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Maastrichtian Ammonites from Hemmoor, Niederelbe (NW-Germany)

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Abstract: Six ammonite species, one of which is new, are described from the Maastrichtian of Hemmoor chalk quarry, Lower Saxony: *Anagaudryceras lueneburgense* (Schlüter), *Saghalinites wrighti* Birkelund, *Acanthoscaphites varians* (Łopuski), *A. schmidi* n. sp., *Hoploscaphites constrictus* (Sowerby), and *H. tenuistriatus* (Kner). The stratigraphic ranges of the species are discussed and related to the belemnite zonation.

Stratigraphic notes: Maastrichtian ammonite stratigraphy is poorly known both in Europe and in other parts of the world. A standard division into two ammonite zones: *Pachydiscus neubergicus* and *Sphenodiscus* spp. as used by Arkell et al. (1957) is not well defined. In order that progress be made, exact records of ammonites in relation to other important guide fossils are needed in a sufficient number of sections, so that the ranges can be properly tested. Against this background, the scarce, poorly preserved ammonite material from Hemmoor gives important new stratigraphic information, supplementing new data on ammonites from the Maastrichtian White Chalk in Denmark (Birkelund 1979). Among other Maastrichtian sequences in Europe, the only ones that have been worked out in any detail are those of the Middle Vistula River valley in Poland, where Pożaryski (1938) recorded ranges of ammonites in relation to an eight-fold subdivision of the Maastrichtian. This fauna has recently been monographed by Błaszkiewicz (1980), who also discussed the stratigraphic distribution of important guide ammonites in relation to the belemnite zonation (see also Błaszkiewicz 1979). The ammonites of the type Maastrichtian, in Limburg, monographed by Binkhorst (1861) and Grossouvre (1908), still await a modern revision.

[Ammoniten des Maastricht von Hemmoor, Niederelbe (NW-Deutschland)]

Kurzfassung: Sechs Ammonitenspezies, von denen eine neu ist, werden aus dem Maastricht des Kreidesteinbruchs von Hemmoor, Niedersachsen, beschrieben: *Anagaudryceras lueneburgense* (Schlüter), *Saghalinites wrighti* Birkelund, *Acanthoscaphites varians* (Łopuski), *A. schmidi n. sp., Hoploscaphites constrictus* (Sowerby), und *H. tenuistriatus* (Kner). Die stratigraphischen Reichweiten der Spezies werden besprochen und auf die Zonierung der Belemniten bezogen.

Stratigraphische Bemerkungen: Die Ammonitenstratigraphie des Maastricht ist in Europa und in anderen Teilen der Welt wenig bekannt. Eine Standard-Gliederung in zwei Ammonitenzonen: *Pachydiscus neubergicus* und *Sphenodiscus* spp. wie sie von Arkell et al. (1957) angewendet wurde, ist nicht gut definiert. Um Fortschritte zu machen, werden genaue stratigraphische Angaben von Ammoniten in Beziehung zu anderen wichtigen Leitfossilien in einer ausreichenden Zahl von Profilen bemötigt, so daß die Reichweiten genau geprüft werden können. Auf diesem Hintergrund liefert das wenige, schlecht erhaltene Ammonitenmaterial von Hemmoor wichtige neue stratigraphische Informationen, die die neuen Angaben über Ammoniten aus der Weißen Kreide des Maastricht in Dänemark ergänzen (Birkelund 1979). Unter anderen Maastricht-Profilen in Europa sind diejenigen des Mittleren Weichsel-Flußtales in Polen, wo Pozaryski (1938) Ammoniten eine achtfache Unterteilung des Maastricht durchführte, die einzigen, die damit bis ins Detail gearbeitet wurden. Diese Fauna ist kürzlich von Błaszkiewitz (1980) in einer Monographie behandelt worden, der auch auf die stratigraphische Verteilung von wichtigen Leit-Ammoniten in bezug auf die Belemniten-Zonierung eingegangen ist (vergl. auch Błaszkiewitz 1979). Die von Binkhorst (1861) und Grossouvre (1908) in einer Monographie behandelten ammoniten des Maastrich-Typusgebietes der Stufe in Limburg warten noch auf eine Neubearbeitung.

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[Маастрихтские аммониты Хеммоора на низовье р. Эльбы (Северо-Западная Германия)]

Резюме Описаны шесть встречающихся в маастрихтских отложениях Хеммоорского мелового карьера (Нижняя Саксония) аммонитовых видов, один из которых является новым: *Anagaudryceras lueneburgense* (Schlüter), *Saghalinites wrighti* Birkelund, *Acanthoscaphites varians* (Łopuski), *A. schmidi* n. sp., *Hoploscaphites constrictus* (Sowerby) и *H. tenuistriatus* (Kner). Стратиграфические диапазоны видов обсуждены и сопоставлены с зональностью белемнитов.

1. Systematic description

The stratigraphic range of the species is indicated in relation to flint layers (F) and metres below or above the tuffaceous layer (T100), which marks the boundary between Lower and Upper Maastrichtian (Schmid 1981).

Reference is further given to the belemnite zonation of Schulz (1979) and some occurrences are indicated in relation to the brachiopod zonation of Surlyk (1972).

Genus *Anagaudryceras* Shimizu, 1934
Anagaudryceras lueneburgense (Schlüter, 1872)
Pl. 1, fig. 1

1872 *Ammonites Lüneburgensis* Schlüter – Schlüter; p. 62, pl. 18, figs 8–9.
1902 *Desmoceras Lüneburgense* Schlüter – Ravn; p. 252.
1979 *Gaudryceras lueneburgense* (Schlüter) – Birkelund; p. 53.
1979 *Anagaudryceras lueneburgense* (Schlüter) – Kennedy & Klinger; p. 146.

Lectotype: Herein designated, the original of Schlüter ,1972, pl. 18, figs 8–9. Kept in the museum of Göttingen University, where the only other specimen belonging to the type-series is also kept.

Locus typicus: Lüneburg

Stratum typicum: „Mucronaten-Schichten", ranging from the Upper Campanian to the lower part of the Lower Maastrichtian according to Schmid (1962).

Material: One specimen collected between F110–F120 (=T100+18.0–+32.0 m).

Description: The fully septate crushed fragment has extremely evolute inner whorls and a slightly less evolute outermost (preserved) whorl. Scattered constrictions and flares are developed on the inner whorls, while the outer half-whorl shows regular constrictions and flares.

Discussion: The specimen is referred to *Anagaudryceras lueneburgense* by comparison with more complete specimens of that species from northern Jylland (Birkelund, in prep.). These show similar inner whorls as the specimen here described and a body chamber with more densely situated, very strong flexuous constrictions and flares similar to those of the lectotype and characteristic of the genus *Anagaudryceras* (Kennedy & Klinger 1979).

Stratigraphy and distribution: The Hemmoor specimen is from the lower part of the Upper Maastrichtian *junior*-Zone. Other occurrences are Lüneburg (Schlüter 1872, Wollemann 1902) and northern Jylland (Ravn 1902, Birkelund 1979). It is

further mentioned from Rügen (SCHLÜTER 1874), Tercis, France, (GROSSOUVRE 1894:231), Scania (MOBERG 1885:24), and the Carpathians (WISNIOWSKI 1907).

SCHLÜTER indicated the species from the upper part of the sequence in Lüneburg (probably the „Mucronaten-Kreide"). In northern Jylland it occurs around the boundary between Lower and Upper Maastrichtian (brachiopod zones 7/8).

Genus *Saghalinites* WRIGHT & MATSUMOTO, 1954
Saghalinites wrighti BIRKELUND, 1965
Pl. 1, figs 2–3

1876 *Ammonites* sp. n.? – SCHLÜTER p. 161, pl. 42, figs 6–7.
1902 *Ammonites* n. sp.? SCHLÜTER. – RAVN: p. 257, pl. 3, fig. 1.
1965 *Saghalinites wrighti* n. sp. – 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.

Holotype: MGUH 9747, the original of BIRKELUND, 1965, pl. 2, figs 5a–c, text-fig. 19, by original designation.

Locus typicus: Nûgssuaq, West Greenland.

Stratum typicum: Oyster-ammonite conglomerate loc. III. Maastrichtian.

Material: One specimen from the upper part of Lower Maastrichtian. Exact level uncertain.

Description: The specimen is somewhat crushed and consists of a phragmocone, 56 mm in diameter, and part of the body chamber. At a diameter of 66 mm the umbilical ratio is 43%. The cross section of the whorls seems to be evenly rounded except for the body chamber which shows an umbilical edge. The whorls may be slightly compressed, but that could be due to crushing. Very weak, scattered, oblique constrictions are visible on the inner whorls, the last one c. 90° from the last suture. Moderately incised suture lines are discernible.

Discussion: The specimen is referred to *Saghalinites wrighti* on the basis of the umbilical ratio and the presence of constrictions on the inner whorls similar to those of that species. Further material from a similar level in northern Jylland clearly shows the octagonal cross-section of the body chamber (characteristic of the genus *Saghalinites*) as well as a constriction at the aperture of mature specimens, and suture lines in full accordance with *S. wrighti* (BIRKELUND 1979 and in prep.).

Another closely related *Saghalinites* sp. occurs at a higher level in northern Jylland and possibly in the Kunrade limestone of Limburg (*Gaudryceras* cf. *kayei* FORBES in GROSSOUVRE 1908, p. 34, pl. 10, fig. 5). It differs from the species here described in having stronger constrictions and a wider umbilicus.

Stratigraphy and distribution: In Europe the species is only known from Hemmoor and from northern Jylland, where it occurs around the boundary between Lower and Upper Maastrichtian in brachiopod zones 7/8. The exact level of the stratum typicum of *Saghalinites wrighti* in West Greenland in relation to European Maastrichtian zonation is uncertain. It occurs in West Greenland in the *Discoscaphites cheyennensis* Zone, which OBRADOVICH & COBBAN (1975) estimated to be no

younger than the lower part of Upper Maastrichtian. On the basis of dinoflagellate evidence J. M. HANSEN (pers. comm. 1978) refers the West Greenland occurrences to the *D. diebeli* Zone of the lower part of Upper Maastrichtian, in agreement with OBRADOVICH & COBBAN's estimate. This is close to the level of European occurrences. The closely related *Saghalinites* sp. from northern Jylland mentioned above occurs in brachiopod zones 9–10 and is thus considerably younger.

Genus *Acanthoscaphites* NOWAK, 1912
Acanthoscaphites varians (ŁOPUSKI, 1911)
Pl. 1, figs 4–6

1911 *Scaphites varians* mihi. – ŁOPUSKI: p. 120, 137, pl. 4, figs 1–3.
1912 *Acanthoscaphites tridens-varians* ŁOPUSKI. – NOWAK: p. 578, pl. 33, fig. 29.
1950 *Acanthoscaphites tridens* (KNER) var. *varians* (ŁOPUSKI). – MICHAILOV: p. 104, pl. 16, figs 72–73.
1965 *Acanthoscaphites tridens varians* (ŁOPUSKI). – SCHMID: p. 684, Taf. 62, Fig. 1; Taf. 63, Fig. 1–3.
1979 *Acanthoscaphites tridens varians* (ŁOPUSKI). – BIRKELUND, p. 55.
1980 *Acanthoscaphites varians* (ŁOPUSKI). – BŁASZKIEWICZ: p. 40, pl. 25, figs 1–2, 5–6.

Holotype: The original of ŁOPUSKI, 1911, pl. 4, figs 1–3, by monotypy.

Locus typicus: Kazimierz, Poland.

Stratum typicum: According to BŁASZKIEWICZ (1980) the *Hoploscaphites constrictus crassus* Zone of Upper Maastrichtian.

Material: 12 specimens. Three specimens were described by SCHMID (1965). They were not collected in situ, but were considered to be from beds between T 100 and F 91 (= T 100 to 10.4 m below). Two specimens are from below T 100 without level indicated. Six specimens are collected in situ between F 96 + 0.8 m and F 120 (= T 100 - 4.0 m and T 100 + 32.0 m).

Description: SCHMID's (1965) three specimens and the additional material show the phragmocone and the early part of the body chamber. The early part of the phragmocone is rather involute, while later parts become more evolute. The sculpture consists of nodes intercalated by one or, in rarer cases, 2 ribs. Longitudinally the nodes form 7 rows, one on the mid-venter and 3 on each side. In some specimens all seven rows of nodes are of the same strength; in other specimens the ventro-lateral nodes are strongest and some of the other rows, especially the mid-lateral row, tend to fade out. The largest specimen, figured by SCHMID (1965, pl. 62, figs 1a–b; pl. 63, fig. 1) shows unchanged sculpture with all 7 rows of nodes developed to a diameter of 110 mm at the beginning of the body chamber.

All specimens here referred to this species seem to be fragments of macroconchs.

Discussion: The holotype shows seven rows of nodes except on the youngest part (possibly the early part of the body chamber) where only two rather weak lateral rows of nodes can be seen.

The specimen figured by BŁASZKIEWICZ (1980) is probably from the same locality as the holotype and is very similar. It shows also a change in sculpture at about the beginning of the body chamber at a diameter of c. 70 mm, where the nodes begin to fade out.

It seems as if node development remains unchanged to a larger diameter in the material from Hemmoor than in specimens from the type area. New material from northern Jylland from about the same level as the Hemmoor specimens shows 7 rows of nodes to a diameter of 135 mm and thus agrees well in this respect with the material here described (BIRKELUND in prep.).

Other figured specimens are not very diagnostic. MICHAILOV's (1951) figure shows only a part of a phragmocone. The specimen figured by NOWAK (1912) is small and seems to be more or less complete. It may be considered a microconch, but has coarser ribs and heavier nodes (especially the ventro-lateral row) than the specimen described below as a microconch of *Acanthoscaphites schmidi* n. sp. (pl. 1, figs 7–9). BŁASZKIEWICZ (1980) considers NOWAK's specimen to be related to *A. trinodosus* KNER.

BŁASZKIEWICZ (1980) stresses that the specimens from the type area are younger than those from Hemmoor and this may account for the small differences in sculpture. Taking the wide range of variation of scaphites into consideration, the forms from Hemmoor (and Jylland) are referred to *Acanthoscaphites varians* as early forms of this species.

Stratigraphy and distribution: The species occurs in the uppermost Lower Maastrichtian and the lowermost Upper Maastrichtian in Hemmoor (upper part of *cimbrica* Zone, *fastigata* Zone and lower part of *junior* Zone), and is known from about the same levels in northern Jylland (BIRKELUND 1979). Polish occurences are claimed to be in the uppermost part of the Maastrichtian (*Hoploscaphites constrictus crassus* Zone, see BŁASZKIEWICZ, 1980), while Russian occurences are referred to the middle part of the Maastrichtian (MIKHAILOV 1951). The species is not known from other areas.

Acanthoscaphites schmidi n. sp.
Pl. 1, figs 7–10; pl. 2, figs 1–4.

Holotype: The microconch figured in pl. 1, figs 7–9 is designated as holotype.

Locus typicus: Hemmoor chalk quarry

Stratum typicum: F 117, lower part of Upper Maastrichtian.

Material: One complete microconch. 7 fragments of macroconchs may further belong to this species. Five specimens were collected in situ between F 99 + 1.2 m and F 120. Two specimens are without any stratigraphic information.

Diagnosis: A small *Acanthoscaphites* having two well developed lateral rows of nodes and a weak row of nodes on the middle of the venter of the phragmocone and early part of the body chamber; venter and ventro-lateral parts of body chamber very finely ribbed.

Description: The holotype is a complete microconch, 47 mm long. It is compressed, but the flattened shape may be due in part to secondary compression. The umbilicus is small, about 2 mm. The body chamber is slender. Its venter forms a cir-

cular outline in side view, and the umbilical wall forms a similar curve, being not much extended beyond the phragmocone. The ribs on the exposed part of the phragmocone form a weak lateral curvature and they bifurcate once or twice across the sides. The ventral ribs are straight. The ratio of primary ribs and ventral ribs is 1:2–3. On the early part of the body chamber the primaries become coarser and more straight, and a great number of fine secondaries are intercalated close to the venter. Rows of ventro-lateral nodes, umbilical nodes and ventral nodes are developed on the exposed part of the phragmocone and on parts of the body chamber. The ventro-lateral and umbilical rows are much stronger than the ventral row. Furthermore, very weak indication of nodes on the middle of the lateral sides can be discerned on the phragmocone.

In addition, a number of fragmentary macroconchs may be referred to this species. They attain a much larger size, up to a length of c. 100 mm, have stout body chambers reaching maximum height at the middle, a straight umbilical wall, and a sculpture very similar to that of the microconch described above. The development of nodes is also similar. Thus, the large fragment of a body chamber shown in pl. 2, fig. 4 shows weak ventral nodes on the early part of the body chamber besides umbilical and ventro-lateral ones. The specimen shown in pl. 2, fig. 2 shows the continuation of the umbilical nodes on the phragmocone, but the ventro-lateral nodes are missing or not preserved.

Discussion: The species is referred to the genus *Acanthoscaphites* mainly on the basis of the presence of ventral nodes in some specimens, although this character may show some variation – as in *Acanthoscaphites pungens* (Binkhorst, 1861) in which the ventral row of nodes is not always present.

Comparison with a rich collection of *Acanthoscaphites varians* from northern Jylland besides material from Hemmoor, shows that *A. schmidi* n. sp. differs from that species in having a much smaller size of both microconch and ? macroconch and having fewer rows of nodes, the ventro-lateral nodes and the umbilical nodes being much more strongly developed than the other rows. It differs further in having much finer secondaries on the ventral part of the body chamber. The species is related to *Acanthoscaphites pungens* which may be regarded as a microconch, and which mainly differs from the microconch here described in having a more square cross-section and heavier nodes. Fragments of the youngest part of the body chamber, figured in pl. 1, fig. 10 and pl. 2, figs 1, 3 show a certain resemblance to *Hoploscaphites roemeri* sensu Schlüter (1871–72), but they are considered to belong to the species here described on the basis of comparison with more complete fragments showing a similar fine sculpture on the younger part of the body chamber.

Stratigraphy and distribution: The species occurs in the Upper Maastrichtian in Hemmoor (lower part of *junior* Zone). It is not yet known from other localities. Thus, like the closely allied species *A. pungens* from the Kunrade limestone of Limburg it is not known from Denmark. The two species may represent a southern faunal element.

Genus *Hoploscaphites* NOWAK, 1911
Hoploscaphites constrictus (SOWERBY, 1818)
Pl. 3, figs 1–14

List of selected synonymes, including subspecies, macroconchs and microconchs.

1818 *Ammonites constrictus* SOWERBY. – p. 189, pl. 184 A, fig. 1.
1840 *Scaphites constrictus* D'ORBIGNY. – d'Orbigny: p. 522, pl. 129, figs 8–11.
1850 *Scaphites constrictus* D'ORBIGNY. – ALTH: p. 207, pl. 10, figs 29–30.
1858 *Scaphites multinodosus* n. sp. – v. HAUER: p. 9, pl. 1, figs 7–8.
1861 *Scaphites constrictus* D'ORBIGNY. – BINKHORST: p. 38, pl. 5d, fig. 6a–h.
1869 *Scaphites constrictus* SOWERBY. – FAVRE: p. 18, pl. 5, figs 1?, 2–4.
1872 *Scaphites constrictus* SOWERBY. – SCHLÜTER: p. 92, pl. 28, fig. 5–9.
1891 *Scaphites constrictus* SOWERBY. – BÖHM: p. 48, pl. 1, figs 10a.
1894 *Scaphites constrictus* SOWERBY. – GROSSOUVRE: p. 248, pl. 31, figs 1, 2, 7, 8.
1902 *Scaphites constrictus* SOWERBY. – RAVN: p. 254, pl. 3, fig. 9.
1908 *Scaphites constrictus* SOWERBY. – GROSSOUVRE: p. 36, pl. 11, figs 3–7.
1911 *Scaphites constrictus* SOWERBY. – ŁOPUSKI: p. 113, 133; pl. 2, figs 3–4.
1911 *Scaphites constrictus* SOWERBY var. *crassus* mihi. – ŁOPUSKI: p. 115, 134; pl. 2, figs 5–6; pl. 3, figs 1–2.
1911 *Hoploscaphites constrictus* SOWERBY. – NOWAK: p. 581, text-figs 15–16.
1911 *Hoploscaphites constrictus* SOWERBY *vulgaris* NOWAK: p. 583, pl. 32, fig. 6?; pl. 33, figs 8–12.
1911 *Hoploscaphites constrictus-tenuistriatus* KNER. – NOWAK: p. 585, pl. 33, fig. 14 (non fig. 13).
1932 *Hoploscaphites constrictus* SOWERBY. – WOLANSKY: p. 10, pl. 1, figs 10, 12.
1951 *Discoscaphites constrictus* (SOWERBY). – MIKHAILOV: p. 90, pl. 17, figs 77–80.
1951 *Discoscaphites constrictus* (SOWERBY) var. *niedzwiedskii* (UHLIG). – MIKHAILOV: p. 93, pl. 15, fig. 65; pl. 17, figs 81–82; pl. 18, fig. 85.
1974 *Hoploscaphites constrictus constrictus* (SOWERBY). – NAJDIN: p. 173, pl. 58, figs 7–9; pl. 61, figs 2–4.
1980 *Hoploscaphites constrictus anterior* BŁASZKIEWICZ: p. 36, pl. 17, fig. 5; pl. 18, figs 4–10.
1980 *Hoploscaphites constrictus crassus* (ŁOPUSKI). – BŁASZKIEWICZ: p. 37, pl. 18, figs 1–3, 11–14.

Holotype: The specimen figured by Sowerby, 1818, pl. 184 A, fig. 1. Kept in British Museum (BM C 36733).

Locus typicus: St. Colombe, Cotentin.

Stratum typicum: Upper Maastrichtian.

Material: About 260 specimens, mostly poorly preserved, and a number of barely determinable fragments. About 25 were collected *in situ* in the Lower Maastrichtian and 5 in the Upper Maastrichtian between F 82 and F 126 + 0.3 m (=T 100 - 24.1 m and T 100 + 40.7 m). About 33 specimens were collected about F 70 to F 80 (=T 100 - 29.9 m to T 100 - 43.8 m) and 8 about F 75 to F 85 (=T 100 - 19.6 to T 100 - 34.9 m). About 168 specimens were collected below T 100 and about 23 specimens above T 100 without exact level indicated. About 10 specimens lack stratigraphic information.

Description: Although the material of this species is large, it is so poorly preserved that a proper description cannot be made.

Macroconchs. The lengths of complete macroconchs vary from 32 to 52 mm (20 specimens). All the specimens seem to be compressed, but the degree of compression is uncertain because all the material is badly crushed. To a large extent the body chamber is in contact with the phragmocone. In side view the venter of the body chamber has a subcircular outline, while the dorsum is nearly straight. The apertural angle is 115°–130°. Primaries on the younger part of the phragmocone are slightly flexuous, showing a weak bend laterally. Close to the venter the primaries bifurcate, or secondaries are intercalated. The ratio between primaries and secondaries is 1:2–3. On the straight part of the body chamber the primaries become weaker and more scattered, while ribbing on the venter and on the apertural part of the body chamber becomes finer than on the phragmocone. Number of ribs per cm on the venter close to the aperture of Lower Maastrichtian specimens seems to be about 10–15, but this can only be seen in very few specimens.

Microconchs. Only one poorly preserved microconch has been found (shown in pl. 2, fig. 5). The length is c. 21 mm. The body chamber is slender and finely ribbed. It is so poorly preserved that the attribution of the specimen to *H. constrictus* or to *H. tenuistriatus* is uncertain.

Discussion: Although *Hoploscaphites constrictus* is widely distributed in the Maastrichtian of Europe, a thorough description of its stratigraphic and geographical variation has never been carried out, partly because stratigraphically well defined material is rare and partly because preservation usually is so poor.

The species – or species group – shows a wide range of variation and certain varieties have therefore been separated at subspecies or species level:

Scaphites tenuistriatus Kner, 1848
Scaphites niedzwiedzkii Uhlig, 1894
Hoploscaphites constrictus vulgaris Nowak, 1911
Scaphites constrictus var. *crassus* Łopuski, 1911
Hoploscaphites constrictus anterior Błaszkiewicz (1980)
(non *Scaphites constrictus* var. *quiriquinensis* Wilckens, 1904)

Among these, *H. tenuistriatus* seems to have a distinct range around the boundary between Lower and Upper Maastrichtian and is here, for the time being treated as a separate species (see p. 21). *H. niedzwiedzkii* is characterized by its small size, a slender body chamber, and a relatively wide umbilicus of similar size as in juveniles of *H. constrictus* of larger size. In accordance with Makowski (1962) it is here regarded as a microconch. *H. constrictus vulgaris* of Nowak (1911) includes all varieties except forms referred to „*H. constrictus-tenuistriatus*" by him.

H. constrictus crassus is characterized by having a less compressed shape than typical forms, by having nodes on larger parts of the phragmocone and body chamber and, according to Błaszkiewicz (1980) by disappearance or weakening of ribs on the body chamber. This subspecies occurs in the upper part of the Upper Maastrichtian and may show a gradual transition to specimens from that level, e. g. close to the type-series of *H. constrictus* from Cotentin. *H. constrictus anterior* occurs in the Lower Maastrichtian of Poland and Russia and is characterized by a relatively small apertural angle (95°), body chamber extending further from the phragmocone than usual, and coarse ribbing.

Among these varieties the Hemmoor material includes *H. tenuistriatus* (here treated as a separate species), but neither the so-called *H. constrictus anterior* nor *H. constrictus crassus*. This may be explained by different stratigraphic ranges of these subspecies, the Hemmoor material being from higher levels of Lower Maastrichtian than that of *H. constrictus anterior*, and from lower levels of Upper Maastrichtian than that of *H. constrictus crassus*.

Although the *H. constrictus* material here described is poorly preserved and most of it was not collected in situ, it gives an idea of the variation of the species in the Upper Lower Maastrichtian. Material from the Upper Maastrichtian, on the other hand, is much more scarce, and it gives very little new information. Most characteristic of the Lower Maastrichtian material is the apertural angle of 115–140°, the fine ribbing on the body chamber, and the restriction of nodes to the early part of the body chamber.

Stratigraphy and distribution: *Hoploscaphites constrictus* has been described from a great number of localities in Europe and USSR. It is the classical guide fossil for the Maastrichtian Stage, but is so rare in the Lower Maastrichtian that it was believed by BIRKELUND (1966) to be missing in the lowermost part of the stage as defined by the appearance of *Belemnella lanceolata*. The rare occurrence of the species in the lowermost Maastrichtian of Kronsmoor has since been demonstrated by SCHULZ (1978). BŁASZKIEWICZ (1980) also mentions that the lower boundary of *Belemnella lanceolata* is situated conspicuously below the corresponding boundary of *Hoploscaphites constrictus* in Polish outcrops.

Genus *Hoploscaphites* NOWAK, 1911
Hoploscaphites tenuistriatus (KNER, 1848)
Pl. 2, figs 8–10

1848 *Scaphites tenuistriatus* m. – KNER: p. 10, pl. 1, fig. 5.
1869 *Scaphites tenuistriatus* KNER. – FAVRE: p. 21, pl. 5, figs 6–7.
1909 *Hoploscaphites constrictus-tenuistriatus* KNER. – NOWAK: p. 775, pl. 1, figs 2, 4, 6.
1911 *Hoploscaphites constrictus-tenuistriatus* KNER. – NOWAK: p. 585, pl. 33, fig. 13 (non fig. 14).
1932 *Hoploscaphites constrictus* var. *tenuistriata* (KNER). – WOLANSKY: p. 10, pl. 1, fig. 6.
1974 *Hoploscaphites constrictus tenuistriatus* (KNER). – NAJDIN: p. 173, pl. 58, fig. 12; pl. 60, fig. 5, ?6.
1979 *Hoploscaphites tenuistriatus* (KNER); BIRKELUND: p. 55.

Type: The only specimen figured by KNER (1948, pl. 1, fig. 5) belongs to a type-series from the surroundings of Lemberg (now Lvov). If it is still preserved it should be designated as lectotype.

Locus typicus: Kieselka at Lvov.

Stratum typicum: Uncertain.

Material: 9 specimens. Three specimens collected in situ at F 95 + 1.0 m and F 101a + 1.1 m respectively (= T 100 - 5.0 m and T 100 + 5.0 m). One specimen was collected about F 70 - F 80 (=T 100 - 29.9 m and T 100 - 43.8 m) and one about F 75 - F 85 (=T 100 - 13.6 m and T 100 - 34.9 m). Two specimens were collected below T 100 and one above T 100, the exact levels not indicated, and one specimen lacks stratigraphic information.

Description: All specimens referred to this species show the body chamber or parts of it and one shows in addition the phragmocone. All are badly crushed. They show no difference from *Hoploscaphites constrictus* in size, shape, and ribbing of the phragmocone. The sculpture of the body chamber, on the other hand, differs by an extremely fine, even ribbing pattern with secondaries intercalated in such a way that the venter and sides show no or nearly no difference in ribbing pattern. Number of ribs on the venter close to the aperture is 20–24 per cm. Furthermore, the specimens here referred to *H. tenuistriatus* have no nodes developed.

Discussion: The specimens show very good accordance with KNER's original description and figure. In addition to forms without nodes, NOWAK (1911; 585) also referred forms having nodes to the variety *H. constrictus-tenuistriatus* (pl. 33, fig. 14). It seems as if forms lacking nodes are more finely ribbed than forms having nodes, and I am therefore inclined to define *H. tenuistriatus* in accordance with the original definition for the time being. However, a thorough analysis of suitable material from the *H. tenuistriatus* level of the *H. constrictus* group has not been carried out so far because of insufficient material, and its relations to the main-stock of *H. constrictus* are still uncertain.

H. tenuistriatus shows a certain similarity to the *Hoploscaphites roemeri* group from the Upper Campanian, but differs in shape of the body chamber, in finer ribbing of the body chamber and in having a different ribbing pattern on the phragmocone, consisting of coarser and more flexuous ribs. (*H. roemeri* sensu SCHLÜTER 1872, see discussion by SCHMID & ERNST 1975).

Stratigraphy and distribution: The species occurs in the upper Lower Maastrichtian and lowermost Upper Maastrichtian in Hemmoor. In northern Jylland it is known from a number of localities spanning the Lower-Upper Maastrichtian boundary, but the exact levels are not known. The stratigraphy of other occurrences is uncertain. In addition to Hemmoor and Jylland and the type area around Lvov, the species has been described from Rügen (WOLANSKY 1931) and southern Russia (MICHAILOV 1951, NAJDIN 1974).

2. Summary of stratigraphic results

It is seen in figure 1 that all the species described here occur both in the upper Lower Maastrichtian and in the lower Upper Maastrichtian except for *Acanthoscaphites schmidi* n. sp. and *Anagaudryceras lueneburgensis* and *Saghalinites wrighti*. The two last, however, seem to span the Lower-Upper Maastrichtian boundary elsewhere.

The range of *Acanthoscaphites varians* is well established on the basis of the Hemmoor material to the upper part of the *cimbrica* Zone, the *fastigata* Zone and the lower part of the *junior* Zone. This range seems to be similar to the range of the species in northern Jylland. However, BŁASZKIEWICZ (1980) claims that this species belongs to the uppermost Maastrichtian in Poland. The new species, *A. schmidi*, has a restricted range in the lower part of the *junior* Zone and disappears at the same level as *A. varians*.

Most of the material of *Hoploscaphites constrictus* has unfortunately not been collected *in situ*. *In situ* material is lacking from the lowermost 10 m of the Lower Maastrichtian exposed and from the uppermost 40 m of the Upper Maastrichtian of the quarry, but this species is known throughout the Maastrichtian in other areas,

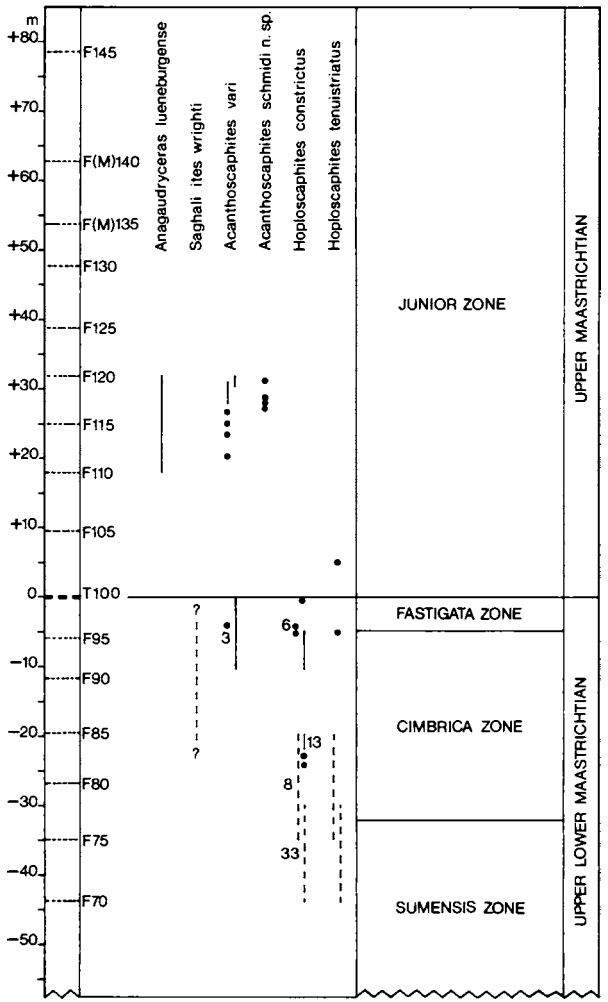

Fig. 1: Stratigraphic distribution of ammonites collected in situ (points) or within a well defined part of the sequence (full line). Uncertain distributions are stippled.
Number of specimens are indicated, where more than one specimen is known from the same level. In the schematized section the tuffaceous layer T 100 and selected flint layers (F) and flint/marl layers (FM) are indicated after SCHMID (1981). Belemnite zonation after SCHULZ (1979).

although extremely rarely in the lowermost part. A large part of the loose material is known to be from the Lower Maastrichtian and in that way it gives a good impression of the variation of the species in the upper part of the *sumensis* Zone, the *cimbrica* Zone and the *fastigata* Zone. Material from the Upper Maastrichtian is much more scarce and cannot be shown to differ significantly from the Lower Maastrichtian material. Morphological varieties known from the uppermost Maastrichtian of other areas (e.g. *H. constrictus crassus*) have not been found.

Hoploscaphites tenuistriatus seems to occur from the upper part of the *sumensis* Zone to the lowermost part of the *junior* Zone. Its occurrences in the upper part of Lower Maastrichtian is well verified in the cliffs of Rügen and its occurrence around the Lower-Upper Maastrichtian boundary can also be demonstrated in northern Jylland.

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Plates 1–3

Plate 1

Fig. 1: *Anagaudryceras lueneburgense* (SCHLÜTER). Lateral view. Between F 110 and F 120 (18.0—32.0 m above T 100). Coll. NLfB Hannover: kma 176.

Figs. 2—3: *Saghalinites wrighti* BIRKELUND. Lateral and ventral views. Upper part of Lower Maastrichtian. Coll. NLfB Hannover: kma 177.

Figs. 4—6: *Acanthoscaphites varians* (ŁOPUSKI). Lateral views.

Fig. 4: F 111 + 1.1 m (20.1 m above T 100). Coll. NLfB Hannover: kma 178.

Fig. 5: F 113 + 1.0 m (23.3 m above T 100). Coll. NLfB Hannover: kma 179.

Fig. 6: Between F 117 and F 119 (28.4 m to 31.0 m above T 100). Coll. NLfB Hannover: kma 180.

Figs. 7—9: *Acanthoscaphites schmidi* n. sp. Lateral and ventral views of holotype. F 117 (28.4 m above T 100). Coll. NLfB Hannover: kma 181.

Fig. 10: ? *Acanthoscaphites schmidi* n. sp.
Ventral view of fragment of body chamber. Horizon unknown. Coll. NLfB Hannover: kma 182.

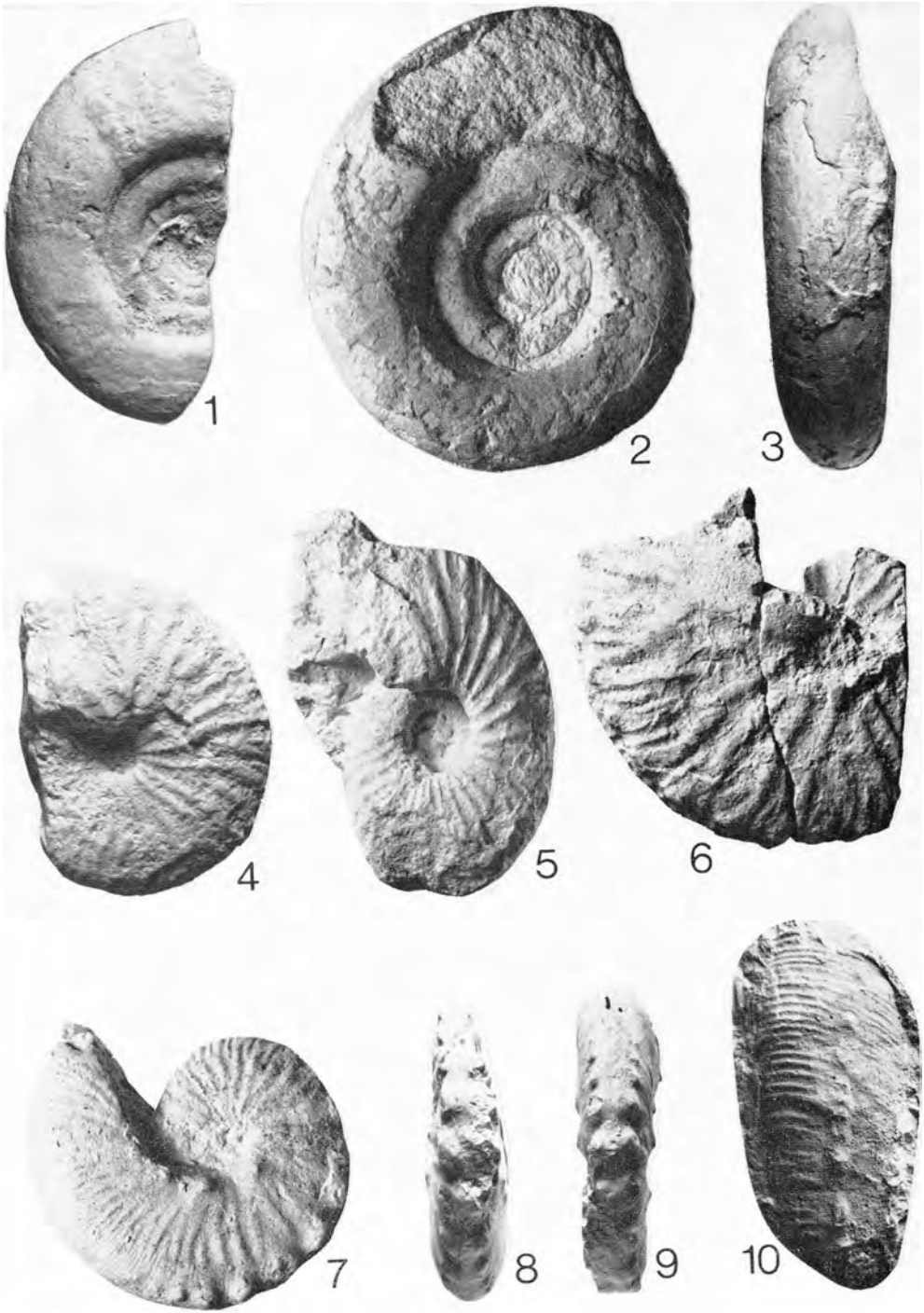
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Plate 2

Figs. 1—4: ? *Acanthoscaphites schmidi* n. sp. Lateral views.

Fig. 1: Fragment of body chamber. Immediately below F 119—120 (c. 31 m above T 100). Coll. NLfB Hannover: kma 183.

Fig. 2: Specimen with part of body chamber preserved. F 111 + 2.1 m (21 m above T 100). Coll. NLfB Hannover: kma 184.

Fig. 3: Fragment of body chamber. Horizon unknown. Coll. NLfB Hannover: kma 185.

Fig. 4: Nearly complete body chamber. F 117 + 0.3 m (28.7 m above T 100). Coll. NLfB Hannover: kma 186.

Fig. 5: Lateral view of microconch of *Hoploscaphites constrictus* (SOWERBY) or *H. tenuistriatus* (KNER) (*H. niedzwiedzkii* (UHLIG)). Above T 100, exact horizon unknown. Coll. NLfB Hannover: kma 187.

Figs. 6—7: Aptychi of *Hoploscaphites* sp.

Fig. 6: 20—22 m below T 100. Coll. NLfB Hannover: kma 188.

Fig. 7: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 189.

Figs. 8—10: *Hoploscaphites tenuistriatus* (KNER). Lateral views.

Fig. 8: Part of body chamber. About F 75—F 85 (19.6—34.9 m below T 100). Coll. NLfB Hannover: kma 190.

Fig. 9: Part of body chamber. F 101 a + 1.1 m (5.0 m above T 100). Coll. NLfB Hannover: kma 191.

Fig. 10: Heavily deformed specimen with body chamber. F 101 a + 1.1 m (5.0 m above T 100). Coll. NLfB Hannover: kma 192.

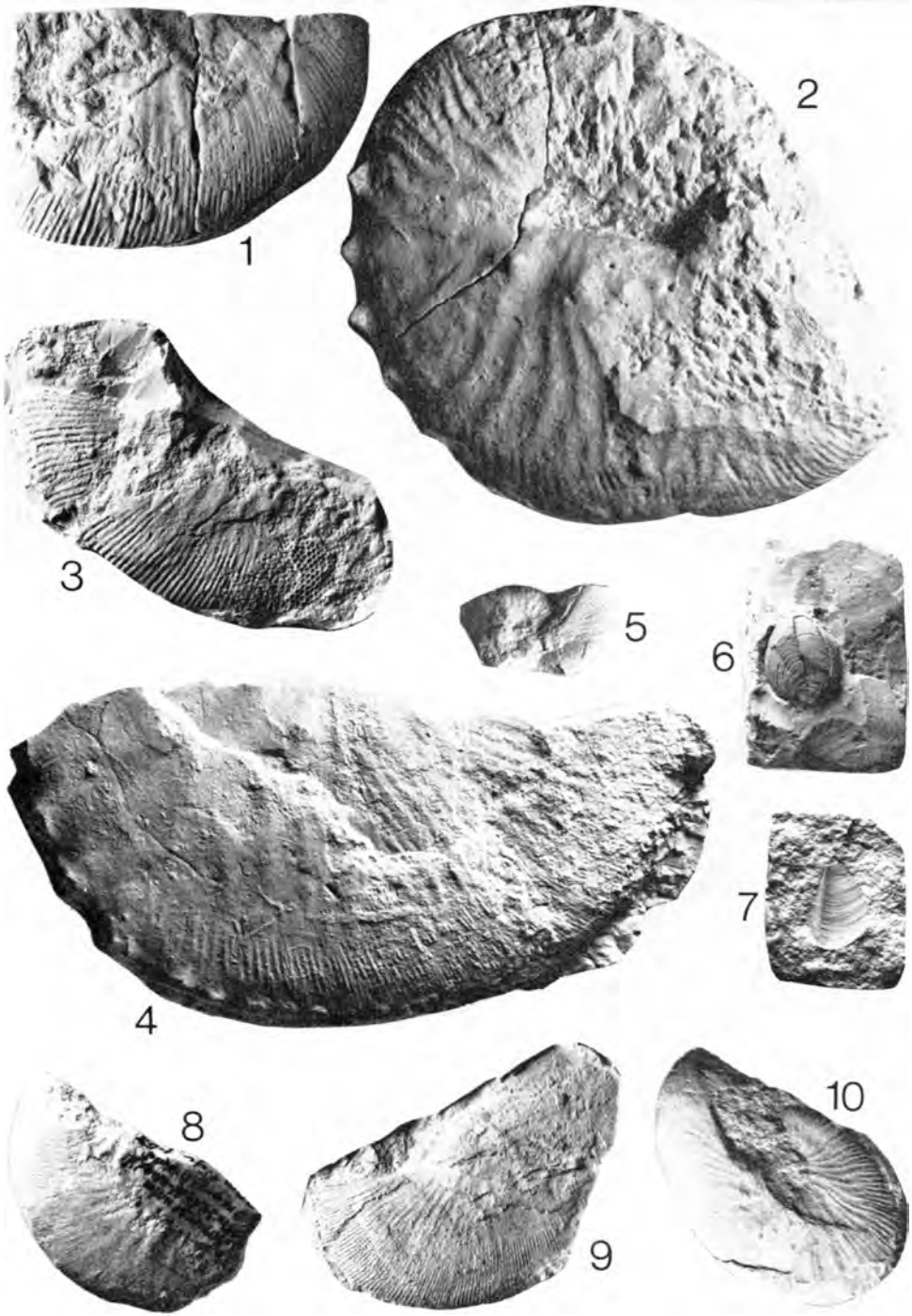
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Plate 3

Figs. 1—14: *Hoploscaphites constrictus* (SOWERBY). Lateral views of more or less complete specimens and a phragmocone (Fig. 8).

Fig. 1: F 82 (24.1 m below T 100). Coll. NLfB Hannover: kma 193.

Fig. 2: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 194.

Fig. 3: C. F 70—F 80 (29.9 m—43.8 m below T 100). Coll. NLfB Hannover: kma 195.

Fig. 4: 4 m below T 100. Coll. NLfB Hannover: kma 196.

Fig. 5: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 197.

Fig. 6: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 198.

Fig. 7: C. F 75—F 85 (19.6 m—34.9 m below T 100). Coll. NLfB Hannover: kma 199.

Fig. 8: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 200.

Fig. 9: Below T 100, exact horizon unknown. Coll. NLfB Hannover, kma 201.

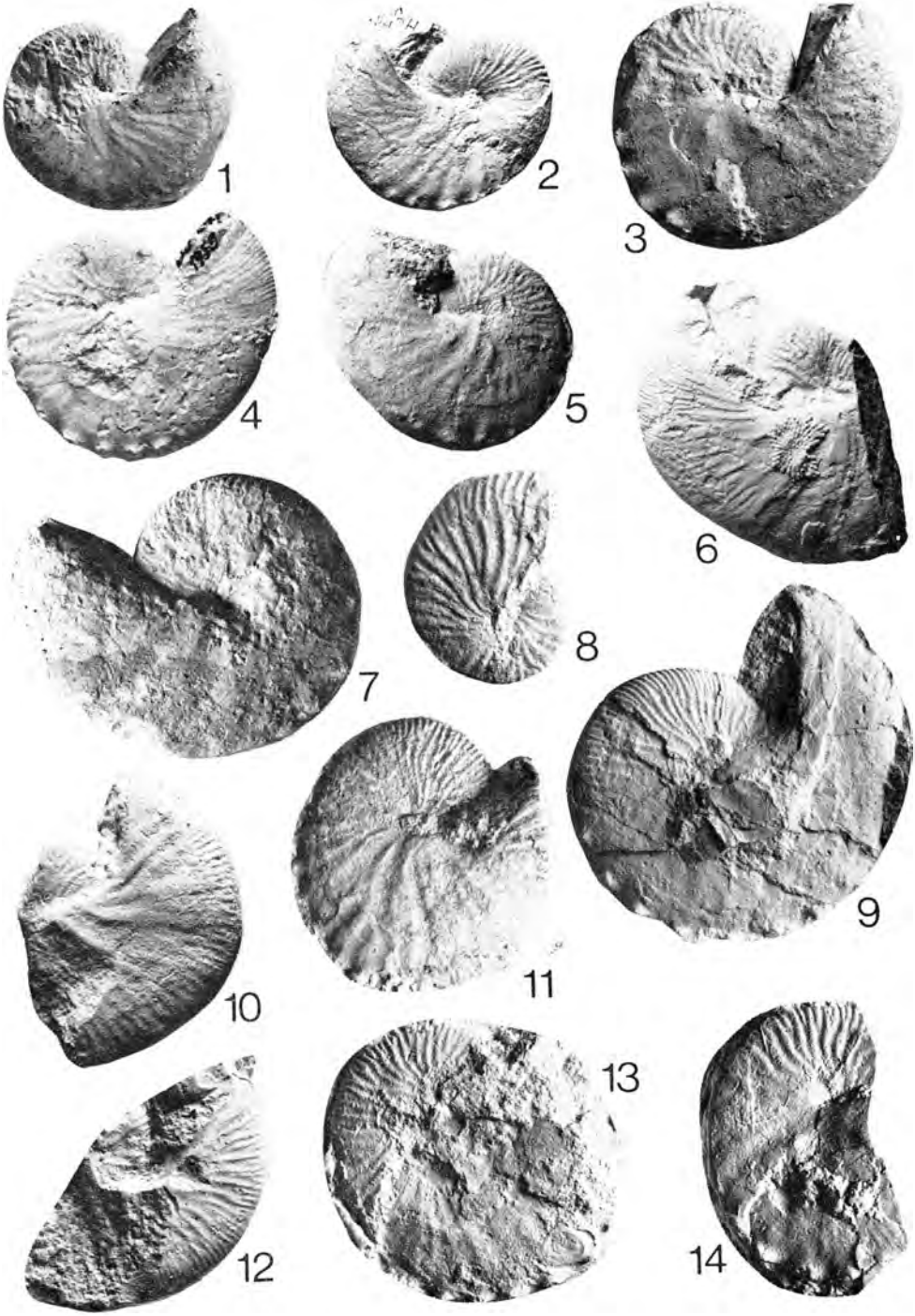
Fig. 10: F 82 + 1.5 m (22.6 m below T 100). Coll. NLfB Hannover: kma 202.

Fig. 11: Below T 100, exact horizon unknown. Coll. NLfB Hannover: kma 203.

Fig. 12: Above T 100, exact horizon unknown. Coll. NLfB Hannover: kma 204.

Fig. 13: Above T 100, exact horizon unknown. Coll. NLfB Hannover: kma 205.

Fig. 14: F 101 a + 1.1 m (5.0 m above T 100). Coll. NLfB Hannover: kma 206.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