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## Hauterivian (Lower Cretaceous) ammonites from Helgoland

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Ammonitida (Perisphinctida, Lytoceratida), Hauterivian, stratigraphic limit, new description  
NW-German Lowlands (Helgoland)

**Abstract:** Over 350 Hauterivian ammonites have recently been collected by skin-divers from the sea floor off Helgoland. They belong to the genera *Aegocrioceras*, *Crioceratites* and *Simbirskites*; the last genus is the most abundant and 16 taxa are described or discussed. One species, *Simbirskites (Milanowskia) helgolandensis*, is new, and neotypes are proposed for *Simbirskites (Milanowskia) rugosus* KOENEN and *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). The *Aegocrioceras* and *Crioceratites* faunas are reviewed briefly. By comparison with the north German and English sequences it is clear that although the bulk of the Lower Hauterivian *Endemoceras*-Schichten fauna is absent on Helgoland, the rest of the Hauterivian succession is practically complete.

### [Ammoniten des Hauterive (tiefe Unter-Kreide) von Helgoland]

**Kurzfassung:** Mehr als 350 Ammoniten des Hauterive sind unlängst von Tauchern auf dem Meeresboden rund um Helgoland aufgesammelt worden. Sie gehören den Genera *Aegocrioceras*, *Crioceratites* und *Simbirskites* an. Die Exemplare der Gattung *Simbirskites* sind am zahlreichsten vertreten. 16 Arten werden beschrieben oder diskutiert. Eine Art, *Simbirskites (Milanowskia) helgolandensis*, ist neu, und Neotypen werden für *Simbirskites (Milanowskia) rugosus* KOENEN und *Simbirskites (Craspedodiscus) phillipsi* (ROEMER) vorgeschlagen. Die *Aegocrioceras*- und *Crioceratites*-Faunen wurden überprüft. Bei einem Vergleich mit norddeutschen und englischen Abfolgen zeigt sich, daß trotz Fehlens des Großteils der Fauna der dem tieferen Hauterive angehörenden *Endemoceras*-Schichten auf Helgoland der Rest der Schichtenfolge des Hauterive nahezu vollständig vorhanden ist.

### [Les ammonites hauteriviennes (Crétacé inférieur) de Helgoland]

**Résumé:** Des plongeurs ont ramassé il y a peu de temps plus de 350 ammonites hauteriviennes sur le fond de la mer autour de Helgoland. Elles font partie des Genera *Aegocrioceras*, *Crioceratites* et *Simbirskites*. Les spécimens du genre *Simbirskites* sont les plus nombreux. On décrit ou discute sur 16 variétés. Une espèce, de *Simbirskites (Milanowskia) helgolandensis*, est nouvelle et on propose des néotypes pour *Simbirskites (Milanowskia) rugosus* KOENEN et *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). On a examiné les faunes *Aegocrioceras* et *Crioceratites*. Une comparaison avec des successions de l'Allemagne du Nord et de l'Angleterre montre que malgré l'absence de la majorité à Helgoland de la faune des couches d'*Endemoceras* appartenant à l'Hauterivien inférieur, le reste de la succession lithologique de l'Hauterivien est quasi complet.

### [Аммониты готеривского яруса (нижний мел) о. Гельгоганда]

**Резюме:** Более 350 готеривских аммонитов были недавно собраны водолазами на дне моря около о. Гельгоганда. Они относятся к родам *Aegocrioceras*, *Crioceratites* и *Simbirskites*. Наиболее многочисленно представлены экземпляры рода *Simbirskites*. 16 видов описываются и обсуждаются. Один вид, *Simbirskites (Milanowskia) helgolandensis* является новым, и неотипы предлагаются для *Simbirskites (Milanowskia) rugosus* KOENEN и *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). Фауны *Aegocrioceras* и *Crioceratites* были проверены. Сопоставление с северогерманскими и английскими последовательностями показывает, что несмотря на отсутствие на Гельголанде фауны нижнеготеривских слоев *Endemoceras* остальная толща слоев готерива является почти совершенной.

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## 1. Introduction

Helgoland is one of the best-known Lower Cretaceous localities in northwest Europe, and the type-locality for a number of ammonite species. There are no on-shore deposits, but ammonites derived from submarine outcrops and washed up on the northern shore of Düne were described by ROEMER (1841) and KOENEN (1904); a few additional specimens have been figured by HILTERMANN & KEMPER (1969). Recently, microfaunal samples have been collected from the sea floor (BARTENSTEIN & KAEVER 1973; BETTENSTAEDT 1973) and local skin-divers have obtained several hundred macrofossils (see KEMPER, RAWSON, SCHMID & SPAETH 1974), including many ammonites. The ammonites are almost all of Hauterivian and Barremian age, the dominant forms being crioceratitids and *Simbirskites*.

The purpose of this paper is to review the Hauterivian ammonite fauna, especially those species which were previously inadequately known or which are new to Helgoland. No attempt is made to redescribe species recorded by previous workers but not represented in the new collections. The fauna consists of over 350 ammonites belonging to the genera *Simbirskites*, *Aegocrioceras* and *Crioceratites*; 2 phylloceratid ammonites in the STÜHMER collection could be of Barremian age and are not described here. I have concentrated on the group of *Simbirskites* species as they are the most numerous and varied forms. The *Aegocrioceras* are invariably fragmentary and waterworn, and all the species recorded from Helgoland have recently been reviewed in a description of the more complete, better preserved Speeton Clay *Aegocrioceras* fauna (RAWSON 1970, 1975 in press). *Crioceratites* is sparsely represented by about 20 whorl fragments.

My visit to Helgoland in May 1973 was under the auspices of the European Exchange Programme between the Royal Society and the Deutsche Forschungsgemeinschaft, and was initiated through the kind invitation of Professor Dr. G. LÜTTIG, Bundesanstalt für Bodenforschung, Hannover. I am especially grateful to the Helgoland collectors, Dr. P. KRUMBELN, Herr P. KÜSTERMANN, Herr W. RAUCHFUSS and Herr H. STÜHMER, for generously making their collections available for study, Herr H. PRIGGE for his continuous help, and Dr. E. KEMPER, Professor Dr. FR. SCHMID and Dr. CHR. SPAETH for the assistance and companionship which made my visit so memorable. A number of the specimens described here were cast by the Niedersächsisches Landesamt für Bodenforschung (NLFB) and others by Mr. A. MCLACHLAN of Queen Mary College. The photographs were taken by Mr. B. J. SAMUELS of Queen Mary College. \*)

## 2. Systematic palaeontology

Superfamily: Perisphinctaceae STEINMANN 1890

Family: Olcostephanidae HAUG 1910

Subfamily: Simbirskitinae SPATH 1924

Genus: *Simbirskites* A. P. PAVLOW 1892

Type species: *Ammonites decheni* ROEMER 1841

\*) The collections are all on the island of Helgoland; the owner of the KÜSTERMANN collection is Mr. D. HOBBE, Helgoland, Unterland.

Discussion: The definition and scope of *Simbirskites* and its constituent subgenera has been discussed by BÄHR (1964 \*) and RAWSON (1971 a), who reviewed the north German and English faunas respectively. The genus embraces coronate to oxycone forms, with every morphological variation between these extremes. The division into subgenera reflects this morphological variation but must be regarded as provisional because there is only limited phylogenetic control. Furthermore, there is an insensible gradation in morphology from one subgenus to another even though the type species are clearly distinct. For these reasons it is impossible to agree with GLASUNOVA (1973) who regards the subgenera *Simbirskites* s. s., *Speetonicer* and *Craspedodiscus* as distinct genera, following SPATH (1924).

*Simbirskites* faunas have been described from widely scattered regions of the Boreal Realm, but some of the constituent species are ill-defined and poorly known, and nowhere is the faunal succession anywhere near complete. Hence the piecing together of "natural" lineages cannot be attempted yet; it is only after this has been done that a more satisfactory division into subgenera will become possible. In this paper, 4 subgenera, *Simbirskites* s. s., *Milanowskia*, *Speetonicer* and *Craspedodiscus*, are recognised; all are represented in the Helgoland fauna.

Helgoland is the locus typicus of several species, namely:

- S. (S.) coronula* KOENEN                    [? = *S. (S.) picteti* (WEERTH)]  
*S. (S.) crassisculptus* KOENEN  
*S. (C?) beyrichi* KOENEN  
*S. (C.) carinatus* KOENEN                    [? = *S. (C.) phillipsi* (ROEMER)]  
*S. (C.) gottschei* (KOENEN)  
*S. (M.) paucilobus* KOENEN  
*S. (M.) rugosus* KOENEN  
*S. (M.) triplicatus* KOENEN

and is jointly, with Bredenbeck and Speeton, a type locality for *S. (C.) phillipsi* (ROEMER). All these species were founded on a very limited number of specimens, often fragmentary and waterworn, and the exhaustive description of 22 discrete taxa by KOENEN (1904) was based on little more than 50 specimens. In contrast, the new material numbers well over 250 specimens, though many are septate nuclei less than 15 mm in diameter and not specifically determinable. More than 180 specimens are described or discussed here, distributed among the following 16 taxa:

<i>S. (S.) cf. decheni</i> (ROEMER)	1	G
<i>S. (S.) spp. (decheni group)</i>	30 (approx.)	G, E
<i>S. (S.) picteti</i> (WEERTH **) & <i>S. (S.) cf. picteti</i>	4	G
<i>S. (Sp.) inversum</i> (M. PAVLOW)	15	G, E, S.U.

\*) The validity of this as a publication requires ratification by the I.C.Z.N. In my previous study of *Simbirskites* (RAWSON 1971a) I regarded it as an unpublished dissertation.

\*\*) record new to Helgoland

<i>S. (M.) rugosus</i> KOENEN	5	
<i>S. (M.) concinnus</i> (PHILLIPS)	2	G, E
<i>S. (M.) helgolandensis</i> sp. nov.*)	3	
<i>S. (M.) ihmensis</i> BAHR	3	G
<i>S. (M.) stali</i> WEDEKIND*)	1	G, E
<i>S. (M.)</i> sp.	3	
<i>S. (C.) gottschei</i> (KOENEN)	45 (approx.)	G, E
<i>S. (C.) phillipsi</i> (ROEMER)	60 (approx.)	G
<i>S. (C.)</i> spp. (3 species)	9	

The right-hand column indicates other regions from which the taxon is definitely known: G = north Germany, E = England, S.U. = Soviet Union. Only one of these species is definitely known from the Soviet Union; two others are similar to Soviet forms but differ in one feature — namely, the length of the primary ribs and the position of the mid-lateral tubercle. *S. (S.)* cf. *decheni* (ROEMER) and *S. (S.) picteti* (WEERTH) have relatively short primary ribs and the mid-lateral tubercle lies some distance away from the umbilical seam of the next whorl, so that the inner portion of each secondary rib is visible in the umbilicus. In their Soviet counterparts [*S. (S.) decheni* PAVLOW non ROEMER and *S. (S.) umbonatus* (LAHUSEN) respectively] the primary ribs are longer so that the mid-lateral tubercle remains in contact with the umbilical seam of the next whorl. The difference has not been appreciated by Soviet authors who (following A. P. PAVLOW 1901) interpret *S. (S.) decheni* after a Russian "type" and include *S. (S.) picteti* (WEERTH) in synonymy with *S. (S.) umbonatus* (LAHUSEN).

In the descriptions below, dimensions of figured specimens are given in the following order: diameter; whorl height (oblique), whorl thickness (at tubercles), width of umbilicus. Some of the figured specimens are incomplete or too water-worn to measure.

#### Subgenus *Simbirskites* A. P. PAVLOW 1892

Diagnosis: Shell inflated to coronate. Short primary ribs end at prominent mid-lateral tubercles, from which arise 2—4 secondary ribs. Other secondaries branch from these or are intercalated higher on the flank. The suture may have short, broad saddles and lobes, or longer, narrower, more deeply subdivided ones.

#### *Simbirskites (Simbirskites) cf. decheni* (ROEMER 1841)

##### Taf. 1, Fig. 3

cf. 1841 *Ammonites decheni* n. — ROEMER, P. 85, Pl. 13, Fig. 1.

Material: A phosphatised steinkern in the KÜSTERMANN/HOBBJE collection.

Description: The shell is moderately evolute with a sub-circular whorl section which appears pentamerous across the tubercles. On the last whorl there are 20 short, strong primary ribs which usually trifurcate about a third of the way over

\*) record new to Helgoland

the whorl flanks at a sharp tubercle, though on the right flank one bifurcates and another branches into four. The secondary ribs curve forwards over the rounded venter; the posterior rib on the right flank usually joins the anterior rib of the preceding group on the left flank. Above about 10 mm diameter the tubercles lie close to, but not in contact with, the umbilical seam of the next whorl, so that the inner portion of each secondary rib becomes visible in the umbilicus.

Dimensions of figured specimen:

(Taf. 1, Fig. 3) 49.5; 18.5, 20.5, 18.5. 20 pr., 60 sec. ribs.

Discussion: Although *S. (S.) decheni* is a difficult species to interpret (see RAWSON 1971a, p. 67) the Helgoland specimen compares reasonably with ROEMER'S (1841) description and figure of the (lost) holotype except in the number of secondary ribs per primary: in the holotype some ribs trifurcate while others bifurcate. In the Soviet forms commonly included in *S. (S.) decheni* (e.g. A. P. PAVLOW 1901; GLASUNOVA 1973) the tubercles remain in contact with the umbilical seam.

The inner whorls of *S. (S?) kleini* (NEUMAYR & UHLIG) are not adequately known, but appear to differ from *S. (S.) cf. decheni* in having four secondary ribs per primary. At comparable growth-stages, *S. (M.) concinnus* (PHILLIPS) is less strongly tuberculate, has a slightly narrower whorl, and bifurcating as well as trifurcating ribs.

*Simbirskites (Simbirskites) spp. (decheni ROEMER group)*

Taf. 1, Fig. 1, 2, 4, 5

Material: Approximately 30 septate nuclei in the STÜHMER, KÜSTERMANN/HOBBJE and PRIGGE collections.

Discussion: The Helgoland specimens are small (the largest about 20 mm in diameter) but show some variation in degree of inflation, strength of tubercles and density of primary and secondary ribs. Most variants can be compared (see explanation of Taf. 1) with one or another of the nuclei figured by BÄHR (1964) as subspecies of *S. (S.) decheni* or by RAWSON (1971a) as varieties of *S. (S.) cf. decheni*. The majority can be matched also by individuals among a highly variable assemblage from the *ihmensis* Subzone (*staffi* Zone) at Sarstedt, collected, by the author. Similar specimens from the same horizon and locality were divided by BÄHR (1964) among his various subspecies of *S. (S.) decheni*, but until the earliest whorls of related forms such as *S. (S?) kleini* are adequately described their taxonomic status is best left open.

*Simbirskites (Simbirskites) picteti* (WEERTH 1884) &

*Simbirskites (Simbirskites) cf. picteti* (WEERTH 1884)

Taf. 1, Fig. 6—10

v\* 1884 *Ammonites (Olcostephanus) picteti* n. sp. — WEERTH, P. 12, Pl. 2, Fig. 5, 6.

d ?1904 *Simbirskites cf. picteti* (WEERTH) — KOENEN, P. 22.

?1904 *Simbirskites coronula* v. KOENEN — KOENEN, P. 18, Pl. 2, Fig. 2, 3.

Lectotype: The original of WEERTH (1884), Pl. 2, Fig. 5, a natural external mould, is here designated lectotype: the specimen is in the Lippisches Landesmuseum, Detmold and casts from the mould made by the NLFb in the Geol. Landesamt Nordrhein-Westfalen, Krefeld and the Niedersächsisches Landesamt für Bodenforschung, Hannover (Orig.-nr. Kh. 63).

Locus typicus: Tönsberg bei Oerlinghausen.

Stratum typicum: Osning Sandstein.

Material: *S. (S.) picteti*: 1 pyritised whorl fragment and 1 phosphatised external mould of an umbilicus in the STÜHMER collection. *S. (S.) cf. picteti*: 2 phosphatised internal moulds in the KÜSTERMANN/HOBBJE collection.

Dimensions of figured specimen:

(Taf. 1, Fig. 7) 40.5; 16.0, 24.2, 18.0 (approx.). Approx. 17 pr. ribs, 58 sec. ribs.

Discussion: *S. (S.) picteti* is to be fully revised in a paper on the Hauterivian ammonites of the Osning Sandstein, now in preparation. The species is characterised by an evolute, coronate shell with short, strong primary ribs which branch into 3 or 4 secondaries at a prominent tubercle. Above about 30 mm diameter the tubercles lose contact with the umbilical seam of the next whorl, so that the inner portion of each secondary rib becomes visible within the umbilical area. In the lectotype, there are 11 primary ribs and tubercles at about 20 mm diameter, rising to 20 at 100 mm diameter.

A topotype of *S. (S.) picteti* is figured here (Taf. 1, Fig. 7) for comparison with the Helgoland material. The 2 specimens in the STÜHMER collection compare closely with this and the lectotype at similar growth stages. Two internal moulds in the KÜSTERMANN/HOBBJE collection figured here as *S. (S.) cf. picteti* are less coronate and have more numerous tubercles per whorl; they thus appear near to the specimens (now destroyed) which KOENEN (1904) compared with *S. (S.) picteti*.

WEERTH's (1884, Pl. 2, Fig. 6) smaller *S. (S.) picteti* (now lost) was included in synonymy with *S. (S.) umbonatus* (LAHUSEN) by A. P. PAVLOW (1901), RAWSON (1971a) and GLASUNOVA (1973), but in *S. (S.) umbonatus* and in the closely related *S. (S.) umbonatifformis* (A. P. PAVLOW) and *S. (S.) kowalewskii* (A. P. PAVLOW) the primary ribs are longer so that the tubercle is higher on the whorl flanks and even in the adult growth-stage remains in contact with the umbilical seam of the next whorl. Thus the secondary ribs are never visible in the umbilicus. The secondary ribs of these Soviet forms also curve forward more strongly over the broad venter. *S. (S.) coronula* KOENEN may be a variety of *S. (S.) picteti* (WEERTH) in which there are 4 secondary ribs to each primary in the inner whorls. Another coronate species, *S. (S.) marginatus* (PHILLIPS) from the Speeton Clay, is known only from septate nuclei up to 15 mm diameter (RAWSON 1971a, P. 65) and cannot be compared directly with *S. (S.) picteti*. *S. (S.) kleini* (NEUMAYR & UHLIG) has a similar rib pattern to that of *S. (S.) picteti* but is less inflated.

Subgenus *Speetonicer* SPATH 1924

Type species: *Sp. subbipliciforme* SPATH 1924

Diagnosis: Shell moderately evolute to evolute, whorl section rounded to coronate. Ribs usually biplicate, occasionally triplicate. The suture has relatively broad, only slightly subdivided saddles and lobes.

*Simbirskites (Speetonicer) inversum* (M. PAVLOW 1886)

Taf. 2, Fig. 5

v 1969 *Simbirskites (Speetonicer) cf. inversus* (M. PAVLOW) — HILTERMANN & KEMPER, P. 22, Pl. 2, Fig. 9.

v 1971a *Simbirskites (Speetonicer) inversum* (M. PAVLOW) — RAWSON, P. 43, Pl. 1, Fig. 1, 3, 4, 6, 7, 9; Pl. 2, Fig. 1; Text-fig. 2d, 3—5 (see this paper for earlier synonymy).

1973 *Speetonicer inversum* (M. PAVLOW) — GLASUNOVA, P. 92, Pl. 51, Fig. 2; Pl. 53, Fig. 1; Text-fig. 10.

Lectotype: The original of M. PAVLOW (1886), Pl. 1, Fig. 5, was selected as lectotype by RAWSON (1971a, P. 44).

Locus typicus: Simbirsk (now Ulyanovsk).

Stratum typicum: (Hauterivian) Clays of Simbirsk.

Material: 15 septate specimens, the largest about 30 mm in diameter, in the KÜSTERMANN/HOBBJE and STÜHMER collections.

Dimensions of figured specimen:

(Taf. 2, Fig. 5) 29.0; 10.6, 10.5, 11.5. 26 pr., 51 sec. ribs.

Discussion: *S. (Sp.) inversum* is characterised by an evolute to moderately evolute shell, sub-circular whorl section and biplicate ribs. The Helgoland examples compare closely with forms from the Speeton Clay, recently revised by the author (RAWSON 1971a). *S. (Sp.) inversum* was first figured from Helgoland by HILTERMANN & KEMPER (1969) but the 2 specimens discussed by KOENEN (1904, P. 17) probably belong to the same species. With the exception of a few specimens from the Gildehauser Sandstein (KEMPER 1973), *S. (Sp.) inversum* is not known from the Lower Saxony Basin, but its stratigraphical range is well-defined at Speeton where it is the index fossil of the *inversum* Zone, overlapping in the upper part of its range with early *Aegocrioceras*. One example of *S. (Sp.) inversum* from Helgoland (STÜHMER collection) is preserved in a nodule with *A. bicarinatum* (YOUNG & BIRD); the 2 species overlap in Bed C7G at Speeton.

HILTERMANN & KEMPER (1969, Pl. 1, Fig. 2) figured a single *S. (Sp.) versicolor* (TRAUTSCHOLD) from Helgoland. It is distinguished from *S. (Sp.) inversum* by its coronate whorl section.

Subgenus *Milanowskia* CHERNOVA 1951

Type species: *Ammonites speetonensis* YOUNG & BIRD 1828.

Diagnosis: Shell moderately evolute to slightly involute, usually moderately compressed though the earliest whorls may be more inflated, resembling those of *Speetoniceras*. Short primary ribs branch at a subdued tubercle into 2—5 secondary ribs, and others may be intercalated. The suture may have short, broad saddles and lobes or longer, narrower ones.

Discussion: The subgenus *Hannoverites* BÄHR 1964 (type species *S. staffi* WEDEKIND 1910) is here considered as a junior subjective synonym of *Milanowskia*. The differences (mainly in degree of evolution of the whorl) which BÄHR (1964, P. 74, 94) observed between the 2 subgenera are minor and apparently reflect the differences between the type species alone. Thus the statistical diagnosis of *S. (H.) staffi* WEDEKIND is very close to that of *S. ihmensis* BÄHR, which BÄHR placed in *Milanowskia*. Furthermore, while BÄHR also regarded *S. concinnus* (PHILLIPS) as a *Milanowskia*, specimens intermediate between this species and *S. staffi* are quite common at the base of the *staffi* Zone at Ziegelei Moorberg, Sarstedt (author's collection).

GLASUNOVA (1973) ignored the subgenus *Milanowskia* and placed *S. speetonensis* in *Craspedodiscus*.

*Sibirskites (Milanowskia) rugosus* KOENEN 1904

Taf. 2, Fig. 1—3

d\* *Sibirskites rugosus* KOENEN — KOENEN, P. 26, Pl. 3, Fig. 1, 2.

Neotype: KOENEN's syntypes (formerly in Hamburg) have been destroyed: a specimen in the KÜSTERMANN/HOBBJE collection (Pl. 2, Fig. 1) is proposed as neotype.

Locus typicus: Helgoland.

Material: In addition to the neotype, there are 2 septate specimens in the STÜHMER collection, 1 septate whorl fragment in the KÜSTERMANN/HOBBJE collection, and 1 fragment in the KRUMBEIN collection.

Description (of growth stages between 25 and 120 mm diameter): The shell is moderately evolute, becoming gradually more evolute with growth. The whorl section is elliptical; the whorl thickness is slightly greater than the whorl height to about 50 mm diameter, but the proportion gradually changes so that above about 70 mm diameter the whorl height is greater than the thickness. There are about 16 primary ribs per whorl at 50 mm diameter, increasing to an estimated 21 at 70 mm and 26 at 95 mm diameter. Each primary extends about a third of the way over the whorl flank and then branches into 2 or 3 secondaries at a slight tubercle; the third secondary rib sometimes appears slightly higher on the flank, branching from an earlier secondary. Most primaries give rise to 3 secondaries (occasionally 2 or 4) at all growth stages, but on the best preserved, large whorl fragment figured on Taf. 2 Fig. 3 the number is usually reduced to 2. Both primary and secondary ribs are slightly prorsiradiate, becoming more strongly so in advanced growth stages.

Dimensions of figured specimen:

(Taf. 2, Fig. 2) 50.0; 20.2, 21.2, 15.9. 18 pr., 43 sec. ribs (estimated).

Discussion: Although the specimens are slightly waterworn and incomplete, they are better preserved than KOENEN's originals, so that the more advanced growth stages can be adequately described for the first time and compared with some of the large "perisphinctoid" *Simbirskites* described by NEUMAYR & UHLIG (1881). Among these, *S. kleini* and *S. virgifer* most closely approach *S. (M.) rugosus*. In *S. (S?) virgifer* the whorl section is more rounded with a broader ventral region; *S. (S?) kleini* has more numerous secondary ribs per primary and stronger tubercles at the point of branching. In both of NEUMAYR & UHLIG's species the secondary ribs are less strongly forwardly projected on the venter.

The inner whorls of *S. (M.) rugosus* (KOENEN) differ from *S. (M.) concinnus* (PHILLIPS) in the fewer primary ribs per whorl and the less evolute, more inflated shell. They are also more involute than the Helgoland specimen of *S. (S.) cf. decheni* (ROEMER) and lack the strong tubercles of that species.

*S. (M.) rugosus* lies on the border between *Milanowskia* and *Simbirskites* s.s. and is included in the former mainly because of the absence of strong tubercles and the rounded rather than inflated whorl section.

*Simbirskites (Milanowskia) concinnus* (PHILLIPS 1829)

Taf. 2, Fig. 4

v 1971a *Simbirskites (Milanowskia) concinnus* (PHILLIPS) — RAWSON, P. 48, Pl. 2, Fig. 2—6, 8; Pl. 12, Fig. 11; Text-fig. 2b, 6 (see this paper for earlier synonymy).

Neotype: The specimen figured by PAVLOW (1892, Pl. 18, Fig. 16) was designated neotype and refigured by HOWARTH (1962, Pl. 19, Fig. 6).

Locus typicus: Speeton, England.

Stratum typicum: Speeton Clay.

Material: 2 whorl fragments in the STÜHMER collection.

Discussion: *S. (M.) concinnus* is known only from septate specimens to about 35 mm diameter. The species is characterised by a moderately evolute shell with sub-circular whorl section; the whorl is slightly higher than wide. Primary ribs branch at a feeble tubercle into 2 or 3 secondary ribs.

*S. (M.) concinnus* has not previously been figured from Helgoland, but the 2 fragments recorded here compare well with Speeton examples of similar size (e.g. RAWSON 1971a, Pl. 2, Fig. 4). It is the index fossil of the lower subzone of the *speetonensis* Zone at Speeton and occurs in the *staffi* Subzone of the *staffi* Zone at Sarstedt and Ovenstadt (author's collection) but the higher (*ihmensis* Subzone, *staffi* Zone) forms described by BÄHR (1964, P. 98) as *S. (M.) concinnus* are a distinct, slightly more compressed species.

*Simbirskites (Milanowskia) helgolandensis* sp. nov.

Taf. 3, Fig. 1, 4, 6

Types: The holotype and 2 paratypes in the STÜHMER collection. All are septate, phosphatised internal moulds; the largest (the holotype) is fragmentary but represents a specimen of about 50 mm diameter.

Locus typicus: Helgoland.

Description (of growth stages between about 15 and 50 mm diameter): The shell is moderately evolute, the whorl section elliptical. The whorl height is slightly greater than the whorl thickness. There are approximately 29 primary ribs per whorl at about 29 mm diameter on the holotype, compared with about 25 at the same diameter on the smaller paratype. The latter specimen has approximately 29 primary ribs on the last whorl (diameter 39 mm). The primary ribs are long, extending almost to the middle of the flank, where they branch into 2 or 3 secondary ribs; the third secondary rib may appear slightly higher on the flank, branching from a lower secondary rib. In general, about two thirds of the primary ribs give rise to 2 secondaries and the other third to 3, but the proportions vary slightly from one specimen to another. At first there are feeble tubercles at the point of branching, but these soon disappear.

The suture line has relatively long, narrow saddles and lobes (visible on Taf. 3).

Dimensions of figured specimen:

(Taf. 3, Fig. 1) 39.0; 16.5, 14.5 (approx.), 12.7. 29 (approx.) pr., 66 sec. ribs.

Discussion: In general shell proportions and ratio of primary to secondary ribs this species is close to *S. (M.) concinnus* (PHILLIPS). It differs in having longer primary ribs, more numerous primary (25—29 compared with 18—22) and secondary ribs per whorl, and a suture with longer, narrower elements. The specimens which WEERTH (1884, Pl. 1, Fig. 4; Pl. 2, Fig. 2) figured as the inner whorls of *S. (M.?) inverselobatus* (NEUMAYR & UHLIG) are very similar to *S. (M.) helgolandensis* but have a slightly broader whorl. The holotype of *S. (M.?) inverselobatus* is large so that no direct comparison with *S. (M.) helgolandensis* can be made.

*Simbirskites (Milanowskia) ihmensis* BÄHR 1964

Taf. 2, Fig. 6, 7

v\* 1910 *Simbirskites* n. sp. — WEDEKIND, P. 96, Pl. 4, Fig. 2.

v\* 1964 *Simbirskites (Milanowskia) ihmensis* n. sp. — BÄHR, P. 101, Pl. 4, Fig. 2; Text-fig. 38—40.

Holotype: The original of WEDEKIND (1910), refigured by BÄHR (1964). Geol. Paläont. Institut, Göttingen.

Locus typicus: Ihme, near Hannover.

Stratum typicum: *ihmensis* Subzone, *staffi* Zone.

Material: 3 pyritised nuclei in the STÜHMER collection.

Dimensions of figured specimen:

(Taf. 2, Fig. 6) 23.3; 9.4, 8.5, 7.6. 19 pr. ribs.

Discussion: *S. (M.) ihmensis* is known only from septate inner whorls to about 25 mm diameter. These are moderately evolute with flat or only slightly curved flanks; strong primary ribs branch into 3, very occasionally 2, secondary ribs about a third of the way over the flank. The most characteristic feature, which distinguishes this species from other *Simbirskites*, is the relatively late stage at

which ribbing appears (BÄHR 1964, Text-fig. 39): primary ribs appear at about 12 mm diameter and secondaries at 16—20 mm. The shell is more compressed than that of *S. (M.) concinnus* (PHILLIPS) and lacks the distinctly virgatome rib pattern of *S. (M.) staffi* WEDEKIND and related forms.

The largest Helgoland specimen is only about 18 mm in diameter, and all 3 examples are slightly waterworn, but they agree closely with comparable growth stages of specimens from Sarstedt and Ihme, near Hannover. The only specimen previously figured is the holotype, so a well preserved specimen from the *ihmensis* Subzone at Sarstedt is figured here (Taf. 2, Fig. 6) for comparison with the Helgoland forms.

*S. (M.) ihmensis* has now been selected (KEMPER 1973, Table 2) as index fossil of the upper subzone of the *staffi* Zone of north Germany.

*Simbirskites (Milanowskia) staffi* WEDEKIND 1910

Taf. 3, Fig. 7

- v\* 1910 *Simbirskites staffi* n. sp. — WEDEKIND, P. 96, Pl. 4, Fig. 3.  
 v\* 1964 *Simbirskites (Hannoverites) staffi* WEDEKIND — BÄHR, P. 74, Pl. 4, Fig. 2—4, Text-fig. 24, 25.  
 v 1971a *Simbirskites (Milanowskia) staffi* WEDEKIND — RAWSON, P. 53, Pl. 2, Fig. 14, 16; Pl. 3, Fig. 1, 4; Text-fig. 2c.

Holotype: The specimen from Ihme, near Hannover, figured by WEDEKIND (1910) and BÄHR (1964). Geol. Paläont. Institut, Göttingen.

Locus typicus: Ihme, near Hannover.

Stratum typicum: *staffi* Zone.

Material: One external mould in a phosphatic nodule in the RAUCHFUSS collection; silicone rubber casts from this in the NLFB, Hannover (Orig. nr. Kh. 44) and the Geol. Paläont. Institut, Hamburg.

Discussion: *S. (M.) staffi* has been redescribed by BÄHR (1964) and English occurrences discussed by RAWSON (1971a). It has a moderately evolute to evolute shell with almost flat flanks. Short primary ribs branch into 2 secondary ribs and the posterior secondary normally branches again, so that a virgatome pattern develops. The Helgoland specimen compares closely with the more evolute varieties in whorl proportions and number and pattern of ribs. This is the first record of *S. (M.) staffi* from Helgoland, but it is abundant in Lower Saxony where it is now used as a zonal and subzonal index (KEMPER 1973).

The Helgoland species *S. (M.) paucilobus* KOENEN and *S. (M.) triplicatus* KOENEN remain poorly known. The holotype of *S. (M.) triplicatus* (formerly at Hamburg) has been destroyed, but a plaster cast in the Göttingen collections shows that it differs from typical *S. (M.) staffi* only in being more involute. *S. (M.) paucilobus* was redescribed by BÄHR (1964, P. 78); it is more involute and has a thicker whorl than *S. (M.) staffi*.

*Simbirskites (Milanowskia) sp.*

Taf. 3, Fig. 3, 5

?1904 *Simbirskites virgifer?* (NEUMAYR & UHLIG) — KOENEN, P. 15, Taf. 4, Fig. 2.

Material: 2 external moulds in the KÜSTERMANN/HOBBJE collection and 1 in the STÜHMER collection. Casts in the NLFB, Hannover (Kh. 45, Kh. 62).

Discussion: The specimens are external moulds of the umbilical region only, so that the outer part of each whorl is not visible. They resemble *S. (M.) staffi* but can be distinguished as follows: a fourth secondary rib is sometimes intercalated in *S. (M.) sp.*; primary ribs are more numerous — 26—29 per whorl compared with 20—22 per whorl at comparable size in *S. (M.) staffi*; the flat flanks merge via a rounded umbilical edge into a well-marked vertical umbilical wall, whereas in *S. (M.) staffi* there is no clearly-defined wall; the whorl is probably thicker.

The specimen described and figured by KOENEN (1904) as *Simbirskites virgifer* (NEUMAYR & UHLIG) apparently belongs to *S. (M.) sp.*; the same specimen was included by BÄHR (1964, P. 80) in his new species *S. (M.) stoeckensis*. The holotype and figured paratype of BÄHR's species are crushed laterally so that the nature of the umbilical wall is not apparent.

Subgenus *Craspedodiscus* SPATH 1924Type species: *Ammonites discofalcatus* LAHUSEN 1874.

Diagnosis: A subgenus of *Simbirskites* with compressed, involute, finely ribbed whorls in at least the juvenile growth stages. The suture has long, narrow elements which become strongly incised during growth.

*Simbirskites (Craspedodiscus) gottschei* (KOENEN 1904)

Taf. 4, Fig. 2, 10

- v 1892 *Olcostephanus (Simbirskites) discofalcatus* (LAHUSEN) — PAVLOW, P. 505, Pl. 18 (11), Fig. 2.
- v\* 1904 *Craspedites gottschei* KOENEN — KOENEN, P. 32, Pl. 1, Fig. 3, 4.
- v 1910 *Simbirskites extremus* n. sp. — WEDEKIND, P. 97, Pl. 4, Fig. 4.
- v 1964 *Simbirskites (Craspedodiscus) gottschei* (KOENEN) — BÄHR, P. 116, Pl. 7, Fig. 2—4 (non Fig. 6); Taf. 8, Fig. 1 (non Fig. 2), Text-fig. 47—51.
- v 1971a *Simbirskites (Craspedodiscus) gottschei* (KOENEN) — RAWSON, P. 56, Pl. 4, Fig. 2, 4, 5; Pl. 5, Fig. 1.

Lectotype: The original of KOENEN (1904), Pl. 1, Fig. 3 (BÄHR 1964; RAWSON 1971a). Geol. Paläont. Institut, Göttingen.

Locus typicus: Helgoland.

Stratum typicum: Upper Hauterivian (*gottschei* Zone).

Material: About 45 specimens, the majority in the STÜHMER collection. The largest is about 75 mm diameter.

Dimensions of figured specimens:

(Pl. 4, Fig. 2) 25.0; 12.0, 9.3, 4.5. 19 pr. ribs.

(Pl. 4, Fig. 10) 53.5; at 48.0; 23.2, 16.7, 9.6. Estimated no. of ribs at 53.5 mm diameter: 18 pr., 73 sec.

Discussion: The species has been fully redescribed by BÄHR (1964) and RAWSON (1971a), who both demonstrated that the involute, *Craspedodiscus*-stage inner whorls characteristically preserved at Helgoland give way to a more evolute, "perisphinctoid" adult stage (see RAWSON 1971 a, Pl. 5, Fig. 1).

The range of variation in rib density of the Helgoland examples confirms that *S. (C.) extremus* WEDEKIND should be regarded as a coarsely ribbed variant (RAWSON 1971a) or subspecies (BÄHR 1964) of *S. (C.) gottschei* (KOENEN). This *Craspedodiscus* stage (which persists to at least 75 mm diameter) is characterised by a weakening of the primary and secondary ribs in the middle of the flank, in extreme examples resulting in a smooth area. Mid-lateral tubercles are absent even on individuals as small as 25 mm diameter (Taf. 4, Fig. 2 here), where the characteristic rib-pattern is already well-developed. The mid-lateral weakening of the ribs and the absence of mid-lateral tubercles distinguishes *S. (C.) gottschei* from other *Craspedodiscus*, and the rounded (though narrow) venter and broader whorl further distinguishes it from the common Helgoland *S. (C.) phillipsi* (ROEMER), with almost carinate venter.

BÄHR (1964, P. 123) regarded "*Craspedites*" *weerthi* KOENEN 1902 as a subspecies of *S. (C.) gottschei*. Should further investigation prove that the 2 species are indeed conspecific then the specific name "*weerthi*" would have priority.

*S. (C.) gottschei* is used as a zonal index in both England (RAWSON 1971a) and northwest Germany (KEMPER 1973). The number of specimens now recorded from Helgoland is double the total previously known from England and the German mainland.

*Simbirskites (Craspedodiscus) phillipsi* (ROEMER 1841)

Taf. 4, Fig. 3—5, 7, 9

- d 1841 *Ammonites phillipsii* n — ROEMER, P. 85.
- d ?1881 *Olcostephanus (?) phillipsi* (ROEMER) — NEUMAYR & UHLIG, P. 33, Pl. 15, Fig. 7.
- d 1884 *Ammonites (Olcostephanus) phillipsii* ROEMER — WEERTH, P. 17, Pl. 4, Fig. 2, ?Fig. 3.
- non 1901 *Simbirskites phillipsi* (NEUMAYR & UHLIG) — PAVLOW, P. 78, Pl. 7, Fig. 3.
- v 1902 *Simbirskites phillipsi* (ROEMER) — KOENEN, P. 157—8, 412—4 (pars).
- v 1904 *Simbirskites phillipsi* (ROEMER) — KOENEN, P. 28, Pl. 1, Fig. 6.
- ?1904 *Simbirskites carinatus* KOENEN — KOENEN, P. 30, Pl. 4, Figs. 6, 7.
- v\* ?1964 *Simbirskites (Craspedodiscus) polyschistus* n. sp. — BÄHR, P. 125, Pl. 8, Fig. 3, 4.

Dimensions of figured specimens:

(Pl. 4, Fig. 2) 25.0; 12.0, 9.3, 4.5. 19 pr. ribs.

(Pl. 4, Fig. 10) 53.5: at 48.0; 23.2, 16.7, 9.6. Estimated no. of ribs at 53.5 mm diameter: 18 pr., 73 sec.

Discussion: The species has been fully redescribed by BÄHR (1964) and RAWSON (1971a), who both demonstrated that the involute, *Craspedodiscus*-stage inner whorls characteristically preserved at Helgoland give way to a more evolute, "perisphinctoid" adult stage (see RAWSON 1971 a, Pl. 5, Fig. 1).

The range of variation in rib density of the Helgoland examples confirms that *S. (C.) extremus* WEDEKIND should be regarded as a coarsely ribbed variant (RAWSON 1971a) or subspecies (BÄHR 1964) of *S. (C.) gottschei* (KOENEN). This *Craspedodiscus* stage (which persists to at least 75 mm diameter) is characterised by a weakening of the primary and secondary ribs in the middle of the flank, in extreme examples resulting in a smooth area. Mid-lateral tubercles are absent even on individuals as small as 25 mm diameter (Taf. 4, Fig. 2 here), where the characteristic rib-pattern is already well-developed. The mid-lateral weakening of the ribs and the absence of mid-lateral tubercles distinguishes *S. (C.) gottschei* from other *Craspedodiscus*, and the rounded (though narrow) venter and broader whorl further distinguishes it from the common Helgoland *S. (C.) phillipsi* (ROEMER), with almost carinate venter.

BÄHR (1964, P. 123) regarded "*Craspedites*" *weerthi* KOENEN 1902 as a subspecies of *S. (C.) gottschei*. Should further investigation prove that the 2 species are indeed conspecific then the specific name "*weerthi*" would have priority.

*S. (C.) gottschei* is used as a zonal index in both England (RAWSON 1971a) and northwest Germany (KEMPER 1973). The number of specimens now recorded from Helgoland is double the total previously known from England and the German mainland.

*Simbirskites (Craspedodiscus) phillipsi* (ROEMER 1841)

Taf. 4, Fig. 3—5, 7, 9

- d 1841 *Ammonites phillipsii* n — ROEMER, P. 85.
- d ?1881 *Olcostephanus (?) phillipsi* (ROEMER) — NEUMAYR & UHLIG, P. 33, Pl. 15, Fig. 7.
- d 1884 *Ammonites (Olcostephanus) phillipsii* ROEMER — WEERTII, P. 17, Pl. 4, Fig. 2, ?Fig. 3.
- non 1901 *Simbirskites phillipsi* (NEUMAYR & UHLIG) — PAVLOW, P. 78, Pl. 7, Fig. 3.
- v 1902 *Simbirskites phillipsi* (ROEMER) — KOENEN, P. 157—8, 412—4 (pars).
- v 1904 *Simbirskites phillipsi* (ROEMER) — KOENEN, P. 28, Pl. 1, Fig. 6.
- ?1904 *Simbirskites carinatus* KOENEN — KOENEN, P. 30, Pl. 4, Figs. 6, 7.
- v\* ?1964 *Simbirskites (Craspedodiscus) polyschistus* n. sp. — BÄHR, P. 125, Pl. 8, Fig. 3, 4.

- v 1964 *Simbirskites (Craspedodiscus) gottschei gottschei* (KOENEN) — BÄHR, Pl. 8, Fig. 2.
- v 1969 *Craspedodiscus carinatus* (KOENEN) — HILTERMANN & KEMPER, P. 22, Pl. 2, Fig. 5, 6, 10.
- v 1971a *Simbirskites (Craspedodiscus) phillipsi* (ROEMER sensu WEERTH) — RAWSON, P. 61, Pl. 9, Fig. 1.
- v ?1971a *Simbirskites (Craspedodiscus) sp. (phillipsi group)* — RAWSON, P. 62, Pl. 5, Fig. 2.

Neotype: *S. (C.) phillipsi* was based partly on a Speeton Clay specimen recorded by PHILLIPS (1829, P. 123) as "*Ammonites lamberti?*" and partly on specimens from Bredenbeck and Helgoland. All are lost, and a specimen in the STÜHMER collection (Pl. 4, Fig. 3) is here designated as neotype.

Locus typicus: Helgoland (neotype).

Material: About 60 septate specimens, mainly pyritised and often waterworn, in the KRUMBEIN, KÜSTERMANN/HOBBJE, PRIGGE, RAUCHFUSS and STÜHMER collections. The majority are less than 40 mm in diameter and indifferently preserved.

Description (of growth stages between 15 and 50 mm diameter): The shell is compressed, involute, with narrow, arched venter which becomes acute by about 20 mm diameter. Primary ribs extend about a third of the way over the whorl flank, terminating at a small, mid-lateral tubercle. Two or 3 long secondary ribs are associated with each primary, 2 usually arising from the tubercle and the third often intercalated at about the same level. One, sometimes 2, of these secondary ribs branches again at a varying level higher on the flank, so that the rib pattern is rather irregular. The secondary ribs curve forwards over the flank and swing strongly forwards over the acute venter, giving it an almost carinate appearance.

There is considerable variation in both rib density and degree of involution of the shell; in general, forms with a wider umbilicus (e. g. Taf. 4, Fig. 4, 7) have fewer primary ribs.

The suture line (visible on Taf. 4, Fig. 3, 4, 7, 9) has relatively long, narrow saddles and lobes.

Dimensions of figured specimens:

(Taf. 4, Fig. 3) 39.0; 20.7, 11.4, 6.0. 25 pr., approx. 78 sec. ribs.

(Taf. 4, Fig. 4) 46.1; 22.1, 13.1, 9.3. 23 pr., estimated 70 sec. ribs.

(Taf. 4, Fig. 5) 20.9; 10.9, 7.2, 4.1. Approx. 25 pr., 70 sec. ribs.

(Taf. 4, Fig. 7) 41.5; 19.8, 13.3, 9.6. 21 pr., approx. 73 sec. ribs.

(Taf. 4, Fig. 9) Max. diam. approx. 64 mm. At 47.5; 25.4, 12.7, 6.5.

Discussion: ROEMER's (1841) brief description referred to a specimen which probably lay towards one end of the range of variation in this species. The specimen selected as neotype matches the original description fairly closely, whereas the majority of individuals have more numerous secondary ribs per primary. In the absence of a figure ROEMER's species has remained difficult to interpret and the name has often been applied to quite distinct forms. Thus A. P. PAVLOW (1901) thought that *S. (C.) phillipsi* was merely a finely-ribbed variant of

*S. (C.) discofalcatatus* (LAHUSEN). Now that there is abundant material from Helgoland, it is apparent that *S. (C.) phillipsi* is a distinct, clearly defined species characterised by the acquisition of a narrow, almost carinate venter at an early growth stage. This readily distinguishes it from the earlier whorls of *S. (C.) discofalcatatus* (e.g. A. P. PAVLOW 1901, Pl. 7, Fig. 1; GLASUNOVA 1973, Pl. 72), even though there is some similarity in rib pattern and degree of involution between *S. (C.) discofalcatatus* and the more coarsely ribbed, less involute examples of *S. (C.) phillipsi*.

The more advanced growth stages of *S. (C.) phillipsi* (above 50 mm diameter) are represented from Helgoland by 2 whorl fragments. These show that the whorl proportions and rib pattern remain similar to diameters of at least 120 mm. The fragments compare closely with a large specimen from the Osning Sandstein of Tönsberg recently figured (RAWSON 1971 a, Pl. 9, Fig. 3) as *S. (C.) phillipsi* (ROEMER sensu WEERTH). This specimen also shows the section of an earlier whorl, which matches that of Helgoland specimens of similar diameter. Thus both it and another large individual from Tönsberg figured by WEERTH (1884, Pl. 4, Fig. 2) can now be confidently attached to *S. (C.) phillipsi* (ROEMER). By this growth stage (120 mm diameter) *S. (C.) discofalcatatus* (LAHUSEN) has become more compressed and has a narrower venter so that it approaches *S. (C.) phillipsi* in general shell proportions, but still has fewer primary ribs and more numerous secondaries per primary.

KOENEN (1904) figured a typical Helgoland example of *S. (C.) phillipsi*, and his new species *S. (C.) carinatus* probably belongs to the same species; KOENEN's figured types are very fragmentary and poorly preserved. Other Helgoland specimens of *S. (C.) phillipsi* have been figured by HILTERMANN & KEMPER (1969) as *S. (C.) carinatus*. *S. (C.) polyschistus* BÄHR may also be a junior subjective synonym of *S. (C.) phillipsi*: the holotype is crushed so that the angularity of the venter cannot be assessed, but in side view it looks like one of the less involute varieties of *S. (C.) phillipsi*. KOENEN's (1904) figured *S. (C.) phillipsi* was included in *S. (C.) polyschistus* by BÄHR, who refigured part of the specimen but mistakenly labelled it as *S. (C.) gottschei gottschei* (KOENEN). *S. (C.) juddi* RAWSON is close to *S. (C.) phillipsi* but is even more involute and compressed.

*Simbirskites (Craspedodiscus) aff. phillipsi* (ROEMER 1841)

Taf 4, Fig. 6, 8

Material: 2 septate, pyritised specimens in the STÜHMER collection.

Discussion: The 2 specimens differ from variants of *S. (C.) phillipsi* in being more inflated and less involute, so that the umbilicus is noticeably wider. The rib pattern is similar to that of *S. (C.) phillipsi* and the venter, though less acute, is still arched. Further material may show that these specimens are extreme variants of *S. (C.) phillipsi*, but they are provisionally regarded as distinct.

*Simbirskites (Craspedodiscus) spp.*

Taf. 3, Fig. 2; Taf. 4, Fig. 1

Discussion: Several other species of *Craspedodiscus* are represented in the Helgoland collections, though none can be adequately described or named from the

limited and incomplete material available. Three septate nuclei in the STÜHMER collection have a compressed, moderately involute shell with flat flanks and a narrow but rounded venter. Short primary ribs bifurcate at a feeble tubercle about a third of the way over the whorl flank; usually one of the secondaries branches again almost immediately. About two thirds of the way over the flank these secondaries bend forward strongly. This species (Taf. 4, Fig. 1) has a more regular rib pattern and more rounded venter than juvenile *S. (C.) phillipsi* (ROEMER), and stronger ribs than *S. (C.) gottschei* (KOENEN). It is also less involute than either of these species. In most features it compares closely with a specimen figured by BÄHR (1964, Pl. 5, Fig. 3) as a juvenile *S. (C.) kayseri* (NEUMAYR & UHLIG) but is less involute.

Three large ammonites collected by Herr STÜHMER since my visit to Helgoland appear, from photographs kindly provided by Professor Dr. FR. SCHMID, to be close to *S. (C.) kayseri* (NEUMAYR & UHLIG) and are probably conspecific with the specimen which KOENEN (1904) recorded as *S. (C.) cf. kayseri*. The largest, badly worn specimen has a diameter of 800 mm., while the better preserved individuals which show the ribs clearly have diameters of 330 and 320 mm.

Another distinctive species (Taf. 3, Fig. 2) is represented by 3 phosphatised specimens in the STÜHMER collection. The primary ribs are short and pinched up, giving rise to 4 or 5 secondaries; the point of branching is obscure because all the specimens are worn. In lateral view it bears some resemblance to *S. (C.) beyrichi* KOENEN (1904) but is less involute. It is more inflated than *S. (C.) gottschei* and has stronger primary ribs.

Superfamily: Ancylocerataceae MEEK 1876

Family: Ancyloceratidae MEEK 1876

Subfamily: Crioceratitinae WRIGHT 1952

Genus: *Aegocrioceras* SPATH 1924

Type species: *Hamites capricornu* ROEMER 1841.

*Aegocrioceras* is a distinctive capricorn genus with crioceratitid coiling and strong, simple radial ribs at all growth stages. It characterises a thin but clearly defined horizon in the middle of the Hauterivian in both north Germany ("*capricornu*-Schichten") and eastern England, where numerous species occur. Jointly with Speeton, Helgoland is a type locality for 3 species proposed by ROEMER (1841) and now included in *Aegocrioceras*: these are "*Hamites*" *semicinctus*, "*H.*" *capricornu* and "*H.*" *subnodosus*. ROEMER also figured a fragment of an indeterminate *Aegocrioceras* which he identified as "*H.*" *raricostatus* PHILLIPS. KOENEN (1904) reviewed the fauna and added *A. torulosum* (KOENEN 1902, a junior subjective synonym of *A. quadratum* CRICK 1898) and *A.?* *seeleyi* (NEUMAYR & UHLIG) to the Helgoland record. Recently, HILTERMANN & KEMPER (1969) have figured *A. bicarinatum* (YOUNG & BIRD) and *A.?* *koeneni* SPATH.

There are about 100 whorl fragments in the new collections, though the majority are waterworn and some are difficult to identify at specific level. All the species represented in these collections have been described in a study of the Speeton Clay *Aegocrioceras* fauna (RAWSON 1975), with which the Helgoland

fauna most closely compares. The Helgoland specimens are not therefore described here, but are reviewed briefly.

The majority are large whorl fragments, often of body chambers, and are usually partly phosphatised. A minority of specimens are small, septate, pyritised whorl fragments. Among the larger specimens, *A. quadratum* (CRICK) and *A. semicinctum* (ROEMER) are dominant: their preservation is identical to that of the same species from Bed C7F at Speeton. A few fragments of *A. bicarinatum* (YOUNG & BIRD) also occur in similar preservation, the best preserved example being the one associated with a specimen of *Simbirskites* (*Speetonicerias*) *inversum* (M. PAVLOW) discussed earlier.

*A. bicarinatum*, *A. quadratum* and *A. semicinctum* together constitute assemblage 1 at Speeton. The overlying assemblages 2 and 3 are characterised by *A. raricostatum* (PHILLIPS) and *A. spathi* RAWSON respectively; pyritised specimens of both species occur at Helgoland. All 3 assemblages occur within the *inversum* Zone at Speeton.

In the STÜHMER collection there are 7 fragments of *Aegocrioceras? seeleyi* (NEUMAYR & UHLIG), a species which occurs well above the main *Aegocrioceras* horizon in England and north Germany. There are also fragments of *A.? koeneni* SPATH, which may represent the inner whorls of *A.? seeleyi*. It is difficult to assign these species to a genus; morphologically, though not stratigraphically, they lie between typical *Aegocrioceras* and early *Crioceratites*.

Among earlier Helgoland records, *A. capricornu* (ROEMER) is not represented in the new collections and *A. subnodosum* (ROEMER) cannot be interpreted (RAWSON 1975).

### Genus *Crioceratites* LÉVEILLÉ 1837

Type species: *C. duvalii* LÉVEILLÉ 1837.

Discussion: About 20 whorl fragments, mostly in the STÜHMER collection, belong to *Crioceratites* of mid-Hauterivian type. The majority can be matched closely with Speeton or north German specimens of the *C. wermbteri* (KOENEN), *C. hildesiensis* (KOENEN) and *C. beani* (YOUNG & BIRD) group. These "Boreal" forms urgently require revision and all are probably conspecific with characteristic Tethyan species of the *C. duvalii* group: the brief incursion of these *Crioceratites* into northwest Europe represents one of several local migrations of crioceratitids from Tethys (RAWSON 1973).

### 3. Stratigraphical discussion

The fauna of the Lower Hauterivian *Endemoceras* beds is almost unknown from Helgoland, though KOENEN's (1904) record of specimens of *Acanthodiscus* and *Distoloceras* suggest that there is at least a thin representative of the *noricum* Zone: although these records are not confirmed by the new collections it is unlikely that KOENEN misidentified such a distinctive form as "*Hoplites*" *radiatus*.

The remainder of the Hauterivian stage is represented by the faunas discussed above; the majority of the *Simbirskites* and *Aegocrioceras* species have been assigned to approximate stratigraphical horizons (zones) by reference to

the Speeton and north German faunal sequences. The partially or wholly phosphatised preservation of some species could indicate condensed horizons, but no major stratigraphical breaks are apparent. The relative abundance of a small number of species [*Aegocrioceras quadratum*, *A. semicinatum*, *Simbirskites (Speetonicerus) inversum*, *S. (S.)* of the *decheni* group, *S. (Craspedodiscus) gottschei* and *S. (C.) phillipsi*] probably means that thin, often condensed, fossiliferous horizons are separated by almost barren strata. This would accord with the preservational pattern observed in the Lower Saxony Basin and at Speeton, and accounts for the variation in abundance and distribution of individual species among the described faunas of northwest Europe.

Although the Helgoland *Aegocrioceras* fauna is only compared with the Speeton fauna, most of the constituent species occur also in north Germany, though here their exact ranges have not been determined (RAWSON 1975). The north German "capricornu-Schichten" are generally underlain by a few metres of poorly fossiliferous clays passing down into the *Endemoceras*-Schichten, whereas at Speeton there is an intervening horizon with abundant *Simbirskites (Speetonicerus) inversum* and allied forms. This earliest simbirskitid fauna is well represented in Helgoland and has recently been recorded from the Gildehäuser Sandstein near Bentheim (KEMPER 1973, P. 343).

The rest of the Helgoland *Simbirskites* fauna is diverse, though the majority of taxa are represented by less than 10 specimens each. The faunas of the lower part of the *S. (M.) staffi* Zone of the Lower Saxony Basin and its approximate cor-

**Table 1. The Hauterivian ammonite zones of northwest Europe.**

\* zone represented in the Helgoland fauna.

? zone probably or possibly represented in the Helgoland fauna.

NORTH GERMANY (KEMPER 1973; KEMPER et al. 1974)		SPEETON (RAWSON 1971b)	
<i>discofalcatus</i> ?		<i>variabilis</i> ?	
		<i>marginatus</i> ?	
<i>gottschei</i> *			
<i>staffi</i> *	<i>ihmensis</i> *	<i>speetonensis</i>	<i>speetonensis</i> *
	<i>staffi</i> *	<i>concinus</i> *	
<i>inversum</i> *			
<i>regale</i>			
<i>noricum</i> ?			
<i>amblygonium</i>			

relative at Speeton, the *concinuus* Subzone of the *speetonensis* Zone, are only sparsely represented, but the common nuclei of the *S. (S.) decheni* group indicate that the upper part of the Zone (*ihmensis* Subzone) is richly fossiliferous around Helgoland. *S. (C.) gottschei*, index fossil of the next zone in both regions, is abundant.

The highest Hauterivian (*discotalcatus* Zone in north Germany; *marginatus* and *variabilis* Zones at Speeton) is probably indicated by *S. (S.) picteti* (WEERTH) and *S. (C.) phillipsi* (ROEMER). The zonal position of *S. (S.) picteti* in the Osning Sandstein is unknown, but its resemblance to *S. (S.) marginatus* (PHILLIPS) from Speeton suggests a late Hauterivian age. The horizon of *S. (C.) phillipsi* is difficult to establish, but it is probably confined to the *discotalcatus* Zone and its English equivalents.

Table 1 summarises the English and north German zonal schemes and indicates which zones are represented in the Helgoland succession.

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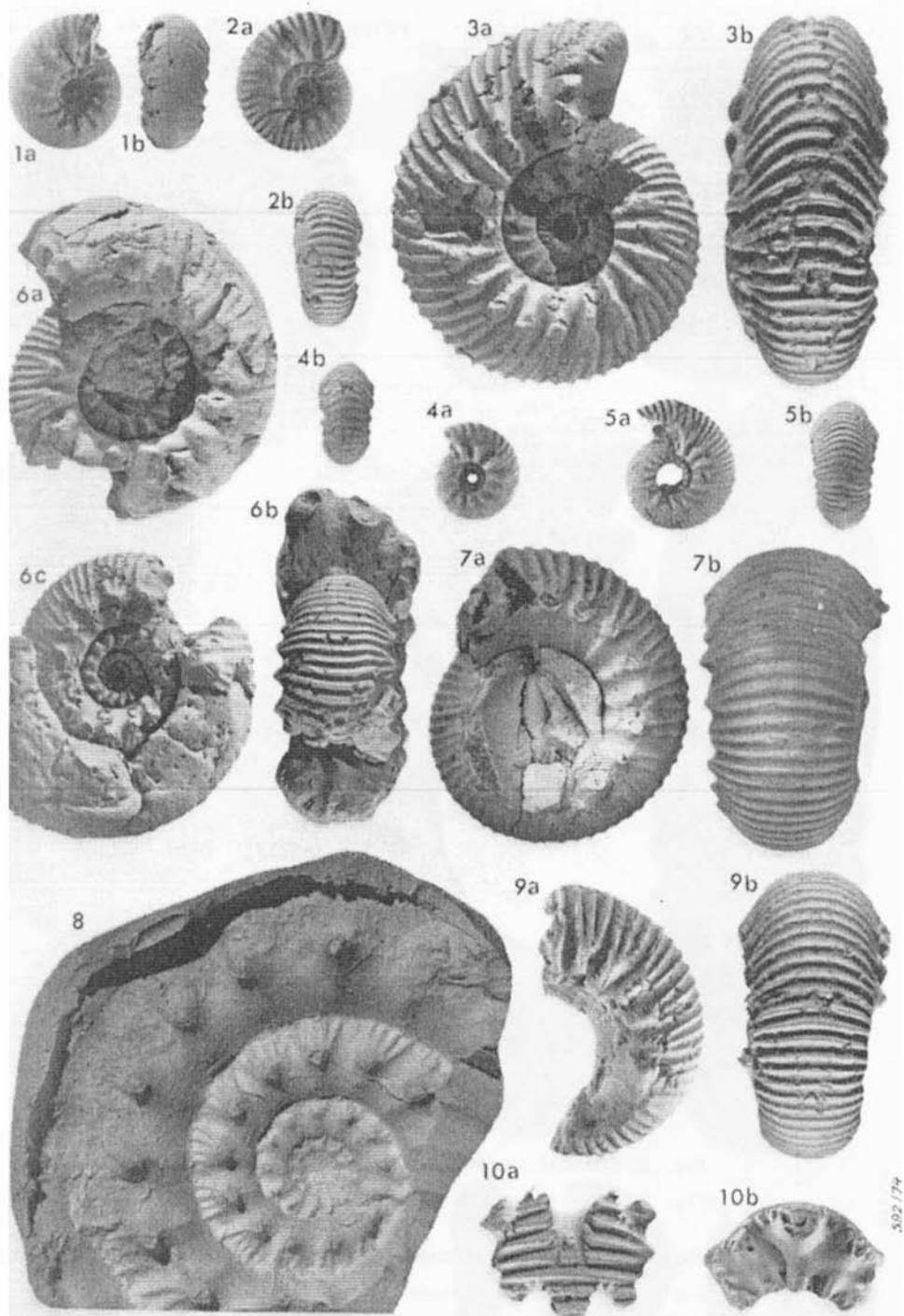
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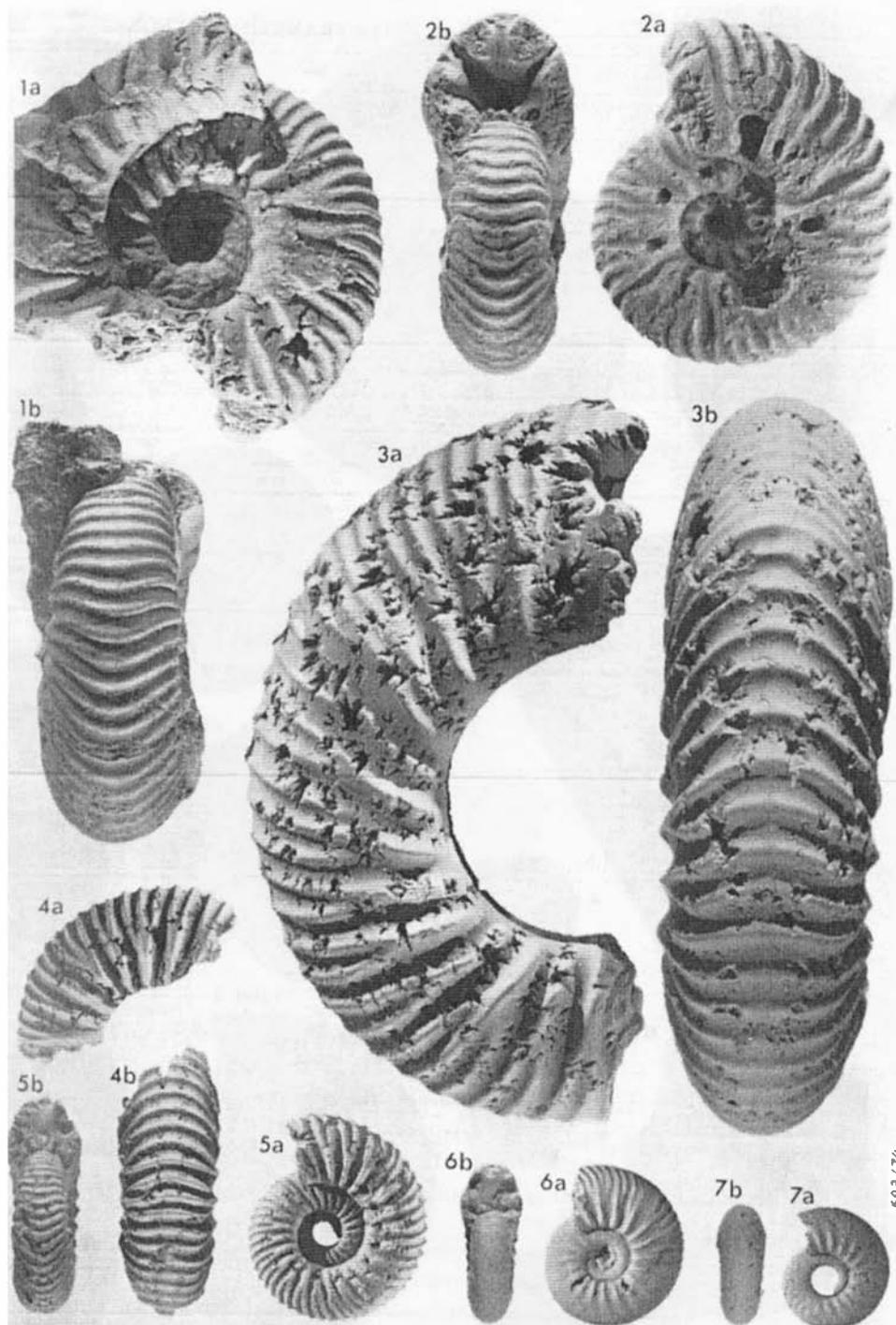
## Tafel 1

- Fig. 1: *Simbirskites (Simbirskites)* sp. (*decheni* group). (cf. *S. (S.) decheni kelleri* BÄUM 1964, Pl. 1, Fig. 8). STÜMER colln.
- Fig. 2: *Simbirskites (Simbirskites)* sp. (*decheni* group). (cf. *S. (S.)* cf. *decheni* var. c in RAWSON 1971a, Pl. 12, Fig. 6). STÜMER colln.
- Fig. 3: *Simbirskites (Simbirskites)* cf. *decheni* (ROEMER). KÜSTERMANN/HOBBE colln. (Cast: NLIB, Kh. 39).
- Fig. 4: *Simbirskites (Simbirskites)* sp. (*decheni* group). (cf. *S. (S.) decheni decheni* (ROEMER) BÄUM 1964, Pl. 1, Fig. 4). STÜMER colln.
- Fig. 5: *Simbirskites (Simbirskites)* sp. (*decheni* group). STÜMER colln.
- Fig. 6: *Simbirskites (Simbirskites)* cf. *picteti* (WEERTH). KÜSTERMANN/HOBBE colln. (Cast: NLIB, Kh. 48).
- Fig. 7: *Simbirskites (Simbirskites) picteti* (WEERTH). Topotype, Osning Sandstein, Tönsberg. WEERTH colln., Lippisches Landesmuseum, Detmold. (Cast: NLIB, Kh. 61).
- Fig. 8: *Simbirskites (Simbirskites) picteti* (WEERTH). Silicone rubber cast (NLIB, Kh. 40) from a natural external mould of the umbilical region in the STÜMER colln.
- Fig. 9: *Simbirskites (Simbirskites)* cf. *picteti* (WEERTH). KÜSTERMANN/HOBBE colln. (Cast: NLIB, Kh. 47).
- Fig. 10: *Simbirskites (Simbirskites) picteti* (WEERTH). STÜMER colln.



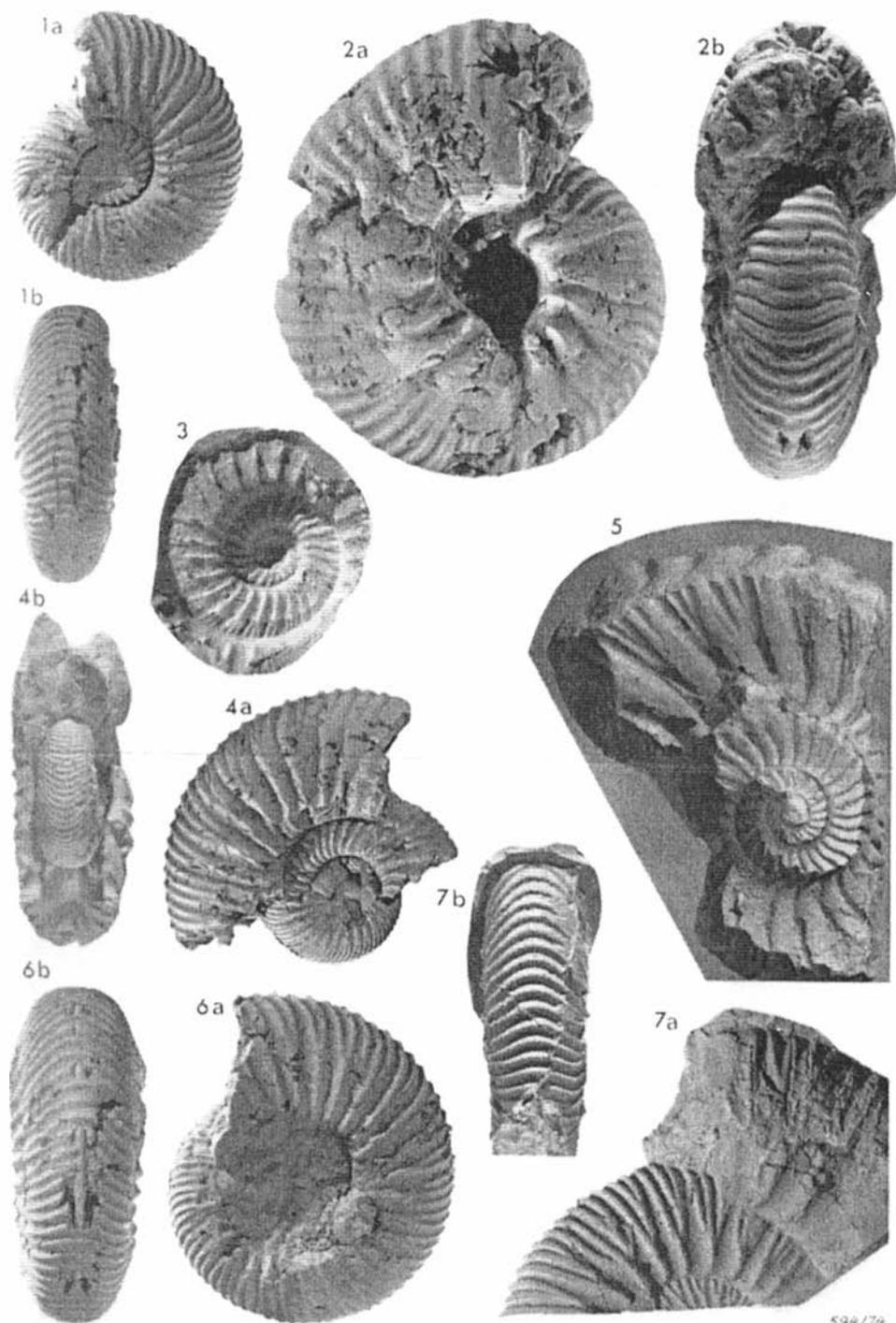
**Tafel 2**

- Fig. 1: *Simbirskites (Milanowskia) rugosus* KOENEN. Neotype, KÜSTERMANN/HOBBE colln. (Cast: NLF, Kh. 42).
- Fig. 2: *Simbirskites (Milanowskia) rugosus* KOENEN. STÜMMER colln.
- Fig. 3: *Simbirskites (Milanowskia) rugosus* KOENEN. KÜSTERMANN/HOBBE colln. (Cast: NLF, Kh. 41).
- Fig. 4: *Simbirskites (Milanowskia) concinnus* (PHILLIPS). STÜMMER colln.
- Fig. 5: *Simbirskites (Speetonicerus) inversum* (M. PAVLOW). STÜMMER colln.
- Fig. 6: *Simbirskites (Milanowskia) ihmensis* BÄHR. *ihmensis* Subzone, *staffi* Zone, Ziegelei Moorberg, Sarstedt. NLF, Kh. 43 (collected by the author).
- Fig. 7: *Simbirskites (Milanowskia) ihmensis* BÄHR. STÜMMER colln.



## Tafel 3

- Fig. 1: *Simbirskites (Milanowskia) helgolandensis* n. sp. Paratype. STÜMMER colln. (Cast: NLIB, Kh. 64).
- Fig. 2: *Simbirskites (Craspedodiscus)* sp. STÜMMER colln.
- Fig. 3: *Simbirskites (Milanowskia)* sp. Silicone rubber cast (NLIB, Kh. 45) of the umbilical region from an external mould in the STÜMMER colln.
- Fig. 4: *Simbirskites (Milanowskia) helgolandensis* n. sp. Holotype. STÜMMER colln. (Cast: NLIB, Kh. 52).
- Fig. 5: *Simbirskites (Milanowskia)* sp. Plaster cast made by the NLIB (NLIB, Kh. 62) of the umbilical region from an external mould in the KÜSTERMANN-HORBEJE colln.
- Fig. 6: *Simbirskites (Milanowskia) helgolandensis* n. sp. Paratype. STÜMMER colln. (Cast: NLIB, Kh. 65).
- Fig. 7: *Simbirskites (Milanowskia) stalli* WEDEKIND. Silicone rubber cast (NLIB, Kh. 44) from an external mould in the RAUCHFUSS colln.



**Tafel 4**

- Fig. 1: *Simbirskites (Craspedodiscus)* sp.
- Fig. 2: *Simbirskites (Craspedodiscus) gottschei* (KOENEN).
- Fig. 3: *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). Neotype, an involute, finely ribbed form. (Cast: NLFB, Kh. 49).
- Fig. 4: *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). A less involute, coarsely ribbed form.
- Fig. 5: *Simbirskites (Craspedodiscus) phillipsi* (ROEMER).
- Fig. 6: *Simbirskites (Craspedodiscus)* aff. *phillipsi* (ROEMER).
- Fig. 7: *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). A less involute coarsely ribbed form. (Cast: NLFB, Kh. 50).
- Fig. 8: *Simbirskites (Craspedodiscus)* aff. *phillipsi* (ROEMER). (Cast: NLFB, Kh. 51).
- Fig. 9: *Simbirskites (Craspedodiscus) phillipsi* (ROEMER). An involute, finely ribbed form. (Cast: NLFB, Kh. 46).
- Fig. 10: *Simbirskites (Craspedodiscus) gottschei* (KOENEN).

All specimens from the STÜRMER collection.

