamber near planispiral in best-preserved specimen (Plate 16, figs. 11, 12) extending for approximately 230°. Strong primary ribs, of which there are 22, arise either singly or in pairs from weak umbilical bullae, are prorsiradiate on the inner flank, flex back and are convex at mid-flank and sweep forwards and are concave over the outer flank. Ribs increase by branching or intercalation on the outer flank so that there are almost twice as many ribs on the outer flank as on the umbilical shoulder. All ribs bear a small ventrolateral clavus, while the clavi are linked over the venter by a distinct convex linguoid rib (Plate 16, fig. 7). Ornament weakens, the ribs become finer and loose the ventral tubercles at the end of the adult body chamber, which is marked by an apertural constriction.

Sutures not seen.

Discussion: These specimens are, by their coiling, slender whorls, ribbing and tuberculation, utterly distinct from the *Hoploscaphites constrictus* found at Neuberg, from Lower Maastrichtian specimens figured by FAVRE (1869, pl. 5, figs. 1–5), mid-Maastrichtian specimens figured by BIRKELUND (1982, pl. 3, figs. 1–14) and upper Maastrichtian material figured by BINKHORST (1861, pl. 5d,

figs. 6a–g), DE GROSSOUVRE (1908, pl. 11, figs. 3–7) and others. Instead, the apparently planispiral coiling with body chamber and phragmocone in contact (Plate 16, fig. 6, 7 – the apparently elliptical coiling is due to post-mortem deformation) suggests a recoiled derivative of *Hoploscaphites* analogous to *Haresiceras* REESIDE, 1927 of the Campanian of the U. S. Western Interior and Greenland (COBBAN, 1964 reviews American occurrences; BIRKELUND, 1965 those in Greenland). This, however, is much more involute, with very feeble ribs. The Maastrichtian *Indoscaphites korojonensis* BRUNNSCHWEILER, 1966 (p. 54, pl. 5, figs. 4–6) is a further comparable form, but is more involute. The Campanian *Parabinneyites* A. F. LEANZA, 1964 *(= Patagoniceras* A. F. LEANZA, 1963 (non WETZEL, 1960)) is evolute, but has strong primaries and fine secondaries and tiny ventral tubercles which are connected over the venter by transverse striae (LEANZA, 1963, pl. 3, figs. 2–4; see also BLASCO DE NULLO, NULLO and PROSERPIO, 1980, pl. 1, figs. 1–4).

Occurrence: Lower Maastrichtian of Neuberg.

THE AGE OF THE NEUBERG FAUNA

The quarry at Neuberg exposes 20 m of section. The ammonite fauna is as follows:

Partschiceras forbesianum (D'ORBIGNY, 1850)
Anagaudryceras lueneburgense (SCHLÜTER, 1872)
Anagaudryceras sp.
Saghalinites wrighti BIRKELUND, 1965
Saghalinites sp. juv.
Pseudophyllites cf. *indra* (FORBES, 1846a)
Pachydiscus (Pachydiscus) neubergicus (HAUER, 1858)
Pachydiscus (Pachydiscus) epiplectus (REDTENBACHER, 1873)
Menuites costatus sp. nov.
Diplomoceras cylindraceum (DEFRANCE, 1816)
Diplomoceras sp. indet.
Eubaculites lyelli (D'ORBIGNY, 1847)
Hoploscaphites constrictus (J. SOWERBY, 1817)
Hoploscaphites ? sp.

There is at present no agreed ammonite zonation for the Maastrichtian stage; indeed, the only well-documented basis for recognising the base of the Maastrichtian using ammonites is the appearance of *Hoploscaphites constrictus* (see reviews in BIRKELUND et al., 1984; KENNEDY, 1984; SCHULZ, ERNST, ERNST & SCHMID, 1984; SURLYK, 1984), and even this is rare at the beginning of its range. Instead, it is at this time only practicable to discuss the age of the Neuberg ammonite assemblage in terms of what we know of ammonite occurrences in the White Chalk sequences of western Europe, where the basic zonation is established on belemnites. A long-established standard sequence is as follows:

Belemnella casimirovensis
Upper Maastrichtian
Belemnitella junior
Belemnella occidentalis
Lower Maastrichtian
Belemnella lanceolata

While SCHULZ (1979) divides the Lower Maastrichtian of north Germany into six *Belemnella* zones:

B. fastigiata, *B. cimbrica*, *B. sumensis* } *occidentalis*

B. obtusa, *B. pseudobtusa*, *B. lanceolata* } *lanceolata*

Ammonites are generally uncommon in the Maastrichtian White Chalk facies of Western Europe, except at well-defined horizons, and the apparent ranges of some of the rarer species are unlikely to correspond to their total range in facies more favourable for ammonite preservation. The most complete records are from the Danish chalk, presented by BIRKELUND (1979) who shows several elements of the Neuberg fauna to be long-ranging (e. g. *H. constrictus, D. cylindraceum,* and others restricted to the top *occidentalis* and bottom *junior* Zones *(A. lueneburgense, S. wrighti, P. (P.) neubergicus).* In north Germany BIRKELUND (1982) shows *A. lueneburgense* restricted to the lower part of the *junior* Zone and suggests that *S. wrighti* comes from the top of the *occidentalis* Zone *(= fastigiata & cimbrica* Zones). SCHULZ, ERNST, ERNST & SCHMID (1984) provide further information, indicating *P. (Pachydiscus) neubergicus)* (specifically the form figured by SCHLÜTER 1872, p. 59, pl. 18, figs. 1–3, = *P. neubergicus raricostatus* according to BLASZKIEWICZ, 1980) to be restricted to the upper part of the lower Lower Maastrichtian, the *Belemnella obtusa* Zone (= top *lanceolata* Zone) of Lüneburg. In Poland BLASZKIEWICZ (1980) records what seems to be typical *P. (P.) neubergicus* from the *lanceolata* and *occidentalis* Zones.

This evidence is clearly unsatisfactory, suggesting no more than a probably Lower Maastrichtian age for the Neuberg fauna. More promising is the assemblage of *Hoploscaphites,* for BIRKELUND (1978) and others have shown how these may be used to determine relative position within the Maastrichtian stage. We note in particular the absence of *Hoploscaphites tenuistriatus* (KNER, 1848) – KENNEDY, 1984, p. 159 was in error in recording this species from Neuberg – and the presence of specimens including the lectotype of *Scaphites multinodosus* HAUER, 1858 (pl. 10, figs. 3–5), that match *Hoploscaphites constrictus anterior* BLASZKIEWICZ, 1980 (p. 36, pl. 17, fig. 5; pl. 18, figs. 4–10) which is restricted to the upper Lower Maastrichtian *occidentalis* Zone of BLASZKIEWICZ'S scheme.

Our conclusion from available ammonite records from the European sequence is that the Neuberg fauna probably falls around the lower/upper Lower Maastrichtian *(lanceolata/occidentalis* Zone) boundary.

We note the complete absence of undisputedly Upper Maastrichtian taxa such as *Anapachydiscus fresvillensis* (SEUNES, 1890) and *Pachydiscus (Pachydiscus) gollevillensis* (D'ORBIGNY, 1850), as well as lower Lower Maastrichtian species such as *Hauericeras sulcatum* (KNER, 1848) and *Pseudokossmaticeras galicianum* (FAVRE, 1869) from the fauna. The poor gastropod fauna (identification by H. A. KOLLMANN, Vienna) does not provide detailed stratigraphic information: *Homalopoma* sp., *Solariaxis* sp., *Tessarolax pyriformis* (KNER).

Parallel investigations on foraminifera and nannoplankton produced mixed results. F. RÖGL (Vienna) investigated six samples, but found only one indeterminate foram. K. PERCH-NIELSEN (Zürich) studied samples from ammonites in museum collections for nannofossils, but with disappointing results, finding only poorly preserved floras of limited stratigraphic value: *Micula* sp., *Lucianorhabdus* sp., *Watznaueria barnesae* (BLACK, 1959) PERCH-NIELSEN, 1968.

M. WAGREICH (Vienna) subsequently studied outcrop samples with generally poor results, but one (field nr. 3; fig. 2) yielded a rich and stratigraphically significant assemblage:

Arkhangelskiella cymbiformis VEKSHINA, 1959
Calculites obscurus (DEFLANDRE, 1959) PRINS & SISSINGH, 1977
Lithraphidites praequadratus ROTH, 1978
Lithraphidites quadratus (form I sensu LAMBERT, 1980) BRAMLETTE & MARTINI, 1964
Prediscosphara cretacea (ARKHANGELSKY, 1912) GARTNER, 1968
Prediscosphaera grandis PERCH-NIELSEN, 1979
Ceratolithoides aculeus (STRADNER, 1961) PRINS & SISSINGH, 1977
Micula decussata VEKSHINA, 1959
Micula concava (STRADNER, 1960) BUKRY, 1969
Micula swastica STRADNER & STEINMETZ, 1984
Lucianorhabdus cayeuxi DEFLANDRE, 1959
Lithraphidites carniolensis DEFLANDRE, 1963
Prediscosphaera spinosa (BRAMLETTE & MARTINI, 1964) GARTNER, 1968
Microrhabdulus attenuatus DEFLANDRE, 1959
Microrhabdulus decoratus DEFLANDRE, 1959
Watznaueria barnesae (BLACK, 1959) PERCH-NIELSEN, 1968
Cyclagelosphaera sp.
Cylindralithus sp.
Chiastozygus litterarius (GORKA, 1957) MANIVIT, 1971
Cretarhabdus crenulatus BRAMLETTE & MARTINI, 1964
Eiffelithus turriseiffeli (DEFLANDRE, 1954) REINHARDT, 1966
Cribrosphaerella ehrenbergi (ARKHANGELSKY, 1912) DEFLANDRE, 1952
Ahmuellerella octoradiata (GORKA, 1957) REINHARDT, 1966
Rhagodiscus sp.
Zygodiscus spiralis BRAMLETTE & MARTINI, 1964
Rucinolithus ? sp.

This assemblage can be compared with the recently described M o o s g r a b e n material from the Ultrahelvetic of Bavaria, German Federal Republic. Here, nannofossils, forams and belemnites co-occur. Nannoplankton, studied by CEPEK (1983, p. 637–652) indicate the *Arkhangelskiella cymbiformis* Zone sensu auctorum; Zones 24 and 25 a, b of SISSINGH (1977).

Note, however, that *Lithraphidites quadratus* is absent in the Moosgraben flora. The forams (HAGN & HERM, loc. cit., p. 613–635) indicate the *gagnebinii* Subzone of the *falsostuarti* Zone, that is to say the lower part of the upper Lower Maastrichtian, while the belemnites (SCHULZ & SCHMID, l. c., p. 653–661) indicate the lower to middle *sumensis* Zone: again, lower part of the upper Lower Maastrichtian.

The presence of *L. quadratus* in the Neuberg flora suggests an age younger than the Moosgraben; upper part of CC Zone 25 b (PERCH-NIELSEN, 1985). The absence of *Micula murus*, indicative of Zone 25 c elsewhere allows us to state that, in terms of belemnite stratigraphy, the Neuberg flora and fauna is **middle *sumensis* Zone and younger**, but possibly not younger than upper *sumensis* Zone. In terms of planktonic foram zones this is the *Globotruncana gansseri* Zone in the sense of BELLIER et al., 1983 (p. 609–611).

L. quadratus appears low in the Maastrichtian in northern Aquitaine, associated with *Sphenodiscus ubaghsi* DE GROSSOUVRE, 1984, *Nostoceras (Nostoceras) hyatti* STEPHENSON, 1941 and *Baculites leopoliensis* NOWAK, 1908 (KENNEDY in preparation) around Maurens (NEUMANN et al. 1984; NEUMANN & ROBASZYNSKI 1985). Its appearance in the Upper Maastrichtian *junior* Zone in the Maastricht area (ROBASZYNSKI et al. 1985) is a localised phenomenon only.

Acknowledgments

We thank Dr. F. STOJASPAL of the Geologische Bundesanstalt, Vienna, Dr. R. LEIN of the Geological Institute of Vienna University, Prof. Dr. F. F. STEININGER of the Paleontological Institute of Vienna University and Mr. D. PHILLIPS of the British Museum (Natural History) for allowing us to study specimens in their care. Dr. H. C. KLINGER (Cape Town) and Dr. C. W. WRIGHT (Seaborough) provided valuable advice. Our thanks are also due to Dr. K. PERCH-NIELSEN (Zürich), Dr. F. RÖGL (Vienna) and Mr. M. WAGREICH (Vienna) for micropaleontological assistance. We thank also Dr. H. A. KOLLMANN (Vienna) for valuable information and identification of the gastropods. The financial support of the Natural Environment Research Council, British Council and Royal Society is gratefully acknowledged by KENNEDY, and of the IGCP Project "Mid Cretaceous Events", the Austrian Academy of Science and the Royal Society by SUMMESBERGER.

References

ANDERSON, F. M., 1958. Upper Cretaceous of the Pacific coast. – Mem. geol. Soc. Am., 71, xi + 378 pp., 75 pls., Washington.

ANDERSON, F. M. & HANNA, G. D., 1935. Cretaceous geology of Lower California. – Proc. Calif. Acad. Sci. (4), 23(1):1–34, pls. 1–11, San Francisco.

ARKELL, W. J., 1950. A classification of the Jurassic ammonites. – J. Paleont., 24:354–364, Chicago.

ATABEKIAN, A. A., 1979. Correlation of the Campanian stage in Kopetdag and western Europe. – Aspekte der Kreide Europas IUGS Series A, 6:511–526, Stuttgart.

ATABEKIAN, A. A. & AKOPIAN, V. T., 1969. [Late Cretaceous ammonites of the Armenian SSR (Pachydiscidae)]. – Izv. AN Armen. SSR Nauk o Zemle, 22(6):3–20, pls. 1–11 [In: Georgian.], Erevan.

BASSE, E., 1931. Monographie paleontologique du Cretace de la Province de Maintirano. – Mem. geol. Serv. Min. Madagascar, 1931, 86 pp., 13 pls., Tananarive.

BELLIER, J.-P., CARON, M., DONZE, P., HERM, D., MAAMOURI, A.-L. & SALAJ, J., 1983. Le Campanien sommital et le Maastrichtien de la coupe du Kef (Tunisie septentrionale): zonation sur le base des Foraminifères planctoniques. – Zitteliana **10**:609–611, 1 fig., 1 tab., München.

BINKHORST, J. T., 1861. Monographie des gastropodes et des Céphalopodes de la Craie Superieure du Limbourg. – vi + 83 pp. (gastropods) + 44 pp. (cephalopods). 17 pls (1–5, 5a, 5a1, 5a2, 5a3, 6, 6b, 5c, 5d, 7, 8, 8a, 9). Muquardt, Brussels; Muller Frères, Maastricht.

BIRKELUND, T., 1965. Ammonites from the Upper Cretaceous of West Greenland. – Medd. ømGrön., **179**, 192 pp., 42 pls., Copenhagen.

BIRKELUND, T., 1979. The last Maastrichtian ammonites. – pp. 51–57 [In:] Cretaceous – Tertiary Boundary Events Symposium, 1, The Maastrichtian and Danian of Denmark. 210 pp., University of Copenhagen, Copenhagen.

BIRKELUND, T., 1982. Maastrichtian ammonites from Hemmoor, Niederelbe (NW Germany). – Geol. Jb., **A61**:13–33, 3 pls., Hannover.

BIRKELUND, T., HANCOCK, J. M., HART, M. B., RAWSON, P. F., REMANE, J., ROBASZYNSKI, F., SCHMID, F. & SURLYK, F., 1984. Cretaceous stage boundaries – Proposals. – Bull. geol. Soc. Denmark, **33**:3–20, Copenhagen.

BLAINVILLE, H. M. D. DE, 1825–1827. Manuel de malacologie et de conchyliologie. – 664 pp. (1825), 87 pls. (1827). Levrault, Paris and Strasbourg.

BLASCO DE NULLO, G., NULLO, F. & PROSERPIO, C., 1980. Santoniano-Campaniano: estratigrafia y contenido ammonitifero. Cuena Austral. – Revta Asoc. geol. argent. **35**:467–493, 5 pls., Buenos Aires.

BLASZKIEWICZ, A., 1965. O dwóch gatunkach rodzaju *Pachydiscus* z Mastrychtu okolic wloszowej (synklinorium miechowskie). – Biul. Inst. geol., **192**:147–166, pls. 1–3, Warsaw.

BLASZKIEWICZ, A., 1980. Campanian and Maastrichtian ammonites of the Middle Vistula Valley, Poland: a stratigraphic-paleontologic study. – Pr. Inst. geol., **92**:1–63, 56 pls., Warsaw.

BÖHM, J., 1891. Die Kreidebildungen des Fürbergs und Salzbergs bei Siegsdorf in Oberbayern. – Palaeontographica, **38**:1–106, pls. 1–5, Cassel etc.

BÖHM, J., 1891. In: BÖHM, J. & HEIM, A., 1902. Neue Untersuchungen über die Senonbildung der östlichen Schweizer Alpen. – Abh. schweiz. paläont. Ges., **36**: 1–61, pls. 1, 2, Basel etc.

BOULE, M., LEMOINE, P. & THÉVENIN, A., 1906–1907. Paléontologie de Madagascar III. Céphalopodes crétacés des environs de Diego-Suarez. – Annls. Paléont. **1**(1906):173–192 (1–20), pls. 14–20(1–7); **2** (1907):1–56 (21–76), pls. 1–8(8–15), Paris.

BRINKMANN, R., 1935. Die Ammoniten der Gosau und des Flysch in den nördlichen Ostalpen. Beiträge zur Kenntnis der alpinen Oberkreide Nr. 2. – Mitt. geol. Staatsinst. Hamburg, **15**:1–14, Hamburg.

BRUNNSCHWEILER, R. O., 1966. Upper Cretaceous ammonites from the Carnarvon Basin of Western Australia. 1. The heteromorph Lytoceratina. – Bull. Bur. Miner. Resour. Geol. Geophys. Aust., **58**, 57 pp., 8 pls., Canberra.

CEPEK, P., 1983. Kalzitisches Nannoplankton der Inoceramen-Mergel (Buntmergelserie, Ultrahelvetikum, Unter Maastricht) des Moos-Grabens SE Siegsdorf (Oberbayern). – Zitteliana, **10**:637–652, 1 fig., 5 pls., 2 tabl., München.

COBBAN, W. A., 1964. The late Cretaceous cephalopod *Haresiceras* and its origins. – Prof. Pap. U. S. geol. Surv., **454-I**, 19 pp., 3 pls., Washington.

COLLIGNON, M., 1931. Faunes sénoniennes du nord et de l'ouest de Madagascar. – Ann. géol. Serv. Min. Madagascar, **1**:1–66, pls. 1–9, Tananarive.

COLLIGNON, M., 1937. Les ammonites pyriteuses de l'Aptien d'Antanatanamirafy. – Annls. Paléont., **26**: 107–132(1–28), pls. 16–18(1–3), Paris.

COLLIGNON, M., 1938. Ammonites Campaniennes et Maestrichtiennes de l'ouest et du sud de Madagascar. – Annls. géol. Serv. Mines Madagascar, **9**:55–118(1–65), pls. 1–9, Tananarive.

COLLIGNON, M., 1952. Ammonites néocrétacées du Menabe (Madagascar). II – Les Pachydiscidae. – Trav. Bur. géol. Madagascar, **41**, 114 pp., 33 pls., Tananarive.

COLLIGNON, M., 1955. Ammonites néocrétacées du Menabe (Madagascar). II – Les Pachydiscidae. – Annls., géol. Serv. Mines Madagascar, **21**, 98 pp., 28 pls., Tananarive.

COLLIGNON, M., 1956. Ammonites néocrétacées du Menabe (Madagascar). IV – Les Phylloceratidae. V. – Les Gaudryceratidae. VI. – Les Tetragonitidae. – Annls. géol. Serv. Mines Madagascar, **23**:1–106, pls. 1–11, Tananarive.

COLLIGNON, M., 1966. Atlas des fossiles caracteristiques de Madagascar (Ammonites). XIV, Santonien. – x+134 pp., pls. 455–513, Service géologique, Tananarive.

COLLIGNON, M., 1971. Atlas des fossiles caractéristiques de Madagascar (Ammonites) **XVII** (Maestrichtien). – iv + 44 pp., pls. 640–658, Service géologique, Tananarive.

DARWIN, C., 1846. Geological observations on South America. – i–vii, 1–279, pls. 1–5, map. Smith, Elder & Co., London.

DEFRANCE, M. J. L., 1816. In: Dictionnaire des Sciences naturelles, dans lequel on traite méthodiquement des differents Etres de la Nature 1816–1830. 60 vols. text, 12 vols. plates. Vol. 3 (1816), 492 pp., + 174 pp. in supplement. Plates-Zoologie, Conchyliologie et Malacologie, by H. M. D. de BLAINVILLE, 1816–1830, 36 pp., 118 pls. Levrault, Paris, Strasbourg.

DIENER, C., 1925. Ammonoidea neocretacea. Fossilium Cat. (1: Animalia), **29**, 244 pp., Berlin, 's-Gravenhage.

DUNDO, O. P., 1971. [A key section of the Maastrichtian sediments of the central part of the Koriaksky Highlands (State Collection)].

FAVRE, E., 1869. Description des Mollusques fossiles de la Craie des environs de Lemberg en Galicie. – xii + 187 pp., 13 pls.,H. Georg, Geneva.

FORBES, E., 1846a. Report on the fossil Invertebrata from southern India, collected by Mr. Kaye and Mr. Cunliffe. – Trans. geol. Soc. Lond. (2), 7:97–174, pls. 7–19, London.

FORBES, E., 1846b. [In:] DARWIN, C., 1946. Geological observations on South America. i–vii, 1–279 + pls. 1–5, map. Smith, Elder and Co., London.

FRECH, F., 1915. Über Scaphites. 1. Die Bedeutung

von *Scaphites* für die Gliederung der Oberkreide. – Zentralbl. Miner. Geol. Paläont., **1915**:553–568, Stuttgart.

FUCINI, A., 1920. Fossili domeriani dei Dintorni di Taormina. – Palaeontogr. Ital., 26:75–116(1–42), pls. 5–8(1–4), Pisa, Siena.

GABB, W. M., 1864. Geological Survey of California. Palaeontology, **1**, Section 4, Description of the Cretaceous fossils, 55–243, pls. 9–32. Published by the authority of the Legislature of California, Caxton Press of Sherman Co., Philadelphia.

GEYER, G., 1889. Beiträge zur Geologie der Mürzthaler Kalkalpen und des Wiener Schneeberges. – Jahrb. Geol. R.-A., Wien, 39:497–784, pl. 13, Vienna.

GILL, T., 1871. Arrangement of the Families of Molluscs. – Smithson. misc. Collns., 227, xvi + 49 pp., Washington.

GROSSOUVRE, A. DE, 1894. Recherches sur la craie superieure, 2, Paléontologie. Les ammonites de la craie superieure. – Mem. Serv. Carte géol. det. Fr., 264 pp., 39 pls. (misdated 1893), Paris.

GROSSOUVRE, A. DE, 1908. Description des ammonites du Crétacé Superieur du Limbourg Belge et Hollandais et du Hainault. – Mém. Mus. r. Hist. nat. Belg., 4:1–39, pls. 1–11, Brussels.

HAGN, H. & HERM, D., 1983. Die Foraminiferen der Inoceramen-Mergel (Buntmergelserie, Ultrahelvetikum, Unter-Maastricht) des Moos-Grabens SE Siegsdorf (Oberbayern). – Zitteliana, **10**:613–635, 2 figs., 4 pls., München.

HAIDINGER, W., 1846. Briefwechsel. Mittheilungen an den Geheimenrath v. LEONHARD gerichtet. – Neues Jb. Miner. Geogn. geol. Petrefakt., **1846**:45–48, Stuttgart.

HAUER, F. VON, 1847. *Hamites hampeanus* von Neuberg. – Ber. Mitt. Freunden Naturwiss. Wien, 2, p. 75.

HAUER, F. VON, 1858. Ueber die Cephalopoden der Gosauschichten. – Beitr. Paläont. Österreich, **1**:7–14, pls. 2–4, Vienna and Olmüz.

HAUER, F. VON, 1866. Neue Cephalopoden aus den Gosaugebilden der Alpen. – Sber. Akad. Wiss. Wien, math.-naturwiss. Cl., 53:1–9, pls. 1, 2, Vienna.

HENDERSON, R. A., 1970. Ammonoidea from the Mata Series (Santonian-Maastrichtian) of New Zealand. – Spec. Pap. Palaeont., **6**, 82 pp., 15 pls., London.

HENDERSON, R. A. & KENNEDY, W. J. (**in press**) *Ammonites chrishna* FORBES, 1846 (Mollusca): proposed supression of specific name. **Bull. zool. Nom.**

HENDERSON, R. A. & MCNAMARA, K. J., 1985. Maastrichtian non-heteromorph ammonites from the Miria Formation, Western Australia. – Palaeontology, 28: 35–88, pls. 1–9, London.

HOFFSTETTER, R., FUENZALIDA, H. & CECIONI, G., 1957. Lexique Stratigraphique International V. Amérique Latine. Fasc. vii Chili. 444 pp., CNRS, Paris.

HOWARTH, M. K., 1965. Cretaceous ammonites and nautiloids from Angola. – Bull. Br. Mus. nat. Hist. (Geol.), **10**:335–412, 13 pls., London.

HUNICKEN, M. A., 1965. Algunos Cefalopodos supracretacios del Rio Turbio (Santa Cruz). – Revista de la Facultad de Ciencias Exactas Fisicas y Naturales, Universidad Nacional de Cordoba, Ano **16**, 1–2, Serie Ciencias Naturales, 52:49–100, pls. 1–8, Cordoba.

HUNICKEN, M. A. & COVACEVICH, V. C., 1975. Baculitidae en el Cretacico Superior de la Isla Quiriquina, Chile, y consideraciones paleontologicas y estratigraficas. – Actas 1. Congreso Argentino de Paleontologia y Bioestratigrafia, Tucuman, Agosto de 1974, 2:141–166, pls. 1–5.

HYATT, A., 1889. Genesis of Arietidae. – Smithson. Contr. Knowl., 673, xi + 238 pp., Government Printing Office, Washington.

HYATT, A., 1900. Cephalopoda, pp. 502–604 [in:] ZITTEL, K. A. VON, 1896–1900. Text-book of Palaeontology, transl. EASTMAN, C. R., Macmillan, London and New York.

IMMEL, H., KLINGER, H. C. & WIEDMANN, J., 1982. Die Cephalopoden des Unteren Santon der Gosau von Brandenberg/Tirol, Österreich. – Zitteliana, 8:3–32, 11 pls., Munich.

IMKELLER, H., 1901. Die Kreidebildungen und ihre Fauna am Stallauer Eck und Enzenauer Kopf bei Tölz. – Palaeontographica, 48:1–64, 3 pls., Cassel etc.

JONES, D. L., 1963. Upper Cretaceous (Campanian and Maastrichtian) ammonites from southern Alaska. – Prof. Pap. U. S. geol. Surv., 432, 53 pp., 40 pls., Washington.

KENNEDY, W. J., 1984. Ammonite faunas and the 'standard zones' of the Cenomanian to Maastrichtian Stages in their type areas, with some proposals for the definition of stage boundaries by ammonites. – Bull. geol. Soc. Denmark, 33:147–161, Copenhagen.

KENNEDY, W. J., 1986. The ammonite fauna of the Calcaire à *Baculites* (Upper Maastrichtian) of the Cotentin Peninsula (Manche, France). – Palaeontology, 29/1: 25–83, pls. 1–16, London.

KENNEDY, W. J., in press. The ammonite fauna of the type Maastrichtian with a revision of *Ammonites colligatus* BINKHORST, 1861. – Bull. Inst. r. Sci. nat. Belg., Brussels.

KENNEDY, W. J. & KLINGER, H. C., 1977. Cretaceous faunas from Zululand and Natal, South Africa. The ammonite family Tetragonitidae HYATT, 1900. – Ann. S. Afr. Mus., 73:149–197, 27 figs., Cape Town.

KENNEDY, W. J. & KLINGER, H. C., 1979. Cretaceous faunas from Zululand and Natal, South Africa. The ammonite family Gaudryceratidae. – Bull. Brit. Mus. nat. Hist. (Geol.), 31(2):121–174, 14 pls., London.

KENNEDY, W. J. & SUMMESBERGER, H., 1979. A revision of *Ammonites mitis* HAUER and *Ammonites glaneggensis* REDTENBACHER from the Gosau Beds (Upper Cretaceous) of Austria. – Beitr. Paläont. Österr., 6: 71–87, 4 pls., Vienna.

KENNEDY, W. J. & SUMMESBERGER, H., 1984. Upper Campanian ammonites from the Gschliefgraben (Ultrahelvetic: Upper Austria). – Beitr. Paläont. Österr., **11**: 149–206, 14 pls., Vienna.

KILIAN, W. & REBOUL, P., 1909. Les céphalopodes néocrétaces des iles Seymour et Snow Hill. – Wiss. Ergebn. Schwed. Südpolarexped. 3(6), p. 175, pls. 1–20, Stockholm.

KLINGER, H. C., 1976. Cretaceous heteromorph ammonites from Zululand. – Mem. geol. Surv. Rep. S. Afr., **69**, 142 pp., 43 pls., Pretoria.

KNER, R., 1848. Versteinerungen des Kreidemergels von Lemberg und seiner Umgebung. – Haidingers naturwiss.

Abh., 2:1–42, 5 pls., Vienna.

KNER, R., 1852. Neue Beiträge zur Kenntniss der Kreideversteinerungen von Ost-Galizien. – Denkschr. Akad. Wiss. Wien, 3:293–334, pls. 15–17, Vienna.

KOSSMAT, F., 1895–1898. Untersuchungen über die Südindische Kreideformation. – Beitr. Paläont. Geol. Österr.-Ung., 9(1895):97–203 (1–107), pls. 15–25 (1–11); 11(1897a):1–46 (108–153), pls. 1–8(12–19); 11(1898):89–152 (154–217), pls. 14–19(20–25), Vienna and Leipzig.

KOSSMAT, F., 1897b. The Cretaceous deposits of Pondicherri. – Rec. geol. Surv. India, 30:51–110, pls. 6–10, Calcutta.

KOVACS, L., 1939. Bemerkungen zur systematischen Einteilung der jurassischen Phylloceraten. – Abh. Min.-Geol. Inst. St.Tisza Univ. Debrecen, 13, 43 pp., Debrecen.

KULLMANN, J. & WIEDMANN, J., 1970. Significance of sutures in phylogeny of Ammonoidea. – Paleont. Contr. Univ. Kansas, 44:1–32, Topeka.

LAMARCK, J. B. P. A. DE M. DE, 1822. Histoire naturelle des Animaux sans vertebres, 7, 711 pp., Verdière, Paris.

LAMBERT, B. & MANIVIT, H., 1985: Nannoplancton. – [In:] Conclusions au Colloque sur les étages Coniacien a Maastrichtien: Echelles biostratigraphiques. – Géol. Mediterranéenne, 10/3–4:417–419, tabl. III, Marseille.

LEANZA, A. F., 1963. *Patagoniceras* Gen. Nov. (Binneyitidae) y otros ammonites del Cretacico Superior de Chile Meridionale con notas acera de su posicion estratigrafia. – Boln. Acad. nac. Cienc. Cordoba, 43:203–225, 4 pls., Cordoba.

LEANZA, A. F., 1964a. Los Estratos con Baculites de Elcain (Rio Negro, Argentina) y sus relaciones con otros terrenos supracretacicos argentinos. – Revtn. Fac. Cienc. exact. fig. y nat. Univ. Nac. Cordoba, anno 25, 3–4, Ser. C, 51:93–107, 1 pl., Cordoba.

LEANZA, A. F., 1964b. *Parabinneyites*, nuevo nombre generico para *Patagoniceras* LEANZA, 1963 non WETZEL, 1960. – Ameghiniana, 19, p. 84, Buenos Aires.

LIEBUS, A., 1902. Über einige Fossilien aus der Karpathischen Kreide. – Beitr. Paläont. Geol. Österr.-Ung., 14: 113–130, pl. 6, Vienna and Leipzig.

LOPUSKI, C., 1911. Przyczynki do znajomósci fauny kredowej gub. Lubelskiej. – C. r. Seanc. Soc. Sci., Varsovie, 4:104–140, pls. 1–4, Warsaw.

MAKOWSKI, H., 1963. Problem of sexual dimorphism in ammonites. – Palaeont. pol., 12:1–92, pls. 1–20, Warsaw.

MARIANI, E., 1898. Ammoniti del Senoniano Lombardo. – Mem. Inst. lombardo, Cl. Sci. Matem. nat. (3), 18: 51–58 (1–8), pl. 8 (1), Milan.

MARSHALL, P., 1926. The Upper Cretaceous ammonites of New Zealand. – Trans. Proc. N. Z. Inst., 56:129–210, pls. 19–47, Wellington.

MARTINEZ, R., 1982. Ammonoides cretacios del Prepirineo de la Provincia de Lleida. – Publicaciones de Geologia, Universidad Autonoma de Barcelona, 17, 197 pp., 30 pls., Barcelona.

MASSALONGO, A., 1855. *Zoophycos*, novum genus plantarum fossilium. 52 p., 3 pls., Antonelli, Verona.

MATSUMOTO, T., 1938. A biostratigraphic study on the Cretaceous deposits of the Naibuchi Valley, South Karahuto. – Proc. Imp. Acad. Japan, 14:190–194, Tokyo.

MATSUMOTO, T., 1947. [A note on the Japanese Pachydiscinae]. – Sci. Rep. Dept. geol. Fac. Sci, Kyushu Univ., 2:34–46 [in Japanese], Fukuoka.

MATSUMOTO, T., 1951. A note on the Pachydiscinae, a Cretaceous ammonite-group. – Trans. Proc. palaeont. Soc. Japan, N. S., 1:19–26, Tokyo.

MATSUMOTO, T., 1954. Selected leading Cretaceous ammonites in Hokkaido and Saghalien. – Pp. 243–313, pls. 17–36 (1–20) [In:] MATSUMOTO, T., 1954 (ed). The Cretaceous System in the Japanese Islands. 324 pp., 36 pls., Japan. Society for the Promotion of Science, Tokyo.

MATSUMOTO, T., 1955. The bituberculate pachydiscids from Hokkaido and Saghalien. – Mem. Fac. Sci. Kyushu Univ. (D) Geol., 5:153–184, pls. 31–37, Fukuoka.

MATSUMOTO, T., 1959a. Upper Cretaceous Ammonites of California. Part II. – Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol., Special Volume, I, 172 pp., 41 pls., Fukuoka.

MATSUMOTO, T., 1959b. Cretaceous ammonites from the Upper Chitina Valley, Alaska. – Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol., 8(3):49–90, pls. 12–29, Fukuoka.

MATSUMOTO, T., 1959c. Upper Cretaceous Ammonites of California. Part 1. – Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol., 8(4):91–171, pls. 30–45, Fukuoka.

MATSUMOTO, T., 1972. [In:] MATSUMOTO, T., MURAMOTO, T. & TAKAHASHI, T., 1972. A new gaudryceratine ammonite from Hokkaido. – Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol., 21:207–215, pl. 33, Fukuoka.

MATSUMOTO, T., 1979. Some new species of *Pachydiscus* from the Tobetsu and the Hobetsu Valleys. – Pp. 50–64. [In:] MATSUMOTO, T., KANIE, Y. & YOSHIDA, S., 1979. Notes on *Pachydiscus* from Hokkaido. – Mem. Fac. Kyushu Univ., Ser. D, Geol., 24:47–73, pls. 8–13, Fukuoka.

MATSUMOTO, T., 1984. Some ammonites from the Campanian (Upper Cretaceous) of northern Hokkaido. – Palaeont. Soc. Japan, Spec. Pap., 27, 93 pp., 31 pls., Tokyo.

MATSUMOTO, T. & OBATA, I., 1963. A monograph of the Baculitidae from Japan. – Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol., 13:1–116, pls. 1–27, Fukuoka.

MATSUMOTO, T. & YOSHIDA, S., 1979. A new gaudryceratid ammonite from eastern Hokkaido. – Trans. Proc. Palaeont. Soc. Japan, 114:65–76, pls. 10, 11, Tokyo.

MAURY, C. J., 1930. O Cretaceo da Parahyba do Norte. – Monografias Serv. Geol. Min. Brasil, 305 pp., Album das estampas i–xxiii, 35 pls., Rio de Janeiro.

MICHAILOV, N. P., 1951. [Upper Cretaceous ammonites from the southern part of european Russia and their importance for zonal stratigraphy (Campanian, Maastrichtian)]. – Trudy Inst. geol. Nauk. Akad. Nauk. SSSR, 129 (Geol. Ser. 50), 143 pp., 19 pls., Moscow [In Russ.].

MOBERG, J. C., 1885. Cephalopoderna i Sveriges Kritsystem. II. – Sver. geol. Unders. Afh. C, 73:1–64, pls. 1–6, Stockholm.

NAIDIN, D. P. & SHIMANSKIJ, V. N., 1959. [Cephalopoda] In: MOSKVINA, M. M. (Ed.), [Atlas of the Upper Cretaceous fauna of the northern Caucasus and Crimea], Trudy V.N.I.I.G.A.Z, 166–220, 23 pls. [in Russian] Moscow.

NEUMANN,, M., ANDREIEFF, P., LAMBERT, B. & PLATEL, J. P., 1984: Un exemple précis du passage Campanien – Maastrichtien en faciès néritique: la region de Maurens, Dordogne (France). – C. R. Acad. Sc. Paris, 298, ser. II, nr. 1984:845–850, 1 pl., Paris.

NEUMANN, M. & ROBASZYNSKI, F., 1985: Tentative de comparaison entre la limite supérieure du Campanien stratotypique et la limite inférieure du Maastrichtien stratotypique. – Géol. Mediterraneenne, **10**(1983), 3–4:73–79, 1 tabl., Marseille.

NOWAK, J., 1909. O kilku glowonogach i charakterze fauny z karpackiego kampanu. – Kosmos, **34**:765–787, 1 pl., Lemberg.

NOWAK, J., 1911. Untersuchungen über die Cephalopoden der oberen Kreide in Polen. II. Teil. Die Skaphiten. – Bull. int. Acad. Sci. Lett. Cracovie Cl. Sci. math. nat. (B), for 1911, 547–589, pls. 32, 33, Cracovie.

NOWAK, J., 1913. Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III. Teil. – Bull. int. Acad. Sci. Lett. Cracovie Cl. Sci. math. nat. (B), for 1913, 355–415, pls. 40–45, Cracovie.

OLSSON, A. A., 1944. Contributions to the Paleontology of Northern Peru. VII. The Cretaceous of the Paita Region. – Bull. Am. Paleont., **28**:1–146, pls. 1–17, Ithaca.

ORBIGNY, A. D', 1840–1842. Paléontologie francaise: Terrains crétaces. 1, Céphalopodes. 1–120 (1840): 121–430 (1841), 431–662 (1842), 148+3 pls., Masson, Paris.

ORBIGNY, A., D', 1847. Paléontologie, pls. 1–6 (Géologie pls. 4–9) [In:] DUMONT D'URVILLE, M. de, 1846–54. Voyage au Pole Sud et dans l'Oceanie sur les corvettes l'Astrolabe et la Zélée pendant les années 1837–1838–1939–1840 sous le Commandement de M. Dumont D'Urville, Capitaine du Vaisseau. Géologie, pls. 1–9 (no text) Gide et J. Baudry, Eds., Imprimerie de J. Claye et Cie., Paris.

ORBIGNY, A., D', 1850. Prodrome de Paléontologie stratigraphique universelle des animaux mollusques et rayonnes. **2**, 428 pp., Masson, Paris.

PAULCKE, W., 1907. Die Cephalopoden der oberen Kreide Südpatagoniens. – Ber. naturf. Ges. Freiburg i. B., **15**:167–248, pls. 10–19, Freiburg.

PERCH-NIELSEN, K., 1985. 10. Mesozoic calcareous nannofossils. [In:] BOLLI, H. M., SAUNDERS, J. B. & PERCH-NIELSEN, K.: Plankton Stratigraphy, p. 329–426, 92 figs., Cambridge.

PERVINQUIÈRE, L., 1907. Études de paléontologie tunisienne. I. Céphalopodes des terrains secondaires. – Carte géol. Tunisie, v + 438 pp., 27 pls. de Rudeval, Paris.

PETHÖ, J., 1906. Die Kreide (Hypersenon-) fauna des Peterwardeiner (Petervarader) Gebirges (Fruška Gora). – Palaeontographica, **52**:57–336, pls. 5–26, Stuttgart.

PETKOVIĆ, K., 1953. Lumachelles des Céphalopodes et des Inocerames dans les couches sénoniennes de la rivière Osmakowska Reka, son importance biostratigraphique et l'explication de ce phenomene (Serbie Orientale). – Rec. Trav. Inst. Geol. Acad. Serbe Sci., **154**/6: 1–66, 17 pls. [In Russian with French summary].

PHILLIPS, D., 1977. Catalogue of the Type and Figured Specimens of Mesozoic Ammonoidea in the British Museum (Natural History). iii + 220 pp. Trustees of the British Museum (Natural History), London.

RAVN, J. P. J., 1902. Molluskerne i Danmarks Kridtaflejringer. II. Scaphopoder, Gastropoder og Cephalopoder. – K. dansk. Vidensk. Selsk. Skr. 6. R. k., nat. og. mat. Afd., **11**:205–270, pls. 1–5, Copenhagen.

REDTENBACHER, A., 1873. Die Cephalopodenfauna der Gosauschichten in den nordöstlichen Alpen. – Abh. k.-k. geol. Reichsanst., **5**:91–140, pls. 22–30, Vienna.

REESIDE, J. B., 1927. The cephalopods of the Eagle Sandstone and related formations in the Western Interior of the United States. – Prof. Pap. U. S. geol. Surv., **151**, 87 pp., 45 pls., Washington.

REYMENT, R. A., 1958a. Neubeschreibung der Redtenbacher'schen Ammoniten-Originale aus den Gosauschichten. – Stockh. Contr. Geol., 2:31–49, 12 pls., Stockholm.

RICCARDI, A. C., 1974. *Eubaculites* SPATH (Ammonoidea) del Cretacico Superior de Argentina. – Ameghiniana, **11**:379–399, 3 pls., Buenos Aires.

RIEDEL, L., 1932. Die Oberkreide vom Mungofluss in Kamerun und ihre Fauna. – Beitr. geol. Erforsch. dt. Schutzgeb., **16**, 154 pp., 33 pls., Berlin.

ROBASZYNSKI, F., BLESS, M. J. M., FELDER, P. J., FOUCHER, J. C., LEGOUX, O., MANIVIT, H., MEESSEN, J. P. M. Th. & TUUK, L. A. v. d., 1985. The Campanien – Maastrichtian boundary in the chalky facies close to the type – Maastrichtian area. – Bull. Centr. Rech. Expl. Prod. Elf-Aquitaine, 9/1:1–113, 35 figs., 22 pls., Pau.

ROMAN, F., 1938. Les ammonites jurassiques et cretacees. Essai de genera. 554 pp., 53 pls., Masson, Paris.

SCHLÜTER, C., 1867. Beitrag zur Kenntnis der jüngsten Ammoneen Norddeutschlands. – 36 pp., 6 pls., Bonn, A. Henry.

SCHLÜTER, C., 1871–1876. Cephalopoden der oberen deutschen Kreide. – Palaeontographica, **21**:1–24, pls. 1–8 (1871); **21**:25–120, pls. 9–35 (1872); **24**:1–144, (121–264) + x, pls. 36–55 (1876), Cassel.

SCHLÜTER, C., 1974. Das Vorkommen des *Ammonites Lüneburgensis* SCHLÜT. in der Schreibkreide Dänemarks. – Sber. niederrhein. Ges. Nat. u. Heilk., 14. Dez., p. 259, Bonn.

SCHMIDT, W., 1908. Die Kreidebildungen der Kainach. – Jb. der k. k. geol. Reichsanst. Wien, 58:223–246, pls. 4–6 (1–3), Vienna.

SCHULZ, M. G., 1979. Morphometrisch–variationsstatistische Untersuchungen zur Phylogenie der Belemniten-Gattung *Belemnella* im Untermaastricht NW Europas. – Geol. Jb., A47:3–157, 12 pls., Hannover.

SCHULZ, M. G., ERNST, G., ERNST, H. & SCHMID, F., 1984. Coniacian to Maastrichtian stage boundaries in the standard section for the Upper Cretaceous white chalk of NW Germany (Lägersdorf–Kronsmoor–Hemmoor): definitions and proposals. – Bull. geol. soc. Denmark, 33:203–215, Copenhagen.

SCHULZ, M.-G. & SCHMID, F., 1983. Die Belemniten der Inoceramen-Mergel (Buntmergelserie, Ultrahelvetikum, Unter-Maastricht) des Moos-Grabens SE Siegsdorf (Oberbayern) und ihre stratigraphische Bedeutung. – Zitteliana, **10**:653–661, 7 figs., 1 pl., München.

SEUNES, J., 1890. Contributions à l'étude des céphalopodes du Crétace Supérieur de France. 1. Ammonites du Calcaire à *Baculites* du Cotentin. – Mém. Soc. géol. Fr. Palaeont., **1**, Mém. 2, 1–7, pls. 2–3 (1–2), Paris.

SEUNES, J., 1891. Contribution à l'étude des Céphalopo-

des du Crétace Supérieur de France. 1. Ammonites du Calcaire à *Baculites* du Cotentin (Suite). II. Ammonites du Campanien de la région sous-pyrenéenne. Département de Landes. – Mem. Soc. géol. Fr., Paléont., 2, Mém. 2, 8–22, pls. 12–15 (3–6), Paris.

SHARPE, D., 1853–57. Description of the fossil remains of Mollusca found in the Chalk of England. I, Cephalopoda. – Palaeontogr. Soc. Monogr., 68 pp., 27 pls, 1–26, pls. 1–10 (1853); 27–36, pls. 11–16 (1855); 37–68, pls. 17–27 (1857), London.

SHIMIZU, S., 1934. [Ammonites] In: SHIMIZU, S. & OBATA, T. [Cephalopoda. Iwanami's lecture series of Geology and Palaeontology –], 137 pp., Tokyo [in Japanese].

SHIMIZU, S., 1935. The Upper Cretaceous cephalopods of Japan. Part 1. – J. Shanghai Sci. Inst. sec. 2, 2:159–226, Shanghai.

SOWERBY, J., 1812–1822. The Mineral Conchology of Great Britain. 1, pls. 1–9 (1812), pls. 10–44 (1913), pls. 45–78 (1814), pls. 79–102 (1815); 2, pls. 103–114 (1815), pls. 115–150 (1816), pls. 151–186 (1817), pls. 187–203 (1818); 3, pls. 204–221 (1818), pls. 222–253 (1819), pls. 254–271 (1820), pls. 272–306 (1821); 4, pls. 307–318 (1821), pls. 319–383 (1822). The author, London.

SPATH, L. F., 1922a. On the Senonian ammonite fauna of Pondoland. – Trans. R. Soc. S. Afr., 10:113–147, pls. 5–9, Cape Town.

SPATH, L. F., 1922b. On Cretaceous Ammonoidea from Angola, collected by Professor J. W. Gregory, D. Sc., F. R. S. – Trans. R. Soc. Edinb., 53:91–160, 4 pls., Edinburgh.

SPATH, L. F., 1923. A monograph of the Ammonoidea of the Gault. – Monogr. Palaeontogr. Soc., Part 1, pp. 1–72, pls. 1–4, London.

SPATH, L. F., 1925a. Sur quelques Ammonites du Gault nommées par P. Reynès. – Annls. Mus. Hist. nat. Marseille, 20:97–106, pl. 4, Marseille.

SPATH, L. F., 1925b. On Senonian Ammonoidea from Jamaica. – Geol. Mag., 62:28–32, pl. 1, London etc.

SPATH, L. F., 1926. On new ammonites from the English Chalk. – Geol. Mag., 63:77–83, table, London etc.

SPATH, L. F., 1927–1933. Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). – Mem. geol. Surv. India, Palaeont. indica (NS), 9, mem. no. 2, pts. 1–6, vii + 945 pp., 130 pls., 1–71, pls. 1–7 (1927a); 72–161, pls. 8–19 (1928a); 162–278 (pls. 20–47), (1928 b); 279–550, pls. 48–102 (1931a); 551–658, pls. 103–124 (1931b); 659–945, i–vii, pls. 125–130 (1933a), Calcutta.

SPATH, L. F., 1940. On Upper Cretaceous (Maastrichtian) Ammonoidea from Western Australia. – J. Proc. Roy. Soc. West. Aust., 26:41–57, pls. 1, 2, Perth.

SPATH, L. F., 1953. The Upper Cretaceous Cephalopod fauna of Grahamland. – Scient. Rep. Br. Antarct. Surv., 3:1–60, pls. 1–13, London.

STEINMANN, G., 1895. Die Cephalopoden der Quiriquina-Schichten. – Neues Jb. Miner. Geol. Paläont. Beilbd. 10:64–94, pls. 4–6, Stuttgart.

STOLICZKA, F., 1963–1966. The fossil cephalopods of southern India. Ammonitidae with revision of the Nautilidae & c. – Mem. geol. Surv. India (1), Palaeont. indica, 3(1), 41–56, pls. 26–31 (1863); (2–5), 57–106, pls. 32–54 (1864); (6–9), 107–154, pls. 55–80 (1865); (10–13), 155–216, pls. 81–94 (1866), Calcutta.

STUR, D., 1851. Die liassischen Kalksteingebilde von Hirtenberg und Enzesfeld. – Jb. k.-k. geol. Reichsanst., Wien, 2:19–26.

SUMMESBERGER, H., 1968. Bericht über Aufnahmen 1966/67 auf Blatt 74 Hohenberg. – Verh. Geol. B.-A., Wien, 1968(3), p. A62, Vienna.

SURLYK, F., 1984. The Maastrichtian stage in N. W. Europe and its brachiopod zonation. – Bull. geol. Soc. Denmark, 33:217–223, Copenhagen.

THIEDIG, F. & WIEDMANN, J., 1976. Ammoniten und Alter der höheren Kreide (Gosau) des Krappfeldes in Kärnten (Österreich). – Mitt. geol. Staatsinst. Hamb., 45:9–27, pls. 1, 2, Hamburg.

TZANKOV, C. V., 1964. [Ammonites from the Maastrichtian near Kladorub village, Belogradchic region, northwest Bulgaria.] – Trudove Varkhu geol. Bulg., 6:143–168, pls. 1–10 [in Bulgarian], Sofia.

TZANKOV, C. V., 1982. [The Fossils of Bulgaria Va. Upper Cretaceous –], 136 pp., 50 pls., Bulgarian Academy of Sciences [in Russian], Sofia.

UHLIG, V., 1894. Bemerkungen zur Gliederung karpathischer Bildungen. Jb. k.-k. geol. Reichsanst., Wien, 44: 215–222, Vienna.

USHER, J. L., 1952. Ammonite faunas of the Upper Cretaceous of Vancouver Island, British Columbia. – Bull. geol. Surv. Can., 21:1–182, pls. 1–30, Ottawa.

VALLE, R. A., DEL & FOURCADE, N. H., 1976. Algunos fosiles Cretacicos de Cabo Hamilton, Isla James Ross, Antartida. – Inst. Antarct. Argent., 198:3–27, pls. 1–4, Buenos Aires.

VALLE, R. A. DEL & RINALDI, C. A., 1975. Sobre la presencia de *Diplomoceras lambi* Spath en la Isla Vicecomodoro Marambio. – Inst. Antarct. Argent., 191, 40 pp., 10 pls., Buenos Aires.

WARD, P. D., 1976. Upper Cretaceous Ammonites (Santionian–Campanian) from Orcas Island, Washington. – J. Paleont., 50:454–461, pl. 1, Chicago.

WEDEKIND, R., 1916. Über Lobus, Suturallobus und Inzision. – Zentralbl. Miner. Geol. Paläont. for 1916: 185–195, Stuttgart.

WELLER, S., 1903. The Stokes collection of Antarctic fossils. – J. Geol., 11:413–419, pls. 1–3, Chicago.

WETZEL, W., 1930. Die Quiriquina-Schichten als Sediment und Paläontologisches Archiv. – Palaeontographica, 73:49–105, pls. 9–14, Stuttgart.

WETZEL, W., 1960. Die Coyhaique-Schichten des patagonischen Neocoms und ihre Ammoniten. – Neues Jb. Geol. Paläont. Mh., 1960:246–254, Stuttgart.

WHITE, C. A., 1890. On certain Mesozoic fossils from the islands of St. Paul's and St. Peter's in the Straits of Magellan. – Proc. U. S. natn. Mus., 13:13–14, pls. 2, 3, Washington.

WHITEAVES, J. F., 1903. On some additional fossils from the Vancouver Cretaceous, with a revised list of the species therefrom. – Geol. Surv. Can., Mesozoic Fossils, 1(5):309–409, pls. 40–51, Ottawa.

WIEDMANN, J., 1960. Le Cretace superieur de l'Espagne et du Portugal et ses cephalopodes. – C. R. Congres des Societes Savantes, Dijon 1959: Colloque sur le Cretace superieur francais, 709–764, 8 pls., Paris.

WIEDMANN, J., 1962 a. Ammoniten aus der Vascogotischen Kreide (Nordspanien). 1. Phylloceratina, Lytoceratina. – Palaeontographica, 118A:119–237, pls. 8–14, Stuttgart.

WIEDMANN, J., 1962 b. Die systematische Stellung von *Hypophylloceras* Salfeld. – Neues Jb. Geol. Paläont. Abh., 115:243–262, pl. 16, Stuttgart.

WIEDMANN, J., 1964. Unterkreide-Ammoniten von Mallorca. 2. Lieferung: Phylloceratina. – Abh. math.-naturwiss. Kl., Akad. Wiss. Mainz, 1963(4):149–264, pls. 11–21, Mainz.

WIEDMANN, J., 1966. Stammesgeschichte und System der posttriadischen Ammonoideen; ein Überblick. – Neues Jb. Geol. Paläont. Abh., 125:49–79, pls. 1–2; 127:13–81, pls. 3–6, Stuttgart.

WILCKENS, O., 1904. Revision der Fauna der Quiriquina-Schichten. – Neues Jb. Min. Geol. Paläont. Beilbd. 18: 181–284, pls. 17–20, Stuttgart.

WISNIOWSKI, T., 1907. Über die obersenone Flyschfauna von Leszczyny. – Beitr. Paläont. Geol. Österr.-Ung., 20:191–205, pl. 17, Vienna and Leipzig.

WOLLEMANN, A., 1902. Die Fauna der Lüneburger Kreide. – Abh. preuss. geol. Landesanst., N. F., 37, 129 pp., 7 pls., Berlin.

WOODWARD, S. P. 1851–1856. A manual of Mollusca. – xvi + 486 pp., 25 pls., Lockwood & Co., London.

WRIGHT, C. W., 1953. Notes on Cretaceous Ammonites. I. Scaphitidae. – Ann. Mag. nat. Hist. (12), 6:473–476, London.

WRIGHT, C. W., 1957 a. Some Cretaceous ammonites from New Zealand. – Trans. R. Soc. N. Z., 84:805–809, pls. 54–55, Duneiden.

WRIGHT, C. W., 1957 b. [In:] MOORE, R. C. (ed.): Treatise on Invertebrate Paleontology. Part L, Mollusca 4, Cephalopoda Ammonoidea. – xxvi + 490 pp., New York and Lawrence, Geol. Soc. Amer. and Univ. of Kansas Press.

WRIGHT, C. W. & KENNEDY, W. J., 1984. The Ammonoidea of the Lower Chalk. – Monogr. Palaeontogr. Soc., Part 1, pp. 1–126, pls. 1–40, London.

WRIGHT, C. W. & MATSUMOTO, T., 1954. Some doubtful Cretaceous ammonite genera from Japan and Saghalien. – Mem. Fac. Sci. Kyushu Univ. (D), Geol., 4:107–134, pls. 7–8, Fukuoka.

WRIGHT, C. W. & WRIGHT, E. V., 1951. A survey of the fossil Cephalopoda of the Chalk of Great Britain. – Monogr. palaeontogr. Soc. 1–40, London.

YABE, H., 1903. Cretaceous Cephalopoda from Hokkaido. Part 1. – J. Coll. Sci. Imp. Univ. Tokyo, 18:1–55, pls. 1–7, Tokyo.

YABE, H. & SHIMIZU, S., 1926. A study on the genus "Parapachydiscus". – Proc. Imp. Acad. Japan., 2:171–173, Tokyo.

YOKOYAMA, M., 1890. Versteinerungen aus der japanischen Kreide. – Palaeontographica, 36:159–202, pls. 18–25, Stuttgart.

YOUNG, K., 1963. Upper Cretaceous ammonites from the Gulf Coast of the United States. – Univ. Tex. Bull., 6304, ix + 373 pp., 82 pls., Austin.

ZABORSKI, P. M. P., 1985. Upper Cretaceous ammonites from the Calabar Region, south-east Nigeria. – Bull. Br. Mus. Nat. Hist. (Geol.), 39:1–72, London.

ZITTEL, K. A. VON, 1884. Handbuch der Palaeontologie. – Abt. 1, 2 (Lieferung 3), Cephalopoda, 329–522, R. Oldenbourg, Munich and Leipzig.

ZITTEL, K. A. VON, 1895. Grundzüge der Palaeontologie (Palaeozoologie), vii + 972 pp., R. Oldenbourg, Munich and Leipzig.

Explanation of Plates

Plate 1

Figs. 1, 8. *Pseudophyllites* cf. *indra* (FORBES, 1846). GBA. 1873.01.16. The holotype of *Ammonites anaspastus* REDTENBACHER, 1873, pl. 26, fig. 1.

Figs. 2, 3, 6. *Partschiceras forbesianum* (D'ORBIGNY, 1850). GBA. 1935.III.14.

Figs. 4, 5, 7. *Saghalinites wrighti* BIRKELUND, 1965. 4, 5, are NHMW 1977.1924.8 7 is GIG 487.

All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.

All figures are x 1.

Plate 2

Figs. 1, 2. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858), the holotype of *Ammonites chrishna* (FORBES, 1846) (p. 103, pl. 9, fig. 2) from Pondicherry, southern India, BMNH C51041.

Figs. 3, 4. *Anagaudryceras* sp. GIUW unregistered, from the Lower Maastrichtian of Neuberg, Steiermark, Austria.

All figures are x 1.

Plate 3

Figs. 1, 2, 3. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858). GBA. 1858.1.6, the lectotype, the original of HAUER, 1858, pl. 2, figs. 1–3.

Fig. 4. *Saghalinites wrighti* BIRKELUND, 1965; NHMW 1977.1924.8.

Fig. 5. *Pseudophyllites* cf. *indra* (FORBES, 1846). GBA. 1873.01.16. The holotype of *Ammonites anaspastus* REDTENBACHER, 1873, pl. 26, fig. 1.

Fig. 6. *Anagaudryceras lueneburgense* SCHLÜTER, 1872). GBA unregistered.

All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.

Plate 4

Figs. 1–5. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858). 1 is JOAG 6109; 2, 3 NHMW 1852. XXI. 1881; 4 is PIUW unregistered; 5 is JOAG 6112.

All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.

All figures are x 1.

Plate 5

Figs. 1, 4, 5. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858). 1 is NHMW 1851.XXI.1880. 4, 5, GIUW 1875.XXX.1.
Figs. 2, 3. *Menuites costatus* sp. nov. GIUW 1876.XV.9.
All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.
All figures are x 1.

Plate 6

Figs. 1, 2, 5. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858). 1, 2, GIUW 1876.XV.7.
Figs. 3, 4. *Pachydiscus (Pachydiscus) epiplectus* REDTENBACHER, 1873) 3 is the paralectotype GBA 1873/01.24 from Grünbach, Lower Austria. The original of REDTENBACHER 1873, pl. 28, fig. 1c. 4 is from the GBA collections.
All specimens with the exception of the original of fig. 3 are from the Lower Maastrichtian, Neuberg, Steiermark, Austria. 1, 2 are x 1,25; 3, 4, 5 are x 1.

Plate 7

Figs. 1, 2. *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873). The lectotype, GIUW ex Vienna High School Collections no. 1868.X.15, the original of REDTENBACHER 1873, pl. 28, figs. 1a, 1b, from Muthmannsdorf, Lower Austria.
All figures are x 1.

Plate 8

Fig. 1, 2. *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873). The lectotype, GIUW ex Vienna High School Collection no. 1868.X.15, the original of REDTENBACHER 1873, pl. 28, figs. 1a, 1b, from Muthmannsdorf, Lower Austria.
All figures are x 1.

Plate 9

Pachydiscus (Pachydiscus) epiplectus (REDTENBACHER, 1873) GIUW 1876.XV.8, from the Lower Maastrichtian of Neuberg, Steiermark, Austria.
Slightly reduced; the original is 230 mm in diameter.

Plate 10

Figs. 1–3. *Pachydiscus (Pachydiscus) epiplectus* (REDTENBACHER, 1873). 1, 2, are the inner whorls of the lectotype GIUW ex Vienna High School Collections no. 1868.X.15, the original of REDTENBACHER, 1873, pl. 28, figs. 1a, 1b, from Muthmannsdorf, Lower Austria. 3 is the venter of GIUW.1876. XV.8, from the Lower Maastrichtian of Neuberg, Steiermark, Austria (see also Pl. 9).
Figs. 1, 2 are x 1; Fig. 3 is slightly reduced.

Plate 11

Figs. 1–4. *Pachydiscus (Pachydiscus) epiplectus* REDTENBACHER, 1873. 1–3 are paralectotype GBA 1873.01.24 from Grünbach, Lower Austria, the original of REDTENBACHER 1873, pl. 28, fig. 1c. 4 is the apertural view of GIUW 1876.XV.8, from the Lower Maastrichtian on Neuberg, Steiermark, Austria (see also Pl. 9).
Figs. 1–3 are x 1; 4 is slightly reduced.

Plate 12

Pachydiscus (Pachydiscus) epiplectus (REDTENBACHER, 1873) GBA „Typensammlung Hauer" from Neuberg, Steiermark, Austria.
Reduced x 0.98.

Plate 13

Pachydiscus (Pachydiscus) epiplectus (REDTENBACHER, 1873) GBA from Neuberg, Steiermark, Austria. The outer whorls of this specimen are shown in Pl. 12.
All figures are natural size.

Plate 14

Figs. 1–5, 9–14. *Eubaculites lyelli* (D'ORBIGNY, 1847). 1, 14 are NHMW 1935.III.19; 2–5 are NHMW 1953.3. 19a; 9 is GBA 1873.01.39a; 10 is GBA 1873.01.39b; 11 is NHMW 1935.III.20; 12, 13 are NHMW 1935.III.18.
Figs. 6–8. *Eubaculites* sp. NHMW.1977.1924.5. 1–8, 11–14 are from the Lower Maastrichtian of Neuberg, Steiermark, Austria. 9, 10 are from Gadenweit next Sieding, Lower Austria.
All figures are x 1.

Plate 15

Figs. 1, 2, 5. *Diplomoceras cylindraceum* (DEFRANCE, 1816). GBA 1858.01.1 the original of HAUER, 1858, pl. 1, figs. 4, 5.
Figs. 3, 6. *Partschiceras forbesianum* (D'ORBIGNY, 1841), JOAG 60.
Fig. 4. *Anagaudryceras lueneburgense* (SCHLÜTER, 1872). JOAG 55.514.
Figs. 7, 8. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858). GBA.1935.01.39.
All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.
All figures are natural size.

Plate 16

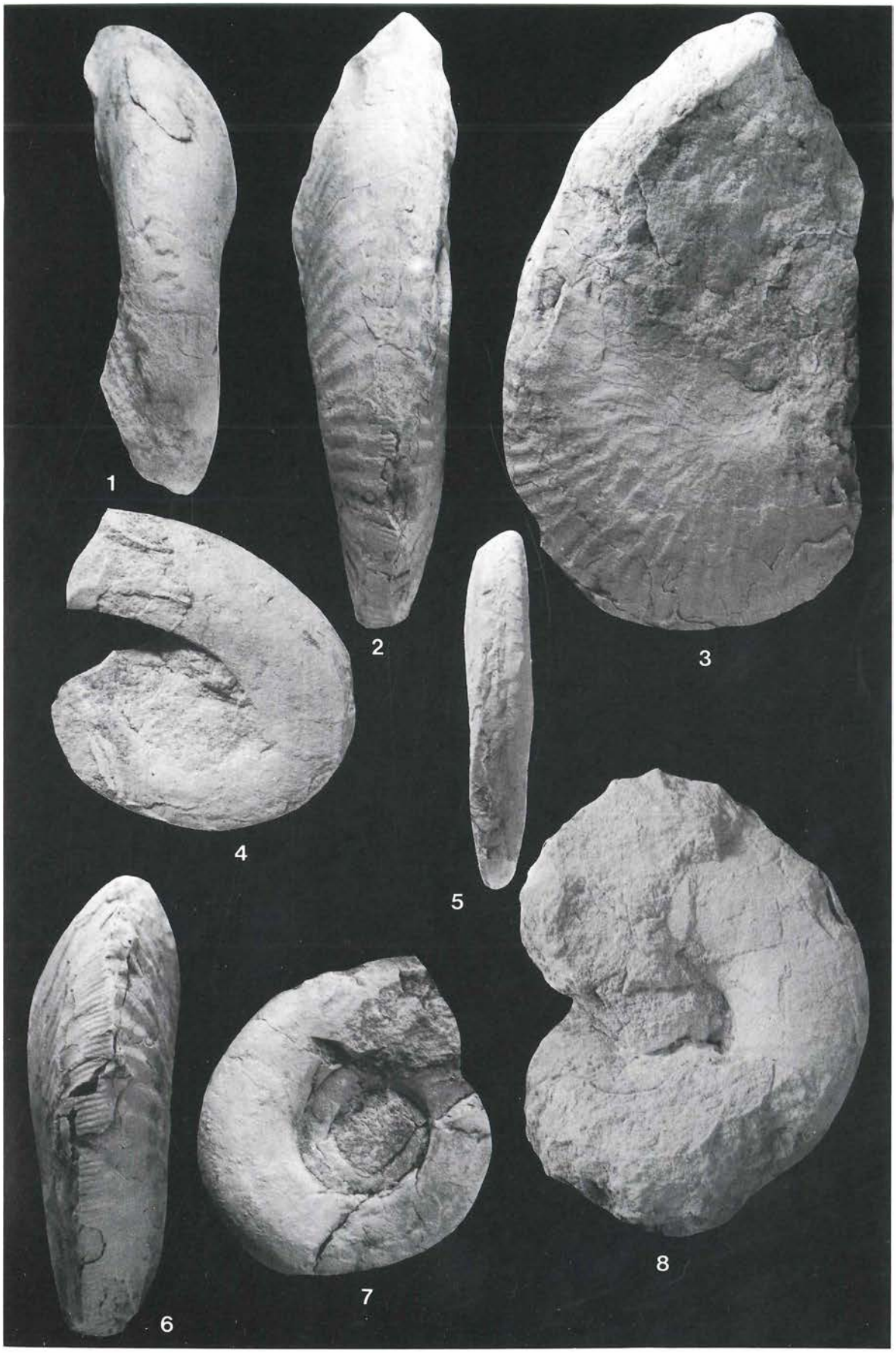
Figs. 1–5, 8–10, 13. *Hoploscaphites constrictus* (J. SOWERBY, 1817). 1, 2, GBA 1858.01.2b, a macroconch, a paralectotype of *Scaphites multinodosus* HAUER, 1858; 3, 4, 5, GBA 1858.01.2a, a macroconch, the lectotype of *S. multinodosus* HAUER, 1858, pl. 1, figs. 7, 8; 8, 9, GBA 1858.01.2 c, a microconch, a paralectotype of *S. multinodosus;* 10, GIG 166.G.S., a macroconch; 13 GBA 1858. 01.2d, a microchonch.

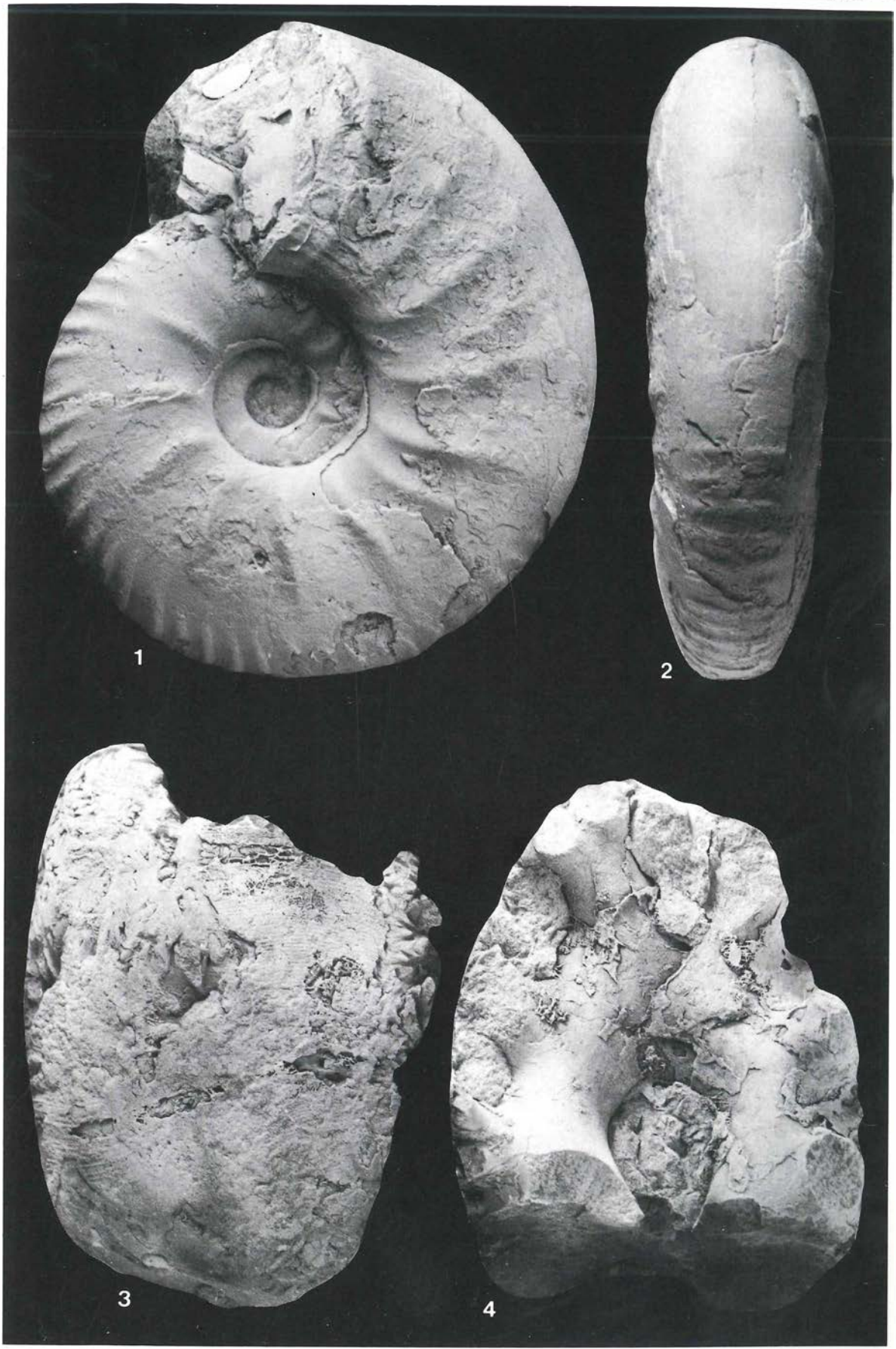
Figs. 6, 7, 11, 12. *Hoploscaphites* ? sp. 6, 7, NHMW 1977.1924.9; 11, 12, NHMW unregistered.

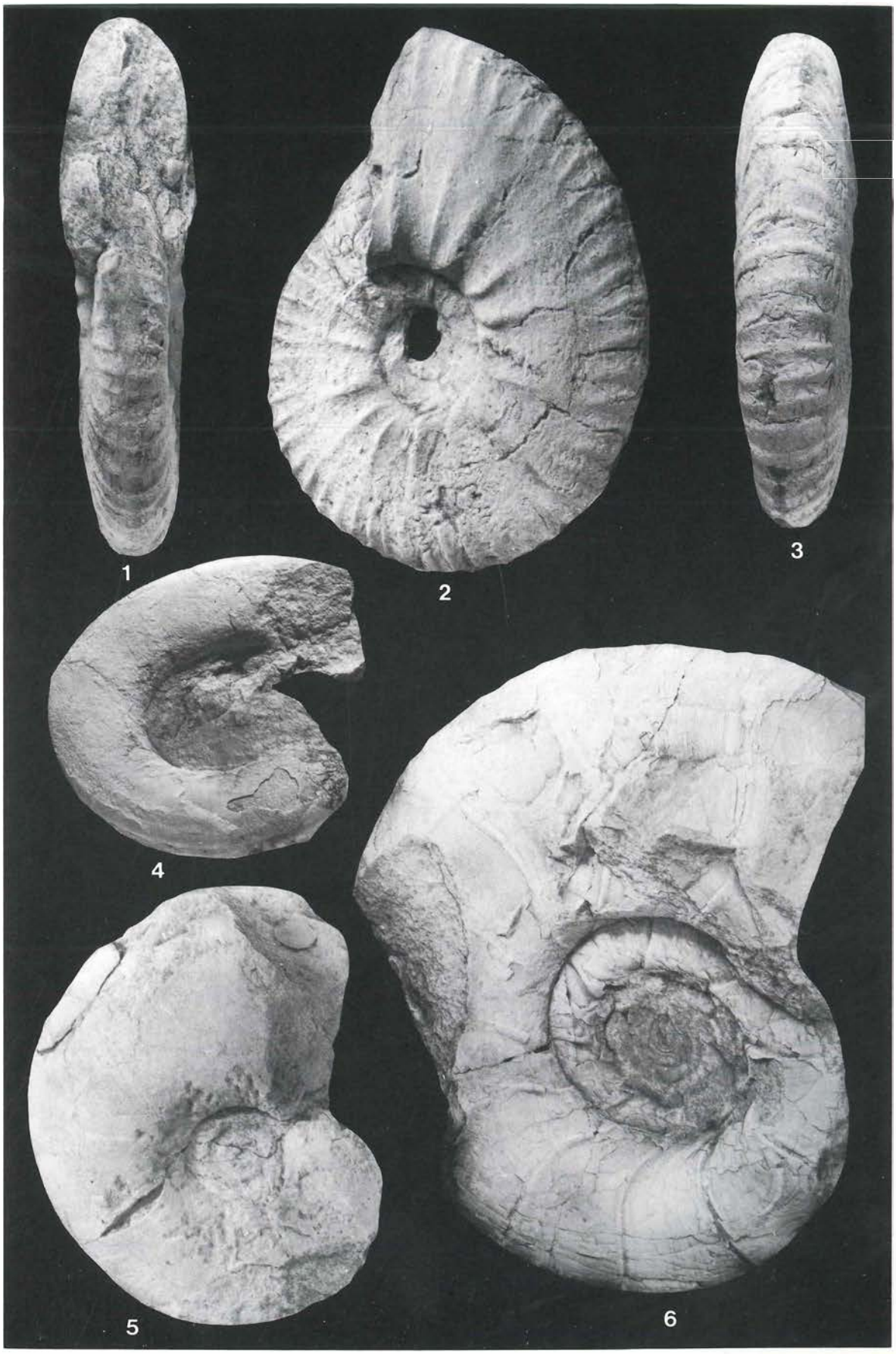
Figs. 14, 15. *Diplomoceras cylindraceum* (DEFRANCE, 1816). GBA unregistered.

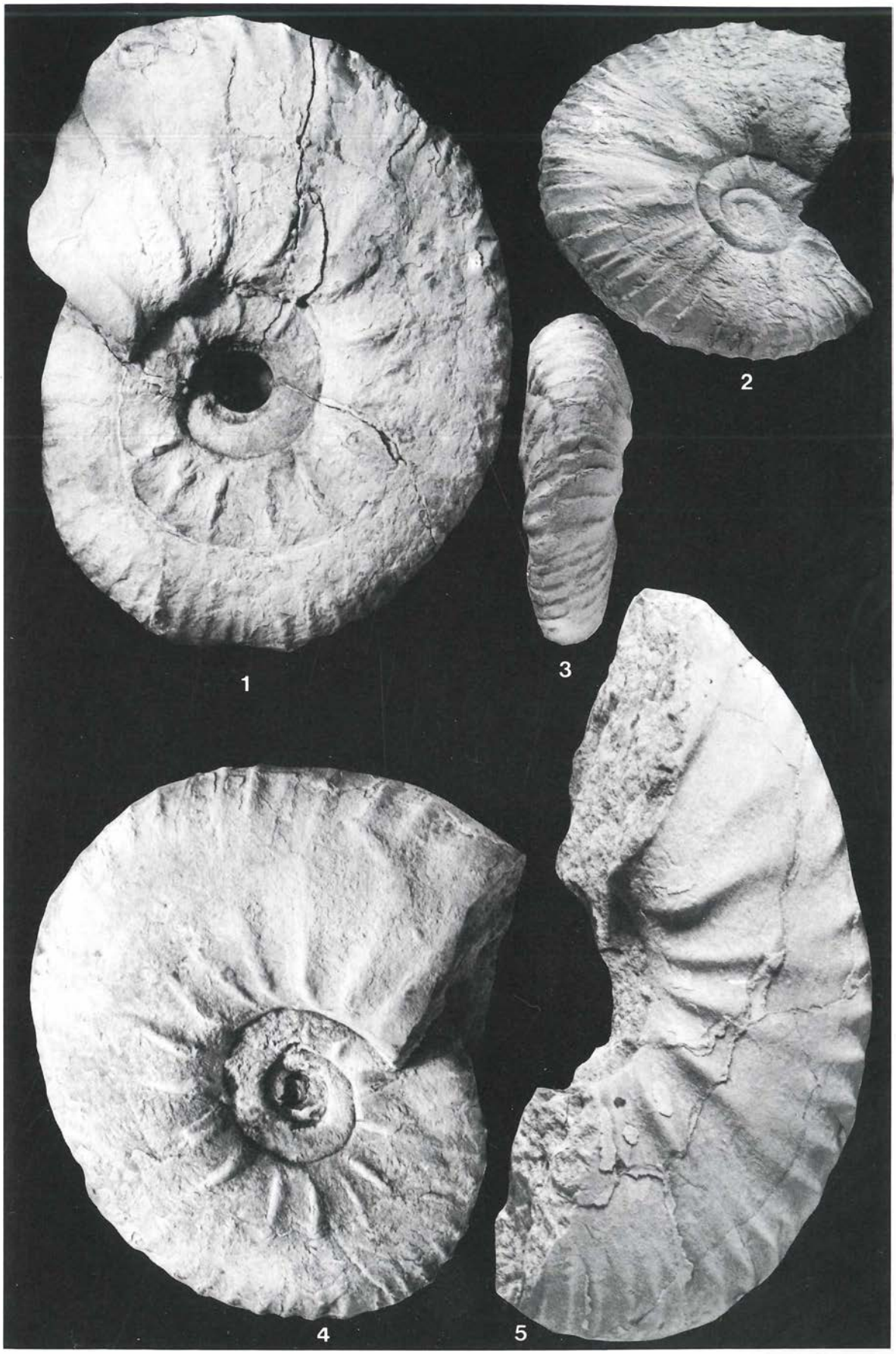
Fig. 16. *Pachydiscus (Pachydiscus) neubergicus* (HAUER, 1858)? PIUW.1991.1698. All specimens are from the Lower Maastrichtian of Neuberg, Steiermark, Austria.

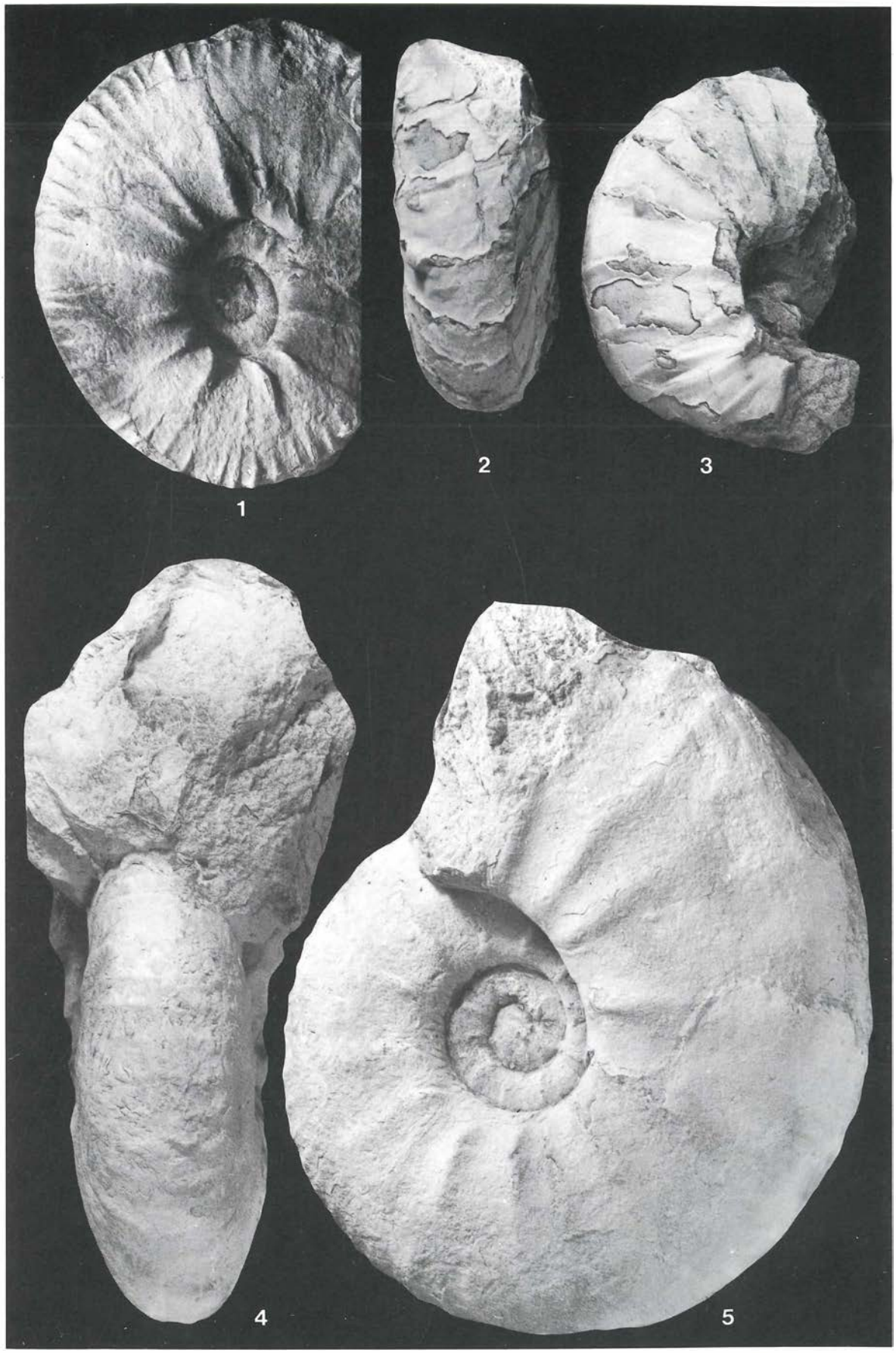
All figures are x 1 except figs. 7, 9 and 13, which are x 2.

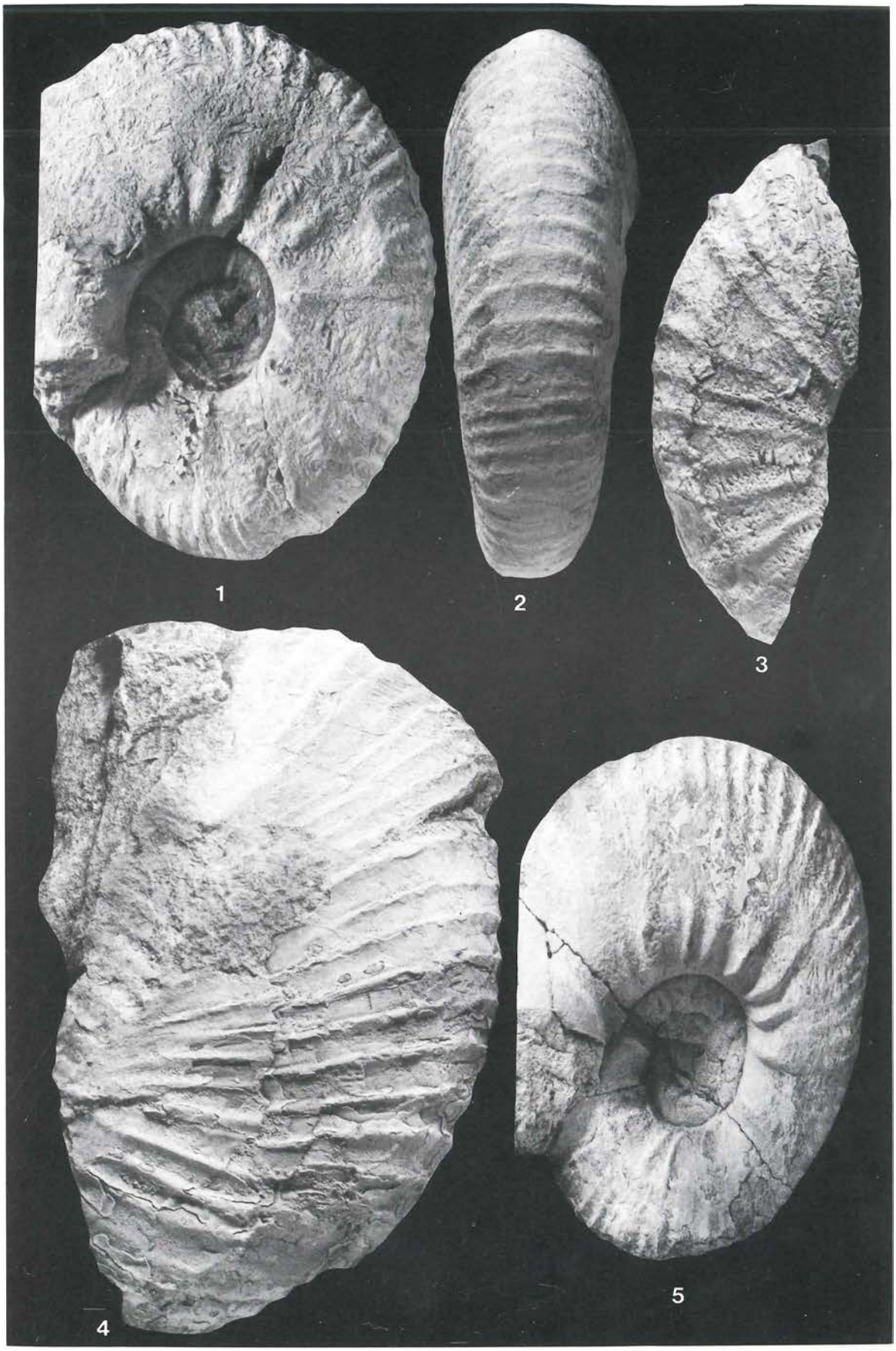

1
2
3
4
5
6
7
8

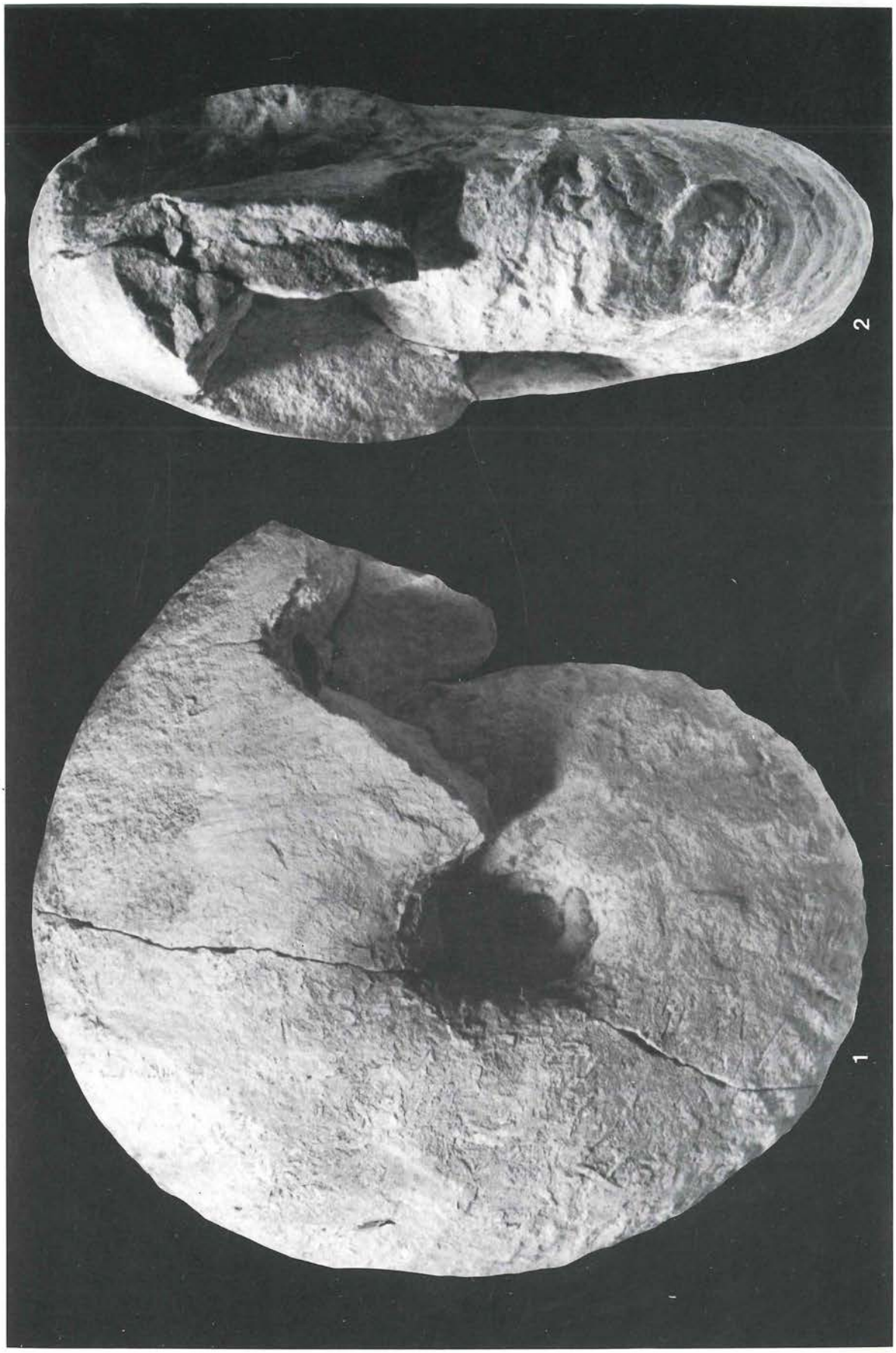

1
2
3
4

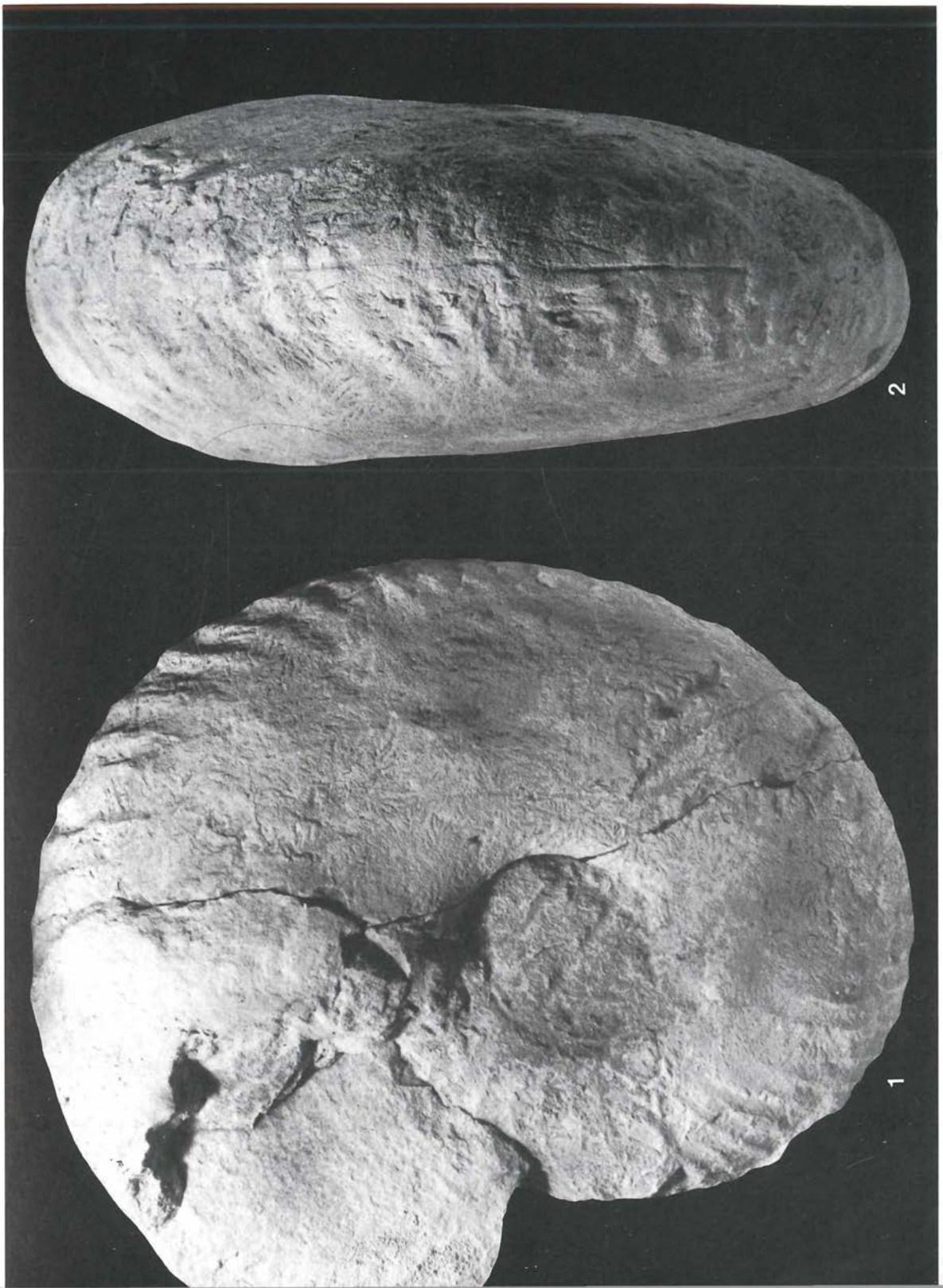

1
2
3
4
5
6

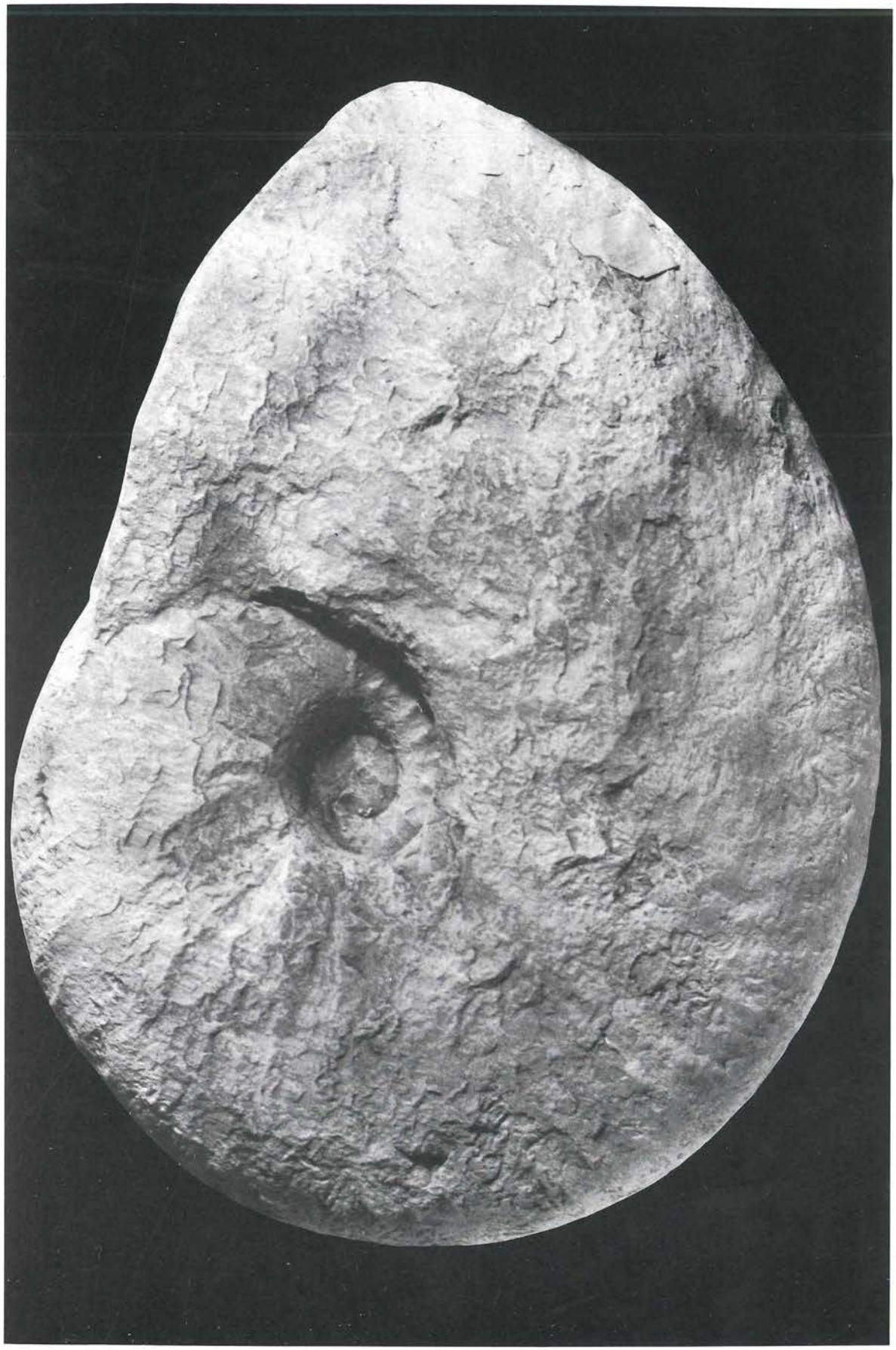

1
2
3
4
5

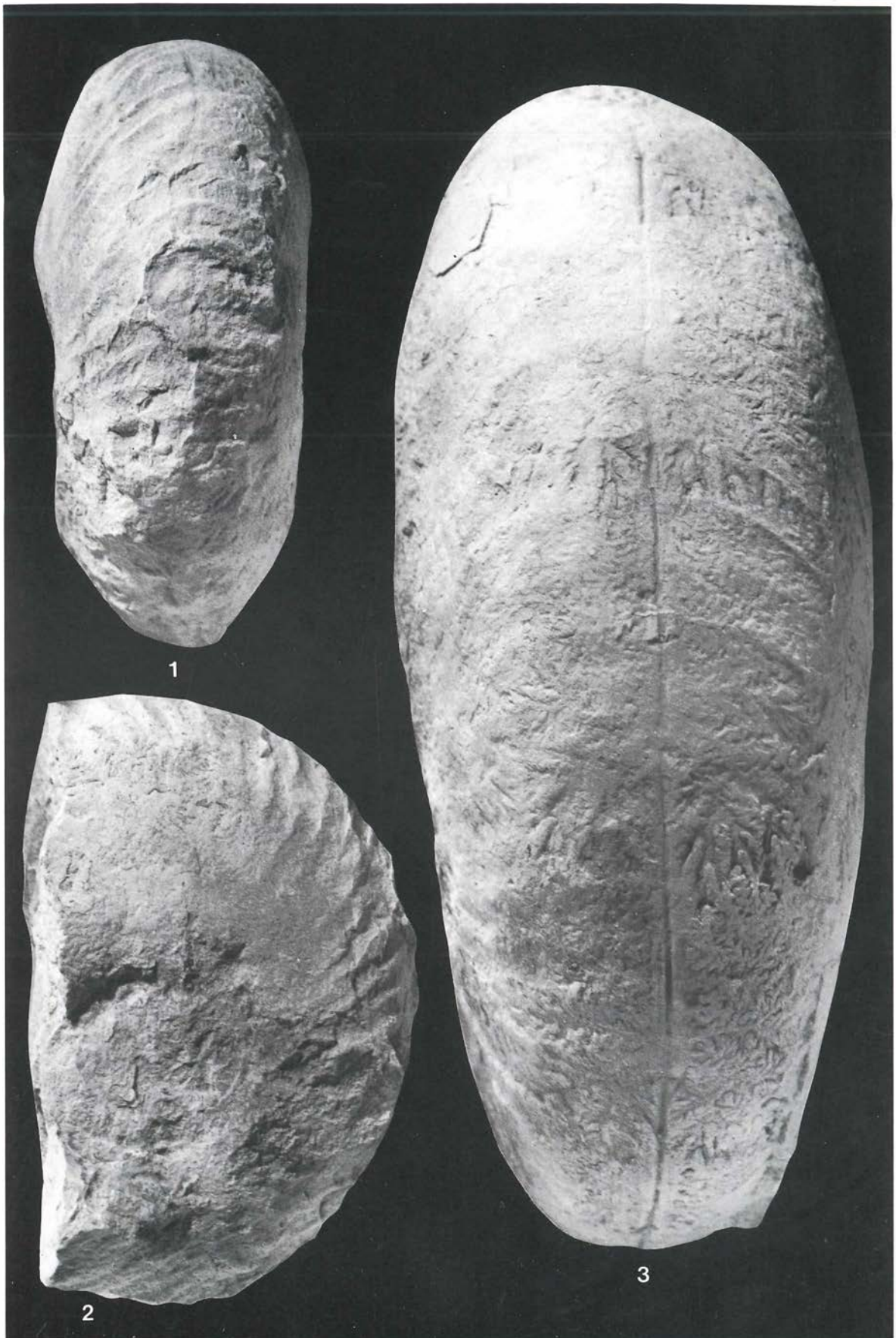

1
2
3
4
5

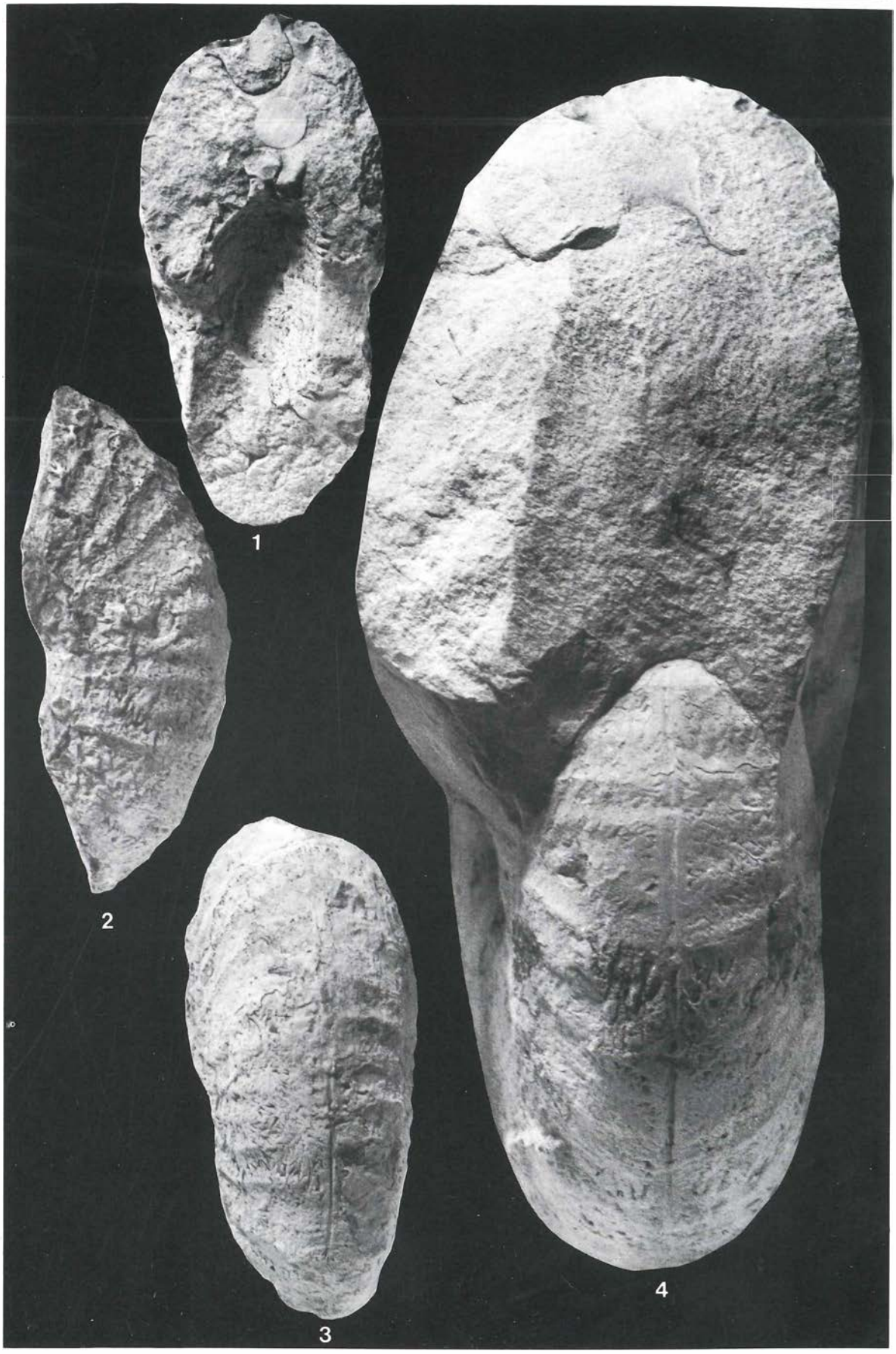

1
2
3
4
5

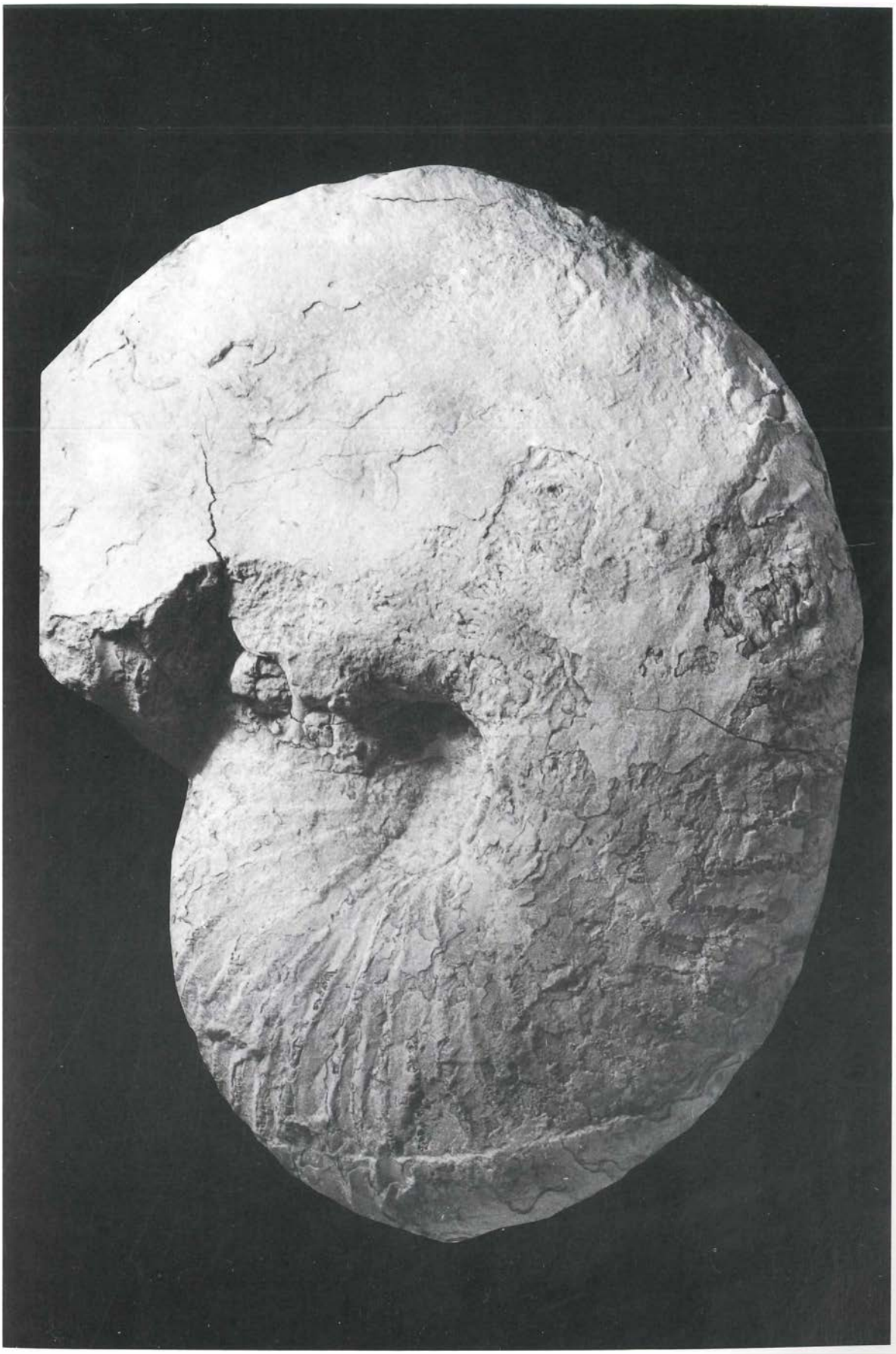

2
1

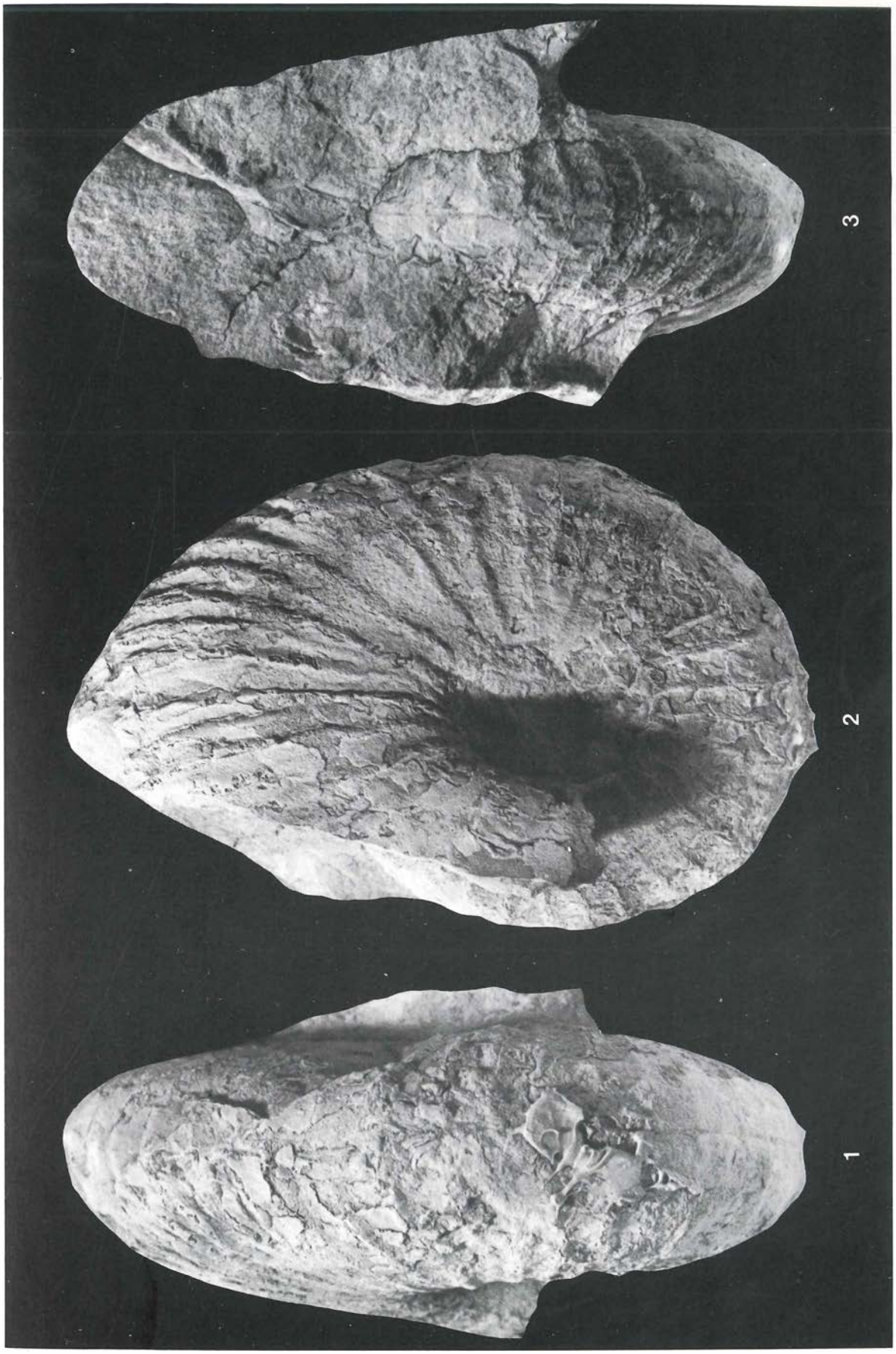

2
1

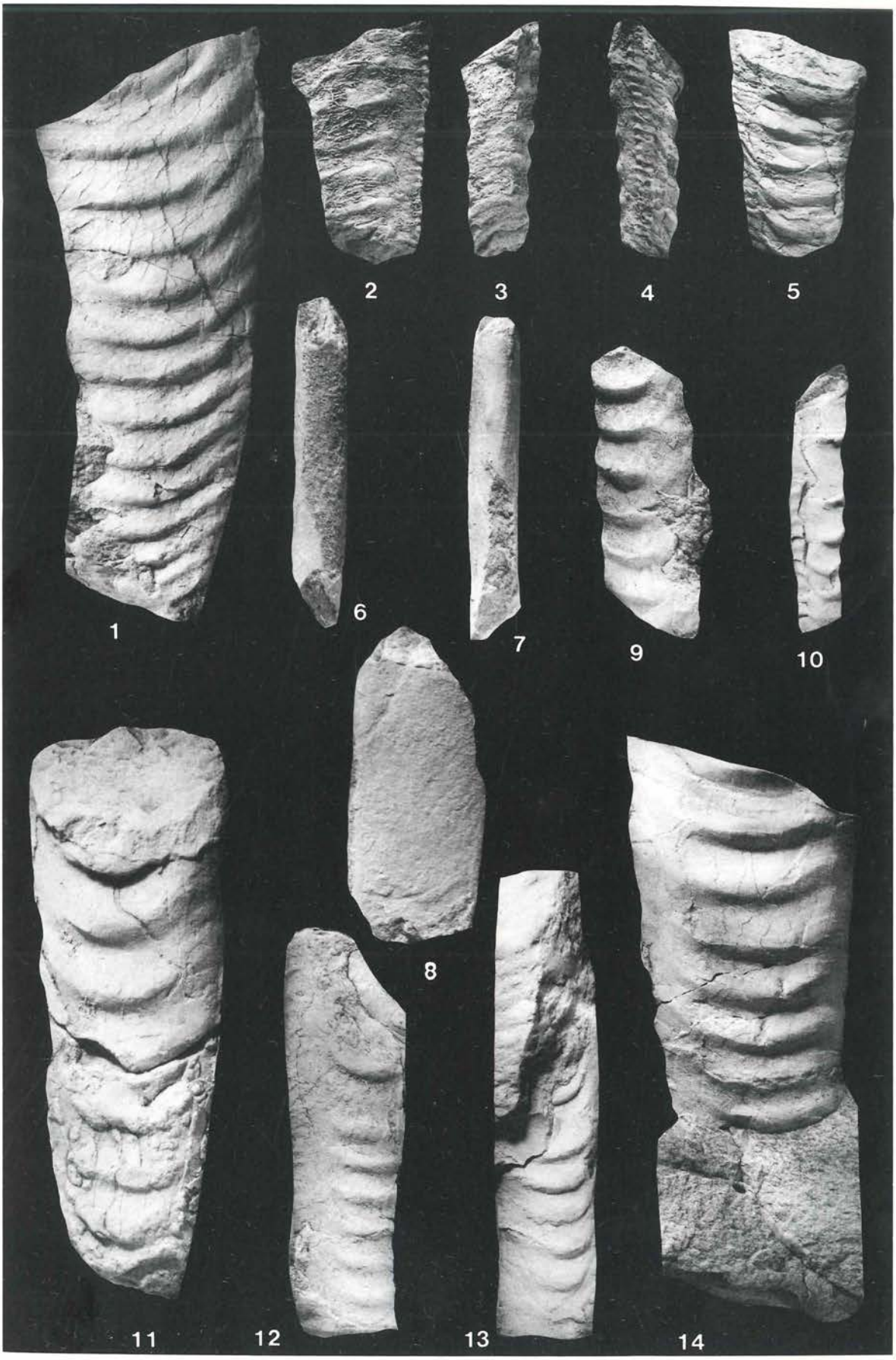


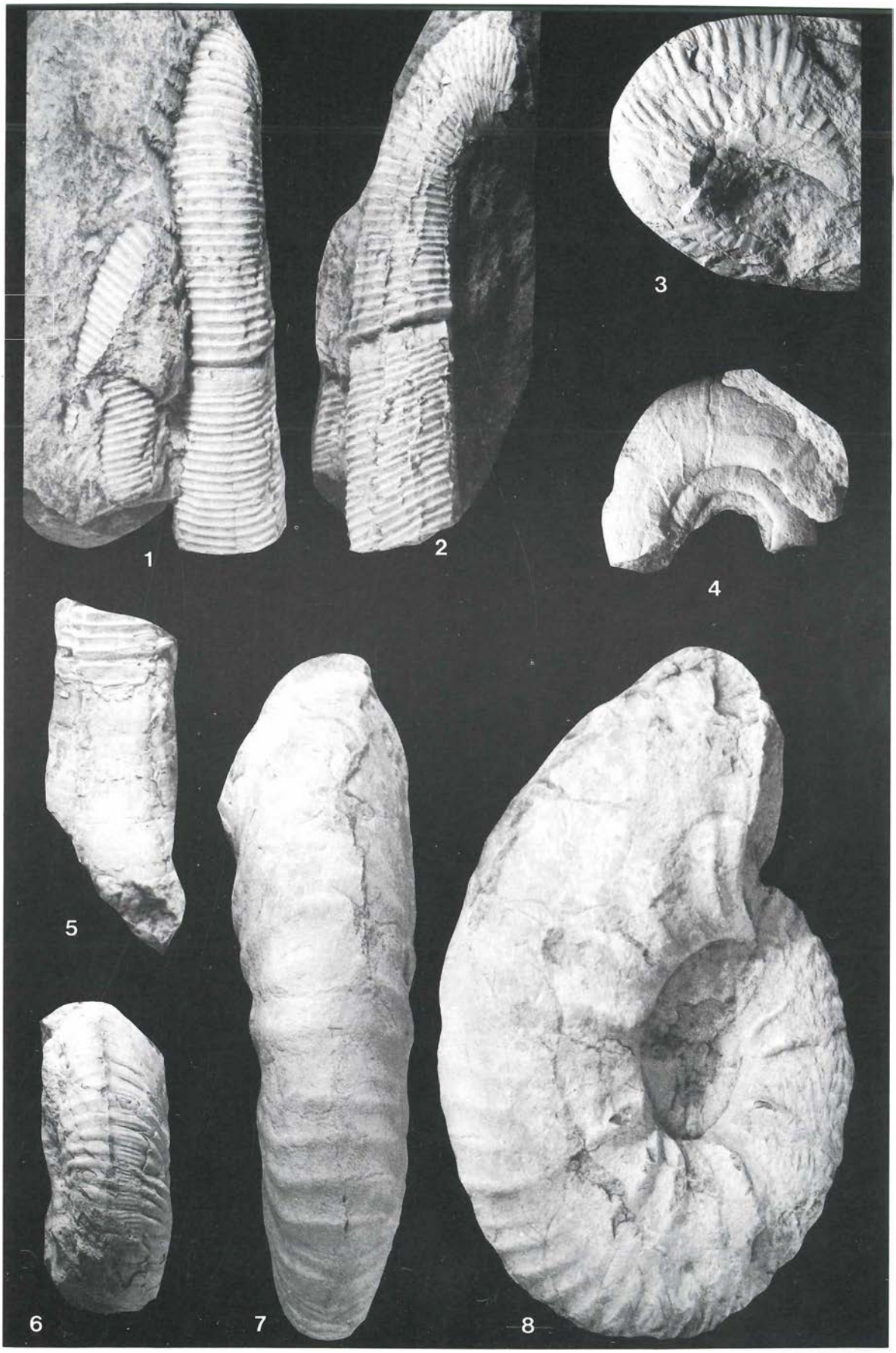

1
2
3

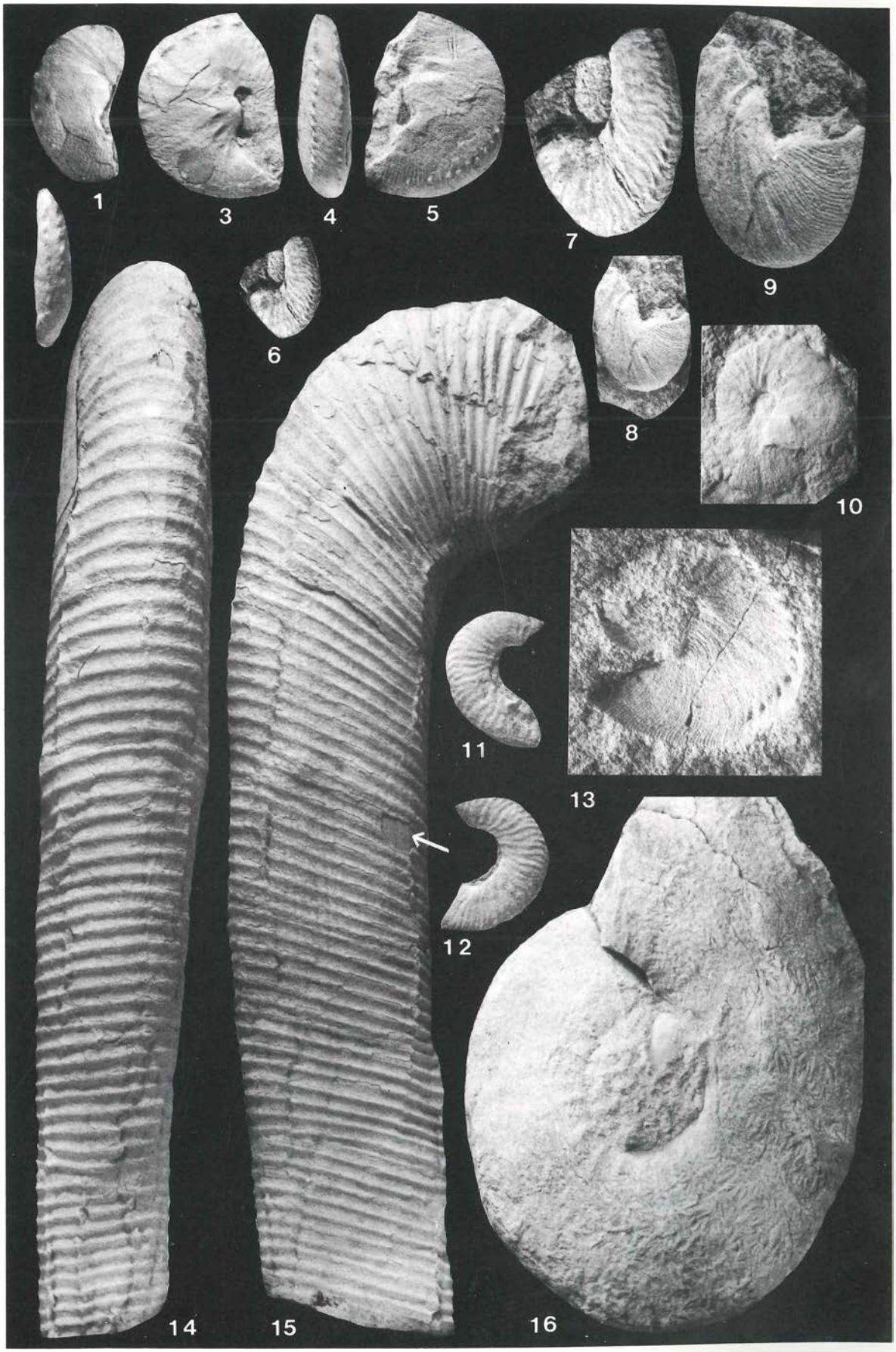

1
2
3
4




3
2
1


1
2
3
4
5
6
7
8
9
10
11
12
13
14


1
2
3
4
5
6
7
8


1
3
4
5
7
9
6
8
10
11
13
12
14
15
16