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DE DANSKE NÛGSSUAQ EKSPEDITIONER 1938–39
UNDER LEDELSE AF ALFRED ROSENKRANTZ

DANIAN FORAMINIFERA FROM NÛGSSUAQ, WEST GREENLAND

WITH SPECIAL REFERENCE TO SPECIES OCCURRING IN DENMARK

BY

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WITH 40 FIGURES IN THE TEXT,
AND 33 PLATES

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København, den 6. juli 1970.

Thor A. Bak
h. a. dec.

1) A technique for depiction of grind sections of foraminifera by aid of compiled electronmicrographs. Meddr dansk geol. Foren. 17, 128–129, 2 pl. 1967.
2) X-ray diffractometer investigations of a radiate and a granulate foraminifer. Meddr dansk geol. Foren. 18, 345–348. 1968.
3) A technique for removing gold from plated calcareous microfossils. Micropaleontology, 14, 499–500. 1968.
4) On the biostratigraphical age of the Lower Selandian of Denmark. Meddr dansk geol. Foren. 18, 277–284, 1968.
5) Combined light- and electron microscope studies on thin sections. Micropaleontology, p. 426, 1970.
6) Electron-microscopical studies on the ultrastructures of some perforate calcitic radiate and granulate foraminifera. Kgl. Dan. Vid. Selsk. Biol. Skr. 17, 2, 16 pp, 26 pl. 1970.

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Abstract

The stratigraphy of the Lower Danian Kangilia Formation and the Upper Danian Agatdal Formation cropping out on the north coast and in the central part of Nûgssuaq is discussed. The local abundance of marine fossils in the Agatdal Formation is explained as due to redeposition and transportation before the shales of the Agatdal Formation were dehydrated and compressed.

On the basis of planktonic foraminifera *viz. Globoconusa daubjergensis*, *Globigerina compressa*, *Subbotina triloculinoides* and *Subbotina pseudobulloides* the age of the Agatdal Formation is assigned to Upper Danian.

The foraminiferal fauna of the Agatdal Formation is composed of 57 species. The affinity of the fauna to European Paleocene faunas is stronger than to North American faunas.

The biostratigraphical zonation of Danian deposits based on the occurrence of planktonic foraminifera is discussed.

In the systematic part the fauna is described and illustrated.

Atlanta primigenia RAVN, 1918, originally described as a heteropod, is shown to be a foraminifer belonging to the genus *Cornuspiroides.*

By measurement of the proloculus diameter it is shown that the distribution of megalospheric proloculi of *Bulimina midwayensis* remains constant from the Upper Maastrichtian to the Middle Selandian.

The same character is used to distinguish *Bulimina rosenkrantzi* from *Bulimina trigonalis* and *Bulimina thanetensis.*

On the basis of studies of wall ultrastructures of *Subbotina triloculinoides* it is shown that the genus *Subbotina* is well distinguished from the genus *Globigerina.* The wall of *Subbotina triloculinoides* is bilamellar with an overlying laminated crust like the one found in *Globorotalia menardii*, which phenomenon is illustrated by transmission electron micrographs.

The genera *Allomorphina*, *Quadrimorphina* and *Pallaimorphina* are discussed. The latter is shown to be a valid genus. *Allomorphina* is inhomogeneous with respect to species with and without tooth-plates. *Allomorphina paleocenica* is an allomorphinid without tooth-plate and should accordingly be referred to a genus other than *Allomorphina.* The author's limited material prevents the establishment of a new genus.

In *Alabamina rosenkrantzi* n. sp. is found a secondary closure of the foramina. Lower Tertiary alabaminas show preferred sinistral coiling.

Granulate monolamellar species earlier referred to the genus *Eponides* are placed in a new genus *Paralabamina* which belongs to the family Alabaminidae.

The genera *Gyroidina*, *Gyroidinoides* and the group of species morphologically close to "*Gyroidina*" *soldanii* are shown to be well distinguished in apertural characters. The genus *Gyroidinoides* is transferred to the family Anomalinidae, in which also *Gyroidina* and "*Gyroidina*" *soldanii* belong.

Eight new species are described. Two belong to the genus *Lenticulina*, two to *Fissurina*, one to *Rosalina*, one to *Pallaimorphina*, one to *Alabamina* and one to *Ceratobulimina.*

CONTENTS

INTRODUCTION

The material described in this paper was collected by Professor A. Rosenkrantz and co-workers during a series of expeditions to Nûgssuaq, West Greenland (figs 1 and 2).

The Danish Nûgssuaq Expeditions 1938–39 and the expeditions by the Geological Survey of Greenland under the leadership of Professor A. Rosenkrantz collected a large quantity of fossils.

During preparation of a gastropod from a Danian sandstone lens from central Nûgssuaq Professor A. Rosenkrantz found uncemented sediment containing foraminifera inside the shell. He drew the author's attention to the possibility of obtaining material of foraminifera by crushing gastropod shells from the sandstone beds. By following the suggested method a foraminiferal fauna was collected.

The author was given the opportunity to join an expedition to Nûgssuaq by the Geological Survey of Greenland in the summer 1968. The programme was a search for foraminifera in the sequence of black shales underlying the fossiliferous sandstones.

The author therefore took into the field a microscope and equipment to disintegrate the sediment samples by the paraffin method. In spite of the rather large number of samples investigated no foraminifera were found and accordingly the present work deals only with the foraminiferal fauna from the sandstone beds.

Earlier records of foraminifera from Nûgssuaq

In 1918 Ravn recorded 2 species of foraminifera from Atâ (fig. 2): *Nodosaria zippei* Reuss and *Dentalina farcimen* Soldani. Both are represented by casts in burned shale. *Nodosaria zippei* is most probably identical with *Nodosaria latejugata* Gümbel while the *Dentalina* casts cannot be determined to species.

In a calcareous concretion from west of Alianaitsúnguaq (fig. 2) Ravn found a fractured specimen which he referred to the genus *Dentalina*. In the opinion of the present author the genus determination is correct, but the material (one specimen) cannot be determined to species.

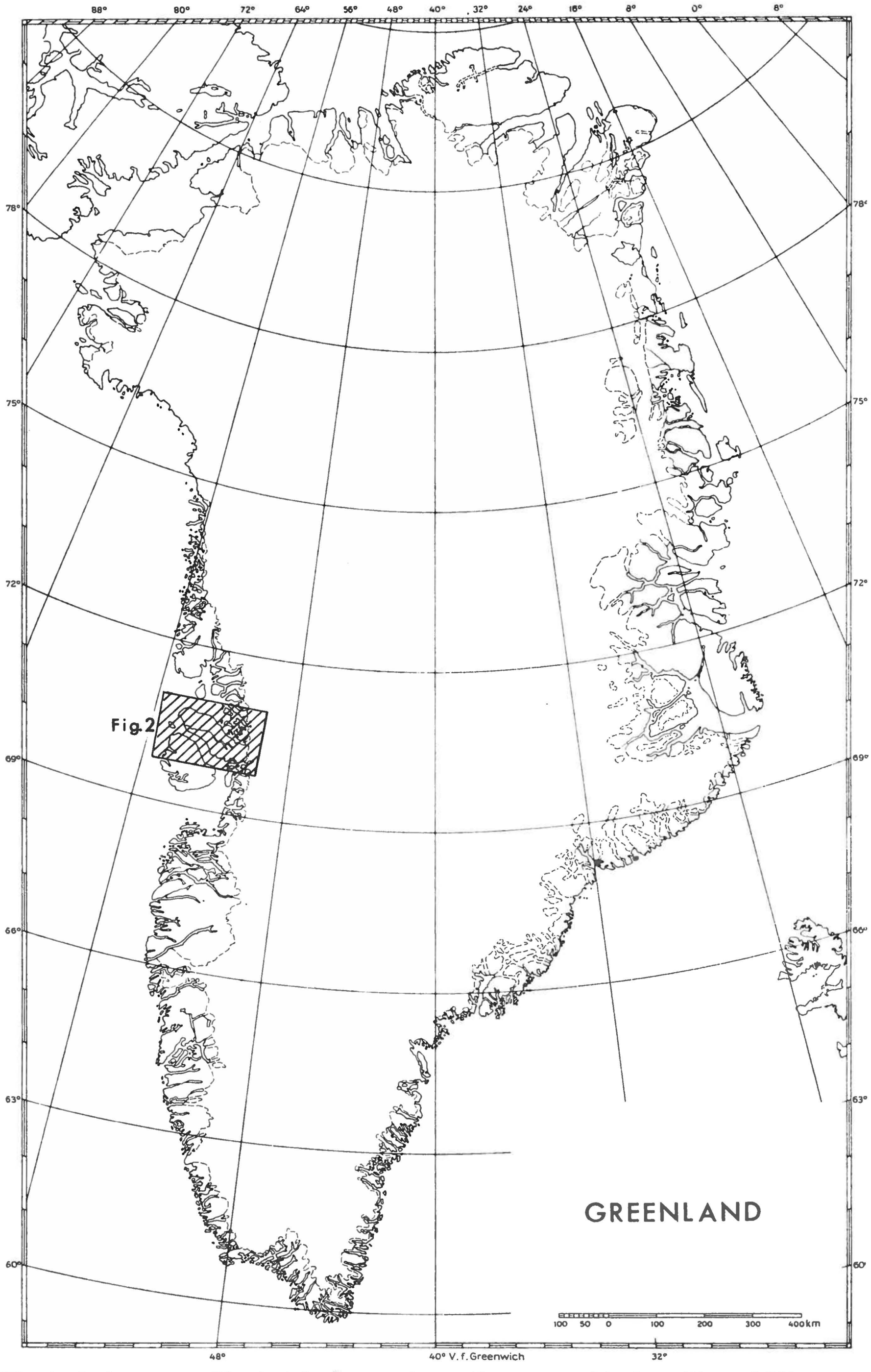

Fig. 1. Index map. The hatched area shows the geographical position of Nûgssuaq. Reproduceret med tilladelse (A. 620/70) af Geodætisk Institut.

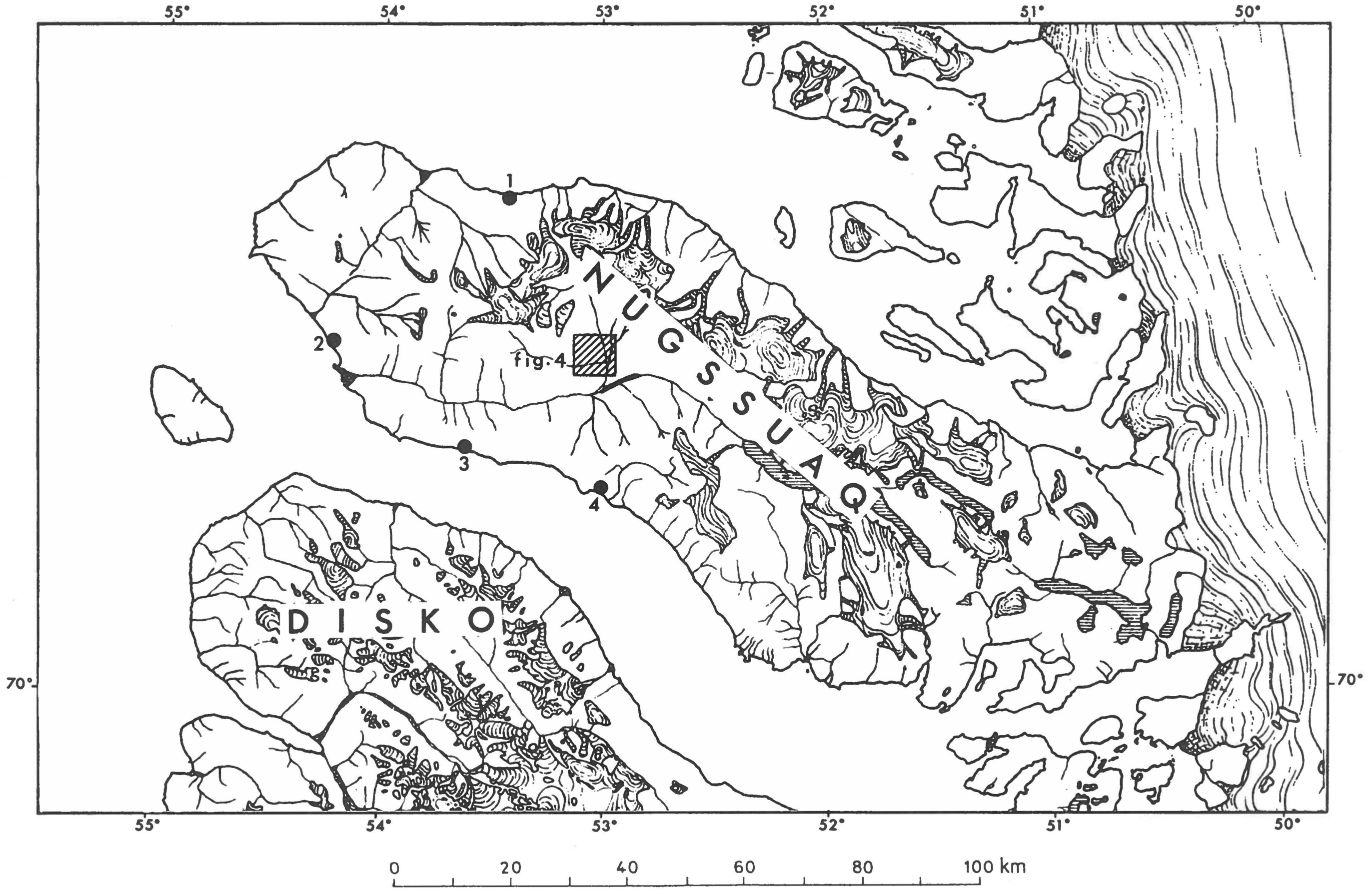

Fig. 2. Nûgssuaq showing numbers referring to localities mentioned in the text: 1. Kangilia and Angnertuneq + Niaqorssuaq. 2. Marrait kitdlît. 3. Alianaitsúnguaq. 4. Atâ.

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Ravn described a new "gastropod" species *Atlanta primigenia* from the Kangilia Formation on the south coast of Nûgssuaq. The "gastropod" is actually a foraminifer belonging to the genus *Cornuspiroides* (see p. 41).

Foraminifera from the Kangilia Formation

Besides the above-mentioned species the author has seen foraminifera in thin sections of concretions from the Kangilia Formation from central Nûgssuaq.

The sections made of concretions both with and without macrofossils showed the presence of foraminifera. Arenaceous and calcareous hyaline radiate and granulate species were found. The random sections do not allow either species or genus determinations.

A piece of burned shale from Atâ (fig. 2) from the Kangilia Formation collected by Professor A. Rosenkrantz contained about 50 casts of *Dentalina* sp. The bad state of preservation prevents a species determination.

LOCALITIES

The following account of the Danian localities and their geological history is based mainly on observations made by Professor A. Rosenkrantz and co-workers during a series of expeditions to Nûgssuaq from 1938 to 1968. Some of the information concerning the deposits and their content of fossils mentioned in the following has already been published (Rosenkrantz, 1951, 1955, 1959, 1970; Rosenkrantz & Pulvertaft, 1969; Rosenkrantz et al., 1940; Koch, 1959, 1963, 1964; Birkelund, 1965; Bendix-Almgreen, 1969; Floris (in press); Szczechura (in press).

As the geological map of Agatdalen and surroundings is in preparation and as a description of the different localities and their stratigraphical relations will be published by Professor A. Rosenkrantz, only the localities of direct interest for the understanding of the stratigraphy of the deposits concerned are described here.

The north coast

The Danian sediments which crop out on the north coast of Nûgssuaq have been studied by the present author in a series of sections extending from Niaqorssuaq in the west to Kangilia in the east, a distance of about 5 km (fig. 2).

The sedimentary sequence is best exposed in the river gullies at Angnertuneq and Kangilia (fig. 3). The whole sedimentary sequence, including the underlying Maastrichtian and Campanian, dip gently towards the southeast.

Overlying the Maastrichtian sediments, which consist of dark bituminous shales with concretions, is a conglomerate with a thickness of about 50 m. In the conglomerate re-deposited concretions of supposed Maastrichtian age are found. Except for a piece of fossil wood so far no fossils have been found in these concretions.

According to studies by Binzer 1968 (personal communication) the conglomerate was most probably deposited by a river running from southeast towards northwest. This is based on observations of boulder

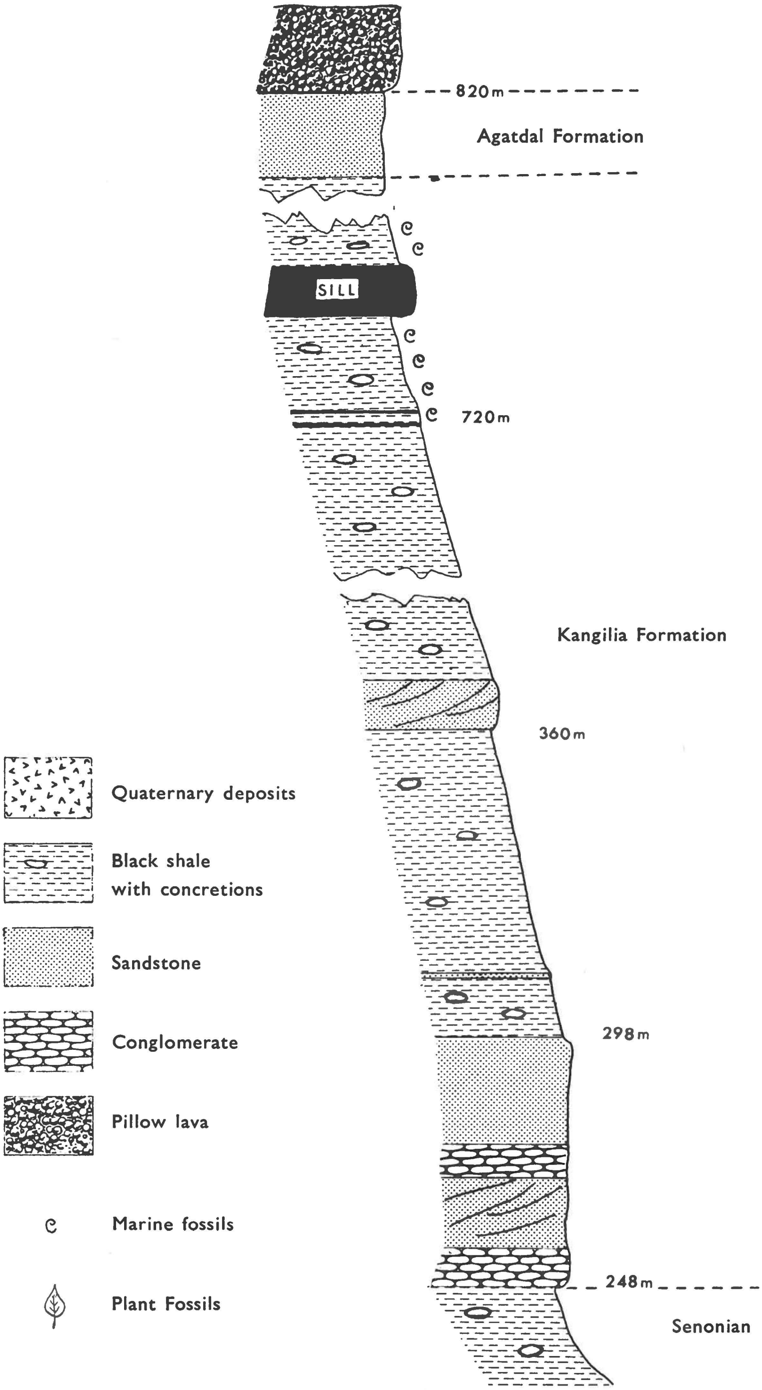

Fig. 3. Idealized section through the sedimentary sequence exposed in the gullies of the rivers at Angnertuneq and Kangilia on the north coast of Nûgssuaq. The tuff layers mentioned in the text are at 720 m. Altitudes above sea level. For description see text. Legend also for figs 5–8.

orientation and cross bedding. The deposition was most likely connected with a tectonic disturbance of the crystalline basement which brought large blocks of gneiss into the sedimentary basin (ROSENKRANTZ & PULVERTAFT 1969).

The crystalline basement crops out at Ikorfat and east of that point and constitutes the main part of the eastern region of Nûgssuaq.

In the western valley of the river at Niaqorssuaq the Maastrichtian-Danian boundary is found at an altitude of 260 m, but the conglomerate is disturbed, most likely by the intrusion of a picrite body, apophyses of which are found in the highest gully of the valley at Kangilia.

Eastwards in the river valleys at Angnertuneq and Kangilia the Maastrichtian-Danian boundary is found at an altitude of 300 and 200 m respectively. In the cliff between the two rivers where the conglomerate is best exposed, the boundary with the underlying Maastrichtian black shales is very sharp and well defined. The topography of the boundary is somewhat undulating and an erosional unconformity seems to be present.

An idealized section through the Danian deposits of the valley of the river at Kangilia is shown as fig. 3.

In the western part of the river valley at Kangilia 60 m above the Danian basal conglomerate is developed a 10 m thick sandstone and conglomerate sequence. Cross bedding and boulder orientation indicate a current direction from the northwest.

In the eastern part of the Kangilia valley the Danian conglomerate is followed by a monotonous series of black, bituminous shale with concretions.

East of Kangilia between the black shales and the overlying basalt breccia there is locally developed an unfossiliferous sandstone sequence of about 20 m thickness. This part of the section is most likely equivalent to the Agatdal Formation from the central area of Nûgssuaq. The total thickness of the basal conglomerate and overlying black shales (= Kangilia Formation) (ROSENKRANTZ & PULVERTAFT, 1969) is about 550 m.

The lower 400 m shales with concretions contain only few fossils.

Above the 400 m shales are found fossiliferous tuff layers intercalated with bituminous shales with concretions. The rich fauna in the concretions at this level consists of gastropods, bivalves, corals, echinoderms and nautiloids which indicate a Lower Danian age.

20 m above the tuff beds in the central part of the valley at Kangilia is found a picrite sill with many xenoliths of unmetamorphosed concretions from the Danian shales. The picrite sill varies in thickness from 20 to 30 m and runs somewhat irregularly in the shales showing many transgressions.

The picrite sill is followed by 120 m of black, bituminous shales with fossiliferous concretions.

A series of samples of the shales from the Kangilia Formation and the underlying Senonian shales have been investigated for foraminifera but nothing was found.

The central part

Agatdalen

The oldest Danian sediment found in the Agatdalen area is the Oyster-Ammonite Conglomerate, which crops out at the three localities shown in fig. 4.

The conglomerate, which rests on Campanian rocks, consists of numerous derived concretions from eroded Maastrichtian and Campanian beds. The concretions contain a rich fauna mainly consisting of ammonites which have been described by BIRKELUND (1965). Besides concretions there are boulders of bituminous shale and sandstone. In the matrix are numerous specimens of a *Pycnodonte.*

Above the Oyster-Ammonite Conglomerate is a monotonous series consisting of black bituminous shale with concretions. Although no continuous section through this part of the series is exposed, the thickness can be estimated to about 75 m. In its upper part exposed below the locality "Ättestupan" (fig. 4) is a molluscan fauna which can be equated with the one found above the tuff layers in the Kangilia Formation on the north coast.

Above the bituminous shales (= Kangilia Formation) follows the Agatdal Formation (see ROSENKRANTZ in KOCH 1959, KOCH 1963, 1964; ROSENKRANTZ & PULVERTAFT 1969, ROSENKRANTZ 1970).

Turritellakløft

A. The Big Section (fig. 4)

The Big Section on the north side of the Turritellakløft is the type locality for the Agatdal Formation which was divided into three members by ROSENKRANTZ (see ROSENKRANTZ in KOCH 1959). The members are in ascending order: Turritellakløft Member — Andreas Member — Abraham Member.

The Turritellakløft Member was described as "a sequence of black shales up to 50 m thick including numerous sandstone lenses carrying plenty of marine fossils".

Foraminifera from this member were first found in the soft infilling of a *Polynices* being prepared by Professor A. ROSENKRANTZ.

The foraminiferal fauna from this gastropod consists of twenty species all of which are found also in the gastropod infillings from the Sonja Member.

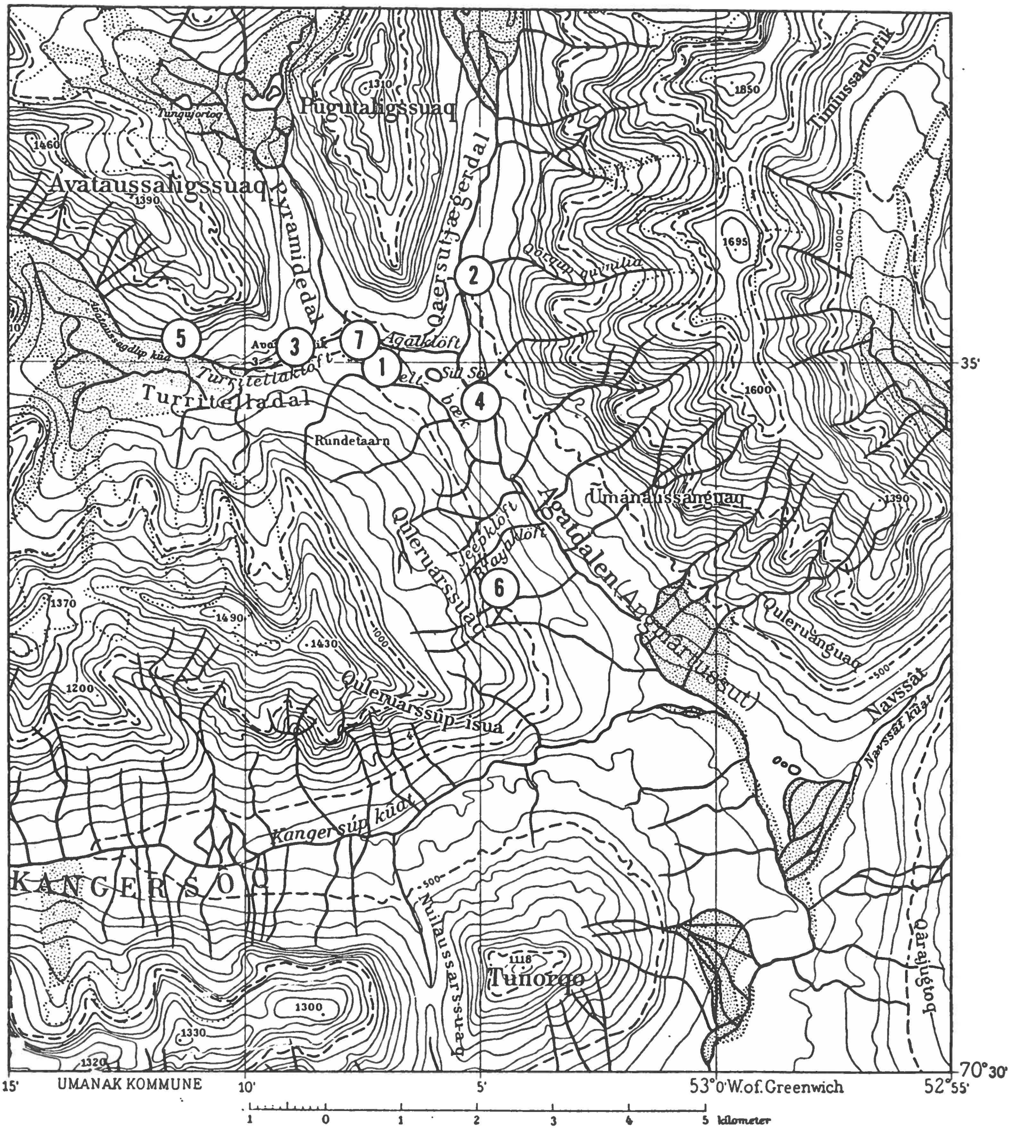

Fig. 4. Map of the Agatdalen area showing localities mentioned in the text. 1. The Sonja Member profile. 2. Qaersutjægerdal. 3. The big section, Turritellakløft. 4. Oyster-Ammonite Conglomerate loc. I and II. 5. The section along the dead glacier, Turritellakløft. 6. Oyster-Ammonite Conglomerate loc. III.

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The foraminifera from the Turritellakløft Member have not been kept separate from the fauna from the Sonja Member (see p. 19).

The Andreas Member was stated to consist of "deltalike deposits of coarse sandstone with very few fossils". Its thickness varies from 10 m increasing eastwards to 25 m.

The Abraham Member was defined as "an up to 12 m thick series of alternating black shales and rather coarse, fossiliferous tuffs".

The Abraham Member is overlain by subaquatic pillow lavas and pillow breccia.

B. The section along the dead glacier (fig. 4)

The section is composed of 5–10 m black bituminous shale of the Turritellakløft Member overlain by conglomerate and sandstone beds of 1 to 2 m thickness alternating with shale. Above the sandstones follow black shales with thin tuff layers which again are overlain by basalt breccia. The alternating shale and tuff layers belong to the Abraham Member, while the Andreas Member cannot be distinguished in the section.

Of particular interest in this section is the occurrence in the conglomerate of bored, derived Danian concretions from the Kangilia Formation.

Qaersutjægerdal

In the eastern side of the gorge of the river in Qaersutjægerdal is a continuous exposure which extends for several hundreds of meters in a north to south direction. Professor A. ROSENKRANTZ measured a section in 1951 in the highest part of the exposure at the south end. In the northern part of the exposure the present author measured another section (fig. 5), largely identical with the one measured by ROSENKRANTZ. The exposure shows an angular disconformity between black, bituminous shale, which according to its fossil content belongs to the Kangilia Formation, and the Turritellakløft Member of the Agatdal Formation. The latter is developed as conglomerate and sandstone which, at certain levels, is highly fossiliferous (see KOCH, 1963).

Above the Turritellakløft Member follows the Abraham Member which again is overlain by basalt breccia.

Agatkløft

A. The Sonja Section

The locality of the Sonja Section is situated in the south side of the Agatkløft very close to the Turritellakløft.

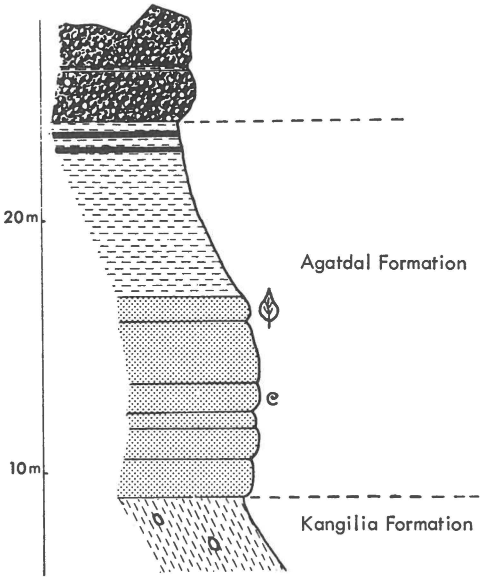

Fig. 5. Measured section in the east wall of the gully of Qaersutjægerdal. The upper part of the section just below the pillow lava belongs to the Abraham Member while the fossiliferous sandstones belong to the Turritellakløft Member. Altitudes above the river bed. For description see text. Legend as in fig. 3.

In 1948 Professor A. Rosenkrantz measured the section in detail, and the author re-measured the exposure in 1968 (fig. 6).

The Sonja Member of the Agatdal Formation was defined by Rosenkrantz (in Koch 1959). It consists of 42 m alternating loose sand, sandstone, conglomerate and black shale.

The Sonja Member is underlain by black bituminous shale. The lowermost 8 m of the section (not shown in fig. 6) were covered by scree in 1968 when the section here shown was measured.

The Sonja Member is a large lens-shaped body deposited by a river with current direction from the southeast. The lens-shape would appear to have arisen in association with the compression of the surrounding black shales. The large conglomerate found about 16 m above the river bed can be followed in an easterly direction in the river gorge where it gets coarser and contains larger boulders.

The Sonja Lens of the Sonja Member lies 37 m above the river bed. The uncemented, fossiliferous lens has been completely excavated by Professor A. Rosenkrantz and co-workers. The amount of material excavated has a weight of about six tons. According to information from Professor A. Rosenkrantz the Sonja Lens was 7 m long and 0.7 m thick.

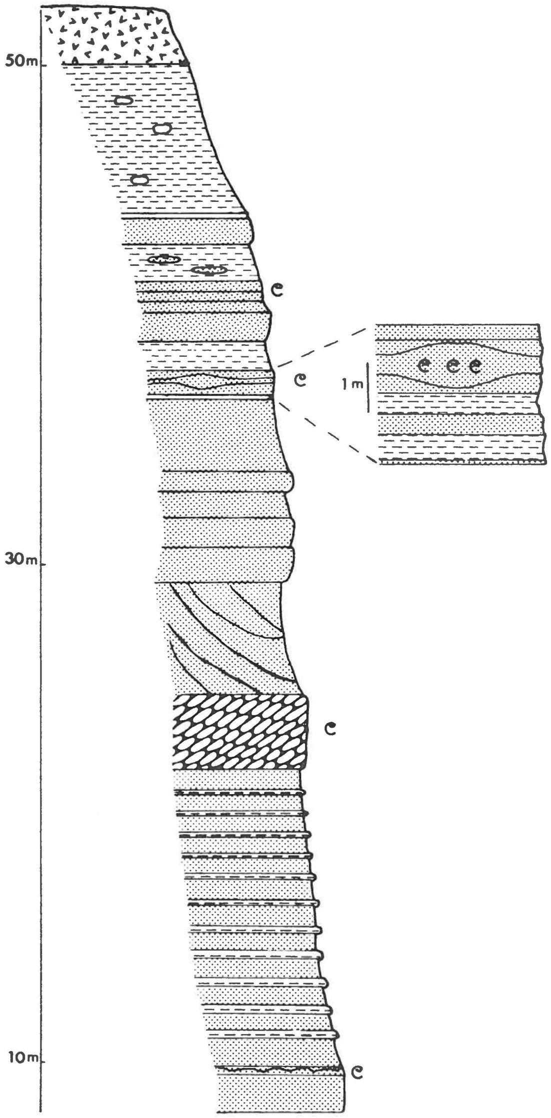

Fig. 6. Measured section, the Sonja Member, in the south wall of Agatkløft. The enlarged part shows the fossiliferous Sonja Lens. Altitudes above the river bed. For description see text. Legend as in fig. 3.

Pieces of the original Sonja Lens have been sectioned and pointcounted by the author. A micrograph of a thin section is shown on pl. 1, fig. 1. The pointcounting based on three thin sections showed the following composition:

quartz	81 %
microcline	6 %
fossils	13 %

On the basis of the pointcountings of these three thin sections the rock must be classified as a fossiliferous subarkose.

Pieces of the rock have been treated with hydrochloric acid resulting in a 12 $^0/_0$ loss of weight. The loose residue was screened to determine the grain size distribution. The sediment is well-sorted with most of the particles lying in the interval between 250 and 500 μ.

The macrofossils in the Sonja Lens are in a good state of preservation. The lens has been lying protected by hardened sandstones both above and below. Inside the gastropods fine, loose material has been protected and the main part of the material, on which the present study is based, originates from gastropod fillings from the Sonja Lens. Several hundreds of worn gastropods were crushed in a rock-crusher and the fine material was washed out. Specimens of the *Natica*-group were used preferably, as they turned out to contain the largest number of foraminifera per gram gastropod. 14 specimens of a *Natica* with a weight of 14 grams contained 118 foraminifera and 8 ostracods.

B. "Ättestupan"

The section at "Ättestupan" is about 500 m northwest of the Sonja Section. It is 76 m high and shows an almost continuous exposure from the river bed upwards. The main part consists of black bituminous shale with concretions. According to fossil evidence the lowermost part belongs to the Kangilia Formation, while the rest of the section has yielded no stratigraphically useful fossils. The uppermost part was measured by the author and is here shown as fig. 7. It consists of alternating shale and tuff beds and belongs to the Abraham Member of the Agatdal Formation. The shale above the one belonging to the Kangilia Formation and below the Abraham Member must, at least partially, be the lateral equivalent of the Sonja Member which again must be con-

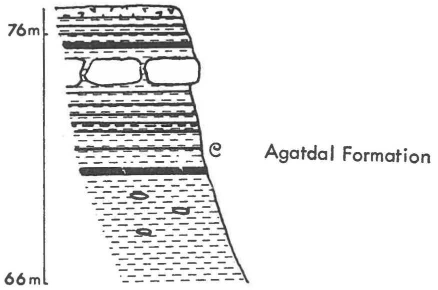

Fig. 7. Measured section at "Ättestupan" in the west wall of Agatkløft. This part of the profile belongs to the Abraham Member. Altitudes above the river bed. For description see text. Legend as in fig. 3.

sidered the equivalent of the Turritellakløft Member and the Andreas Member.

Samples of the Senonian and Danian shale sequence from Agatdalen have been investigated for foraminifera by the present author but nothing was found.

Conclusions

The development of the sedimentary basin as found on Nûgssuaq and Svartenhuk has been described by ROSENKRANTZ & PULVERTAFT (1969). The following is an attempt to place the sections described above in relation to the development of the sedimentary basin during Danian times.

Danian sedimentation was initiated on the north coast of Nûgssuaq west of the Ikorfat fault with the development of about 50 m of conglomerate.

The instability in connection with the Laramide Orogeny (ROSENKRANTZ et al. 1940, ROSENKRANTZ 1951, 1970) caused movement of the eastern part of Nûgssuaq giving rise to the thick conglomerate which thins out towards west. After the initial instability a quieter period followed in which the monotonous Kangilia Formation was deposited on the north coast. This time interval most probably lasted through the main part of the Lower Danian. New instability is indicated by the tuff layers in the upper part of the Kangilia Formation. These tuffs probably mark the time when sedimentation in the central part of Nûgssuaq started with the deposition of the Oyster-Ammonite Conglomerate. The erosion of the Senonian sediments in the central part would thus appear to have lasted during the main part of the Lower Danian. After the extrusion of the volcanic ash a more stable period with the sedimentation of the bituminous shale of the Kangilia Formation occurred both on the north coast and in the central area.

Renewed movements in the Ikorfat fault allowed the deposition of the Agatdal Formation in which are found boulders of Precambrian rocks. These boulders presumably originated from exposures of the crystalline basement found just east of the Ikorfat fault.

The Agatdal Formation must therefore be visualised as somewhat variable deltaic deposits from rivers affected by the tectonic movements marking the beginning of the extrusion of the kilometer thick basalt series. These movements caused the unconformity between the Kangilia Formation and the Agatdal Formation in Qaersutjægerdal which lies towards the east close to the Precambrian basement. Fig. 8 is a schematic correlation diagram.

The local abundance of marine fossils in the Agatdal Formation is related to the fact that many of the specimens show signs of transporta-

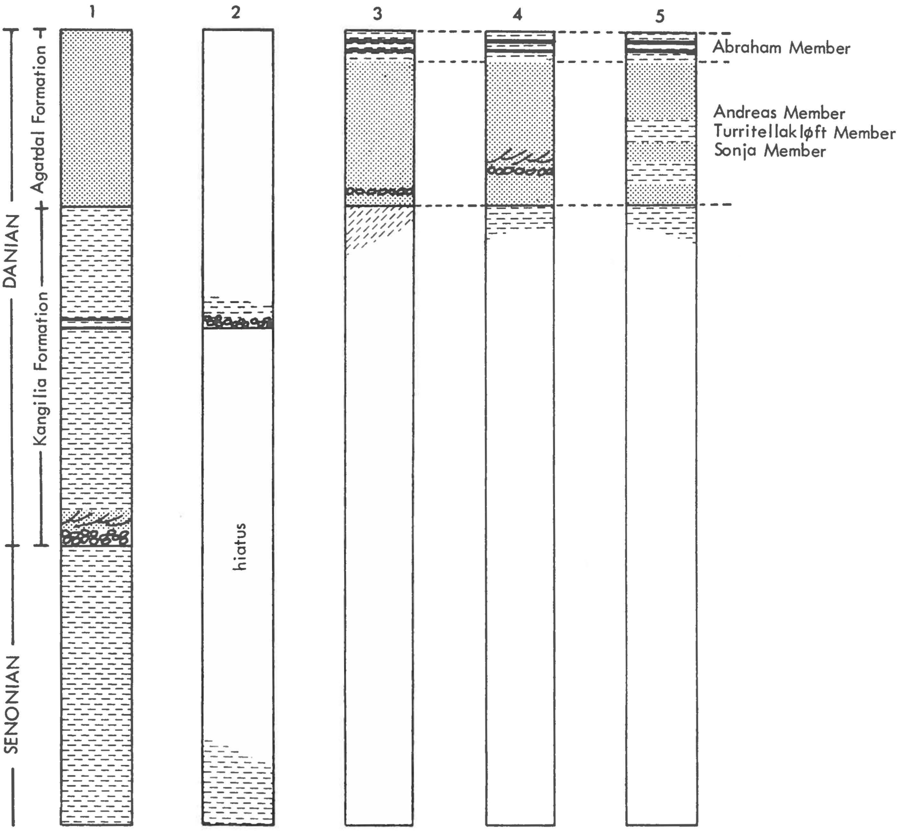

Fig. 8. Highly schematic correlation diagram between outcrops mentioned in the text. Not to scale. 1. The north coast. 2. Oyster-Ammonite Conglomerate localities I, II and III. 3. Qaersutjægerdal. 4. The Sonja Section and "Ättestupan". 5. The Big Section, Turritellakløft. Legend as in fig. 3. The thicker dark bands represent tuff layers.

tion. It is highly unlikely that the more than 300 species of gastropods found in the Sonja Lens should have been living together in the same environment.

When studying the character of the bituminous shale of the Kangilia and Agatdal Formations, it is evident that the calcareous organisms have been living on the bottom, but that their shells in general have been dissolved in the shale although they have been preserved in the concretions. In some concretions whole bedding planes are found covered with fossils. It is the opinion of the present author that the fossils of the Agatdal Formation have been concentrated by the rivers, which brought material from east towards west. They have brought with them not yet dissolved fossils from the underlying shale (which in most places belongs to the Turritellakløft Member) before the shale was dehydrated. That the surrounding shale had not yet suffered diagenesis when the conglomerates and sandstones of the Agatdal Formation were deposited is indicated by the shape of the Sonja Member mentioned earlier.

The river at Marrait kitdlît

In the western part of Nûgssuaq at the locality Marrait kitdlît (fig. 2) in 1964 K. Binzer found a fossiliferous whitish-greyish layer about 1 m thick resting on tuff-beds and overlain by pillow lava. The rock is a fossil breccia composed almost exclusively of fragments of fossils. Thin sections of the rock showed that the shells are recrystallized. However, a more hardened variety of the rock, the so-called Skou Lens, yielded some poorly preserved foraminifera during the preparation of macrofossils.

In spite of the poor state of preservation the following species could be recognized:

Quinqueloculina naheolensis Cushman, 1927 (6 specimens).
Quinqueloculina plummerae Cushman & Todd, 1942 (8 specimens).
Pararotalia tuberculifera (Reuss, 1862) (1 specimen).
Rosalina elegans n. sp. (2 specimens).
Anomalinoides howelli (Toulmin, 1941) (5 specimens).
Gavelinella danica (Rrotzen, 1940) (2 specimens).
Lenticulina spp. (11 specimens).
Patellina sp. (1 specimen).

The remaining 98 specimens of foraminifera from the Skou Lens are in such a bad state of preservation that they can hardly be determined to genus.

The age of the fossil breccia must be regarded as Upper Danian (~ Agatdal Formation) because of the occurrence of a *Tylocidaris* close to *Tylocidaris vexillifera* which is found also in the Abraham Member of the Agatdal Formation (Rosenkrantz, 1970).

The major part of the above listed foraminifera are referred to forms occurring in the Agatdal Formation of central Nûgssuaq.

THE STRATIGRAPHICAL AGE OF THE FAUNA

The Danian deposits on Nûgssuaq are naturally divided into a lower and an upper part corresponding respectively to the Kangilia Formation and the Agatdal Formation. These formations are separated by either an unconformity or by a disconformity.

In the Kangilia Formation is e.g. found *Tylocidaris* aff. *oedumi* (see ROSENKRANTZ, 1951). *T. oedumi* is guide fossil for the Lower Danian in Denmark. In the Abraham Member of the Agatdal Formation is a *Tylocidaris* which is close to *Tylocidaris vexillifera* (see ROSENKRANTZ, 1970). *T. vexillifera* is guide fossil for the Upper Danian in Denmark.

Few of the foraminiferal species from the Agatdal Formation are of stratigraphic importance. When, however, considered together with the macrofauna the Agatdal Formation can be assigned to the Upper Danian.

Of the 57 species of foraminifera from the Sonja Member of the Agatdal Formation from central Nûgssuaq 8 are described as new and 11 not identified to species. Of the remaining 38 species 18 are found both in Europe and North America; 13 species are found only in Europe and 7 are known only from North America.

Of the foraminifera the planktonic forms *Globoconusa daubjergensis*, *Subbotina triloculinoides*, *Subbotina pseudobulloides*, and *Globigerina compressa* constitute a typical Upper Danian fauna (TROELSEN, 1957). The two specimens of *G. compressa* have not been described and figured in the systematic part of this paper. The specimens were lost by a technician in Stockholm, where the author had taken some material to be examined in a Jeol scanning electron microscope.

According to ROSENKRANTZ (1970) the Agatdal Formation must be placed in the lower part of the Upper Danian in view of the composition of the very rich gastropod fauna.

STRATIGRAPHICAL DISCUSSION

A vast amount of literature dealing with Danian sediments, fossils, and stratigraphy has accumulated during the last 50 years. The majority of stratigraphers now place the Mesozoic-Cenozoic boundary at the base of the Danian, thus including the Danian as the oldest part of the Tertiary. This point of view is shared by the present author.

In his original definition of the Danian, DESOR (1847) mentioned Fakse and Stevns Klint as representative of the Danian in its type area. The delimitation of the Danian in Denmark has later been subject to some discussion (reviewed by BERGGREN, 1964). The lower boundary of the Danian is well exposed on Stevns Klint and has been described by several authors (see e.g. ROSENKRANTZ, 1924a, 1939, 1966; BERGGREN 1962, POZARYSKA 1965). In his study of 1926 ØDUM divided the Danian sediments of Denmark into a lowermost zone without *Tylocidaris* and above that four zones each characterized by a species of the echinoid genus *Tylocidaris.*

The *Tylocidaris*-free part of the Danian sediments is developed as the so-called Fish-Clay (0.2 m). The Fish-Clay is overlain by Cerithium-Limestone (2 m). The sediments of the four *Tylocidaris* zones are developed as bryozoan limestone, coral limestone and so-called coccolith limestone. The upper boundary of the Danian was placed by ØDUM at the Selandian basal conglomerate as exposed at the locality Hvalløse in Jylland.

The upper boundary of the Danian in Denmark has recently been discussed by the present author (HANSEN, 1968), who showed it to correspond well with the first appearance of *Globorotalia angulata* just above the Lower Selandian basal conglomerate in the Copenhagen region. The same boundary exposed in Hvalløse in Jylland corresponds well with the boundary in the Copenhagen region.

BANG (1969) recorded possible continuous sedimentation across the Danian-Selandian boundary encountered in submarine cores from Store Bælt in Denmark, without a marked change in fauna (see also LARSEN, 1965). This sequence has not been found in outcrops as far as the present author knows.

In the present work the Danian stage is defined as the time interval between the rocks found above the Maastrichtian White Chalk exposed on Stevns Klint up to and including the time of deposition of the rocks found below the Selandian basal conglomerate exposed at the locality Hvalløse in Jylland.

In his study of the foraminifera from the type Danian, TROELSEN (1957) found that *Globoconusa daubjergensis* occurred in all Danian rocks. The same applies to *Subbotina pseudobulloides* while *Subbotina triloculinoides* is not found earlier than the zone with *Tylocidaris bruennichi*. Of special importance (and this must be strongly stressed) is that *Globigerina compressa* makes its first appearance in the lowest part of the *Tylocidaris vexillifera* zone. This fact has been overlooked by many later authors.

In several papers BERGGREN (1960c, 1962, 1964) has discussed the Danian and Maastrichtian stratigraphy of Denmark and adjacent areas based on the occurrence of planktonic foraminifera. He stressed the profound change in fauna between the Maastrichtian and the Danian and consequently included the Danian in the Tertiary. His record of the range of planktonic forms in the Danian is largely identical with that of TROELSEN (1957). Berggren included the transition between the *bruennichi-vexillifera* zones and the whole of the *vexillifera* zone in a subzone characterized by *Globigerina compressa*. In his thorough review of earlier investigations of papers dealing with the Danian of southern Scandinavia, BERGGREN covered all essential publications up to 1963.

Later HOFKER (1966) discussed the stratigraphy of the Danian and Selandian of Denmark and repeated his earlier erroneous correlation of the type Maastrichtian with the type Danian (1962a). He correlated, in 1966, the Tuffeau de Ciply and Calcaire Grossier de Mons with beds slightly younger than the Lower Selandian. As shown by VINCENT (1930) and later by RASMUSSEN (1965) and MEIJER (1969) the Tuffeau de Ciply is of Danian age and is not correlatable with Middle Selandian beds. HOFKER's record of specimens from the Tuffeau de Ciply determined by him as species belonging to the keeled *Globorotalia* group has led many authors to assign a wrong age to this deposit. The mistake has already been corrected by BERGGREN (1962), BARR & BERGGREN (1964, 1965), and by GOHRBANDT (1963) who stated that the forms mentioned by HOFKER are poorly preserved benthonic forms. MEIJER (1969) found *G. compressa* in the type section of the Tuffeau de Ciply and accordingly correlated it with the *G. compressa* subzone which is of Upper Danian age.

In a series of publications POZARYSKA (1952, 1964, 1965, 1966), POZARYSKI & POZARYSKA (1960), and POZARYSKA & SZCZECHURA (1968) have dealt with Danian, Middle and Upper Paleocene foraminifera and sedimentation in Poland. In the most recent paper POZARYSKA & SZCZECHURA (1968) discussed the distribution of Paleocene faunal communities of NW Europe.

The investigations have mainly been concentrated on the following four subjects: 1. The Maastrichtian-Danian boundary. 2. The Danian-Middle Paleocene boundary. 3. The occurrence and migration routes of a "meridional" Paleocene fauna. 4. The question of whether or not the Danian should remain a substage of the Paleocene due to difficulty in defining the boundary between the Danian and the Middle Paleocene.

Very few authors today express any doubt as to the profound faunal break between the Maastrichtian and the Danian. The reason for this faunal break remains an enigma although many explanations have been proposed among which the considerations by TAPPAN (1968) especially should be mentioned (see also BRAMLETTE & MARTINI, 1964). The Maastrichtian-Danian boundary is everywhere easily recognizable by biostratigraphers and the discussion about placing the Danian in the Tertiary would seem to be one of formality only.

The question of the delimitation of the Danian from the Middle Paleocene seems more questionable and deserves more refined palaeontological studies than distinguishing the Maastrichtian from the Danian.

When discussing the Danian-Middle Paleocene boundary on evidence from foraminifera POZARYSKA (1965) stressed that *Lamarckina rugulosa*, *Lamarckina naheolensis*, *Ceratobulimina tuberculata*, *Globigerina kozlowskii*, *Loxostomum applinae*, *Cibicides succedens* etc. are confined to the so-called Montian in Poland. (It should be mentioned that POZARYSKA used the term Montian for beds directly overlying the Danian strata in Poland). The three first mentioned species are all aragonitic and hence not good guide fossils as their shells are not preserved in limestones. The species *L. rugulosa* was furthermore described from Upper Cretaceous deposits in New Jersey by OLSSON (1960) and does not seem to be an excellent guide fossil for the Montian as stated by POZARYSKA. *Globoconusa kozlovskii* (= *G. daubjergensis*) is, as shown by HANSEN (1970), the stratigraphically youngest evolutionary stage of *Globoconusa daubjergensis* and therefore cannot be used to separate the Danian from the "Montian". As far as is known *Loxostomum applinae* has not been reported from beds older than the *G. angulata* zone except from the Danian Chalybeate Limestone Member of the Clayton Formation of Alabama and Mississippi. *Cibicides succedens* is a common species in the Danian of Denmark and is definitely not restricted to the "Montian".

It appears to the present author that attempts to make correlations over greater distances based exclusively on benthonic foraminifera is not to be recommended. In local stratigraphy they may be useful, but as with most facies-dependent fossils their presence or absence is highly dependent on the bottom conditions. To apply them in a detailed stratigraphy across greater distances may easily lead to errors. In contrast to this, the planktonic foraminifera, when present, seem to offer a more reliable basis for correlation over larger distances.

In her paper from 1966 Pozaryska discussed the Cretaceous-Tertiary boundary in Poland and the Paleocene of the Mons Basin in Belgium. She wrote concerning her own material from the Mons Basin: "......, obtained in 9 samples from the type locality, e.g. an artesian well drilled at the Polytechnic College in Mons." The type locality of the Montian is not, however, the artesian well drilled at the Polytechnic College in Mons but the Puits Goffin in the neighbouring area from which a rich molluscan fauna has been described.

El-Naggar (1967 a, b) claimed that both in the type Heersian and in lateral equivalents of the Montian there occurs the Middle Paleocene foraminiferal fauna belonging to the *Globorotalia angulata* zone. As mentioned by Hansen (1968) the type Montian has never been investigated for foraminifera.

In the paper by Pozaryska & Szczechura (1968) the distribution and migration of a "meridional" (i.e. a warmer water fauna) and a fauna indicative of somewhat colder conditions (a "Selandian" fauna) was described. Their use of the term "Selandian" in this connection is unjustified. The term was originally introduced by Rosenkrantz (1924b) as a stage covering the time-interval in which the Lellinge Greensand, the Kerteminde Marl, the non-calcareous greensand and the non-calcareous clay in Denmark was deposited. (In modern terminology it would be called a substage of the Paleocene equal in rank to the other substage Danian as is evident from Rosenkrantz's stratigraphical scheme). It was especially stressed by Rosenkrantz that the Selandian should be regarded as a purely preliminary name. The name was introduced as it was impossible to correlate the fauna from the sediments between the Upper Danian and the Lower Eocene of Denmark with the Paleocene type sections of northern Europe. (For discussion see Hansen 1968). Hansen & Andersen (1969) showed that also the Upper Selandian non-calcareous greensand must be referred to the Paleocene, but the biostratigraphical age of the uppermost part of the Upper Selandian has not yet been fixed.

In their study of the Slovac Carpathian Paleogene Samuel & Salaj (1968) could distinguish a *Globigerina compressa* zone characterized by *G. compressa*, *S. pseudobulloides*, *S. triloculinoides* and *G. daubjergensis*. Samuel & Salaj claimed continuous sedimentation across the Maastrichtian-Danian boundary in Western Slovakia. They stated, however, that at the place where the Upper Maastrichtian microfauna becomes extinct its place is taken by e.g. *G. compressa.* In view of TROELSEN's find (1957) of the restricted range of *G. compressa* in the Danian of Denmark sedimentation in western Slovakia would not seem to be continuous.

HILLEBRANDT (1962) described the foraminifera of the Paleocene deposits in the Reichenhall-Salzburg basin. He could distinguish a series of zones based on planktonic foraminifera. The lowermost Paleocene was divided into zones A and B both of which contained *Globoconusa daubjergensis*, *Subbotina triloculinoides*, *Subbotina pseudobulloides*, and *Globigerina compressa. Globorotalia angulata* occurs at the junction between zone C and D. *Globigerina spiralis* is absent in zone A but present in zone B and in the younger zones. The composition of the assemblage of planktonic foraminifera in zone A definitely points to an Upper Danian age due to the presence of *Globigerina compressa.*

SCHMID (1962) recorded both planktonic and benthonic foraminifera of the Bruderndorf Feinsand from Austria. He mentioned *Globoconusa daubjergensis*, *Subbotina triloculinoides*, *Globigerina compressa*, and *Subbotina pseudobulloides* as well as *Globigerina trinidadensis.* Based on these species together with the benthonic forms he correlated the deposits with the Danian of Denmark. The present author has had the opportunity to study samples of the Bruderndorf Feinsand. The evolutionary development stage of *Globoconusa daubjergensis* would indicate that the Bruderndorf Feinsand should be placed in the uppermost Danian or probably slightly younger.

GOHRBANDT (1963) described a rock sequence from Haunsberg near Kroisbach in Austria, the so-called Oichinger Schichten. He could distinguish three zones, A, B, and C, correlatable respectively with the Danian, Montian and Thanetian. The boundary between zones B and C was placed at the first occurrence of *Globorotalia angulata.* In zone A, assigned to the Danian, he found a typical Upper Danian planktonic foraminiferal assemblage i.e. *Globoconusa daubjergensis*, *Globigerina compressa*, *Subbotina pseudobulloides*, and *Subbotina triloculinoides.* In addition to these forms he found *Globigerina trinidadensis* and *Globigerina varianta.*

G. trinidadensis is the zonal marker for the *Globigerina trinidadensis*-zone of the Tethys region and is correlatable with the type Danian. (See BOLLI 1957, 1966).

BERGGREN (1960a) reviewed and discussed the recent works on Paleogene biostratigraphy based on foraminifera from the SW Soviet Union. In the same year at the 21st International Geological Congress, Norden the reports by Soviet geologists on the Cretaceous-Tertiary boundary brought out the most recent Soviet investigations; lately the work by SAMUEL & SALAJ (1968) has made possible a correlation between the Paleogene foraminiferal zones of western and eastern Europe.

BERGGREN discussed the record in the SW Soviet Union of Danian deposits said to be older than the Danian beds found in Denmark. BERGGREN regarded *Globigerina* (*Eoglobigerina*) *eobulloides* MOROZOVA as a relatively early developmental stage of *Subbotina pseudobulloides* found in the Danian of Denmark. *Globigerina* (*Eoglobigerina*) *eobulloides* and *Globoconusa daubjergensis* were reported from the lowermost Danian in Crimea. This corresponds well with the assemblage found in the lower part of the Danish Danian (see TROELSEN, 1957; BERGGREN, 1962). However, two forms of the *Subbotina triloculinoides* group (i.e. *Globigerina pseudotriloba* WHITE and *Globigerina triangularis* WHITE) reported also from these beds would indicate, as pointed out by BERGGREN, that the lowest zone of the Danian in the SW Soviet Union is to be correlated with the Middle Danian of Denmark.

The idea of the presence of Danian rocks in the SW Soviet Union older than any found in Denmark was stressed by MOROSOVA (1960, p. 98): "The presence of *Globoconusa daubjergensis* and *Planorotalia compressa* indicates a possible correlation between the Upper Danian substage in the USSR and the whole of the stratigraphic section of the Danian in Denmark (Fax, Stevn Klint)".

This Upper Danian substage in the USSR corresponds well with the Upper Danian of Denmark and it is noteworthy that the overlying deposits are characterized by e.g. *Globorotalia angulata* (the zone Dn_2III^2) which thus seems to be equivalent to the Lower Selandian of Denmark.

BOLLI & CITA (1960) described the Cretaceous-Tertiary boundary in the Paderno d'Adda Section in northern Italy. They found rocks of Maastrichtian age directly overlain by deposits containing a planktonic foraminiferal assemblage with e.g. *Globigerina compressa*, indicative of an Upper Danian age. The boundary with the overlying *Globorotalia uncinata* zone was marked by the appearance of *G. uncinata* and *G. angulata.*

In their paper of 1964 LUTERBACHER & SILVA established a new zone, the *Globigerina eugubina* zone, belonging to the Tertiary and underlying the zone with *Globoconusa daubjergensis*/*Subbotina pseudobulloides*. This again was overlain by a *Globigerina trinidadensis* zone followed by the *Globigerina uncinata* zone in the central Apennines, Italy. They especially stressed the occurrence of many very small new planktonic foraminiferal species in the *Globigerina eugubina* zone. Their material was poorly preserved and their study of this zone is based mainly on thin sections of the rock. The *Globigerina eugubina* zone has attracted special interest as it would seem to represent the oldest part of the Danian not present in the type area in Denmark. The validity of the *Globigerina eugubina* zone was strongly doubted by BERGGREN (1965a).

He suggested that many of the forms from the *G. eugubina* zone illustrated by LUTERBACHER & SILVA were juvenile forms whose morphologic characters had not yet developed. BERGGREN (p. 1481) concluded: "In the absence of an opportunity to make direct comparison with type material, this writer would only caution that the Cretaceous-Tertiary boundary is fraught with problems in regard to the nature of the planktonic foraminiferal fauna. The *Globigerina eugubina* zone may well be a significant biostratigraphic entity (cf. LEHMANN, 1964), but it may actually contain a mixed (i.e., transitional) fauna with both Maestrichtian and Danian faunal elements in a stratigraphic interval which straddles the Maestrichtian-Danian boundary as is now recognized. It is also possible that the minute forms which characterize this stratigraphic level also could be an upper Maestrichtian stratigraphic condensate as a result of winnowing action by weak currents."

In the northern part of the Pyrenees, MANGIN (1960) assigned to the Danian deposits with a thickness varying between 0.4 and 60.0 m containing *Subbotina triloculinoides*, *S. pseudobulloides*, *Globoconusa daubjergensis*, and *Globigerina compressa.* This faunal assemblage corresponds well with the one from the Upper Danian in Denmark. The overlying deposits were characterized by *Globigerina imitata*, *Globorotalia elongata* (= *G. emilei* EL-NAGGAR) and *Globigerina perclara.* These deposits should thus be correlated with a zone younger than the subzone characterized by *Globigerina compressa.*

LOEBLICH & TAPPAN (1957a, b) reported the occurrence of *Globoconusa daubjergensis* in the Wills Point Formation, the McBryde Limestone Member, and the Pine Barren Member of the Clayton Formation, the Brightseat Formation, and the Kincaid Formation. Of these only the Pine Barren Member and Kincaid Formation did not contain *Globigerina compressa.* The specimens of *Globoconusa daubjergensis* illustrated by LOEBLICH & TAPPAN from these two deposits show no supplementary sutures along the spire. This character is common in the specimens of *G. daubjergensis* from the Upper Danian or younger.

BERGGREN (1965a, b) discussed the same formations and their content of planktonic foraminifera. He used the term Danian s. l. in contrast to Danian s. str. and Montian s. str. According to EL-NAGGAR (1967a) the term Danian s. l. or Dano-Montian is unwarranted as the type Montian has never been investigated for foraminifera and therefore its biostratigraphical position is unknown. It would seem unjustified to use the substage Montian as identical with the Upper Danian, as this supposition is without palaeontological support. EL-NAGGAR's investigations leave three possibilities concerning the biostratigraphical age of the Montian. 1. The Montian may be equivalent to the Upper Danian. 2. The Montian may belong to the biozone characterized by *Globorotalia* *angulata* and would in this case be a junior synonym of the Heersian stage. 3. The *Globorotalia uncinata/Globigerina spiralis* zone is not represented in Denmark as far as is known; the gap in sedimentation between the Upper Danian and the Lower Selandian may represent the time when the Calcaire Grossier de Mons was deposited in the Mons Basin.

The Upper Cretaceous-Lower Tertiary deposits of the New Jersey Coastal Plain were described by OLSSON (1960, 1963). He distinguished as the lowermost part of the Tertiary a zone characterized by *Globigerina compressa* and *Globoconusa daubjergensis.* The change from the Danian to a younger substage of the Paleocene is marked by the first occurrence of *Globoratalia angulata.* The same distribution of planktonic foraminifera was described by NOGAN (1964) from the Aquia Formation of Maryland and Virginia. NOGAN showed that *Globigerina compressa*, *Globoconusa daubjergensis*, *Subbotina triloculinoides*, and *Subbotina pseudobulloides* occurred in the underlying Brightseat Formation. The base of the Aquia Formation is marked by the occurrence of *Globorotalia angulata* which corresponds to the Danian-Selandian boundary in Denmark. The Brightseat Formation must be considered equivalent to the Upper Danian of Denmark.

HERRICK & RIMA (1968) listed Paleocene foraminifera from the Clayton Formation of Tennessee and compared the fauna with the faunas from the McBryde Limestone Member of the Clayton Formation of Alabama, the Clayton Formation of Mississippi and the Kincaid Formation of Texas and correlated them with each other. HERRICK & RIMA based their correlation on benthonic foraminifera but listed *Subbotina triloculinoides*, *S. pseudobulloides*, *Globigerina compressa* and *Globorotalia cassata* var. *aequa* CUSHMAN & RENTZ from the Clayton Formation of Tennessee and from the Matthew's Landing Member of the Clayton Formation from Alabama.

They did not list *Globoconusa daubjergensis* in contrast to LOEBLICH & TAPPAN (1957a) and BERGGREN (1965b). The faunal list by HERRICK & RIMA would point to a younger age of the formations discussed than that assigned to them by previous authors. The contrasting points of view may be caused by different sampling levels or different species concepts.

FOX & OLSSON (1969) reported a planktonic foraminiferal fauna from the Cannonball Formation of North Dakota indicative of a Lower Danian age.

HAY (1960) described the Cretaceous-Tertiary boundary in the Tampico Embayment in Mexico. He found the Maastrichtian directly overlain by rocks assigned to the Danian containing an Upper Danian planktonic foraminiferal association. In this area *Globoconusa daubjergen-*

sis is not found in the following zone characterized by *G. uncinata* assigned by HAY to Upper Danian. The boundary between the Danian and overlying rocks is marked by the first occurrence of *Globorotalia angulata*.

BERTELS (1964) and MENDEZ (1966) described Lower Tertiary foraminiferal faunas from Argentina. BERTELS found in the Rocanense-beds in the province of Rio Negro planktonic foraminifera identified as *Globigerina daubjergensis*, *Globigerina triloculinoides* and *Globigerina pseudobulloides* together with more than 50 species of benthonic foraminifera. Based on the planktonic forms the age of the deposits was determined as Danian.

MENDEZ described a somewhat similar fauna from the Salamenquian-beds of Punta Peligro from the province of Chubut. The planktonic part of the fauna found here consists of only three species i.e. "*Globigerina*" cf. "*Globigerina*" *kozlowskii* (= *Globoconusa daubjergensis*), "*Globigerina*" sp. (= *Globoconusa daubjergensis*) and *Subbotina triloculinoides*. Based on the development of *S. triloculinoides* the age of the deposits was assigned to Middle—Upper Danian in spite of the absence of *Globigerina compressa*. The latter was to be expected if the rocks were to be of Upper Danian age. Based on the development stage of *Globoconusa daubjergensis* (the specimen illustrated by MENDEZ on his plate 3, figure 1 shows 11 chambers) the age should be assigned to the lower part of the Middle Paleocene rather than to the upper part of the Lower Paleocene (= Middle—Upper Danian) (HANSEN, 1970).

In his discussion of the Cretaceous-Tertiary boundary in Israel and in the Near East, REISS (1955) reviewed earlier works and stressed the value of a *Globigerina* zone as evidence for Danian sediments. He further regarded the junction between the *Globigerina* and the *Globigerina-Globorotalia* zone as identical with the Danian-Paleocene boundary.

REISS (p. 108) stated "... throughout the Tethys area (Americo-Carribean region, Pyrenees, Alps, Apennines, North Africa, Near East, Caucasus-Caspian Sea region, southern Asia) the *Globigerina* zone shows a strongly varying extent, being sometimes completely absent".

EL-NAGGAR (1966) showed that the Danian is incomplete in the Esna-Idfu region in Egypt.

LEHMANN (1964) described the sediment sequence across the Cretaceous-Tertiary boundary in the Sirte Basin in Libya. Based on evidence from borings he (p. 59) found a "stratigraphical break with weathered surface preserved" at the Maastrichtian-Danian boundary. In other cores, however, he found *Globoconusa daubjergensis* with *Pseudotextularia elegans* and more than 6 species of *Globotruncana* in supposed Upper Maastrichtian sediments. On p. 66 he stated that "Pelagic species are abundant in these samples and their excellent, identical state of preservation does not permit this previously undescribed microfaunal association to be explained by reworking or tectonic processes. The association is interpreted to be one of geologically contemporaneous existence of the species concerned". With reference to LEHMANN's own statement as to weathered surface of the Upper Maastrichtian sediments encountered in neighbouring boreholes the Upper Maastrichtian fauna found together with *G. daubjergensis* may well have been redeposited although this is not evident from the lithology and preservation of the faunal elements.

Reworking of microfossils in spite of identical state of preservation is known from numerous places, and the present author therefore considers it highly unlikely that there was a co-existence of *G. daubjergensis* with *Pseudotextularia elegans* and more than 6 species of *Globotruncana*, until further evidence has been published.

BERGGREN (1960b) recorded planktonic foraminifera indicative of Danian age in Nigeria in West Africa.

He found *Globoconusa daubjergensis*, *Subbotina triloculinoides*, and *S. pseudobulloides*, and mentioned in his paper that the lack of *Globigerina compressa* may be due to insufficient sample material. The boundary with the Middle Paleocene was drawn at the first occurrence of *Globorotalia angulata* appearing together with an assemblage of keeled globorotaliids.

LYS (1960) described Danian deposits from Madagascar with an assemblage of planktonic foraminifera consisting of *Globoconusa daubjergensis*, *Subbotina triloculinoides*, *S. pseudobulloides*, *Globigerina* cf. *linaperta* and *Globigerina* sp. (aff. *spiralis*).

This assemblage would seem to be indicative of a Danian age, but on the one hand the Upper Danian subzone fossil *Globigerina compressa* was not encountered while on the other hand a form described as close to *Globigerina spiralis* would indicate an Upper Danian age. The beds overlying the Danian deposits contained *Globorotalia angulata* thus corresponding to the Danian-Selandian junction in Denmark.

The biostratigraphy based mainly on planktonic foraminifera from the Cretaceous to the Eocene deposits in India, Pakistan and Burma was described by NAGGAPA (1959). The *Cardita beaumonti*-beds were correlated with the type Danian based on the occurrence of *Subbotina pseudobulloides*, and *Subbotina triloculinoides*. Later SASTRY & RAO (1964) discussed the Cretaceous-Tertiary boundary in South India. They concluded that the Niniyurs-beds containing *Globorotalia* (*Truncorotalia*) *mosae* HOFKER should be assigned to the Danian. As pointed out by McGOWRAN (1968b) *G. mosae* is not a *Globorotalia* and indicates a Maastrichtian age.

ASANO (1962) recorded a Danian foraminiferal fauna from the Nemuro Group of Hokkaido in Japan. MATSUMOTO (1964) stressed that the Danian foraminiferal fauna occurred in beds containing Upper Cretaceous ammonites; the foraminiferal fauna consisted of *Globoconusa daubjergensis*, *Subbotina pseudobulloides*, *S. triloculinoides*, and *Globigerina compressa* which were found to occur together with *Neophylloceras* sp., *Pachydiscus* aff. *obsoletus* and *Anagaudryceras* n. sp. YOSHIDA (1969) briefly discussed the occurrence of planktonic foraminifera of Danian age together with ammonites. He mentioned that the Nemuro Group in the centre of its geographical distribution shows that the ammonite-bearing horizon is different from the one carrying Danian foraminifera and thus indicates that there has not been co-existence of ammonites and typical Upper Danian foraminifera.

Conclusions

As stated by REISS (1955) the varying thickness and local absence of Danian rocks have contributed greatly to the confusion about the delimitation of the Danian substage and have led authors to doubt the independence of a Danian stage or substage (see e.g. VOIGT, 1960; POZARYSKA & SZCZECHURA, 1968).

The Danian is of transitional nature following the widespread Upper Maastrichtian regression and the profound change in fauna. The lack of a definite guide fossil for the Danian as stressed by POZARYSKA & SZCZECHURA makes the recognition of the Danian one of negative nature, as the new, rapidly evolving globigerinid group is at its beginning. However, the delimitation of the Danian by means of planktonic foraminifera does not seem to be difficult as the lower boundary coincides with the Cretaceous-Tertiary junction where the globotruncanas, rugoglobigerinids, etc. become extinct and are replaced by species belonging to the genera *Globoconusa* and *Subbotina*. The upper boundary coincides with the first appearance in the type area of *Globorotalia angulata*. The latter seems to be a reliable guide fossil which is traceable over most of the world.

The Danian stage in the type area coincides with the *Globoconusa daubjergensis/Subbotina pseudobulloides* zone. The upper part of this zone can be defined as a *Globigerina compressa* subzone (BERGGREN, 1962).

The proposal by EL-NAGGAR (1967 a) to make a primary tripartite zonation with a Lower Paleocene *Globoconusa daubjergensis/Subbotina pseudobulloides* zone, a Middle Paleocene *Globorotalia angulata* zone and an Upper Paleocene *Globorotalia velascoensis* zone or, in other words, a *Globigerina* zone, a zone with non-keeled globorotalias and a zone with keeled globorotalias would be a reasonable basic division of the Paleocene.

Of these three suggested zones only the lowest, the *Globoconusa daubjergensis/Subbotina pseudobulloides* zone, can at present be correlated with a substage i. e. the Danian substage as represented in the type area.

That the three zones can easily be divided into a series of subzones is evident from the literature, but the correlation of these subzones with the type sections of the different substages still needs a thorough study.

It can be stated that Danian rocks older than those of the Lower Danian of Denmark so far have not been proved to exist. The majority of Danian deposits found throughout the world seem to correspond to the Upper Danian of Denmark; this is also the case with the Upper Danian deposits from Nûgssuaq in Greenland.

SYSTEMATIC PART

In this work the classification by Loeblich & Tappan (1964) has been adopted with some modifications. The genus *Pallaimorphina* is recognized as a valid genus and the genus *Gyroidinoides* is transferred to the family Anomalinidae. Unless otherwise indicated all specimens figured originate from the Upper Danian Sonja Member of the Agatdal Formation from Nûgssuaq, West Greenland.

The abbreviation MMH followed by a number is the registration code in the type collection at the Mineralogical Museum of the University of Copenhagen where the material is deposited.

Order	**Foraminiferida** Eichwald, 1830
Suborder	**Textulariina** Delage & Hérouard, 1896
Superfamily	**Ammodiscacea** Reuss, 1862
Family	**Ammodiscidae** Reuss, 1862
Genus	*Glomospira* Rzehak, 1885

Glomospira sp.
pl. 2, fig. 1

Description

Test an irregularly coiled tube. Aperture funnel shaped. Wall arenaceous with a smooth surface.

Material: 1 specimen.

Superfamily	**Lituolacea** de Blainville, 1825
Family	**Hormosinidae** Haeckel, 1894
Genus	*Reophax* Montfort, 1808

Reophax sp.
pl. 3, fig. 1

Description

Test elongate with circular cross section. Uniserial, consisting of three slightly inflated chambers. Sutures slightly depressed. Aperture terminal, at the end of a small neck. Wall coarsely arenaceous, with large agglutinated quartz grains in a brownish matrix.

Remarks

As only one whole specimen was found a species determination could not be made.

Material: 1 specimen and 1 fragment.

Family **Lituolidae** DE BLAINVILLE, 1825
Genus *Haplophragmoides* CUSHMAN, 1910

Haplophragmoides sewellensis OLSSON, 1960
pl. 2, fig. 4; pl. 15, fig. 3

1944 a *Haplophragmoides* cf. *sphaeriloculum* CUSHMAN; CUSHMAN: p. 19, pl. 3, fig. 24
1948 *Haplophragmoides* cf. *sphaeriloculum* CUSHMAN; SHIFFLETT: p. 45, pl. 1, fig. 5
1960 *Haplophragmoides sewellensis* OLSSON: p. 5, pl. 1, figs 1–2
1964 *Haplophragmoides aquiensis* NOGAN: p. 20, pl. 1, figs 2–3

Description

In the Greenland material the tests are planispiral, involute, biconvex and compressed. 5–6 chambers in the final whorl. General outline moderately lobate. Periphery broadly rounded. Sutures depressed, radial. Aperture interiomarginal. Wall moderately to finely arenaceous. The agglutinated particles consist of quartz grains.

Discussion

In the material from Greenland there is intergradation between the species *H. sewellensis* and *H. aquiensis*. The latter is therefore listed as a synonym of the former. According to the descriptions and illustrations *H. sewellensis* has closer coiling than has *H. aquiensis*. This character is not constant in the Greenland material and, therefore, cannot be regarded as valuable for species distinction in the present case.

Material: 10 specimens.

Occurrence

Upper Cretaceous-Paleocene, New Jersey; Paleocene, Virginia, U.S.A.

Family **Textulariidae** EHRENBERG, 1838
Genus *Textularia* DEFRANCE, 1824 emend. NØRVANG, 1966

Textularia wilcoxensis (CUSHMAN & PONTON, 1932)
pl. 2, figs 7–8

1927 *Spiroplecta sagittula* f. *deperdita* FRANKE: p. 9, pl. 1, fig. 5
1932 *Spiroplecta wilcoxensis* CUSHMAN & PONTON: p. 51, pl. 7, fig. 1

1939	*Spiroplectammina wilcoxensis* Cushman & Ponton; Cushman & Garret: p. 78, pl. 13, figs 1–2
1941	*Spiroplectammina wilcoxensis* Cushamn & Ponton; Toulmin: p. 571, pl. 78, fig. 1
1944 c	*Spiroplectammina wilcoxensis* Cushman & Ponton; Cushman: p. 8, pl. 1, figs 1–2
1944 a	*Spiroplectammina wilcoxensis* Cushman & Ponton; Cushman: p. 19, pl. 3, figs 26–27
1948	*Spiroplectammina wilcoxensis* Cushman & Ponton; Brotzen: p. 34, text-fig. 6, 2
1951	*Spiroplectammina wilcoxensis* Cushman & Ponton; Cushman: p. 6, pl. 1, figs 21–23
1955	*Spiroplectammina wilcoxensis* Cushman & Ponton; Hofker: p. 8, pl. 5, figs a–b
1960	*Spiroplectammina wilcoxensis* Cushman & Ponton; Olsson: p. 5, pl. 1, fig. 3
1964	*Spiroplectammina wilcoxensis* Cushman & Ponton; Nogan: p. 21, pl. 1, fig. 4
1965	*Spiroplectammina wilcoxensis* Cushman & Ponton; Pozaryska: p. 50, pl. 3, fig. 1
1966	*Spiroplectammina wilcoxensis* Cushman & Ponton; Hofker: p. 277, pl. 64, fig. 130
1968	*Spiroplectammina wilcoxensis* Cushman & Ponton; Pozaryska & Szczechura: p. 35

Description

The Greenland specimens have elongate tests, tapering towards the initial plano-spire. Later becoming biserial. Consisting of up to 26 chambers. Test compressed with somewhat rounded margins. The chambers in the earlier part level with the surface, in the latest part becoming slightly inflated. Chambers in the earlier part about twice as broad as high, later almost as broad as high. Sutures slightly, if at all, depressed, very slightly curved. Apertural end flattened. Aperture at the basal suture in the final chamber, shaped as a low arch. Wall calc-arenitic, with agglutinated quartz grains.

Discussion

Following the emended diagnosis of the genus *Textularia* by Nørvang (1966, p. 10) *Spiroplectammina wilcoxensis* must be placed within this genus. The species has an initial plano-spire and a calc-arenitic wall. The genus *Textularia* is distinguished from *Spiroplectammina* by the calcitic matrix between the agglutinated grains. As, however, the wall material in arenaceous forms hardly can be regarded as a specific character, it would appear to be a very doubtful distinctive generic character. The genus *Spiroplectammina* must therefore be regarded as a junior synonym of the genus *Textularia*.

The difficulties in determining the true nature of the matrix of arenaceous species originating from a lime-mud environment was clearly illustrated by GIGNOUX & MORET (1920) and BONTE (1944) who found that genera described as having a granular calcareous test actually had a calc-arenitic wall with agglutinated lime particles.

Remarks

Of the 46 specimens from Greenland very few had a preserved initial part and many were also damaged in the later part.

Material: 46 specimens.

Occurrence

Midway Formation, Texas, Arkansas; Porter's Creek Clay, Tennessee; Clayton Formation, Naheola Formation, Alabama; Hornerstown Formation, New Jersey; Brightseat Formation, Maryland; Aquia Formation, Maryland, Virginia; Vincentown Formation, New Jersey, U.S.A.; Paleocene, Poland, Sweden, Denmark.

Genus *Textilina* NØRVANG, 1966

Textilina plummerae (LALICKER, 1935)
pl. 1, fig. 2; pl. 2, figs 9–10; pl. 15, fig. 1

1926	*Textularia eocenica* GÜMBEL; PLUMMER: p. 67, pl. 3, fig. 2
1935	*Textularia plummerae* LALICKER: p. 50, pl. 6, fig. 10
1937	*Textularia plummerae* LALICKER; GLAESSNER: p. 364
1940	*Textularia plummerae* LALICKER; CUSHMAN: p. 52, pl. 9, fig. 4
1941	*Textularia plummerae* LALICKER; DAVIS: p. 151, pl. 25, figs 8–9
1946	*Textularia plummerae* LALICKER; CUSHMAN & TODD: p. 46, pl. 7, fig. 2
1947	*Textularia plummerae* LALICKER var. *arkansasana* Cushman: p. 81, pl. 17, figs 18–19
1966	*Textularia plummerae* LALICKER; HOFKER: p. 334, pl. 76, fig. 6
1968	*Textularia plummerae arkansasana* CUSHMAN; POZARYSKA & SZCZECHURA: p. 35

Description

The material to hand has biserial tests and is somewhat compressed. Cross section elliptical. Chambers about as high as broad, slightly inflated, especially in the later part. Sutures in the juvenile part indistinct. In the adult part slightly depressed running at almost right angles to the central axes of the test. Aperture a rounded rectangular opening at the basal suture of the last chamber. Wall arenitic, perforate.

Discussion

The Greenland material varies considerably in the tapering of the tests. The illustrated specimen, pl. 2, figs 9–10, was chosen for illustration as it is the only undamaged individual in the material.

CUSHMAN's variety *T. plummerae* var. *arkansasana* definitely falls within the field of variation of the material from Greenland.

The pores of the wall characteristic of the genus *Textilina* are shown on pl. 15, fig. 1. A thin section is shown on pl. 1, fig. 2.

Material: 87 fragments and 1 whole specimen.

Occurrence

Paleocene, Gulf Area, U.S.A.; Paleocene, Denmark.

Family **Trochamminidae** SCHWAGER, 1877

Genus *Trochammina* PARKER & JONES, 1859

Trochammina sp. 1

pl. 2, figs 5–6

Description

Test trochospirally coiled with three chambers to a whorl. Chambers almost spherical. Sutures on the umbilical side distinct and depressed, radial and slightly curved. Sutures on spiral side depressed and curved in the last whorl; between the earlier chambers they become indistinct. Aperture umbilical. Wall arenaceous. The agglutinated particles are quartz grains.

Remarks

Due to very sparse material, a proper species determination cannot be made.

Material: 5 specimens, 1 damaged.

Trochammina sp. 2

pl. 2, figs 2–3; pl. 15, fig. 4

Description

Test coiled in a low trochospire. 5 chambers in the final whorl. Chambers somewhat flattened in peripheral view. General outline lobate. Periphery rounded. Sutures on the umbilical side radial, straight to slightly curved; slightly depressed. Sutures on the spiral side curved and slightly depressed in the final whorl, indistinct between the earlier chambers. Spiral suture indistinct. Aperture umbilical. Wall arenaceous. The agglutinated particles are quartz grains.

Material: 2 specimens.

Family **Ataxophragmiidae** Schwager, 1877
Genus *Gaudryina* d'Orbigny, 1839

Gaudryina geometrica Howe, 1939
pl. 2, figs 11–12

1939 *Gaudryina geometrica* Howe: p. 33, pl. 2, figs 6–7

Description

The Greenland material has tapering tests with a triserial early part and a biseral later part. Cross section of the early part rounded-triangular; may have slightly depressed sides. Cross section of the biserial part elliptical. General outline lobate but not strongly so. Sutures in the triserial part very slightly, if at all, depressed. Sutures in the biserial part distinct and slightly depressed. Chambers broader than high and only slightly, if at all, inflated. Distal face almost plane. Aperture a slit with a small lip at the basal suture of the final chamber. Wall finely arenaceous.

Discussion

It is with some hesitation that the specimens from Greenland are referred to the species *Gaudryina geometrica* which was originally described from the Eocene Cook Mountain Formation in Louisiana as all the specimens are damaged. However, the observable characters are consistent with this identification. The figured specimen is the largest preserved.

Material: 25 damaged specimens.

Occurrence

Eocene, Cook Mountain Formation, Louisiana, U.S.A.

Suborder **Miliolina** Delage & Hérouard, 1896
Superfamily **Miliolacea** Ehrenberg, 1839
Family **Fischerinidae** Millett, 1898
Genus *Cornuspiroides* Cushman, 1928

Cornuspiroides primigenia (Ravn, 1918)
pl. 4, figs 1–2

1918 *Atlanta primigenia* Ravn: p. 359, pl. 8, fig. 12
1927 *Cornuspira foliacea* Phillippi; Gripp: p. 29, pl. 5, fig. 1

Description (from RAVN)

"Shell very thin, compressed, coiled in closed spiral and composed of 4 to 5 volutions. Whorls oval in section, very narrow; last whorl very great, regularly increasing in height towards the aperture. Ornamentation consists of finer and stronger lines of growth, which form nearly a right angle with the suture, but are gradually bent more backwards and reach the outer periphery in a very acute angle. Under a strong lens slight traces of quite fine longitudinal striæ are seen. Keel not observed.—Greatest diameter 1.6 mm".

Discussion

RAVN misidentified his specimen which originated from the Kangilia Formation of the south coast of Nûgssuaq.

That he had some doubt about the affinity of the specimen is evident from his remarks, which are here translated from Danish: "In its present state of preservation the shell is very strongly compressed, but this is partly due to compression of the very delicate shell by the pressure from the overlying strata. That the thin, fine keel has disappeared is not surprising".

The specimen is preserved in a calcareous concretion and is in good condition. The periphery of the specimen shows no sign of compression and it is evident that a keel has never been present.

The rapidly enlarging final whorl, planispiral coiling and other characters place this species in the genus *Cornuspiroides*. According to the Catalogue of Foraminifera (ELLIS & MESSINA) the name *Cornuspiroides primigenia* is not preoccupied. As it is different from earlier described species *Cornuspiroides primigenia* is a valid species.

GRIPP (1927) recorded *Cornuspira foliacea* PHILLIPPI from Lower Tertiary deposits of Spitsbergen. His material, which was kept in Germany, was lost during the second world war. His illustrated specimen from Spitsbergen has a diameter of 2.0 mm while RAVN's specimen measures 1.6 mm. This difference is so slight, however, that the author does not hesitate to place *C. foliacea* from Spitsbergen as a synonym of *C. primigenia.*

Cornuspira foliacea from Spitsbergen is distinctly different from *Cornuspira foliacea* PHILLIPPI, which was originally described as a recent form from the Mediterranean Sea.

Locality: Alianaitsúnguaq, south coast of Nûgssuaq, West Greenland.

Level: Lower Danian.

Material: 1 specimen. Holotype MMH 1737.

Occurrence

Lower Tertiary, Spitsbergen.

Family **Miliolidae** EHRENBERG, 1839

Genus *Quinqueloculina* D'ORBIGNY, 1826

Quinqueloculina naheolensis CUSHMAN, 1947
pl. 3, figs 4–5

1947 *Quinqueloculina naheolensis* CUSHMAN: p. 82, pl. 17, fig. 14
1951 *Quinqueloculina naheolensis* CUSHMAN; CUSHMAN: p. 10, pl. 2, fig. 22

Description

In the Greenland material the tests are about twice as long as wide and about twice as wide as thick. General outline smooth, a compressed ellipse with subparallel sides. Periphery rounded but not broadly. Chambers slightly inflated. Sutures very slightly depressed. Aperture almost terminal, subcircular, truncate without neck but with a distinct tooth. Test delicate, almost transparent and unornamented.

Material: 394 specimens.

Occurrence

Paleocene, Porter's Creek Formation, U.S.A.

Quinqueloculina plummerae CUSHMAN & TODD, 1942
pl. 3, figs 6–7; pl. 15, fig. 2

1926 *Quinqueloculina ferussacii* D'ORBIGNY; PLUMMER: p. 161, pl. 12, fig. 10
1942 *Quinqueloculina plummerae* CUSHMAN & TODD: p. 25, pl. 5, fig. 2
1944 b *Quinqueloculina plummerae* CUSHMAN & TODD; CUSHMAN: p. 30, pl. 5, fig. 3
1947 *Quinqueloculina plummerae* CUSHMAN & TODD var. *flectata* CUSHMAN: p. 82, pl. 17, fig. 15
1951 *Quinqueloculina plummerae* CUSHMAN & TODD; CUSHMAN: p. 11, pl. 2, figs 25–26
1951 *Quinqueloculina plummerae* CUSHMAN & TODD var. *flectata* CUSHMAN; CUSHMAN: p. 11, pl. 2, fig. 27

Description

The present material has the test nearly as long as wide and about half as thick as wide. General outline irregular, subcircular. Chambers distinct, flat; may become slightly concave towards periphery. Periphery truncate with low carinate edges. The periphery may bear a few low, irregular costae. Sutures slightly, if at all, depressed. Test surface unornamented except for the periphery. Aperture almost terminal, subcircular, without a neck, but with a short, blunt tooth.

Discussion

Quinqueloculina plummerae is an abundant species in the Sonja Member and shows a wide range of variation.

The variety *Q. plummerae* var. *flectata* described by Cushman was distinguished by a tortuous peripheral line in the later chambers, in some specimens associated with a depressed area at the edge. Individuals with these characters are found in the Greenland material and they fall within the infraspecific variation of *Q. plummerae.*

The truncate periphery with low carinae at the edges is only well developed in larger specimens. Smaller individuals show the truncate periphery, but only faintly developed carinae.

Plummer erroneously attributed her material from the Midway Formation of Texas to the species *Q. ferrussacii* d'Orbigny, 1826. She mentioned, however, that her material was not in perfect agreement with d'Orbigny's species. She thought that this might have been due to unfavorable growth conditions during Midway times.

Material: 222 specimens.

Occurrence

Paleocene, Gulf Coastal area, Porter's Creek Formation, Naheola Formation, Will's Point Formation, U.S.A.

Suborder **Rotaliina** Delage & Hérouard, 1896
Superfamily **Nodosariacea** Ehrenberg, 1838
Family **Nodosariidae** Ehrenberg, 1838
Genus *Nodosaria* Lamarck, 1812

Nodosaria latejugata Gümbel, 1868
pl. 3, figs 2–3

1868	*Nodosaria latejugata* Gümbel: p. 619, pl. 1, fig. 32
1885	*Dentalia obliqua* Linné; Koenen: p. 110, pl. 5, fig. 21
1885	*Nodosaria raphanistrum* Linné; Koenen: p. 110, pl. 5, figs 16–20
1926	*Nodosaria affinis* Reuss; Plummer: p. 89, pl. 14, figs 2a–d
1927	*Dentalina obliqua* Linné; Franke: p. 15, pl. 1, fig. 18
1927	*Nodosaria polygona* Reuss; Franke: p. 16, pl. 1, fig. 22
1927	*Nodosaria raphanistrum* Linné; Franke: p. 17, pl. 1, fig. 21
1943	*Nodosaria* aff. *latejugata* Gümbel; Wick: pl. 5, figs 1–6, pl. 9, figs 10–16
1943	*Nodosaria latejugata* Gümbel; Kline: p. 27, pl. 2, fig. 10
1944	*Nodosaria latejugata* Gümbel; Cooper: p. 348, pl. 55, figs. 24–25
1944 b	*Nodosaria latejugata* Gümbel; Cushman: p. 37, pl. 6, figs 6–8
1944	*Nodosaria latejugata* Gümbel; Dam: p. 94
1946	*Nodosaria latejugata* Gümbel; Cushman & Todd: p. 52, pl. 8, figs 19–20
1953	*Nodosaria affinis* Reuss; Le Roy: p. 40, pl. 4, fig. 15
1953	*Nodosaria paupercula* Reuss; Le Roy: p. 40, pl. 4, fig. 11
1962	*Nodosaria latejugata* Gümbel; Simon & Bartenstein: p. 364, tab. 20, pl. 52, figs 23–24
?1962	*Nodosaria vertebralis* (Batsch); Schmid: p. 326
1964	*Nodosaria latejugata* Gümbel; Nogan: p. 25

1964 *Nodosaria latejugata carolinensis* CUSHMAN; NOGAN: p. 25, pl. 1, fig. 22
1964 *Nodosaria affinis* REUSS; BERTELS: p. 137, pl. 2, fig. 3
1964 *Nodosaria latejugata* GÜMBEL; BERTELS: p. 137, pl. 2, fig. 4
1966 *Nodosaria latejugata* GÜMBEL; HOFKER: pl. 68, fig. 58; pl. 79, figs 63–64

Description

The tests in the Greenland material are elongate, uniserial, consisting of up to 6 spherical chambers. The surface is ornamented with from 11 to 16 costae which run in a direction parallel to the long axis of the test. The costae are continuous across the sutures and are only slightly higher than the width of their base. Sutures generally strongly depressed but often somewhat veiled by the costae.

The material from Greenland consists of 55 fragments each constructed of two or more chambers. The state of preservation is rather bad as the specimens were preserved directly in the coarse sediment and not in the fine sediment within the gastropods. Most specimens were heavily incrusted with sediment of which they could not be freed either by boiling, using an ultrasonic vibrator, or by manual preparation. The majority of specimens were therefore treated with HF, which dissolved the silicious matter and left the tests altered to fluorite.

The variation shown by the fragments from Greenland is rather wide. As mentioned above the state of preservation of this material is not good and therefore a large material of *Nodosaria latejugata* from the Selandian beds at Copenhagen was used to determine the variation width of the species. The latter material consists of 126 whole specimens.

Description of the material from Denmark

Test uniserial, elongate, consisting of up to 16 spherical chambers in a rectilinear or very slightly arcuate row. In megalospheric individuals the proloculus is often followed by a few chambers having a smaller diameter. In adult specimens the greatest diameter is found near the apertural end. In microspheric individuals the chambers become slightly larger as added. The sutures are more strongly depressed in megalospheric than in microspheric specimens. The sutural depression is often veiled by the ornamental costae. In general the costae are rather sharp and high but lower costae are found as well. The costae continue over the sutures but both discontinuity and torsion may occur on the same individual. On proloculi the number of costae ranges from 7 to 16 and on final chambers it ranges from 7 to 17. The aperture is terminal, radial at the end of a small, slightly inflated neck. Test wall composed of radiate, perforate calcite. The costae are composed of radiate, non-perforate calcite. Proloculus diameter measured on outer surface between the costae ranges in microspheric specimens from 187 to about 487 μ and in megalospheric from about 487 to 937 μ. Septa monolamellar.

Variation

The 126 specimens were measured for proloculus diameter (measured on outer surface between the costae), number of chambers, total length and number of costae on both the proloculus and the final chamber.

Fig. 9 shows the existence of both a megalospheric and a microspheric generation. The limit between the specimens of the two generations is drawn in such a way that individuals with a proloculus diameter of 487 μ or more are considered megalospheric and the remainder are considered microspheric. The ratio of microspheric specimens to megalospheric specimens is about 1:3. It should be mentioned that the number of microspheric individuals is possibly too high. Because of its generally more stout construction the microspheric test is not so easily broken as is the megalospheric.

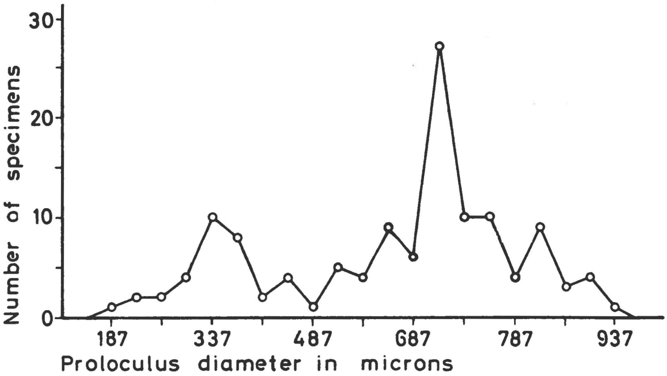

Fig. 9. Size-frequency distribution of proloculus diameters of 126 whole specimens of *Nodosaria latejugata* GÜMBEL from Sundkrogen (Lower Selandian).

Figs 10 and 11 show that the microspheric form has a higher number of chambers per size unit than has the megalospheric. The broken line is placed in such a way that dots representing megalospheric specimens fall either on or above it.

Four microspheric specimens fall above this line and the remaining microspheric fall below.

Fig. 12 shows 11 larger fragments of *Nodosaria latejugata* from Nûgssuaq. They are figured in the same way as in figs 10 and 11. Fig. 12 demonstrates that the fragments most likely have arisen from megalospheric individuals.

Figs 13 and 14 show that the number of costae on the proloculus and on the final chamber diverge from each other with a tendency toward higher number on the proloculus. Figs 13 and 14 are based on only 98 observations as some of the specimens had very faintly developed costae on the final chamber not allowing sufficient accuracy in counting.

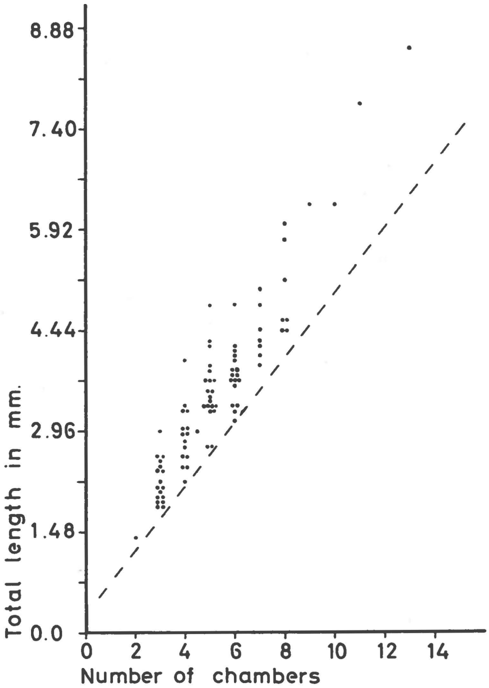

Fig. 10. Relationship between number of chambers and total length of 94 megalospheric specimens of *Nodosaria latejugata* Gümbel from Sundkrogen (Lower Selandian).

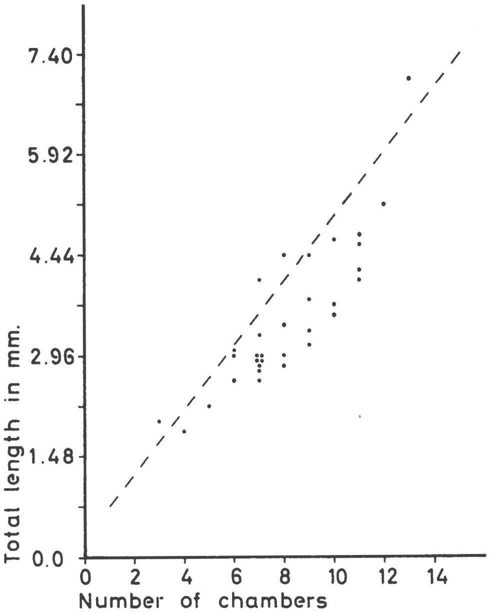

Fig. 11. Relationship between number of chambers and total length of 32 microspheric specimens of *Nodosaria latejugata* Gümbel from Sundkrogen (Lower Selandian).

There could not be found any difference in the number of costae between micro- and megalospheric individuals.

Discussion

Species belonging to the genera *Nodosaria* and *Dentalina* have to some extent been ignored as they were considered to be without great stratigraphic importance. Early workers such as Reuss and Gümbel described numerous species of these genera based either on fragmentary material or on single specimens. This had led to some confusion as to the delimitation of many species. The same species often bears different names which have been applied to variants differing slightly in ornamentation, and the two generations of a single species have often been described as different species. This difficulty can be understood as the larger nodosariids and dentaliniids often occur in very small quantities in the samples, and it is therefore difficult to determine the variability of a species.

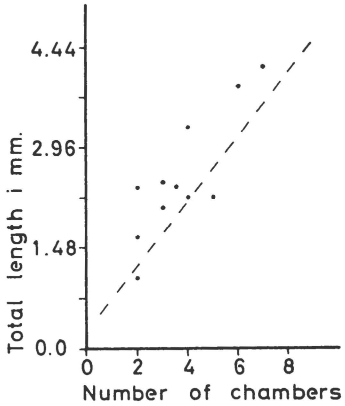

Fig. 12. Relationship between number of chambers and total length of 11 larger fragments of *Nodosaria latejugata* Gümbel from the Sonja Member, Nûgssuaq.

Koenen (1885) described two species of foraminifera as respectively *D. obliqua* and *N. raphanistrum* from the Selandian deposits from Vestre Gasværk in Copenhagen (MMH 939–944). The material consists of 3 microspheric and 3 megalospheric individuals of *N. latejugata.*

Franke's (1927) material originated from Lower Selandian deposits in Sundkrogen and Rugård. He referred to three species: *D. obliqua*, *N. polygona* and *N. raphanistrum* which, when restudied, were also found to represent two generations of *N. latejugata.*

Le Roy (1953) recorded both *N. affinis* and *N. paupercula* from the Esna Shale of Egypt. His fig. 15 shows a specimen which in all characters is identical with *N. latejugata.* His fig. 11 differs in having chambers

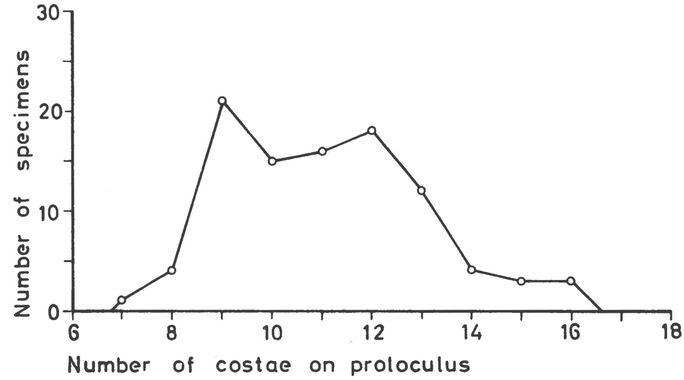

Fig. 13. Size-frequency distribution of number of costae on the proloculus of 98 specimens of *Nodosaria latejugata* Gümbel from Sundkrogen (Lower Selandian).

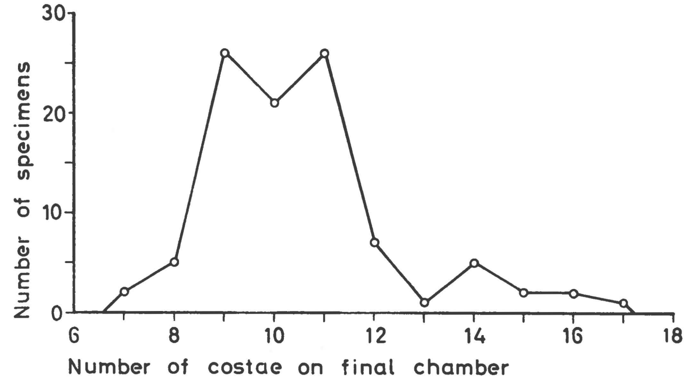

Fig. 14. Size-frequency distribution of number of costae on the final chamber of 98 specimens of *Nodosaria latejugata* Gümbel from Sundkrogen (Lower Selandian).

which are slightly longer than wide. This, however, falls within the variation of *N. latejugata.*

Specimens of *N. latejugata* from the Midway Formation and from the Brightseat Formation from USA present in the author's collection are identical with the Danish and Greenland material of *N. latejugata.*

It is a contradiction that Nogan (1964) recorded both *N. latejugata* and a subspecies, *N. latejugata carolinensis*, from the same samples. *N. latejugata carolinensis* cannot be a subspecies of *latejugata* as it is neither distinguished in time nor in geographical distribution.

N. latejugata has often been misidentified as *N. affinis* Reuss. *N. affinis* was described from Cretaceous deposits in central Europe. Reuss (1845, p. 26) described the ornamentation of the test as: "... von 4–5 hohen Flügel-artigen, unregelmässigen Rippen bedeckt sind, ...". The lowest number of costae found in the measured population of *N. lateju-*

gata from Denmark was 7, and the costae on this species are never so high and sharp as those of *N. affinis*.

The species *N. torsicostata*, described by TEN DAM (1944) from the Dutch Paleocene, differs from *N. latejugata* in being twisted the same way at each suture where the costae cross without interruption. The costae are not so high and broad as in *N. latejugata*.

The occasional find of specimens of *N. latejugata* which are twisted at one or more sutures can perhaps be explained as a repair of a broken test. The twisted sutures are strongly depressed and distinctly different from those of *N. torsicostata*, both in their number of costae and in their discontinuity. A fragment from Nûgssuaq consisting of two chambers with twisted suture shown on pl. 3, fig. 2 shows that some of the costae are interrupted at the suture; in addition, since the number of costae is 16 in contrast to 18–20 in *N. torsicostata*, the fragment is determined as *N. latejugata*.

Material: 55 fragments.

Occurrence

Lower Tertiary, Argentine, north and central Europe, north Africa, America.

Genus *Lagena* WALKER & JACOB, 1798

Lagena aff. *apiopleura* LOEBLICH & TAPPAN, 1953
pl. 6, fig. 2

1953 *Lagena apiopleura* LOEBLICH & TAPPAN: p. 59, pl. 10, fig. 14

Description

Test unilocular and pear-shaped in outline. Base rounded. Cross section of test circular. Surface ornamented with longitudinal rounded ribs, extending upward from the base and merging into a smooth collar a short distance below the apertural neck. Each rib at the base of the test parts into two parallel ribs which again unite into one rib just before reaching the apertural collar.

Affinity

The Greenland specimen is very close to LOEBLICH & TAPPAN's illustration. However, *L. apiopleura* has a tiny ring at the base of the chamber which is not found on the specimen from Nûgssuaq and accordingly it is named *Lagena* aff. *apiopleura*.

Material: 1 specimen.

Lagena sp.
pl. 6, fig. 3

Description

Test unilocular, fusiform. Surface ornamented with 7 longitudinal costae with angled cross-section. They run from the aperture to the base of the test. Aperture circular, terminal. Test wall composed of radiate, perforate calcite.

Affinity

Only two specimens were found. Both of them appear to be damaged around the aperture. An apertural tubus may have been present before the fossilisation.

The specimens resemble the specimen figured by KLINE (1943, p. 38, pl. 7, fig. 21) but differ in not having the crenulated costae shown on KLINE's figure.

Material: 2 specimens.

Genus *Lankesterina* LOEBLICH & TAPPAN, 1961

Lankesterina sp.
pl. 3, figs 8–9; pl. 15, fig. 5

Description

Test compressed, almost lancet-shaped, biserial throughout. General outline smooth, slightly lobate. Cross section rectangular with convex sides in the final part of the test, while in the earlier part they are straight to slightly concave. Chambers curved, hardly inflated, bordered by the raised sutures, which along the margins make up a peripheral costa. Chambers distally somewhat overlapping. Aperture terminal, radial.

Remarks

As only one specimen was found, a reliable species determination could not be made.

Material: 1 specimen.

Genus *Lenticulina* LAMARCK, 1804

Lenticulina centrotuberculata n. sp.
pl. 5, figs 1–2

Diagnosis

A *Lenticulina* with 10–13 chambers in the final whorl, somewhat depressed. With a smooth peripheral keel. Sutures limbate with angled cross section. Umbo with several smaller knobs.

Description

Test large, planispiral, involute and biumbonate. 10–13 chambers in the final whorl, commonly 11. Test somewhat compressed. The ratio diameter/thickness is about 2:1. Periphery angled; the peripheral angle is about 50°. Outline subcircular. A smooth peripheral keel is present. Sutures limbate and rather strongly curved. The sutures flatten out close to the periphery and become more raised towards the umbo. In the umbonal region the sutures may unite and develop one knob for each pair of sutures or the single suture may end in a knob. The cross section of the suture is angled. The surface of the test is smooth. The septa are smooth and gently curved. The foramen is a subcircular opening placed exteriomarginally. The proloculus diameter of megalospheric forms ranges from 234 to 378 μ and in the microspheric form is about 35 μ. Test wall composed of radiate, perforate calcite. Septa monolamellar.

Dimensions of holotype:
Diameter 2520 μ. Width 1185 μ.

Differential diagnosis

Lenticulina centrotuberculata n. sp. resembles *Lenticulina pseudomamilligerus* (PLUMMER) but differs in its larger diameter, less compressed test and much heavier ornamentation. Specimens of *Lenticulina pseudomamilligerus* from the Lower Midway Formation in the author's collection are very clearly distinguished by the above-mentioned characters.

Variation

None of the specimens had the final chamber preserved so details of the aperture are not known.

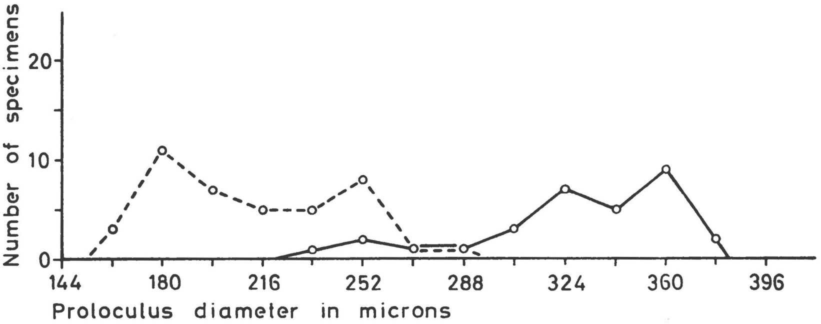

Fig. 15. Size-frequency distribution of proloculus diameters of 39 megalospheric specimens of *Lenticulina macrocentra* n. sp. (full line) and of 31 megalospheric specimens of *Lenticulina centrotuberculata* n. sp. (broken line).

The 42 specimens present in the material were found during a search for macrofossils, in the Sonja Member. They were in a rather bad state of preservation in the coarse rock. 32 of the 42 specimens were ground half way down in the equatorial plane to study the proloculus size. Of the 32 individuals only one was microspheric and the remainder were all megalospheric. The distribution of proloculus diameters of the megalospheric generation is shown in fig. 15. It is seen that the megalospheric generation is well distinguished from that of *Lenticulina macrocentra* n. sp. Figure 16 shows the distribution of number of chambers to a whorl. In this character *L. centrotuberculata* is also readily separated from *L. macrocentra* n. sp.

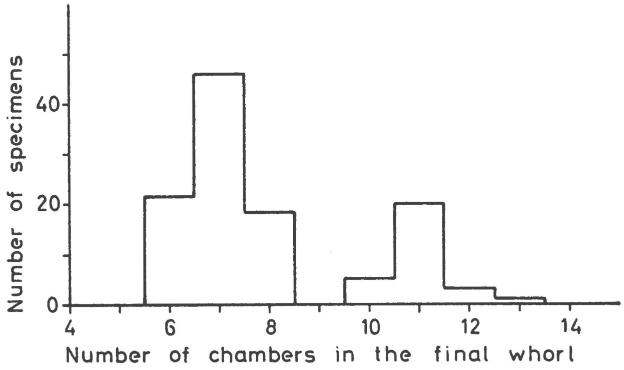

Fig. 16. Size-frequency diagram of number of chambers in the final whorl of *Lenticulina macrocentra* n. sp. (interval 5.5 to 8.5) and *Lenticulina centrotuberculata* n. sp. (interval 9.5 to 13.5) from the Sonja Member, Nûgssuaq.

As two of the ground specimens have less than one whorl preserved, the diagram is based upon only 29 observations. The microspheric specimen has 12 chambers in the last whorl.

Type locality:	Agatdalen, Nûgssuaq, West Greenland.
Type level:	Upper Danian.
Holotype:	MMH 10626 (pl. 5, figs 1–2).
Material:	42 specimens.

Lenticulina macrocentra n. sp.
fig. 17; pl. 5, figs 3–5

Diagnosis

A large *Lenticulina* with a very large elevated central disc. Sutures limbate, curved. 6–8 chambers in the final whorl. Periphery angled with a thick keel.

Description

Test large, planispiral, involute and biumbonate. 6–8 chambers in the final whorl, commonly 7. General outline circular. Test somewhat compressed. The ratio diameter/thickness is about 2:1. Periphery angled; peripheral angle in the final part about 50°. The thick peripheral keel often bears small tubercles. Sutures limbate and curved, generally with a rounded cross section. They may be ornamented with smaller knobs. In some individuals they are in certain areas divided into a series of tubercles. The umbonal disc varies in appearance. In some specimens it is half the total diameter of the test, and it is often cut by several furrows. The sutures continue from the umbonal disc to the peripheral keel either elevated or flattening out just before reaching the keel. A few specimens show traces of a peripheral flange. The aperture is situated in the peripheral angle, not protruding, radial and compressed elliptical. Some of the ridges between the grooves in the aperture protrude and divide it into elongated, irregular smaller openings. Apertural face gently curved; the central part depressed. Proloculus diameter in the megalospheric form ranges from 162 to 288 μ; in the microspheric generation it is about 35 μ. Test wall composed of radiate, perforate calcite. Septa monolamellar.

Dimensions of holotype:
Diameter 2082 μ. Thickness 1208 μ.

Differential diagnosis

Lenticulina macrocentra n. sp. differs from earlier described species of the genus *Lenticulina* by its stout test, large irregular umbonal discs and strongly thickened sutures.

Variation

Due to the poor state of preservation only one specimen was found with the final chamber preserved. This specimen was not chosen as holotype as it was badly damaged in another part of the test. One of the best preserved specimens was chosen although the final chamber is missing.

Of the material of 120 specimens 86 were ground in equatorial section to measure the proloculus diameter. Of these, 39 were megalospheric and 47 microspheric. The distribution of proloculus diameters of the megalospheric individuals is shown in fig. 15, and the distribution of number of chambers in the last preserved whorl in fig. 16. The micro- and megalospheric individuals do not differ from each other in external morphology.

The number of whorls in the microspheric generation is $3–3^1/_2$ compared with $1^1/_2–2$ in the megalospheric. As the total size of the two generations is equal, the microspheric is more compact and may therefore show greater resistance to abrasion. This could explain the relatively

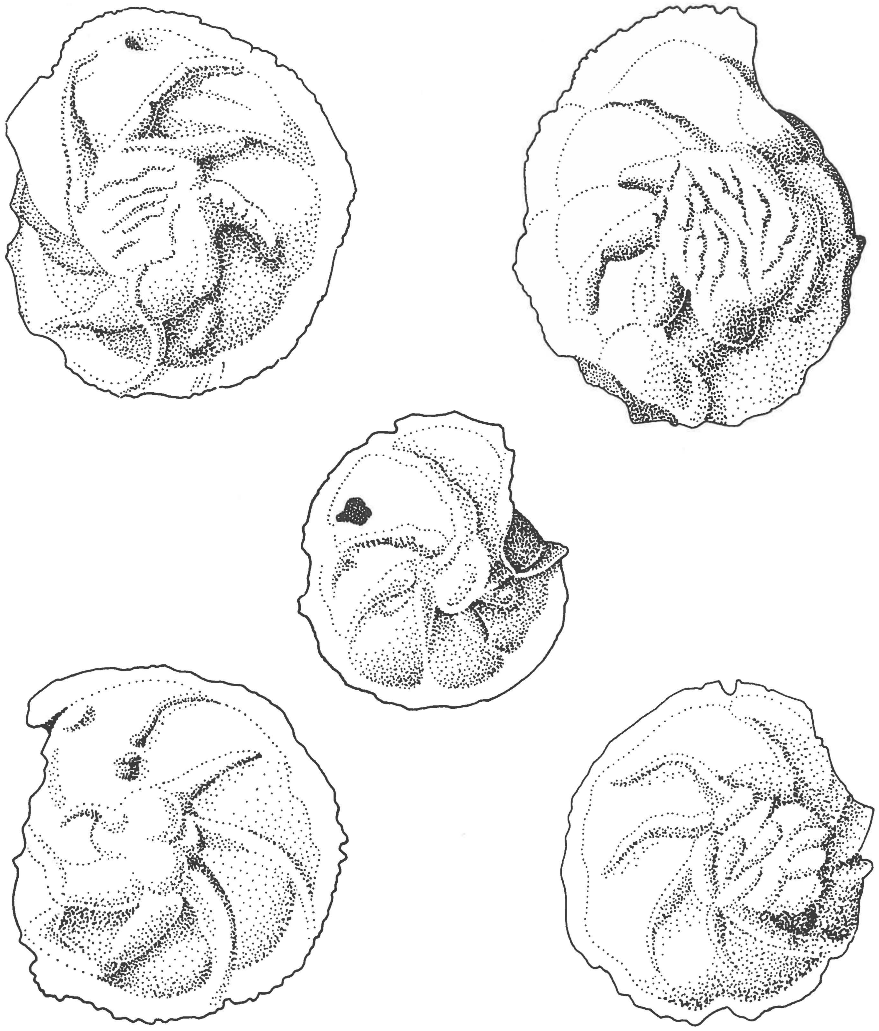

Fig. 17. *Lenticulina macrocentra* n. sp. specimens showing the variation of the ornamentation. 18×.

high number of microspheric forms compared with the number of megalospheric. The variation in ornamentation is illustrated in fig. 17.

Type locality: Agatdalen, Nûgssuaq, West Greenland.

Type level: Upper Danian.

Holotype: MMH 10624 (pl. 5, figs 4–5)

Material: 120 specimens.

Lenticulina klagshamnensis (BROTZEN, 1948)
pl. 5, figs 6–7

1885	*Cristellaria* cf. *clypeiformis* D'ORBIGNY; KOENEN: p. 108, pl. 5, fig. 14
1927	*Cristellaria osnabrugensis* VON MÜNSTER; FRANKE: p. 27, pl. 2, fig. 14
1948	*Robulus klagshamnensis* BROTZEN: p. 41, pl. 7, figs 1–2
1962	*Robulus* cf. *klagshamnensis* BROTZEN; SCHMID: p. 325, pl. 1, fig. 4
1965	*Robulus klagshamnensis* BROTZEN; POZARYSKA: p. 63, pl. 8, fig. 5
1966	*Robulus klagshamnensis* BROTZEN; HOFKER: p. 219, pl. 40, figs 12–13

Description

The tests of the Greenland specimens are large, planispiral, biumbonate and involute but tending to become evolute in the final part. Strongly compressed in the adult. 7–11 chambers in the final whorl. General outline smooth but may become slightly lobate around the last chambers. Periphery generally angled with a peripheral keel or flange. Sutures curved, limbate, most strongly elevated near the umbo. The umbonal disc somewhat elevated and occasionally developed as a group of larger tubercles. Chambers not inflated. Aperture at the peripheral angle, radial and a little protruding. The outer margins of the apertural face slightly elevated. Apertural face narrow. Diameter of megalospheric proloculus about 126 μ, in microspheric about 10 μ.

Discussion

As described by BROTZEN this species shows wide variation.

In the author's collection there are well preserved specimens of *Lenticulina klagshamnensis* from the type locality (Klagshamn, Sweden) and from Vestre Gasværk in Copenhagen. This material shows considerable variation in the development of the sutural ridges, umbilical knob and peripheral keel. The most stable character seems to be the strong compression of the test in adult specimens.

KOENEN's material from the Lower Selandian beds in the Copenhagen area is kept in the Mineralogical Museum in Copenhagen (MMH 937). It consists of 9 specimens of *L. klagshamnensis* and one *Lenticulina* sp. All are labelled *Christellaria* cf. *clypeiformis* D'ORBIGNY.

FRANKE's material from beds of the same age housed in the Geological Survey of Denmark and labelled *C. osnabrugensis* MÜNSTER also belongs to *L. klagshamnensis.*

Material: 10 specimens.

Occurrence

Paleocene, Sweden, Denmark, Poland, Austria and Holland.

Genus *Amphimorphina* Neugeboren, 1850

Amphimorphina sp.

pl. 6, figs 4–5; pl. 16, fig. 1

Description

Test unilocular, ovate. Surface smooth. Apertural end thickened and truncate. Aperture terminal with a slightly depressed central area. Test wall composed of radiate, perforate calcite.

Material: 3 specimens.

Family **Polymorphinidae** d'Orbigny, 1839

Genus *Guttulina* d'Orbigny, 1839

Guttulina communis d'Orbigny, 1826

pl. 6, figs 6–7

Selected synonyms:

1826	*Guttulina communis* d'Orbigny: p. 266, pl. 12, figs 1–4
1826	*Guttulina problema* d'Orbigny: p. 266, pl. 26, fig. 14
1930	*Guttulina communis* d'Orbigny; Cushman & Ozawa: p. 19, pl. 2, figs 1–6

Description

The Nûgssuaq specimens are subovate with the chambers in a slowly ascending quinqueloculine arrangement. Chambers slightly to moderately inflated. Outline smooth, may become gently lobate. Cross section subcircular to deformed elliptical. Chambers rather strongly embracing. Sutures flush with surface. Aperture terminal, radial. Wall composed of radiate, perforate calcite. Septa monolamellar.

Discussion

Cushman & Ozawa (1930) placed the species *Guttulina problema* d'Orbigny in synonymy with *G. communis* as they regarded it as an infraspecific variety of the latter. *G. problema* is somewhat more slender than *G. communis* with slightly less embracing chambers. This variation is also found in the Greenland material although there are only 22 individuals. As it has been impossible to delimit the one form from the other in their general characters, the author prefers to follow Cushman & Ozawa's point of view in placing tentatively *G. problema* as a synonym of *G. communis*. A statistic analysis has not been carried out due to the lack of material.

Material: 22 specimens.

Occurrence

Upper Cretaceous to Recent. Worldwide distribution.

Genus *Sigmomorphina* CUSHMAN & OZAWA, 1928

Sigmomorphina wilcoxensis CUSHMAN & PONTON, 1932
pl. 6, figs 8–12; pl. 1, fig. 3

1932	*Sigmomorphina wilcoxensis* CUSHMAN & PONTON: p. 61, pl. 8, fig. 7
1941	*Sigmomorphina wilcoxensis* CUSHMAN & PONTON; TOULMIN: p. 595, pl. 80, fig. 15
1942	*Sigmomorphina wilcoxensis* CUSHMAN & PONTON; CUSHMAN & TODD: p. 35, pl. 6, fig. 15
1944 b	*Sigmomorphina wilcoxensis* CUSHMAN & PONTON; CUSHMAN: p. 41, pl. 7, fig. 4
1946	*Sigmomorphina wilcoxensis* CUSHMAN & PONTON; CUSHMAN & TODD: p. 57, pl. 10, fig. 9

Description

The specimens from Greenland have alternating chambers in a slightly sigmoid, almost biserial arrangement. General outline smooth and slightly oblique elliptical with a rounded prolongation of the apertural part. Cross section strongly compressed elliptical. Sutures very slightly curved, at an angle of about 45° to the axial line of the test. Sutures flush with the surface. Aperture terminal, radial. Test wall composed of radiate, perforate calcite. Septa monolamellar.

Specimen with fistulose chamber

Among the specimens was found one with a fistulose final chamber. As the apertural end was covered by the fistulose part, the specimen was studied by use of an x-ray microscope. The x-ray micrograph (pl. 1, fig. 3) showed that there exists a secondary resorbed area next to the aperture. The shape of the distal end of the test is identical with the one described above for the non-fistulose specimens.

Material: 9 specimens.

Occurrence

Paleocene, Gulf Area, USA.

Family **Glandulinidae** REUSS, 1860

Genus *Oolina* D'ORBIGNY, 1839

Oolina sp.
pl. 6, fig. 1; pl. 15, fig. 6

Description

The Greenland specimen has ovate test and is unilocular. Surface ornamented with depressed polygonal areas. Aperture projecting with a slightly elevated apertural neck. Test wall composed of radiate, perforate calcite.

Discussion

The specimen very much resembles *Oolina hexagona* (Williamson, 1848) but is different in having somewhat larger, depressed areas. As, however, only one specimen was found, a safe species determination cannot be made.

Material: 1 specimen.

Genus *Fissurina* Reuss, 1850

Fissurina prolongata n. sp.
pl. 7, figs 5–7; pl. 16, fig. 2

Diagnosis

A *Fissurina* with an elongated outline, slightly compressed chamber, a blunt, broad, peripheral keel and a prolonged apertural part with a transverse furrow near the aperture. The short internal tube is trumpet-shaped.

Description

Test unilocular. Slightly compressed. General outline elongate rounded. The ratio length/width/thickness is 10:8:5. There is an elevated, broadly rounded, thick, equatorial keel which is prolonged in apertural direction. The apertural part shows an equatorial fissure which on both sides closes to the aperture, and it continues into a short, sharp keel. The apertural part is delimited by a smooth, transverse, curved furrow. The aperture is elliptical. It continues into a short trumpet-shaped internal tubus. Wall composed of radiate, perforate calcite.

Differential diagnosis

Fissurina prolongata differs from earlier described species of this genus by its prolonged apertural part and transverse furrow near the aperture.

Dimensions of holotype:
Length 290 μ. Width 203 μ. Thickness 118 μ.

Type locality:	Agatdalen, Nûgssuaq, West Greenland.
Type level:	Upper Danian.
Holotype:	MMH 10601 (pl. 7, figs 6–7).
Material:	5 specimens.

Fissurina sonjae n. sp.
pl. 7, figs 8–10; pl. 16, figs 3–4

Diagnosis

Test compressed, central part very slightly inflated. Marginal part raised. With entosolenian tubus. Aperture elliptical in a smooth depression.

Description

Test unilocular, low cylindrical. Central part slightly inflated. Marginal part slightly raised. Cross section of test rounded, rectangular. Equatorial outline rounded, a little compressed in the apertural area and slightly pointed at the proximal end. Aperture elliptical in a depression. The aperture continues into an internal tube extending beyond the center of the chamber. Test wall composed of radiate, perforate calcite.

Dimensions of holotype:
Length 225 μ. Width 207 μ. Thickness 72 μ.

Differential diagnosis

Fissurina sonjae differs from earlier described species of the genus *Fissurina* by its low, almost cylindrical shape.

Type locality:	Agatdalen, Nûgssuaq, West Greenland.
Type level:	Upper Danian.
Holotype:	MMH 10603 (pl. 7, figs 9–10).
Material:	6 specimens

Derivatio nominis

The species is named in honour of Mrs. SONJA A. JACOBSEN, who, as a member of the Nûgssuaq expeditions, took part in the discovery of the highly fossiliferous Sonja Member.

Fissurina sp.
pl. 7, figs 11–13; pl. 16, figs 5–6

Description

Test unilocular, compressed. Equatorial outline ovoid. The ratio length/width/thickness is about 25:19:12. Periphery with an angled keel, which continues into a thickened apertural part. The inner peripheral part has a low, barrel-shaped cross section. It forms a loop around the chamber but flattens out near the apertural end. The area inside the loop is slightly inflated and the central part is more inflated thus forming a double dome. The aperture is a small, circular opening placed in a fissure in the thickened part of the marginal keel. The aperture continues into a short entosolenian tubus with a short compressed, trumpet-shaped extension. Wall composed of radiate, perforate calcite.

Variation and affinity

Variation is found in the degree of inflation. Two of the specimens had the double inflation described above, while the remaining six individuals did not show this character. The most constant character is the development of the keels; this is the same in all individuals. The ornamentation of the central area is a slight reticulation in one specimen while it is a fine punctation in the remainder. The species shows some resemblance to *Entosolenia crumenata* CUSHMAN, 1935, but it is distinguished by the development of the keels and also by the lack of a tubular neck.

Material: 9 specimens

Superfamily **Buliminacea** JONES, 1875
Family **Turrilinidae,** CUSHMAN, 1927
Genus *Spirobolivina* HOFKER, 1956

Spirobolivina scanica (BROTZEN, 1948)
fig. 18; pl. 8, figs 1–2; pl. 17, figs 1–6

1948 *Bolivinopsis* (*Spiroplectoides*) *scanica* BROTZEN: p. 54, pl. 6, fig. 3, text-fig. 14
1964 *Spirobolivina scanica* (BROTZEN); KUSELEVA: p. 289, pl. 63, figs 1–11
1966 *Spirobolivina scanica* (BROTZEN); HOFKER: p. 311, pl. 70, fig. 105

Description

Test in Nûgssuaq specimens initially planispiral with 1–1$^1/_2$ whorls, later becoming biserial. Consisting of up to 18 chambers. Margins of the test generally smooth and subparallel. Cross section compressed elliptical. Sutures curved, depressed in the later part where the chambers may become faintly inflated and show overlap. The sutures in the earlier part are curved and level with the surface. They are transparent and rather broad owing to the deposition of secondary calcite layers. The aperture is bolivine and a bolivine tooth-plate is present in all chambers as well as in the coiled part of the test. Wall composed of radiate, perforate calcite. Septa monolamellar. The pore-diameter averages 0.5 μ. Some of the pores appeared under the electron microscope to be circular and some elliptical. There is no regularity in the distribution of circular and elliptical pores. Proloculus diameter from 12 to 20 μ.

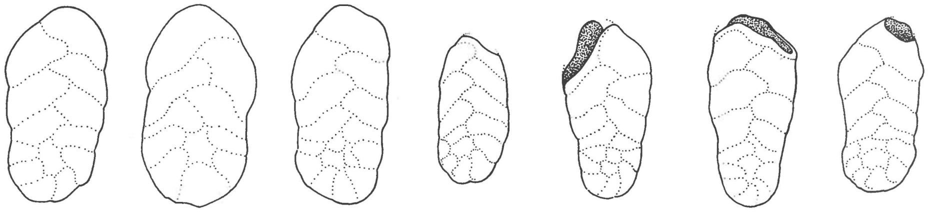

Fig. 18. *Spirobolivina scanica* (BROTZEN, 1948). 125×.

Variation and discussion

BROTZEN mentioned that he found two forms of *Spirobolivina scanica* in the Selandian beds of Scania. "One of them has a biserial part which over the spiral is as broad as the spiral itself, later increasing a little in breadth. In the other type the test has a uniform breadth and is broader and not so long as in the first type. The chambers over the spiral in the first type are broader than high, later becoming higher than broad. In the other type all chambers in the biserial part are broader than high."

In spite of the small material from Greenland both morphological forms mentioned by BROTZEN could be found as shown in fig. 18. As, however, the material is too sparse to allow a statistical test of the possibility of a correlation between general morphology and proloculus diameter, material consisting of 150 specimens from one of the localities mentioned by BROTZEN, i.e. Klagshamn was used; in addition 100 specimens from the Selandian beds at Vestre Gasværk in Copenhagen were studied.

Many of the specimens from these localities could without hesitation be referred to one of the two morphological forms, but about one fourth were intermediate. As many of the specimens from both Klagshamn and Vestre Gasværk were pyritized in the initial part, only 41 specimens from Klagshamn and 70 from Vestre Gasværk could be measured for proloculus diameter. Figs 19 and 20 show that it is not possible to distinguish two generations in the material. It should be mentioned that both larger and smaller proloculi appeared in both morphological forms.

The distributions of proloculus diameters depicted in figs 19 and 20 have statistically been treated as one population in order to obtain a sufficiently large number of observations. To test whether two generations according to proloculus diameter should be present in the material the χ^2-test was applied. The χ^2 value is 1.388 which for two degrees of freedom corresponds to a probability value of about 50 %. There is thus no statistical indication of the presence in the population of more than one generation according to the measured parameter.

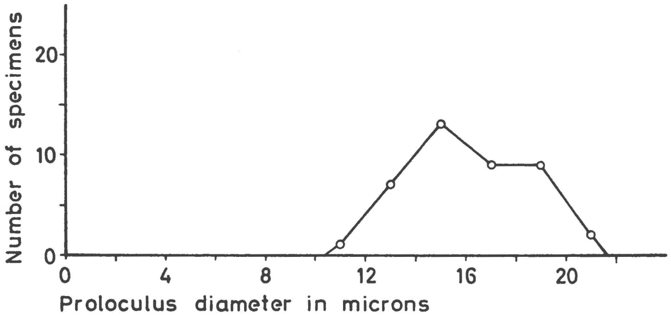

Fig. 19. Size-frequency distribution of proloculus diameters of 41 specimens of *Spirobolivina scanica* (BROTZEN) from Klagshamn (Lower Selandian).

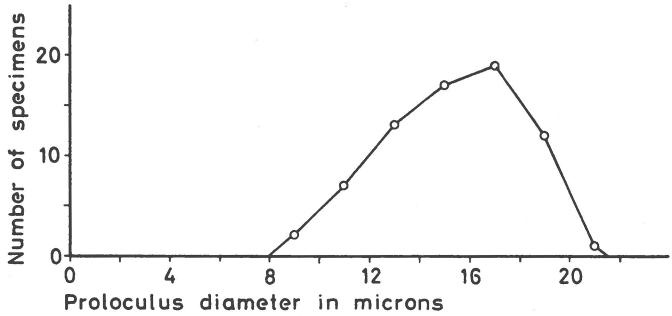

Fig. 20. Size-frequency distribution of proloculus diameters of 70 specimens of *Spirobolivina scanica* (BROTZEN) from Vestre Gasværk (Lower Selandian).

KUSELEVA (1964, p. 290) stated that both megalospheric and microspheric individuals were present in her material from the West Sibirian plains. KUSELEVA's illustrations (pl. 63, figs 4–6) show sections of specimens with proloculus diameters of about 13 μ. Pl. 63, figs 7, 9–10 show individuals with proloculus diameters of about 20 μ. KUSELEVA mentioned that the diameter of the coiled portion of the test of the microspheric generation is small and that its width is smaller than that of the biserial part. By contrast the megalospheric form was said to have a diameter of the coiled portion larger than the width of the biserial part.

As mentioned above it has not been possible to establish a correlation between morphology and proloculus size in material from the type area of the species. From figs 19 and 20 it appears that KUSELEVA's illustrated specimens (proloculus diameter of 13 and 20 μ) are from either end of the variation width.

The diameter of the proloculus of the Greenland specimens lies within the interval 12–20 μ.

Material: 10 specimens.

Occurrence

Selandian, Sweden and Denmark; Maastrichtian, West Siberia.

Family **Eouvigerinidae** CUSHMAN, 1927

Genus *Siphogerinoides* CUSHMAN, 1927

? *Siphogerinoides* sp.

pl. 8, fig. 7

Description

Test with biserial earlier part and uniserial rectilinear later part. 10 chambers in biserial part and 3 in uniserial part. Chambers spherical. Sutures in the biserial part depressed. Sutures in the uniserial part broad and not depressed. Chambers ornamented with a band of rounded tubercles placed a little below the equatorial plane of each chamber. Aperture terminal, circular and protruding at the end of a small neck. Test wall thick, composed of radiate, perforate calcite. Septa monolamellar.

Discussion

Only one specimen was found in the material. It was heavily incrusted with quartz grains and only the final chamber was free of sediment. As the test seemed quite fragile it was decided to free the test by changing it to fluorite (UPSHAW et al., 1957).

This method often leads to the destruction of delicate inner structures such as tooth-plates. The specimen from Greenland does not now show any internal structures although they may have been present originally.

The wall structure and lamellar character was determined by sectioning a small fragment of the final chamber of the original test.

The species should, according to wall structure, lamellar character and general morphology, be referred to the genus *Siphogerinoides*, but lack of information concerning internal structures makes a reliable determination of the genus impossible.

Material: 1 specimen.

Family **Buliminidae,** JONES, 1875

Genus *Bulimina* D'ORBIGNY, 1826

Bulimina midwayensis CUSHMAN & PARKER, 1936

pl. 7, figs 1–2; pl. 18, figs 5–6

1926 *Bulimina aculeata* D'ORBIGNY; PLUMMER: p. 73, pl. 4, fig. 3

1929 *Bulimina aculeata* D'ORBIGNY; WHITE: p. 47, pl. 5, fig. 5

1936 *Bulimina arkadelphiana* var. *midwayensis* CUSHMAN & PARKER: p. 42, pl. 7, figs 9–10

1944	*Bulimina* aff. *aculeata* d'Orbigny; Dam: p. 111, pl. 3, fig. 12
1947	*Bulimina arkadelphiana* var. *midwayensis* Cushman & Parker; Cushman: p. 92, pl. 21, figs 24–25
1948	*Bulimina midwayensis* Cushman & Parker; Brotzen: p. 58, pl. 10, fig. 8
1960	*Bulimina arkadelphiana midwayensis* Cushman & Parker; Olsson: p. 31, pl. 5, fig. 9
1962	*Bulimina midwayensis* Cushman & Parker; Hillebrandt: p. 76, pl. 5, fig. 19
1964	*Bulimina midwayensis* (Cushman & Parker); Buch: p. 107, pl. 6, fig. 68
1964	*Bulimina* ex. gr. *inflata* Seguenza; Frejman & Kiselman: p. 282, pl. 61, figs. 20–22
1966	*Bulimina midwayensis* Cushman & Parker; Hofker: p. 335, pl. 81, figs 129, 134, 136, 138, 139, 142, 143, 151

Description

In the Greenland material the tests are conical, consisting of up to 6 whorls, each composed of three chambers arranged in an ascending spiral. Chambers inflated, enlarging rapidly as added in the megalospheric form and somewhat slower in the microspheric form. Sutures distinct and somewhat depressed. Proloculus in the adult bears one large basal spine. Additional smaller spines may also be present on the proloculus. Juvenile specimens usually have a coarse tuberculation instead. Along the basal part of each chamber is ornament consisting of spines of varying diameter and length. In some individuals the spines are reduced and can be described as a pointed plication. When the spines are well developed, each of them continue over the lower third of the chamber as a low flattening list. The ratio between total length and width of the last volution is constant at about 1.6. The aperture is loop-shaped extending from the basal suture of the final chamber into the terminal face. It has a bulimine tooth-plate connecting successive foramina.

Variation

As the material from Greenland is too sparse for variation studies, a population of *Bulimina midwayensis* from a Danish Paleocene locality has been studied. For comparison a population from the Upper Maastrichtian Kjølbygaard Marl from the locality "Dania" in Jylland has been used.

In the measured populations two generations could be distinguished according to their proloculus diameters (figs 21 and 22). The ratio between number of microspheric to number of megalospheric individuals is about 1:4 in the Paleocene population while the corresponding value for the Upper Maastrichtian population is about 1:10. The ratio between total length and total width is about 1.6 and slightly higher for the microspheric forms, but this tendency is not pronounced (fig. 23). Compared with total length, there are more chambers in microspheric than

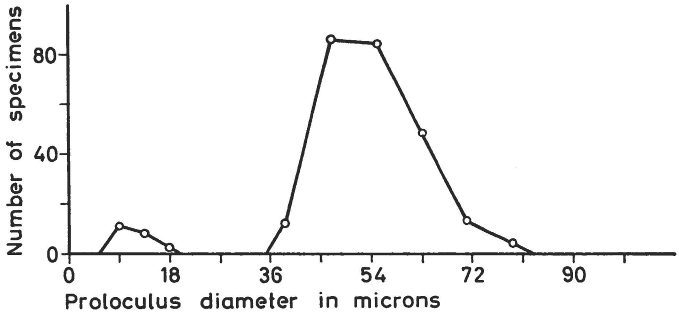

Fig. 21. Size-frequency distribution of proloculus diameter of 269 specimens of *Bulimina midwayensis* (CUSHMAN & PARKER) from the Upper Maastrichtian Kjølbygaard Marl.

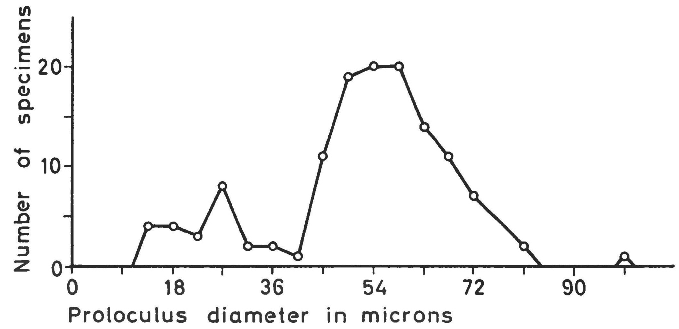

Fig. 22. Size-frequency distribution of proloculus diameters of 127 specimens of *Bulimina midwayensis* CUSHMAN & PARKER from Lellinge (Lower Selandian).

in megalospheric individuals (fig. 24). The number of chambers is higher in microspheric than in megalospheric forms (fig. 25).

Discussion

BROTZEN (1948) raised the subspecies *Bulimina arkadelphiana midwayensis* CUSHMAN & PARKER to species rank because of its differing general shape. Through the courtesy of Dr. B. F. CLARDY the author received material of *Bulimina arkadelphiana* CUSHMAN & PARKER from the Arkadelphia Marl (section 12 township 8 S, range 20 W, 5 miles south of Arkadelphia at the junction of US. highway 67 and the road to Gum Springs, Arkansas).

From a study of this material it seems that *Bulimina arkadelphiana* is separated from *Bulimina midwayensis* by its general shape (especially its slender spire).

The Upper Maastrichtian specimens from Denmark are identical with those from Greenland and from the Danish Paleocene, but differ in morphology from *Bulimina arkadelphiana* from the Arkadelphia

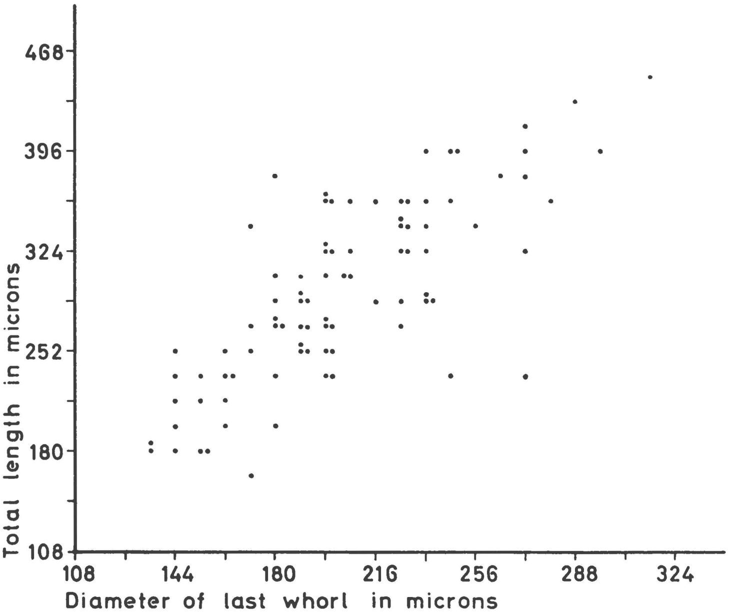

Fig. 23. Relationship between the diameter of the last whorl and total length of 90 specimens of *Bulimina midwayensis* Cushman & Parker from Lellinge (Lower Selandian).

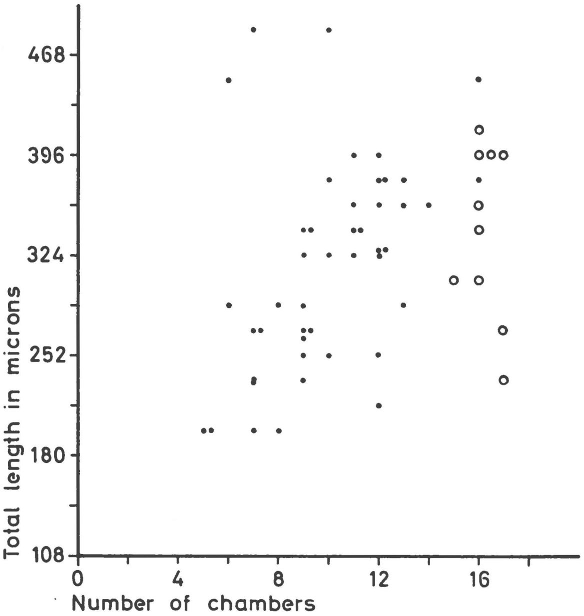

Fig. 24. Relationship between number of chambers and total length of 54 specimens of *Bulimina midwayensis* Cushman & Parker from Lellinge (Lower Selandian). The circles represent microspheric specimens.

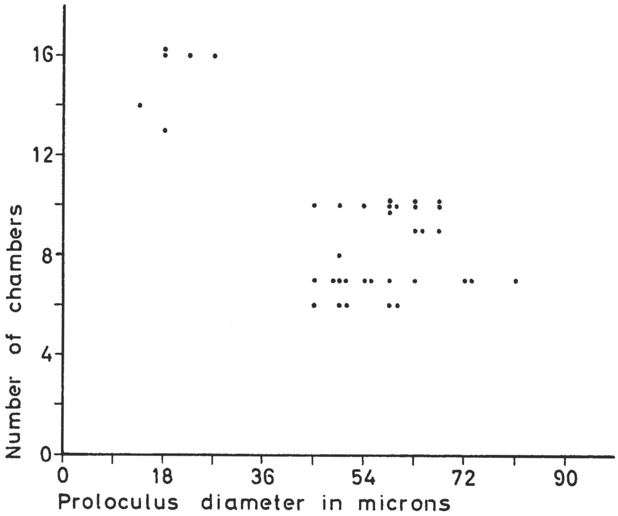

Fig. 25. Relationship between proloculus diameters and number of chambers in 36 specimens of *Bulimina midwayensis* CUSHMAN & PARKER from Lellinge (Lower Selandian).

Marl. The Danish Maastrichtian specimens are therefore also referred to the species *Bulimina midwayensis*.

The presumed megalospheric generations with a proloculus diameter of 36 μ or larger of the populations from Denmark (figs 21–22) have been treated statistically and tested against each other.

As the F-test gave a P_F-value higher than 10 $^0/_0$, the t-test was applied. This gave a t-value of 1.052 corresponding to a P_t-value of 25–30 $^0/_0$ for a total number of observations of 355. There is thus no significant difference in the distribution of megalospheric proloculus diameters between the Upper Maastrichtian and the Lower Selandian *Bulimina midwayensis*, indicating that this character of the species remained constant through a rather long time interval pointing to the validity of the proloculus diameter as a specific character.

FREJMAN & KISELMAN's description and figures clearly demonstrate that their material recorded under the name *Bulimina* ex. gr. *inflata* SEGUENZA most probably belongs to the species *Bulimina midwayensis*.

Bulimina inflata SEQUENZA was originally described from Pleistocene deposits from Sicily and is distinctly different from *Bulimina midwayensis*.

OLSSON listed *Bulimina midwayensis* as a subspecies of *Bulimina arkadelphiana*. He did not, however, state whether transitional forms were present in his material.

Material: 8 specimens.

Occurrence

Maastrichtian, West Siberia. Paleocene, Midway Formation, Texas; Hornerstown Formation, New Jersey; Velasco Formation, Mexico; Holland; Sweden; Denmark; Austria. Upper Eocene, Søvind Marl, Denmark.

Bulimina rosenkrantzi BROTZEN, 1948
pl. 1, fig. 5; pl. 8, fig. 5

1948 *Bulimina rosenkrantzi* BROTZEN: p. 61, pl. 9, fig. 1; pl. 10, fig. 5
1964 *Bulimina rosenkrantzi* BROTZEN; FREJMAN & KISELMAN: p. 276, pl. 61, figs 1–6

Description

Tests of the specimens from Greenland are elongate, coiled in an ascending spiral. Three chambers to a whorl. Test 3–$3^1/_2$ times as long as broad. Cross section of older part in some specimens rounded and in others rounded-triangular. Final whorl comprises $^1/_2$–$^1/_3$ of the total length of test in the adult. Chambers inflated, particularly in the final whorl. Sutures depressed, narrow and distinct. Aperture loop-shaped at basal suture of final chamber. Usually the apertural area is somewhat depressed. Aperture provided with a bulimine tooth-plate connecting successive foramina. Wall composed of radiate, perforate calcite. Pore diameter about 2 μ. Septa monolamellar.

Variation and discussion

FREJMAN & KISELMAN's statement as to a two-layered wall of *Bulimina rosenkrantzi* cannot be confirmed. Both ordinary light microscopy of thin sections as well as electron microscopical studies of sections show that *B. rosenkrantzi* is a monolamellar species with secondary thickening of the earlier part of the test associated with the addition of new chambers.

BROTZEN (1948) mentioned that the distinguishing characters of this species are the slender test and high final whorl, which characters are clearly demonstrated by his figures.

However, young individuals which have not yet developed the high final whorl are difficult to distinguish from young *Bulimina trigonalis* DAM as well as from *B. thanetensis* CUSHMAN & PARKER. As the material from Greenland was too sparse for variation studies, a population from the type locality of *B. rosenkrantzi* was used. This population was compared with a population of *B. trigonalis* from the Selandian Kerteminde Marl. By testing statistically the distribution of the presumed megalospheric proloculus diameters of the two measured populations

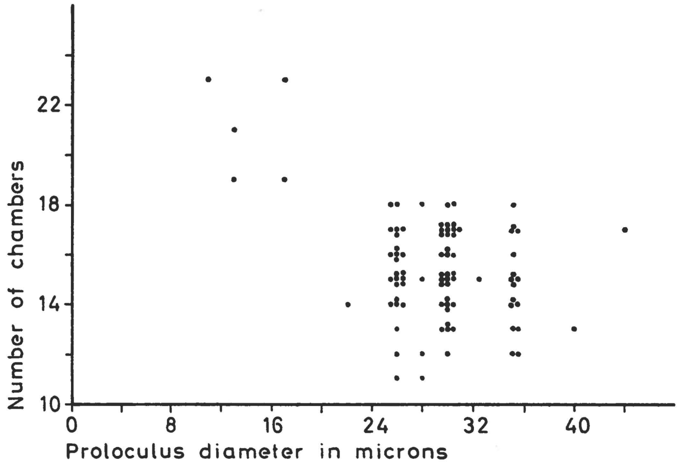

Fig. 26. Relationship between proloculus diameters and number of chambers in 88 specimens of *Bulimina trigonalis* DAM from Hanerup, Kerteminde Marl (Selandian).

(figs 26 and 27) a P_t-value of less than 0.1 $^0/_0$ was found, indicating a significant difference between the two species in this parameter.

B. rosenkrantzi and *B. trigonalis* can furthermore be distinguished by their different wall thickness (pl. 1, figs 4–5).

The difference between *B. rosenkrantzi* and *B. thanetensis* in megalospheric proloculus diameter is very pronounced (figs 27 and 28). The

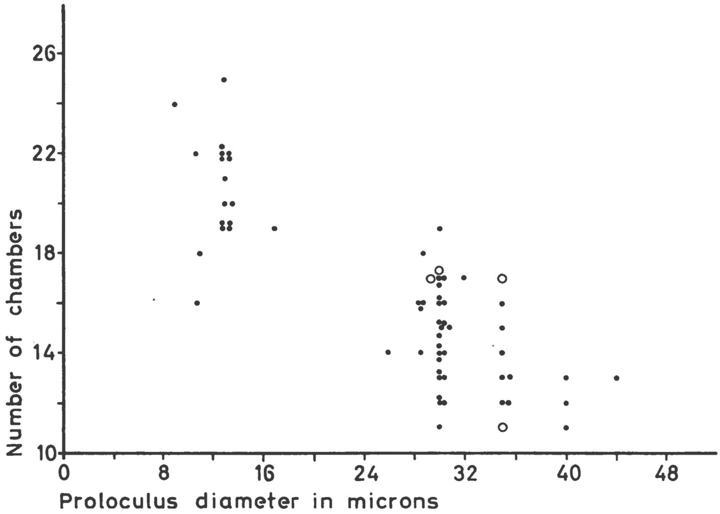

Fig. 27. Relationship between proloculus diameters and number of chambers in 60 specimens of *Bulimina rosenkrantzi* BROTZEN from Klagshamn (Lower Selandian). The circles represent four specimens of *Bulimina rosenkrantzi* BROTZEN from the Sonja Member, Nûgssuaq.

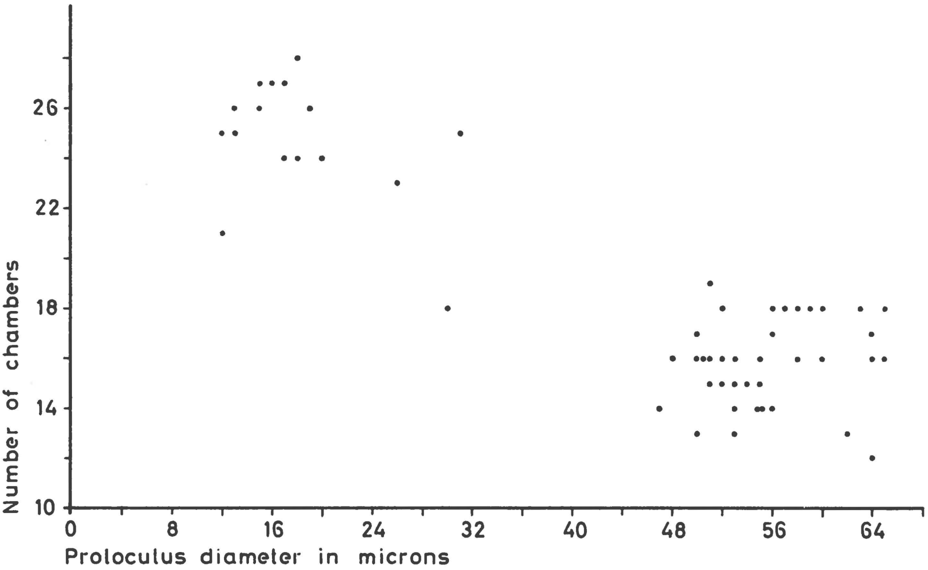

Fig. 28. Relationship between proloculus diameters and number of chambers in 53 specimens of *Bulimina thanetensis* CUSHMAN from the Thanet Sands, England (data from HAYNES 1954).

proloculus diameter of the presumed megalospheric generation of *B. rosenkrantzi* falls within the interval 26–44 μ, while the corresponding interval for *B. thanetensis* according to HAYNES (1954) is 47–65 μ.

HOFKER (1957, p. 193) mentioned in his description of *Praebulimina rosenkrantzi* from the Upper Maastrichtian of NW Germany that the species *B. rosenkrantzi* must belong to the genus *Praebulimina*, as it has 4 chambers to the whorl instead of 3 which is characteristic of the genus *Bulimina.*

The large number of specimens of *B. rosenkrantzi* from the type locality in Sweden present in the collection of the Geological Institute of the University of Copenhagen all show 3 chambers to a whorl, and the same applies to the material from Nûgssuaq. Therefore HOFKER's material cannot be regarded as identical with BROTZEN's *B. rosenkrantzi* and has not been recorded in the present list of synonyms.

Bulimina thanetensis CUSHMAN & PARKER, 1947 was originally described from the Thanet Sands of the section near Reculver, SE England. HAYNES described the foraminiferal fauna of the same beds in a series of publications from the years 1954–1958 and recorded *B. thanetensis* as the dominant species at several levels.

By careful studies of this species HAYNES concluded (1954, p. 187–188) that *B. thanetensis* is distinguished from *B. trigonalis* DAM by the following characters:

1. *B. thanetensis* has a thin wall in contrast to *B. trigonalis.*
2. At the same number of whorls *B. thanetensis* has a length of 0.5 mm while *B. trigonalis* has 0.3 mm.
3. The size of proloculus of *B. thanetensis* is distinctly different from that of *B. trigonalis.*
4. The tooth-plate is simpler in *B. thanetensis* than in *B. trigonalis.*

HAYNES added however (p. 188): "The difference shown by *B. thanetensis* in size and tongue structure, and especially in shell thickness might conceivably be the result of adaption to deeper shelf conditions." The difference in proloculus size cannot, however, readily be explained as caused by environmental factors, and the two species are therefore here regarded as different.

In 1958 HAYNES listed the three species *B. thanetensis*, *B. trigonalis* and *B. rosenkrantzi* as infraspecific variants and in his concluding remarks wrote an equal-sign between them thus disregarding his own investigations from 1954.

Probably this made HOFKER (1966, p. 287) refer to *B. thanetensis* as an independent species which he illustrated on pl. 61, fig. 56, while he, in the same publication, on p. 326 and p. 335 placed it in synonymy with *B. trigonalis* and *B. rosenkrantzi.*

Material: 4 specimens.

Occurrence

Upper Maastrichtian, West Siberia; Paleocene, Sweden and Denmark.

Bulimina rugifera GLAESSNER, 1937
pl. 7, figs 3–4; pl. 18, figs 1–4

1937 *Bulimina rugifera* GLAESSNER: p. 372, pl. 2, fig. 19

Description

The tests from Greenland are trochospirally coiled with three chambers to a whorl. Tests may become slightly twisted. Cross section broadly rounded, triangular with concave sides. Chambers somewhat inflated. Approximately in the middle of the sides in each chamber's basal suture is a sinus, which does not coincide with the suture running in direction of the long axis of the test. The presence of these sini causes the main part of the concavity of the sides. The sutures in the later part of the test are distinct and slightly depressed. In the earlier part they are somewhat obscured by the ornamentation. Proloculus bears a short, slender spine. With the exception of the last whorl, the test is ornamen-

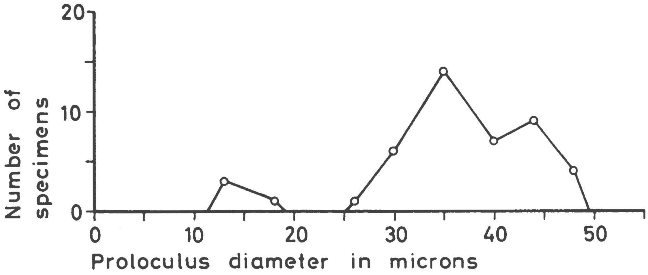

Fig. 29. Size-frequency distribution of proloculus diameters of 45 specimens of *Bulimina rugifera* GLAESSNER.

ted with narrow, low and irregular costae which may continue across the sutures. The ornamentation is most strongly developed in the older part of the test. The aperture is bulimine with a bulimine tooth-plate. Proloculus diameter in the microspheric form ranges from 13 to 17 μ and in the megalospheric from 26 to 48 μ. Septa monolamellar.

Variation

Due to the state of preservation it was possible to measure the proloculus diameter of only 45 specimens, including both whole and damaged individuals. Fig. 29 shows that there are two well separated generations present in the Nûgssuaq material. Four specimens had a proloculus diameter between 13 and 17 μ and are regarded as microspheric, while the remaining 41 specimens are regarded as megalospheric having proloculus diameters between 26 and 48 μ.

Discussion

GLAESSNER (1937) placed *Bulimina velascoensis* CUSHMAN of WHITE (1929, p. 50, pl. 5, fig. 13) in synonymy with *B. rugifera.* However, CUSHMAN & PARKER (1947, p. 85) recorded WHITE's material as *B. velascoensis*, stressing that it "in some respects resembles *Bulimina tabascoensis* GALLOWAY & MORREY . . ." but that it should be referred to *B. velascoensis.*

According to WHITE's illustration and description his material is different from *Bulimina rugifera* GLAESSNER. WHITE's description says: "Test broadly oval in outline, early portion triangular in cross-section, later portion may become somewhat quadrangular . . .". Oval outline and a somewhat quadrangular later portion is not found in *B. rugifera* and WHITE's material is therefore here regarded as belonging to another species.

Material: 132 specimens.

Occurrence

Lower Paleocene, NW Caucasus, USSR.

Genus *Praeglobobulimina* Hofker, 1951

Praeglobobulimina ovata (d'Orbigny, 1846)

pl. 8, fig. 6

1846	*Bulimina ovata* d'Orbigny; p. 185, pl. 11, figs 13–14
1897	*Bulimina ovata* d'Orbigny; Burrows & Holland: p. 32, pl. 11, fig. 11
1947	*Bulimina ovata* d'Orbigny; Cushman & Parker: p. 106, pl. 25, figs 8–9
1948	*Bulimina* aff. *ovata* d'Orbigny; Brotzen: p. 59, pl. 10, fig. 9 (non fig. 10)
1954	*Praeglobobulimina ovata* (d'Orbigny); Haynes: p. 190, text figs 9–12, 17–19
1964	*Bulimina ovata* d'Orbigny; Nogan: p. 32, pl. 2, fig. 19
1965	*Bulimina ovata* d'Orbigny; Pozaryska: p. 98, pl. 15, fig. 10
1966	*Praeglobobulimina ovata* (d'Orbigny); Hofker: p. 335, pl. 81, figs 130, 141, 149, 150, 154–156
1968	*Bulimina ovata* d'Orbigny; Pozaryska & Szczechura: p. 47, text fig. 10

Description

Tests of the Nûgssuaq material ovate to fusiform, triserial throughout. Chambers moderately inflated with rather strong overlap, showing strong tendencies to become embracing. Sutures oblique to the axes of coiling, depressed but not strongly so. Initial end more pointed in microspheric specimens than in megalospheric. Aperture loop-shaped, extending into the apertural face from the basal suture of the final chamber, either away from or at the junction of the sutures between the three last chambers. Aperture with a rather simple bulimine tooth-plate, which does not show any protruding part in the aperture. Test surface smooth and unornamented. The ratio between length and width is about 1.7. Test wall composed of radiate, perforate calcite. Septa monolamellar. Proloculus diameter from 18 to 96 μ.

Micro- and megalospheric generations

Haynes (1954) found in the "D" marl in the Thanet Sands three microspheric specimens of *Praeglobobulimina ovata* with a proloculus diameter of less than 20 μ while the rest of his measured population ("about 50 specimens") were considered megalospheric with a proloculus diameter ranging from 60 to 80 μ.

On plate 10, figs 9 and 10 Brotzen (1948) illustrated both the supposed micro- and megalospheric form of *Bulimina* aff. *ovata* from the Lower Selandian deposits of Scania. The specimens from Greenland agree well with Brotzen's fig. 9, while they differ somewhat from his fig. 10. As both generations according to proloculus diameter are present in the material from Greenland and as these specimens all agree well with Brotzen's fig. 9 but not with his fig. 10 the forms depicted by Brotzen were made the subject of a more detailed investigation. For

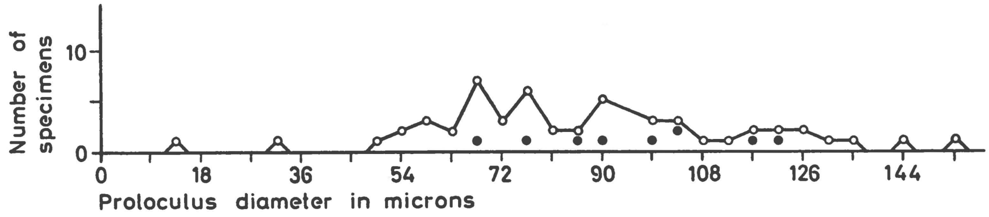

Fig. 30. Size-frequency distribution of proloculus diameters of 53 specimens of *Praeglobobulimina ovata* (d'Orbigny) from Basballe and Egsmark (Selandian) (open circles). The dots represent 9 specimens of ***Praeglobobulimina*** sp. (identical with Brotzen's pl. 10, fig. 10, 1948) from the same localities.

this purpose material from the Danish Selandian deposits was used as material of this species in the samples from Brotzen's localities present in the author's collection was too sparse.

P. ovata is not common in the Danish Selandian deposits; therefore specimens from two localities, Basballe and Egsmark, were treated as one population.

The distribution interval of the proloculus diameter of the presumed megalospheric generation is wider (49.5 to 153.0 μ) (fig. 30) than that found by Haynes for the English material (60 to 80 μ).

Both morphological forms depicted by Brotzen were found in the Danish material. 9 specimens identical with Brotzen's fig. 10 were found which had the ratio between length and width about 2.1, while 53 specimens identical with his fig. 9 had a length-width ratio of about 1.7. The proloculus diameter of the specimens identical with Brotzen's figured microspheric specimen (i.e. his fig. 10) ranged from 67.5 to 121.5 μ indicating that all nine specimens are megalospheric and not microspheric.

The 53 specimens identical with Brotzen's fig. 9 had proloculus diameters ranging from 13.5 to 153 μ. This indicates that a microspheric generation also is present in view of the proloculus diameter interval of less than 20 μ for the microspheric generation found by Haynes. It is therefore likely that the form illustrated by Brotzen on pl. 10, fig. 10 represents the megalospheric form of a species other than *P. ovata.*

Haynes (1954) studied topotypes of *P. ovata* from the Miocene deposits from the Vienna Basin, and stated that the Miocene form could not be distinguished from the English Lower Tertiary specimens.

Brotzen (1948) determined his material as *Bulimina* aff. *ovata* as he had not been able to compare his specimens with topotypes. According to his fig. 9 and remarks on the species, his material must be identical with *P. ovata.*

The Greenland specimens are in a somewhat poor state of preservation, and only two specimens out of 11 were undamaged. The individuals show some variation in the degree of inflation of the chambers. The specimen illustrated here is the most strongly inflated example. Only one of the individuals had the aperture at the junction of the sutures between the last three chambers; the remaining specimens all had the aperture away from the junction, which is also the case with the holotype illustrated by D'ORBIGNY.

The pores of the wall of *P. ovata* on the inner surface terminate in small pits which have a diameter of about 2.5 μ (pl. 32, figs 1–2; pl. 33, fig. 1). In the bottom of the pits are found the actual pore-entrances with a diameter of about 1 μ.

In the scanning electron microscope specimens of *P. ovata* from the Miocene beds of the Vienna Basin on their outer surfaces showed elongated pores (pl. 33, fig. 2). Other specimens from the same sample, however, showed circular to slightly oval pores.

HAYNES (1954, p. 190) described the pores of *P. ovata* based on light microscope studies as: "... round to oval pores, about 0.005 mm in diameter, possibly with very minute ones between. The large pores maintain a constant diameter through the test but widen slightly at the interior surface."

The possible minute pores between larger ones have not been found by the present author. The dark spots between the pores shown on HAYNES' micrograph (HAYNES, 1954, pl. 35, fig. 2) may well be explained as irregularities in the test surface.

HOFKER (1966, p. 335) stated that: "Some specimens have round and fine pores, others show more elongate pores".

In this connection it should be mentioned that this statement by HOFKER would appear to apply to the pore terminations on the shell surface only as the present author has been unable to find elongated pores on inner surfaces.

Material: 11 specimens (2 undamaged).

Occurrence

There are numerous records in the literature of this species which ranges from Danian to Miocene in north and central Europe and in North America.

Genus *Stainforthia* HOFKER, 1956

Stainforthia sp.

pl. 14, figs 3–4; pl. 30, figs 5–6

Description

Initial part triserial, later biserial, rather strongly twisted. Chambers inflated, twice as high as broad and moderately overlapping. General outline distinctly lobate. Sutures narrow and distinct. Aperture loop-shaped, in the youngest chamber extending upwards from the basal suture. One side of the aperture with a distinct protruding lip, the other side with a broad tooth-plate. Test surface smooth. Test wall composed of radiate, perforate calcite.

Affinity

According to their general morphology and wall structure the specimens from Greenland must belong to the genus *Stainforthia.*

They are close to *Stainforthia sandegreni* (BROTZEN, 1948) but differ in not having the aperture extending up to an almost terminal position characteristic of that species.

Material: 2 specimens.

Superfamily **Discorbacea** EHRENBERG, 1838
Family **Discorbidae** EHRENBERG, 1838
Genus *Rosalina* D'ORBIGNY, 1826

Rosalina elegans n. sp.

pl. 8, figs 9–11; pl. 20, figs 1–6

Diagnosis

A *Rosalina* with open deep umbilicus with rounded umbilical flaps. Spiral side moderately convex. Umbilical side concave or flat. Periphery subacute.

Description

Test trochospiral, planoconvex to concavoconvex. Spiral side convex. Umbilical side flat or concave. Umbilicus open and deep. 6–7 chambers in the final whorl. Chambers somewhat inflated on both sides, especially on the umbilical side. General outline subcircular and slightly lobate. Periphery subacute to rounded. Sutures on the spiral side narrow, depressed and irregularly curved. Spiral suture depressed. Sutures on the umbilical side depressed, curved with the strongest sinus about midway between the umbilicus and the periphery. Aperture interiomarginal umbilical and confined to the umbilical side. It extends from near the periphery into the umbilicus below umbilical flaps which are somewhat twisted so that each flap covers the distal part of the preceding flap. Older apertures remain open into the umbilicus. There are sutural slits present in the umbilical area representing remnants of older apertures. The flaps have slightly crenulate lips. Test wall composed of radiate, perforate calcite. The septa are monolamellar. Proloculus diameter of holotype is 17 μ.

Dimensions of holotype:
Diameter 315 μ. Thickness 102 μ.

Differential diagnosis

Rosalina elegans n. sp. differs from the Paleocene *Rosalina mimiconcinna* HAYNES, 1956 by having 6–7 chambers in the final whorl, in contrast to 3 in the final whorl of *R. mimiconcinna.*

From other species of the genus *Rosalina*, *Rosalina elegans* is distinguished by its subacute to rounded periphery and by its umbilical portion.

Variation

One specimen with a diameter of 594 μ is present in the material. The remaining specimens all had a diameter close to that of the holotype. The large specimen has a proloculus diameter of 44 μ and is composed of 16 chambers. The remaining specimens have proloculus diameters ranging from 13 to 17 μ and a total number of chambers from 16 to 23.

Rosalina elegans n. sp. shows some variation in the shape of the last whorl and the shape of the umbilical side. Apparently it had a clinging mode of life and consequently the test has to some extent taken the form of the substrate.

Some of the specimens show slightly limbate sutures (pl. 20, figs 2, 4–5). This phenomenon may well be due to corrosion which preferably attacks the perforate chamber wall and causes exfoliation of the secondary lamination.

Type locality:	Agatdalen, Nûgssuaq, West Greenland.
Type level:	Upper Danian.
Holotype:	MMH 10648 (pl. 8, figs 9–11).
Material:	88 specimens.

Rosalina ystadiensis BROTZEN, 1948
pl. 19, figs 1–3

1948	*Rosalina ystadiensis* BROTZEN: p. 72, pl. 9, fig. 9
1966	*Rosalina ystadiensis* BROTZEN; HOFKER: p. 196, 225, pl. 35, fig. 19; pl. 45, fig. 137; pl. 83, fig. 206
1968	*Rosalina ystadiensis* BROTZEN; POZARYSKA & SZCZECHURA: p. 53, pl. 16, fig. 7

Description

The Greenland specimens are planoconvex to concavoconvex, trochospirally coiled. Spiral side cone-shaped with rounded apex. General outline smooth, slightly lobate and subcircular. Periphery acute to subacute. Chambers sickle-shaped; 5 in the last whorl. Sutures on the spiral side flush with the surface. Sutures on the umbilical side broad and faintly depressed. Umbilicus somewhat depressed with distinct tuberculation and radiating grooves. Aperture umbilical below the posterior lobe and the tenon. Spiral side ornamented with low pustules. Test wall composed of radiate, perforate calcite. Septal lamellar character unknown.

Discussion

In its umbilical characters and ornamentation this species resembles species referred to *Glabratella* by LOEBLICH & TAPPAN (1964). However, the apertural characters suggest the genus *Rosalina* in which it is here tentatively placed.

Rosalina ystadiensis was recorded by HOFKER from the zones N-P-Q (on the stratigraphical scheme on page 7) while according to his text it occurs only in zones M and P. HOFKER also recorded it from the Selandian beds of Denmark.

POZARYSKA (1965, p. 26) listed *Rosalina* aff. *ystadiensis* from the Middle Danian of Sweden, while POZARYSKA & SZCZECHURA (1968) found one specimen in the Paleocene of Poland. Their specimen differs from the holotype in the lack of the umbilical tuberculation.

Material: 2 specimens.

Occurrence

Paleocene in Sweden, Denmark and Poland; zone N-P-Q in the Netherlands.

Family **Asterigerinidae** D'ORBIGNY, 1839
Genus *Asterigerina* D'ORBIGNY, 1839

Asterigerina primaria PLUMMER, 1926
pl. 9, figs 1–3; pl. 19, fig. 4

1926	*Asterigerina primaria* PLUMMER: p. 157, pl. 12, fig. 8
1941	*Asterigerina* cf. *primaria* PLUMMER; TOULMIN: p. 606, pl. 81, fig. 22
1948	*Asterigerina norvangi* BROTZEN: p. 126, pl. 18, figs 4–5
1951	*Asterigerina primaria* PLUMMER; CUSHMAN: p. 56, pl. 15, fig. 15
1954	*Asterigerina norvangi* BROTZEN; TROELSEN: p. 466
1966	*Asterigerina primaria* PLUMMER; HOFKER: p. 257, pl. 53, fig. 73

Description

In the material from Greenland the tests are free, trochospiral. Spiral side strongly convex, umbilical side almost flat to somewhat convex. Outline moderately lobate to smooth. Periphery rounded to almost angled. 5–7 chambers in the final whorl. Sutures on the spiral side curved, thickened and gently raised. Spiral suture thickened, gently raised and continuing into a non-perforate peripheral band. Chambers not inflated. "Chamberlets", which are level with the surface, are arranged in a rosette-like pattern. Each of the chamberlets is delimited internally by an attached tooth-plate causing the external suture. Neither the chambers nor the "chamberlets" on the umbilical side are inflated. Tuberculation of the umbilicus and adjacent areas is especially well developed in the area in front of the aperture. The aperture is situated basally in the distal end of the final chamber. It has the shape of a wide arch. Wall composed of radiate, perforate calcite. Septa monolamellar.

Discussion

Asterigerina primaria, as described by PLUMMER from the Midway Formation of Texas, has a rather low umbilical side. The same applies to most of the specimens from Nûgssuaq, but individuals with a more elevated umbilical side are found as well.

Asterigerina cf. *primaria* listed by TOULMIN from the Paleocene beds of Alabama is illustrated by a specimen showing only the spiral side. Toulmin mentioned that his material had 7 chambers in the final whorl instead of 5–6 as originally described for *A. primaria*. In the Nûgssuaq material there is one specimen with 7 chambers in the final whorl. This character therefore cannot be regarded as distinctive.

The distinguishing characters of *A. norvangi* are according to BROTZEN's description the higher umbilical side and the common lack of tuberculation on this side. TROELSEN studied material from the Danish Selandian referred to as *A. norvangi*. He stated: "Specimens from the Danish Paleocene show transitions from one type to the other, and the two species may have to be united". The tuberculation of the umbilical side is on some individuals from Nûgssuaq poorly developed and the degree of elevation of the umbilical side varies from almost flat to somewhat convex. *A. norvangi* is therefore here listed as a synonym of *A. primaria*.

Material: 17 specimens.

Occurrence

Paleocene, Porter's Creek Formation, Alabama; Naheola Formation, Alabama; Midway Formation, Texas; Selandian, Sweden and Denmark.

Superfamily **Spirillinacea** REUSS, 1862
Family **Spirillinidae** REUSS, 1862
Genus *Spirillina* EHRENBERG, 1843

Spirillina ? recta BROTZEN, 1940
pl. 8, fig. 8

1940 *Spirillina recta* BROTZEN: p. 28, fig. 6; 5a–c

Remarks

Only three very badly preserved specimens were found. All of them had the concave side filled up with sediment of which they could not be cleaned. The other side of the tests strongly resembles the figure and description of *S. recta* and the material is with some hesitation referred to this species.

Material: 3 specimens, badly preserved.

Occurrence

Sweden; seldom in Lower and Middle Danian, common in Upper Danian.

Spirillina striatogranulosa TERQUEM, 1822
pl. 19, figs 5–6

1882 *Spirillina striato-granulosa* TERQUEM: p. 33, pl. 1, fig. 30
1882 *Spirillina nodifera* TERQUEM: p. 33, pl. 1, figs 32a–b
1909 *Spirillina selseyensis* HERON-ALLAN & EARLAND: p. 440, pl. 18, figs 6–7
1939 *Spirillina selseyensis* HERON-ALLAN & EARLAND; CUSHMAN & GARRET: p. 84, pl. 14, figs 28–29
1942 *Spirillina selsyensis* HERON-ALLAN & EARLAND; CUSHMAN & TODD: p. 38, pl. 7, fig. 2
1944 b *Spirillina selseyensis* HERON-ALLAN & EARLAND; CUSHMAN: p. 45, pl. 7, fig. 20
1948 *Spirillina nodifera* TERQUEM; BROTZEN: p. 67, pl. 10, fig. 12
1949 *Spirillina striato-granulosa* TERQUEM; LE CALVEZ: p. 11, pl. 1, figs 3–4

Description

The Greenland specimens have planispiral tests, composed of proloculus and one long undivided tube. The one side with an elevated unornamented spiral showing the peripheral part of the older part of the tube. Tube wall depressed with fine ornamentation consisting of small tubercles. The other side with the inner part of the tube ornamented with transverse depressions. These depressions may on some individuals be slightly indistinct especially in the older part of the tube. There seems to be a tendency for the grooved side to have a stronger overlap of the tube than has the tuberculated side. General outline almost circular. Periphery rounded rectangular. Aperture interiomarginal with a backward bending border on the side with the strongest overlap of the tube.

Discussion

Le Calvez (1949) revised the foraminifera from the Eocene of the Paris Basin. She studied the collections of Terquem and found that *S. nodifera* is identical with *S. striatogranulosa*. She thought Terquem's separation of the material into two species was due to the state of preservation.

Le Calvez believed it probable that the species *Spirillina selseyensis* described by Heron-Allan & Earland in 1909 from the coast at Selsey is a synonym of *S. striatogranulosa*. The specimen is most likely washed out from the Eocene deposits at Selsey and mixed with recent forms.

The diameter of the largest specimen illustrated here is 207 μ or less than half the diameter of the specimen figured by Le Calvez which has a diameter of 423 μ.

Pozaryska & Szczechura (1968) recorded *Spirillina* cf. *nodifera* from the Paleocene of Poland.

Material: 3 specimens.

Occurrence

Lower Tertiary in north Europe and USA.

Superfamily **Rotaliacea** Ehrenberg, 1839
Family **Rotaliidae** Ehrenberg, 1839
Genus *Pararotalia* Le Calvez, 1949

Pararotalia tuberculifera (Reuss, 1862)
pl. 9, figs 4–6; pl. 21, figs 1–2

1862	*Rotalia tuberculifera* Reuss: p. 313, pl. 2, fig. 2
1957	*Pararotalia tuberculifera* (Reuss); Hofker: p. 32, text figs 1–18
1960 b	*Pararotalia tuberculifera* (Reuss); Hofker: p. 79, text figs 1–8
1963 a	*Pararotalia tuberculifera* (Reuss); Hofker: p. 80, text figs 2–6
1965	*Pararotalia tuberculifera* (Reuss); Pozaryska: p. 118, pl. 20, fig. 3 a–c
1968	*Pararotalia tuberculifera* (Reuss); Pozaryska & Szczechura: p. 59, pl. 7, figs 1–10, text fig. 13

Description

Test in the Greenland specimens biconvex to almost planoconvex, trochospiral. 8 chambers in the final whorl. Spiral side less convex than umbilical side. General outline lobate to ragged. Periphery rounded angular. Sutures on the umbilical side radial, depressed, becoming deeply excavated near the umbilicus. Sutures on the spiral side almost radial and depressed between the latest chambers; in the early part of the test becoming thickened and raised. Spiral suture also thickened and raised. The thickened sutures continue in the earlier part into a tuberculated peripheral keel. Umbilicus rather large, deep, with an umbilical plug, the top of which is developed as rounded knobs. Chambers on the spiral side slightly, it at all, inflated in the later part. Chambers on the umbilical side rather strongly inflated. Surface papillate; the papillae most strongly developed on the umbilical side. Aperture at the umbilical boundary of the youngest chamber. Septa rotaliid.

Remarks

This species has been described in detail by HOFKER in several publications. He illustrated its evolution and wide variation. Of the five specimens from Greenland, four are damaged. The only whole specimen (here shown on pl. 21, figs 1–2) was lost during transport from England to Denmark. Although the five specimens vary somewhat in their ornamentation they fall within the variation of *Pararotalia tuberculifera* as described by HOFKER.

Material: 4 incomplete specimens.

Occurrence

Maastrichtian-Paleocene, Holland; Paleocene, Belgium; Paleocene, Poland.

Superfamily **Globigerinacea** CARPENTER, PARKER & JONES, 1862
Family **Heterohelicidae** CUSHMAN, 1927
Genus *Chiloguembelina* LOEBLICH & TAPPAN, 1956

Chiloguembelina crinita (GLAESSNER, 1937)
pl. 8, figs 3–4; pl. 21, fig. 6

1937 *Gümbelina crinita* GLAESSNER: p. 383, pl. 4, figs 34 a–b
1957 *Chiloguembelina crinita* (GLAESSNER); BECKMANN: p. 89, pl. 21, fig. 4
1957 a *Chiloguembelina crinita* (GLAESSNER); LOEBLICH & TAPPAN: p. 178, pl. 49, fig. 1; pl. 51, figs 1–3; pl. 56, fig. 1; pl. 60, fig. 6

1960 *Chiloguembelina crinita* (GLAESSNER); OLSSON: p. 29, pl. 4, figs 14–15
1964 *Chiloguembelina crinita* (GLAESSNER); NOGAN: p. 30, pl. 2, figs 9–10

The specimen from Nûgssuaq is biserial throughout, flaring. It consists of 9 chambers. Chambers inflated in the earlier part, becoming almost globular in the later part. Sutures distinct, depressed and very slightly oblique. Aperture semicircular, prolonged into a thin, vitreous collar. Test surface with short spines except on the last chamber. Test wall composed of radiate, perforate calcite.

Discussion

Due to lack of material no thin sections were made and consequently the lamellar character of the Greenland specimen is unknown. Specimens of *Chiloguembelina midwayensis* (CUSHMAN) from the Midway Formation in Texas showed bilamellar septa, and it is supposed that the same structure is found in *C. crinita.*

BECKMANN (1957) described the possible evolutionary lines of chiloguembelinas in the Lower Tertiary of Trinidad. He indicated a development from *C. midwayensis* leading to *C. crinita. C. crinita* is characterised by almost globular chambers, a semicircular aperture and a more spinose wall than is found in *C. midwayensis.* The latter is furthermore somewhat compressed and not so flaring as *C. crinita.* BECKMANN indicated also an evolutionary line starting with *C. midwayensis* leading to *C. midwayensis strombiformis.* The latter is approximately identical with *C. midwayensis* but has a spinose wall. The specimen from Nûgssuaq is not compressed and more flaring than both *C. midwayensis* and *C. midwayensis strombiformis.* It is in good agreement with the description of the ornamentation of *C. crinita* by GLAESSNER. "Die Schalenoberfläche ist bei manchen Exemplaren von einer feinen Körnelung bedeckt, stets finden sich auf den Endflächen der letzten Kammern zarte, aber trotz ihrer Kleinheit besonders an der Peripherie deutlich sichtbare spitze Höckerchen". *C. crinita* from Nûgssuaq has this ornamentation in the youngest part although it is only slightly developed (pl. 21, fig. 6).

Material: 1 specimen.

Occurrence

Paleocene, NW and SE Caucasus, USSR; Paleocene, Trinidad, (*G. pseudomenardii* and *G. velscoensis* zones); Vincentown Formation, Hornerstown Formation, New Jersey; Nanafalia Formation, Salt Mountain Limestone, Alabama; Aquia Formation, Maryland-Virginia, U.S.A.; Velasco Formation, Mexico.

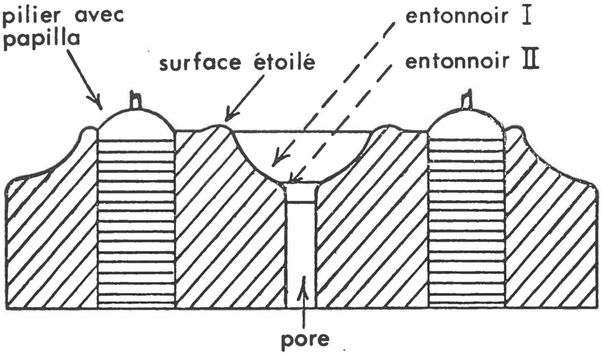

Fig. 31. *Subbotina triloculinoides* (PLUMMER). Construction of the wall. After BROTZEN & POZARYSKA, 1961.

Family **Globigerinidae** CARPENTER, PARKER & JONES, 1882

Genus *Subbotina* BROTZEN & POZARYSKA, 1961

Based on differences in wall structure between the type species of the genus *Globigerina* viz. *Globigerina bulloides* D'ORBIGNY, and *Globigerina triloculinoides* PLUMMER, BROTZEN & POZARYSKA (1961) established a new genus *Subbotina* with *Globigerina triloculinoides* PLUMMER as type species.

BROTZEN & POZARYSKA (1961) claimed the presence of papillae on the wall surface of *Subbotina*, while they were unable to find such a structure in *Globigerina*. Their schematic drawing of a section of the wall of *Subbotina triloculinoides* is reproduced in fig. 31. They did not, however, illustrate an actual section but a surface view of the wall.

The present author has used thin sections, transmission electron microscopy of sections as well as scanning electron microscopy to try to find the papillate structure of the wall of *S. triloculinoides* as described by BROTZEN & POZARYSKA but has not succeeded in doing so.

The characteristic pitted wall surface of *S. triloculinoides* without any trace of papillae is here shown on pl. 21, fig. 4.

A thin section of the wall as seen in the light microscope (pl. 1, fig. 6) may give the impression that a papillate structure is present, but this is contradicted by the electron micrographs. Replicas of etched sections of *S. triloculinoides* studied in the transmission electron microscope (pl. 24, fig. 1; pl. 31, fig. 2) did not reveal any structure which could be correlated with that described by BROTZEN & POZARYSKA. The photo micrographs shown by BROTZEN & POZARYSKA of the wall of the type species of the genus *Globigerina*, leave some doubt as to its detailed structure. By contrast BARTLETT (1968) showed scanning electron micrographs of

Globigerina bulloides, which clearly demonstrated the presence of delicate spines.

The wall of *G. bulloides* from its type locality shows areas with a reticulate surface different from the pitted one in *S. triloculinoides* (pl. 24, fig. 1). As the specimens from the type locality most likely have been abraded by rolling in the beach sand, the delicate spines are not to be seen.

The difference in wall structure between the two genera *Globigerina* and *Subbotina* is the presence of spines and locally reticulate surface in *Globigerina* while the wall structure of *Subbotina* is pitted and without spines.

Subbotina triloculinoides (PLUMMER, 1926)
pl. 10, figs 4–6; pl. 1, fig. 6; pl. 21, fig. 4; pl. 24, fig. 1; pl. 31, figs 1–2

1926	*Globigerina triloculinoides* PLUMMER: p. 134, pl. 8, figs 10a–b
1962	*Globigerina* (*Subbotina*) *triloculinoides* PLUMMER; SCHMID: p. 346, pl. 6, fig. 3
1963	*Globigerina triloculinoides* PLUMMER; GOHRBANDT: p. 42, pl. 1, figs 1–3
1964	*Globigerina triloculinoides* PLUMMER; NOGAN: p. 38, pl. 4, figs 7–9
1965	*Globigerina* (*Subbotina*) *triloculinoides* PLUMMER; POZARYSKA: p. 124, pl. 22, fig. 2
1966	*Globigerina triloculinoides* PLUMMER; HOFKER: p. 318, pl. 75, figs 178–179, 183
1966	*Globigerina triloculinoides* PLUMMER; EL-NAGGAR: p. 178, pl. 15, figs 7a–c (for additional synonyms see EL-NAGGAR 1966)

Description

Tests of the Greenland specimens trochospiral, composed of about $2^1/_2$ whorls with 3–$3^1/_2$ chambers in the final whorl. Chambers strongly inflated, almost spherical. Spiral side moderately convex with a low spire. Umbilical side convex with a narrow, open and shallow umbilicus. Periphery almost circular. General outline rounded, lobate. Sutures on the umbilical side distinct, narrow, straight or very slightly curved. Sutures between the chambers of the older whorls on the spiral side somewhat obscured by secondary thickening of the test. Aperture arched, umbilical to slightly extraumbilical with a distinct overhanging lip with subparallel sides. Surface of test coarsely pitted with a pore situated in the bottom of each pit. Test wall composed of radiate, perforate calcite. Septa bilamellar, with secondary thickening of the outer wall. Wall thickness measures from the bottom of the pits to the inner surface about 5 μ. The thickness of the single secondary deposited layer outside the primary bilamellar wall of the final chamber is about 0.5 μ. Pore diameter about 2 μ.

Discussion

The synonymy and affinities of this species, of world-wide distribution, was discussed in detail by EL-NAGGAR (1966).

It has a rather long stratigraphic range and is found throughout the Paleocene. It has, as such, been recorded by numerous authors.

Transmission electron microscopy of polished, etched sections of *S. triloculinoides* showed that the part of the wall constituting the "reticulation" is built of thin lamels (pl. 31, fig. 1). The "reticulation" becomes more strongly developed from the later to the earlier chambers.

The secondary thickening of the earlier part of the test in connection with addition of new chambers is well known (see e.g. REISS, 1963). The thickening in *S. triloculinoides* cannot, however, be due alone to secondary deposition in connection with chamber formation as the lamination of the "reticulation" is also present in the final chamber.

The development of "reticulation" would seem to be of the kind described from recent planktonic species in association with a gradually increasing depth of living habitat (BÉ & ERICSON, 1963; BÉ & LOTT, 1964; BÉ, 1965).

Incisional thickening of the crust overlying a primary bilamellar wall was illustrated by HEMLEBEN (1969).

The present author found incisional thickening in the crust of *Globorotalia menardii* (pl. 24, fig. 2). The thickening of the crust in *S. triloculinoides* would seem to be of that kind also.

Material: 6 specimens.

Occurrence

Global distribution in Paleocene times.

Subbotina pseudobulloides (PLUMMER, 1926)
pl. 10, figs 7–9; pl. 21, figs 3 and 5

1926	*Globigerina pseudobulloides* PLUMMER; p. 133, pl. 8, figs 9a–c
1964	*Globigerina pseudobulloides* PLUMMER; BERTELS: p. 178, pl. 7, fig. 9
1964	*Globigerina pseudobulloides* PLUMMER; NOGAN: p. 41, pl. 6, figs 1–3
1965	*Globigerina pseudobulloides* PLUMMER; POZARYSKA: p. 123, pl. 23, figs 2–3
1966	*Globorotalia pseudobulloides* (PLUMMER); EL-NAGGAR: p. 224, pl. 18, figs 3a–c
1966	*Globigerina pseudobulloides* PLUMMER; HOFKER: p. 317, pl. 72, figs 152–153; pl. 73, figs 156–157, 161; pl. 74, figs 167, 173, 176; pl. 76, figs 186, 189 (for additional synonyms see EL-NAGGAR, 1966)

Description

Test of the Greenland specimens trochospirally coiled, biconvex, 4–4$^1/_2$ chambers in the final whorl. General outline moderately to strongly lobate. Periphery almost circular. Chambers strongly inflated, spiral side almost plane to somewhat convex. Umbilical side convex with a rather deep and open umbilicus. Sutures distinct, narrow, radial, straight to slightly curved, especially so between the earliest chambers on the spiral side. Aperture umbilical with a distinct overhanging lip. Test surface pitted. Test wall calcitic, perforate radiate. Septa bilamellar.

Discussion

The specimens from Greenland have been compared with examples from the Midway Formation of Texas (specimens determined by H. J. PLUMMER from the collection of the Mineralogical Museum of the University of Copenhagen). The Greenland specimens are identical with the paratypes from the Midway Formation.

One of the paratypes was studied in the scanning electron microscope. The structure of the surface of the test wall (pl. 21, fig. 3) is identical with the one found in *Subbotina triloculinoides* (pl. 21, fig. 4). *S. pseudobulloides* must therefore be referred to the genus *Subbotina* and not to the genus *Globigerina* as its wall structure is basically different from the structure of the latter.

The differences between *S. triloculinoides* and *S. pseudobulloides* can be summarized as:

1. The number of chambers in the final whorl in *S. triloculinoides* is 3–3$^1/_2$, while it is 4–4$^1/_2$ in *S. pseudobulloides.*
2. The coiling of *S. triloculinoides* is somewhat closer than in *S. pseudobulloides.*
3. The density of the pores in *S. pseudobulloides* is about three times as great as in *S. triloculinoides.*

HOFKER (1960c) described the development of *S. pseudobulloides* through the Danian beds of Denmark. He found that the stratigraphically younger forms developed a more prominent "reticulation" than could be found in the stratigraphically older specimens. This development was also found by the present author.

McGOWRAN (1968a) referred *G. pseudobulloides* to the genus *Subbotina* based on studies of thin sections.

EL-NAGGAR (1966) pointed out that *S. pseudobulloides* may be the species from which *S. triloculinoides* later evolved.

The possible close affinity between these two species would seem to gain support through their identity in wall structure.

HOFKER's record of *S. pseudobulloides* in the Upper Maastrichtian of Holland and Belgium seems very doubtful as stated by EL-NAGGAR.

This author wrote (1966, p. 226): "... he confused the present species with apparently similar *Hedbergella* species in the Maestrichtian rocks ...".

Material: 7 specimens.

Occurrence

Subbotina pseudobulloides is recorded from nearly all localities where Danian and Middle Paleocene faunas have been described. The geographical distribution extends from about 70° N to about 35° S latitude.

Genus *Globoconusa* KHALILOV, 1956

Globoconusa daubjergensis (BRÖNNIMANN, 1953)
pl. 10, figs 1–3; pl. 22, figs 1–6; pl. 23, figs 1–2

1953 *Globigerina daubjergensis* BRÖNNIMANN: p. 340, text fig. 1
(for additional synonyms see HANSEN, 1970)

Remarks

The specimens from Greenland are in good agreement with specimens from the biozone of *Tylocidaris vexillifera* from the Danian beds of Denmark. The specimens show the characteristic spinose wall and supplementary apertures along the spiral suture. One of the specimens has a bulla-like smooth final chamber, which character is also common for the specimens of *Globoconusa daubjergensis* from the Danish Upper Danian deposits.

Material: 4 specimens (of which 2 were lost after depiction in the scanning electron microscope).

Occurrence

Global distribution in Danian time.

Superfamily **Orbitoidacea** SCHWAGER, 1876
Family **Cibicididae** CUSHMAN, 1927
Genus *Cibicides* MONTFORT, 1808

As the author of the present paper has followed the main classification as outlined by LOEBLICH & TAPPAN (1964), the species *Cibicides ekblomi* and *Cibicides succedens* are referred to the genus *Cibicides* in spite of their umbilical apertures. This problem was discussed by REISS (1963) and the evident disagreement between morphology and wall structure has led to descriptive terms like "reversed trochoid" (DROOGER, 1960) which term is applied to the two species *C. ekblomi* and *C. succedens.*

If the importance of the apertural character is stressed instead of the wall structure, it would lead to families including both types of wall structure.

The term "spiral side", as here understood, represents the side closest to the proloculus when seen in vertical section.

Cibicides ekblomi BROTZEN, 1948
pl. 9, figs 7–9

1948	*Cibicides ekblomi* BROTZEN: p. 82, pl. 13, fig. 2a–c
1962	*Gavelinella ekblomi* (BROTZEN); SCHMID: p. 340, pl. 4, fig. 10
1965	*Anomalina ekblomi* (BROTZEN); POZARYSKA: p. 127, pl. 27, fig. 6a–c
?1966	*Gavelinella ekblomi* (BROTZEN); HOFKER: p. 259, pl. 56, fig. 108

Description

In the Greenland specimens the test is trochospiral, planoconvex to slightly biconvex. General outline very slightly lobate. Periphery subacute. 8 chambers in the final whorl. Spiral side moderately convex and involute, except for the central knob, which is the thickened wall of the proloculus placed in a small depressed area. Umbilical side only faintly convex to almost plane. Centrally with an open umbilicus, which bears an indistinct small central plug. Chambers hardly inflated, except for the latest three. Sutures on the spiral side broad, strongly curved, not depressed in the earlier part, but slightly depressed between the three latest chambers. Sutures on the umbilical side broad, strongly curved and slightly depressed between the three latest chambers. Aperture interiomarginal, umbilical-extraumbilical in position. It extends from near the periphery on the spiral side onto the umbilical side where it runs in the basal suture of the final chamber into the umbilicus. It is slit-shaped with a well developed smooth lip. Earlier apertures remain open into the umbilicus below umbilical lips. Test wall composed of radiate, perforate calcite. Septa bilamellar. Pores small; they appear to be of equal size on both sides of the test.

Discussion

Except for the depression of the sutures between the latest chambers the Greenland specimens agree very well with the holotype (with which they have been compared). BROTZEN's diagnosis says: "Wall smooth, finely perforated on the spiral side and more perforated on the umbilical side". The author has not noticed this difference in perforation between the two sides of this species, and it is not clear whether "more perforated" means more densely perforated or that the pores are coarser. It would seem that there is no obvious difference between the perforation of the spiral and umbilical sides.

From the brief description and illustration by HOFKER (1966) it is not clear whether the Greenland material can be considered identical with the material recorded under the name of *Gavelinella ekblomi* by HOFKER.

SCHMID mentioned that his material did not differ in pore size between the two sides of the test, and he considered this due to the state of preservation.

Cibicides ekblomi cannot belong to the family Anomalinidae, to which the genera *Anomalina* and *Gavelinella* belong as it has a radiate wall. Specimens of *C. ekblomi* from the Paleocene of Poland (kindly placed at the author's disposal by Professor K. POZARYSKA) in thin section also showed radiate wall and bilamellar septa.

Material: 3 specimens.

Occurrence

Paleocene, Austria; Lower Paleocene, Sweden and Denmark; Upper Maastrichtian-Paleocene, Poland.

Cibicides succedens BROTZEN, 1948
pl. 23, figs 4–6

1944	*Cibicides cryptomphalus* (REUSS) var. *hercegovinensis* DE WITT PUYT; DAM: p. 132, pl. 5, fig. 9
1948	*Cibicides succedens* BROTZEN; p. 80, pl. 12, figs 1–2
1955 a	*Parrelleoides succedens* (BROTZEN); HOFKER: p. 13, pl. 1–2
1957	*Cibicides* (*Cibicidina*) *succedens* BROTZEN; WOOD & HAYNES: p. 50, pl. 5, figs 6–7
1960	*Cibicides* (*Cibicidina*) *succedens* BROTZEN; ROUVILLEOIS: p. 76, pl. 4, fig. 59
1960	*Cibicides succedens* BROTZEN; OLSSON: p. 53, pl. 12, figs 10–12
1963 b	*Gavelinopsis succedens* (BROTZEN); HOFKER: p. 7, text fig. 5
1965	*Cibicides succedens* BROTZEN; POZARYSKA: p. 136, pl. 28, figs 1–5
1966	*Gavelinopsis succedens* (BROTZEN); HOFKER: p. 228, 244, 259, pl. 43, fig. 93; pl. 56, fig. 118; pl. 47, fig. 29; pl. 85, figs 230–239
1968	*Cibicides succedens* BROTZEN; POZARYSKA & SZCZECHURA: p. 79, text fig. 18

Description

Tests of the Greenland material small, planoconvex, low trochospirally coiled. 10 chambers in the final whorl. General outline smooth subcircular; periphery rounded subangular. Sutures oblique and curved on both sides, broadened and flush with the surface except for those between the last three chambers which are narrow and slightly depressed. Aperture interiomarginal, extending across the periphery onto the umbilical side with a continuation below the three latest chambers. Spiral side strongly convex with a large rounded smooth transparent central knob. Test in general heavily thickened by deposition of secondary calcite layers. Wall composed of radiate, perforate calcite. Septa bilamellar.

Discussion

The specimens from Greenland are identical with the specimen figured by BROTZEN on his pl. 12, fig. 2 but are different from the holotype illustrated on pl. 12, fig. 1. BROTZEN mentioned that *C. succedens* is very common in the Selandian deposits above the Danian beds in Sweden. Specimens identical with the holotype are also abundant in the Selandian deposits of Denmark, but the form identical with that from Greenland is seen only in the basal part of the Selandian where it is evidently redeposited. In Denmark the form depicted by BROTZEN on pl. 12, fig. 2 seems to be restricted to the Danian limestones.

HOFKER (1966) recorded *Cibicides succedens* from the zone P-Q-R in the Netherlands and from the Selandian of Denmark. However, he did not record it in his distribution diagram on page 7.

Material: 6 specimens.

Occurrence

Paleocene, Poland; Sweden; Denmark; Netherlands; England; Paris Basin; New Jersey, USA.

Superfamily **Cassidulinacea** D'ORBIGNY, 1839
Family **Nonionidae** SCHULTZE, 1854

LOEBLICH & TAPPAN (1964) defined the genera *Allomorphina* and *Quadrimorphina* so that they included in *Allomorphina* species with involute spiral side while they placed the species with evolute spiral side in *Quadrimorphina*. However, they did not take the investigations of TROELSEN (1954) and HOFKER (1954) into consideration.

TROELSEN described an internal partition in the type species of the genus *Quadrimorphina* while he said that this partition was absent in the type species of *Allomorphina*. He therefore referred *Allomorphina halli* JENNINGS which possesses an internal partition described in detail by BROTZEN (1948) to the genus *Quadrimorphina*. TROELSEN did not illustrate the type species of the genus *Allomorphina* i.e. *Allomorphina* *trigona* REUSS, but instead "*Allomorphina*" aff. *macrostomata* KARRER from the Selandian of Denmark, which has no internal partition.

The author has had the opportunity to study TROELSEN's material kept in the Mineralogical Museum in Copenhagen. TROELSEN's specimens of *A. trigona* are somewhat pyritized and seem to be recrystallized. This would explain the absence of the internal partition which in this species is a very delicate structure.

As pointed out by HOFKER (1954) TROELSEN used a preparation technique where the chambers were opened with a needle. As *A. trigona* has a very thin test, the technique applied by TROELSEN may well have caused the disappearance of an internal partition. HOFKER used a thin section technique and found a very delicate partition in specimens of *A. trigona* from its type locality.

Thus both the genera *Allomorphina* and *Quadrimorphina* possess an internal partition. This character is not considered by LOEBLICH & TAPPAN in their definition of the genera. They listed the genus *Pallaimorphina* as a synonym of the genus *Quadrimorphina.* The author has studied paratypes of the type species of *Pallaimorphina* i.e. *Pallaimorphina ruckerae* TAPPAN, 1957 (U.S. Nat. Mus. No. P. 4682) and they had no internal partition. Thus the genus *Quadrimorphina* sensu LOEBLICH & TAPPAN (1964) is inhomogeneous and the genus *Pallaimorphina* must be regarded as a valid genus differing from *Quadrimorphina* in the lack of an internal partition.

"*Allomorphina*" aff. *macrostomata* KARRER illustrated by TROELSEN is close in external morphology to *Allomorphina halli* JENNINGS but differs in being very delicate and by lacking the internal partition. The same applies to "*Allomorphina*" *paleocenica* CUSHMAN described below. Thus the genus *Allomorphina* sensu LOEBLICH & TAPPAN also seems to be inhomogeneous and a new genus may have to be erected for species like the above-mentioned. As the material on hand is very limited, the question must be left open.

"*Allomorphina*" *paleocenica* CUSHMAN, 1948
pl. 11, fig. 3; pl. 25, fig. 1

1926 *Allomorphina trigona* REUSS; PLUMMER: p. 129, pl. 8, fig. 5
1943 *Allomorphina trigona* REUSS; KLINE: p. 56, pl. 6, figs 1–2
1948 *Allomorphina paleocenica* CUSHMAN: p. 45, pl. 8, fig. 10a (non 10b)
1951 *Allomorphina paleocenica* CUSHMAN: p. 58, pl. 16, figs 19–21 (non fig. 22)

Description

The tests of the Greenland specimens are trochospiral and biconvex with three chambers in the final whorl. The latest chamber comprises in apertural view about one half or more of the test. General outline compressed ovoid, and very slightly lobate. Periphery broadly rounded. The latest chamber slightly pointed. One margin less curved than the other. Chambers inflated. Sutures distinct, slightly curved and slightly depressed. Aperture a low arch with an overhanging lip. One apertural margin is attached very close to the suture between the two preceding chambers. Surface of test smooth and unornamented. Test wall composed of granulate, perforate calcite.

Discussion

The Greenland specimens are identical with those described and figured by PLUMMER and KLINE and erroneously referred to the Miocene species *Allomorphina trigona* REUSS. *Allomorphina paleocenica* is readily distinguished from *A. trigona*, which has almost spherical chambers, lobate periphery and a very narrow apertural lip.

In 1948 CUSHMAN erected a new species *Allomorphina paleocenica* and listed PLUMMER's and KLINE's *A. trigona* as a synonym. However, his figure 10b from the type description does not show the holotype, but was erroneously copied after CUSHMAN & TODD (1946, pl. 11, fig. 11). This was corrected in CUSHMAN (1951) where the apertural view of the holotype was published for the first time. There seems to be a considerable difference between the first published figure and the holotype. The holotype has a much narrower aperture and a smaller final chamber. Further, the holotype has an overhanging lip which is not seen on the somewhat indistinct first published figure. CUSHMAN & TODD's (1946) material would seem to belong to another species.

The material recorded by HILLEBRANDT (1962, p. 91, pl. 6, fig. 23) from the Paleocene of Austria would appear, from his illustration, to be identical with CUSHMAN's first published figure. Accordingly it is not here regarded as identical with the holotype.

Material: 8 specimens.

As can be seen from the illustration, the material is in a rather bad state of preservation. The original tests had a size about double the specimen illustrated here. However, in spite of the damaged later part, the characters can still be seen on the preserved earlier part.

Occurrence

Paleocene, Porter's Creek Formation, Alabama; Midway Formation, Arkansas; Midway Group, Texas, U.S.A.

Genus *Pallaimorphina* Tappan, 1957

Pallaimorphina minuta n. sp.
pl. 10, figs 10–12; pl. 25, figs 2–5

Diagnosis

A *Pallaimorphina* with 4–5 chambers in the final whorl, strongly inflated.

Description

Test biconvex to almost spherical, trochospiral. Spiral side strongly convex and evolute. Opposite side involute with a narrow and shallow umbilicus. 4–5 chambers in the final whorl. General outline very slightly to moderately lobate. Periphery very broadly rounded. Sutures on the umbilical side slightly depressed; curved, but not strongly. Sutures on the spiral side slightly depressed and curved in the final whorl; in the older part of the spiral they are broadened by secondary calcite, slightly elevated and curved. Chambers distinctly inflated, more so on the umbilical side than on the spiral side. Aperture confined to the umbilical side, umbilical to slightly extraumbilical in position. Just above the aperture is a small, slightly bulging area. The aperture bears a narrow lip. Proloculus diameter in the microspheric generation about 12 μ and in the megalospheric from 18 to 30 μ. Wall surface unornamented. Test wall composed of perforate, granulate calcite.

Dimensions of holotype:
Diameter 243 μ. Thickness 154 μ.

Differential diagnosis

Pallaimorphina minuta n. sp. is well distinguished from earlier described species of the genus *Pallaimorphina* by its almost globular test.

Generations and variation

Of the 79 specimens from Nûgssuaq, 25 individuals were incrusted with iron-compounds which prevented measurement of the proloculus diameter. The remaining 54 specimens were measured for proloculus diameter, total number of chambers, number of whorls, number of chambers in the final whorl and coiling direction. Fig. 32 shows the presence of two generations. Fig. 33 would indicate that the microspheric generation has relatively more chambers than has the megalospheric.

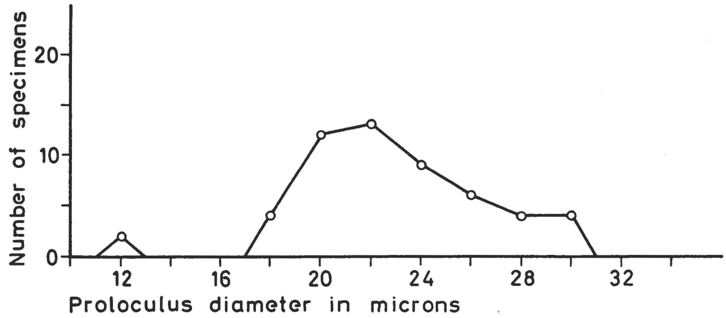

Fig. 32. Size-frequency distribution of proloculus diameters of 54 specimens of *Pallaimorphina minuta* n. sp. from the Sonja Member, Nûgssuaq.

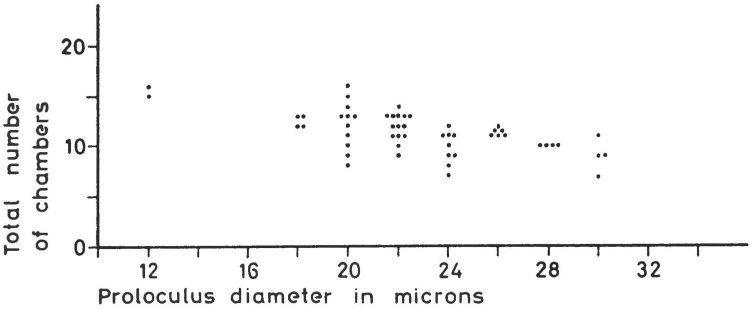

Fig. 33. Relationship between proloculus diameters and number of chambers in 54 specimens of *Pallaimorphina minuta* n. sp. from the Sonja Member, Nûgssuaq.

The average number of whorls in the megalospheric form is 1.9 while the two microspheric forms have 2.3 and 2.5 respectively.

It should be mentioned, however, that two of the megalospheric individuals have 2.5 and 2.8 whorls. The material of both generations is too poor to allow any conclusions.

In orientated thin section no lamination of the chamber wall was found. The only secondary thickening was found in the sutures in the earlier part of the test.

Pallaimorphina minuta would thus seem to be an exception to the rule stated by Reiss (1959) that: "all calcareous or aragonitic, distinctly and regularly perforate foraminifera are lamellar . . .".

The lack of lamination in the chamber walls of the earlier part of the test may be due to exfoliation of the secondary lamels, which are now preserved only in the sutures. This phenomenon was also found in a specimen of the radiate, calcitic *Spirobolivina scanica* from Nûgssuaq (pl. 17, figs 1–3).

Presumed exfoliation of secondary lamels of the chamber wall of *Pallaimorphina minuta* is shown on pl. 25, fig. 5. The preservation of lamels in the thickened sutures is most probably connected with the lack of pores in this part of the shell, and therefore not subject to penetration by solutions as in the perforate chamber walls.

Type locality: Agatdalen, Nûgssuaq, West Greenland.
Type level: Upper Danian.
Holotype: MMH 10637 (pl. 10, figs 10–12).
Material: 79 specimens.

Genus *Nonion* MONTFORT, 1808

Nonion graniferum (TERQUEM, 1882)
fig. 34; pl. 11, figs 1–2; pl. 26, figs 1–2

1882	*Nonionina granifera* TERQUEM: p. 42, figs 8a–b, (non figs 9a–b)
1939	*Nonion graniferum* (TERQUEM); CUSHMAN: p. 4, pl. 1, figs 9–11
1939	*Nonion mauricensis* HOWE & ELLIS: p. 57, pl. 8, figs 1–2
1948	*Nonion* cf. *graniferum* (TERQUEM); BROTZEN: p. 69, pl. 8, fig. 1
1950	*Nonion graniferum* (TERQUEM); LE CALVEZ: p. 53, pl. 4, figs 58–59
1960	*Nonion mauricensis* HOWE & ELLIS; OLSSON: p. 26, pl. 4, figs 2–3
1964	*Nonion mauricensis* HOWE & ELLIS; NOGAN: p. 29, pl. 2, figs 4–5
1965	*Nonion graniferum* (TERQUEM); POZARYSKA: p. 93, pl. 21, figs 5a–b
1968	*Nonion graniferum* (TERQUEM); POZARYSKA & SZCZECHURA: p. 81, pl. 9, figs 10–12, text fig. 19

Description

The tests of the Greenland specimens are involute and somewhat compressed. Periphery broadly rounded. Outline subcircular. Slightly, if at all, lobate. 6–8 chambers in the final whorl. Umbilical region covered with fine papillate material of varying extent. Sometimes prolonged to cover the inner part of the sutures. Sutures radial in the earlier part of the final whorl, somewhat depressed near umbilicus. Sutures between the last 3–4 chambers more strongly depressed and curved. Most strongly depressed near umbilicus. Aperture an equatorial, interiomarginal arch at the base of the final chamber, not extending to the umbilici. Wall calcitic, granulate and perforate. Monolamellar septa.

Discussion

The Nûgssuaq material agrees very well with TERQUEM's figure 8a–b, but not with his figure 9a–b, which shows a specimen bearing spines on the earlier part of the final whorl. The Greenland material shows a great amount of variation in the following characters: compression,

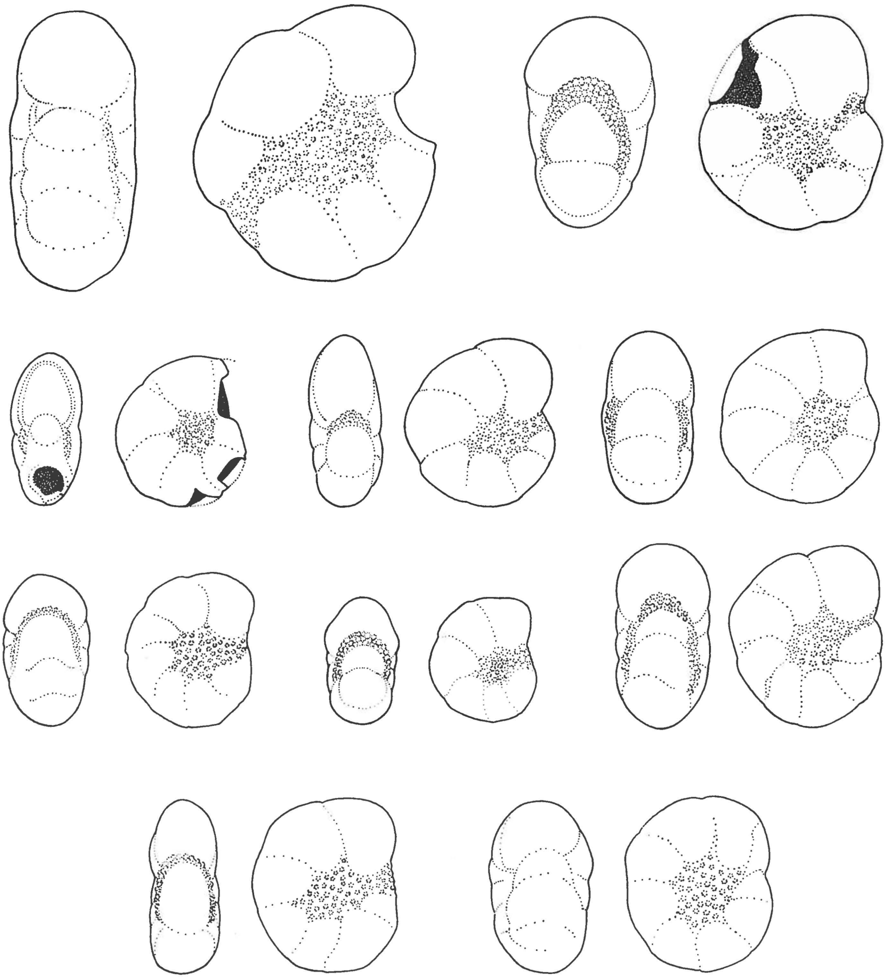

Fig. 34. *Nonion graniferum* (TERQUEM), illustrating the variation of general shape and distribution of the papillate area. 75×.

extension of umbilical papillate area and general outline of the test (see fig. 34).

Nonion mauricensis HOWE & ELLIS falls within this variation and is here listed as a synonym. This also applies to the material figured by OLSSON (1960). He stated (p. 26): "This species is easily identified by the small, subcircular test with a slightly lobate periphery, and the cluster of small projecting papillae in the umbilical region". Fig. 34 shows that the variability of these characters makes it probable that they cannot be used to distinguish *N. mauricensis* from *N. graniferum.*

HOFKER (1966, p. 224) recorded material from the Netherlands under the name of *Nonion graniferum* (TERQUEM). As, according to

Hofker's remarks and sketches, the form has 11–13 chambers in the final whorl, it cannot belong to this species, which is characterised by 6–8 chambers in the final whorl. Hofker stated in his remarks that his material is common in the upper part of his zone P. However, his range chart (p. 7) shows it to occur only in the zone S. Moreover, on pl. 42, fig. 57 b–c his sketches show the two sides of the same individual. They do not have the same number of chambers in the final whorl, in contrast to what might be expected since the form is involute.

Material: 31 specimens (of which 6 are damaged).

Occurrence

Paleocene, Sweden, Denmark, Poland and USA. Lutetian, France.

Genus *Nonionella* Cushman, 1926

Nonionella ovata Brotzen, 1948
pl. 12, figs 1–3; pl. 25, fig. 6

1948	*Nonionella ovata* Brotzen: p. 68, pl. 10, figs 13–14
1965	*Nonionella ovata* Brotzen; Pozaryska: p. 94, pl. 21, fig. 1 a–c
1968	*Nonionella ovata* Brotzen; Pozaryska & Szczechura: p. 83

Description

In the specimens from Nûgssuaq the test is trochospiral, about equally biconvex. General outline ovate and smooth. 5–6 chambers in the final whorl. Periphery rounded. Umbilicus covered by umbilical part of the large final chamber, which makes up about $^1/_2$ of the largest diameter. Sutures straight or slightly curved, may become slightly depressed. Aperture interiomarginal umbilical. Aperture an arched opening extending across periphery and continuing below umbilical part of final chamber. There is a more or less well developed overhanging lip. Surface smooth and unornamented. Test wall composed of granulate, perforate calcite.

Discussion

The Greenland material is identical with individuals from the type locality in Sweden. The narrow central plug found on the spiral side as mentioned by Brotzen in the diagnosis is not a plug but the proloculus.

One of the specimens from Nûgssuaq shows 8 chambers in the last whorl, a small final chamber and a compressed test, which form is not found in the Swedish material. This specimen appears to be closer to *Nonionella aquiensis* NOGAN (NOGAN, 1964, p. 29, pl. 2, figs 6–7).

Material: 15 specimens

Occurrence

Paleocene, Sweden, Denmark and Poland.

Family **Alabaminidae** HOFKER, 1951

Genus *Alabamina* TOULMIN, 1941

Alabamina rosenkrantzi n. sp.

pl. 11, figs 4–8; pl. 26, figs 3–6

Diagnosis

An *Alabamina* with strongly convex umbilical side and slightly elevated spiral side. The apertural face gently infolded and the peripheral part of the apertural face only slightly projecting. Apertural face high.

Description

Test trochospiral with evolute spiral side and involute umbilical side. $4–4^1/_2$ chambers in the final whorl. Umbilical side strongly convex, spiral side commonly flat. If the spiral side is elevated, it affects only the central part. Sutures on the spiral side level with the surface, only slightly curved, running tangential to the spiral suture. Sutures on the umbilical side slightly, if at all, depressed, radial. Outline subcircular. Periphery broadly rounded. Apertural face high and gently infolded. Aperture interiomarginal, slit-shaped, with a narrow overhanging lip. Aperture centrally placed, extending neither to the umbilicus nor to the periphery. Below and a little in front of the aperture is a small uneven threshold. An infundibulum is present. The foramina are closed in the part nearest the umbilicus by a secondary deposited layer of calcite which is more strongly developed in the older foramina. The secondary layer extends also onto the floor below the foramina and smoothens the thresholds. The layers are deposited on the distal side of the septa. The wall is composed of perforate, granulate calcite. Septa monolamellar. Average pore diameter 0.6 μ.

Dimensions of holotype:

Diameter 511 μ. Thickness 398 μ.

Differential diagnosis

Alabamina rosenkrantzi is distinguished from *Alabamina dorsoplana* (Brotzen) by its flatter spiral side, considerably higher umbilical side, higher apertural face and by the lack of pronounced projection of the tectum. From the other species of the genus *Alabamina* it is distinguished by its high umbilical side and high apertural face.

Remarks

The 20 specimens from Nûgssuaq all have sinistral coiling. Preferred sinistral coiling was also found in alabaminas from the Danish Paleogene.

Type locality: Agatdalen, Nûgssuaq, West Greenland.
Type level: Upper Danian.
Holotype: MMH 10581 (pl. 11, figs 6–8).

Derivatio nominis

The new species is named in honour of Professor A. Rosenkrantz who collected the material on which the present work is based.

Material: 20 specimens (of which 8 lack the final chamber).

Genus *Paralabamina* n. gen.

Type species: *Eponides lunata* Brotzen, 1948

Diagnosis

Test free, biconvex and trochospiral. Outline subcircular. Periphery subangular. Spiral side evolute with all chambers visible. Umbilical side involute with only the chambers of the final whorl visible. Sutures on the umbilical side radial, curved and sigmoid. Sutures on the spiral side oblique and curved. Test wall composed of granulate, perforate calcite. Septa monolamellar. Aperture slit-like or slightly arched, interiomarginal on umbilical side extending from near periphery almost to umbilicus. Pores generally large.

Differential diagnosis

The genus *Paralabamina* differs from the genus *Alabamina* in the lack of the indentation of the apertural face being characteristic of the genus *Alabamina*, and in the pore size.

Discussion

Since Loeblich & Tappan (1962) chose a neotype for the genus *Eponides*, some species, viz. "*Eponides*" *lunata* and "*Eponides*" *toulmini*, could not be placed within any established genus. The genus *Eponides* is characterised among other things by radiate wall structure and bilamellar septa while the wall of "*Eponides*" *lunata* and "*Eponides*" *toulmini* is granulate and the septa are monolamellar.

HOFKER (1959b) listed the genus *Alabamina* as a synonym of the genus *Eponides* as he evidently regarded the above mentioned "*Eponides*"-species as representative of the genus *Eponides*. These species are here referred to a new genus as they cannot be placed within the genus *Alabamina*.

The term "indentation" was introduced by TOULMIN (1941, p. 602) to characterise the small, internal prolongation of the apertural face in the peripheral part of the aperture in the genus *Alabamina*. Later BROTZEN (1948, p. 97) used the term "infundibulum" for the same morphological structure.

The "indentation" or "infundibulum" was called a "tooth-plate" by HOFKER (1959b).

When discussing the species "*Eponides*" *toulmini* BROTZEN, HOFKER (1959b, p. 112) wrote: "*E. toulmini* also has the typical infundibulum, but the tooth-plate is much more reduced and scarcely detectable".

It is therefore a contradiction that a typical infundibulum is present while a tooth-plate is scarcely detectable, when the two terms are used for the same morphological structure.

The author has not observed any infundibulum in specimens of "*Eponides*" *toulmini* or in specimens of "*Eponides*" *lunata* from the Swedish and Danish Paleocene deposits.

The morphology and wall structure indicate that the genus *Paralabamina* must be placed in the family Alabaminidae.

Paralabamina lunata (BROTZEN, 1948)
pl. 14, figs 5–7; pl. 27, figs 1–2

1948	*Eponides lunata* BROTZEN: p. 77, pl. 10, figs 17–18
1953	*Eponides lunatus* (BROTZEN); LE ROY: p. 30, pl. 9, figs 24–26
1960	*Eponides lunata* BROTZEN; OLSSON: p. 36
1965	*Eponides lunata* BROTZEN; POZARYSKA: p. 110
1966	*Eponides lunata* BROTZEN; HOFKER: p. 337, pl. 83, fig. 205

Description

Tests of the Greenland material trochospiral, biconvex. Evolute spiral side consisting of one and a half whorls. Umbilical side involute with closed umbilicus. Six chambers in the final whorl. Umbilical side more strongly elevated than the spiral side. Periphery subacute, somewhat rounded. The periphery of the final chamber more rounded than that of the earlier part of the test. Outline slightly lobate. Sutures on the spiral side oblique, gently curved and slightly depressed. Sutures on the umbilical side radial, sigmoid, curved and somewhat depressed. Aperture at the base of the final chamber on the umbilical side, extending from near the periphery almost to the umbilicus. It is slit-shaped with a central widening bordered by a narrow lip. Wall surface smooth. Wall more densely perforate on spiral side than on umbilical side. Test wall composed of granulate, perforate calcite. Septa monolamellar.

Remarks

The Greenland specimens have been compared with the holotype and found to be identical, except for the central arch in the aperture in the Greenland individuals. The species determination has been confirmed by the late Dr. F. BROTZEN.

Material: 4 specimens.

Occurrence

Paleocene in Sweden and Denmark; Hornerstown Formation, New Jersey, U.S.A.; Esna Shale, Egypt; Upper Maastrichtian and Paleocene, Poland.

Family **Anomalinidae** CUSHMAN, 1927

Anomalinoides howelli (TOULMIN, 1941)
pl. 12, figs 4–9; pl. 27, figs 3–4

1941	*Cibicides howelli* TOULMIN: p. 609, pl. 82, figs 16–18
1942	*Cibicides howelli* TOULMIN; CUSHMAN & RENZ: p. 13, pl. 3, fig. 10
1944 a	*Cibicides howelli* TOULMIN; CUSHMAN: p. 28, pl. 4, fig. 29
1944 b	*Cibicides howelli* TOULMIN; CUSHMAN: p. 50, pl. 8, fig. 9
1948	*Cibicides howelli* TOULMIN; SHIFFLETT: p. 74, pl. 5, fig. 3
1964	*Cibicides howelli* TOULMIN; NOGAN: p. 46, pl. 7, figs 7–9

Description

Tests of the Nûgssuaq material low trochospiral, planoconvex. 7–11 chambers in the final whorl, generally from 8 to 10. The umbilical side nearly involute generally with a large, smooth and distinct umbonal knob. The spiral side partially evolute, showing a part of the penultimate whorl. General outline smooth, subcircular, becoming lobate in the final half of the last whorl. Periphery in the earliest part of the final whorl subacute to acute but never sharp, while the periphery of the latest chambers is in general more rounded. Chambers in the older part very slightly, if at all, inflated. Sutures curved on both sides and somewhat depressed between the latest chambers but not in the earlier part where the sutures are filled in and broadened by transparent secondary calcite. Secondary calcite is also deposited on the periphery of the earlier part of the test. Aperture interiomarginal, arching over a short distance on the umbilical side onto the spiral side where it continues along the spiral suture below the overhanging, slightly twisted, apertural flaps of the preceding chambers. Aperture of the final chamber in the peripheral part with a bordering, smooth lip which broadens into a flap along the spiral suture. Apertural face smooth and gently inflated. The central part of the spiral side ornamented with a rather large, irregular knob or aggregate of knobs with indistinct boundaries. Wall composed of granulate, perforate calcite. Apertural face, earlier sutures, periphery and umbilical knob without pores. Septa bilamellar.

Discussion

The Greenland material has been compared with specimens of *A. howelli* from TOULMIN's locality no. 3. The only difference between the two forms is the slightly larger umbilical disc in some of the specimens from Greenland; in all other characters there is a very good agreement. NOGAN's illustrated specimen from the Aquia Formation differs from both the Greenland and the Salt Mountain specimens in the poorly developed apertural lip. This difference would seem to fall within the variation of *A. howelli.*

When sectioned parallel to the axis of coiling the proloculus is found closest to the side where the aperture is located. Thus the species should, according to general morphology, be referred to the genus *Cibicides.* As it has a granular wall structure and bilamellar septa, it is here referred to the genus *Anomalinoides* but the coiling is of the "reversed trochoid" type.

Of 58 measured specimens 55 had from 8–10 chambers in the final whorl.

There is some variation in the elevation of the final whorl relative to the spiral side. In general the final whorl is level with the spiral side, but in some specimens there is a tendency for the last whorl not to be level with the spiral side (pl. 12, figs 4–9).

The degree of depression of the sutures between the latest chambers seems to be dependent upon the size of the test. The sutural depression is comparatively deeper in large tests than in smaller ones.

Material: 187 specimens.

Occurrence

Paleocene, Gulf Area, USA.

Genus *Gyroidinoides* BROTZEN, 1942

The systematic position and relationship of the genera *Gyroidinoides* BROTZEN, 1942, *Gyroidina* D'ORBIGNY, 1826 and *Gyroidina* sensu LOEBLICH & TAPPAN, 1964.

For some years there has existed a slight uncertainty with respect to the difference in apertural characters between the genera *Gyroidina* and *Gyroidinoides*.

According to the emended diagnosis of the genus *Gyroidina* by HANSEN (1967) in which a lectotype was designated, it is evident that the description of the genus *Gyroidina* by LOEBLICH & TAPPAN (1964) is incorrect. The species illustrated and described by them is not the type species *Gyroidina orbicularis* but "*Gyroidina*" *soldanii.*

The type species of *Gyroidina* has granulate wall structure and bilamellar septa. These characters as well as general morphology and aperture place the genus *Gyroidina* in the family Anomalinidae in the classification of LOEBLICH & TAPPAN (1964).

Gyroidina orbicularis is clearly distinguished from "*Gyroidina*" *soldanii* both in general morphology and in apertural characters. *G. orbicularis* has no umbilical aperture. The aperture is interio-marginal extending from near the periphery almost to the umbilicus. The aperture in "*G.*" *soldanii* is double i.e. an interiomarginal slit confined to the mid-portion of the chamber and an umbilical aperture with an overhanging apertural flap (pl. 27, fig. 5).

The umbilical apertural part in the type species of the genus *Gyroidinoides* i.e. *Rotalina nitida* REUSS, 1844 was described by BROTZEN (1942, p. 19) as: "... umbilical Mündung bei der letzten Kammer vorhanden, bei den vorhergehenden oft reduziert, ...". His fig. 6, however, shows that the aperture continues into the umbilicus where the umbilical part of the previous apertures remains open.

LOEBLICH & TAPPAN (1964, p. 753) described the apertural characters of the genus *Gyroidinoides* as: "..., aperture a continuous, low, interiomarginal slit extending from periphery to umbilicus, umbilical portion partially obscured by umbilical flap from each chamber."

In their remarks they stated: "*Gyroidinoides* differs from *Pseudovalvulineria* in being planoconvex, rather than biconvex, and in having the final aperture as the only opening to the exterior, rather than having the umbilical portion of earlier apertures remaining open."

Specimens of the type species of *Gyroidinoides* from Eriksdal and from a boring near Ystad in Sweden showed that the older umbilical apertures remain open into the umbilicus (pl. 27, fig. 6).

Gyroidinoides was by LOEBLICH & TAPPAN (1964) placed in the family Osangulariidae. As the apertural characters of *Gyroidinoides* do not support the placing of the genus in this family, it is here transferred to the family Anomalinidae where it must belong because of its general morphology and wall structure (granulate, calcitic perforate wall and bilamellar septa) and because of its lack of a "murus reflectus" characteristic of the family Osangulariidae (see e.g. REISS, 1960, 1963).

The genera *Gyroidina* and *Gyroidinoides* as well as the group of forms represented by "*Gyroidina*" *soldanii* are thus well distinguished in apertural characters.

Gyroidinoides octocamerata (CUSHMAN & HANNA, 1927)
pl. 13, figs 1–3

1927 *Gyroidina soldanii* var. *octocamerata* CUSHMAN & HANNA: p. 223, pl. 14, figs 16–18
1948 *Gyroidinoides pontoni* BROTZEN: p. 76, pl. 11, figs 4–5
1964 *Gyroidinoides octocameratus* (CUSHMAN & HANNA); NOGAN: p. 35, pl. 3, figs 3–5
1965 *Gyroidinoides octocamerata* CUSHMAN & HANNA; POZARYSKA: p. 107, pl. 18, figs 3a–c, 5a–c
1965 *Gyroidinoides pontoni* BROTZEN; POZARYSKA: p. 108, pl. 18, figs 4a–c
1966 *Gyroidinoides octocamerata* CUSHMAN & HANNA; HOFKER: p. 336, pl. 83, fig. 198
1966 *Gyroidinoides pontoni* BROTZEN; HOFKER: p. 336, pl. 83, fig. 201
1968 *Gyroidinoides octocamerata* (CUSHMAN & HANNA); POZARYSKA & SZCZECHURA: p. 85
1968 *Gyroidinoides pontoni* BROTZEN; POZARYSKA & SZCZECHURA: p. 85
(for additional synonyms see NOGAN, 1964)

Description

The tests of the specimens from Nûgssuaq are biconvex, trochospiral with evolute spiral side and involute umbilical side. Umbilical side with a deep and rather narrow umbilicus. $6^1/_2$–10 chambers in the final whorl. General outline slightly lobate. Periphery generally broadly rounded. Sutures on both sides slightly to moderately depressed, becoming more depressed on the umbilical side towards the umbilicus. Sutures on the umbilical side almost radial; curved on the spiral side. Spiral suture hardly depressed in the earlier part of the test, slightly depressed in the later part. Chambers faintly to slightly inflated. Aperture a slit-shaped opening placed interiomarginally in the final chamber, extending from the periphery into the umbilicus. It is equipped with a distinct, smooth overhanging lip which broadens into a large umbilical flap. The umbilical part of the older apertures remains open into the umbilicus below the somewhat twisted umbilical flaps. The flaps are slightly overlapping without touching each other. Test wall composed of granulate, perforate calcite. Septa bilamellar.

Discussion

Brotzen (1948) described a new species, *Gyroidinoides pontoni*, from the Lower Selandian beds of Scania. He distinguished this species from *G. octocamerata* on the basis of its more convex umbilical side. Nogan (1964) placed this species as a synonym of *Gyroidinoides octocamerata* as his material from the Aquia Formation showed a wide range of variation in the convexity of the umbilical side. *Gyroidinoides pontoni* at its type locality in Sweden and in the Paleocene beds in the Copenhagen area, also shows large variation in the elevation of the umbilical side. *Gyroidinoides pontoni* is therefore, in accordance with Nogan, regarded as an infraspecific variety of *Gyroidinoides octocamerata.*

The Greenland material is very close to the specimen illustrated by Nogan. Available specimens of *Gyroidinoides octocamerata* from the Brightseat Formation are identical with the specimens from Greenland.

It was not possible to find enough specimens for variation analysis at the type locality of *Gyroidinoides pontoni.* For comparison with the specimens from Greenland, 26 specimens from Vestre Gasværk in Copenhagen were measured for proloculus diameter, number of whorls and number of chambers (fig. 35). The same parameters of 17 specimens from Nûgssuaq which were preserved well enough to allow measurements, are shown in fig. 36.

In fig. 35 it seems possible to distinguish a microspheric generation with a large number of chambers and whorls and by small proloculus

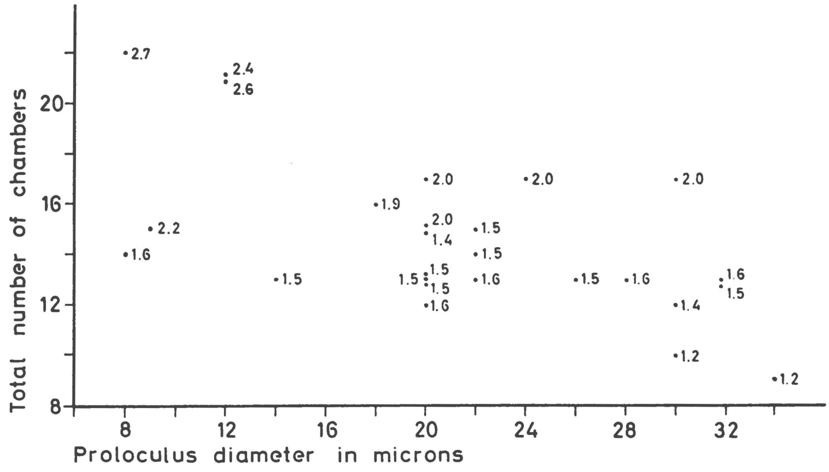

Fig. 35. The relationship between proloculus diameter and number of chambers in 26 specimens of *Gyroidinoides octocamerata* (Cushman & Hanna) from Vestre Gasværk (Lower Selandian). The inserted numbers indicate the number of whorls.

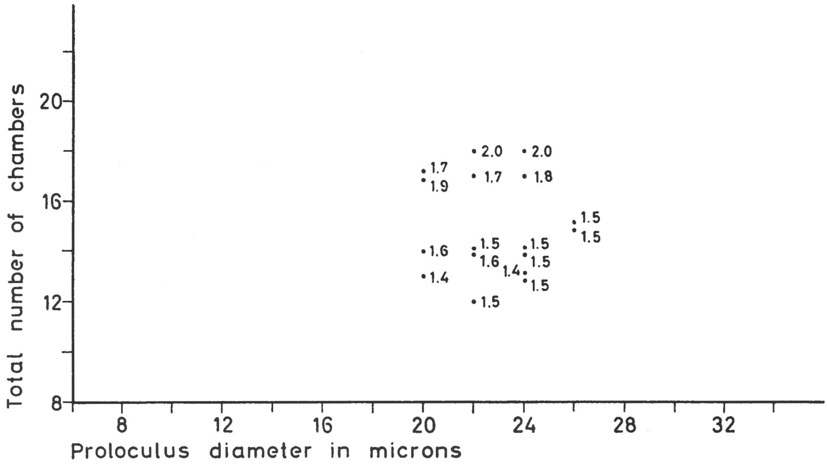

Fig. 36. The relationship between proloculus diameter and number of chambers in 17 specimens of *Gyroidinoides octocamerata* (CUSHMAN & HANNA) from the Sonja Member, Nûgssuaq. The inserted numbers indicate the number of whorls.

diameter, but the material is too limited to allow conclusive statements. The Greenland specimens would all seem to belong to the supposed megalospheric generation (fig. 36).

Material: 25 specimens.

Occurrence

According to HOFKER in the Upper Cretaceous of Holland. Paleocene in north and central Europe; Paleocene and Eocene in the Gulf Coast area and California, USA.

Genus *Gavelinella* BROTZEN, 1942

[*Gavelinella danica* (BROTZEN, 1940)

fig. 38; pl. 13, figs 4–6; pl. 28, figs 2–5

1927	*Anomalina grosserugosa* GÜMBEL; FRANKE: p. 37, pl. 4, fig. 3
1940	*Cibicides danica* BROTZEN: p. 31, figs 7, 2
1948	*Anomalinoides danica* (BROTZEN); BROTZEN: p. 87, pl. 14, fig. 1, text fig. 22
1953	*Anomalina granosa* (HANTKEN); LE ROY: p. 17, pl. 6, figs 1–3
1955 a	*Gavelinella danica* (BROTZEN); HOFKER: p. 49, figs 1–2
1955 b	*Gavelinella danica* (BROTZEN); HOFKER: p. 11, pl. 1
1962	*Gavelinella danica* (BROTZEN); SCHMID: p. 339, pl. 5, figs 1 a–c
1964	*Anomalinoides grosserugosa* (GÜMBEL); BUCH: p. 104, pl. 4, fig. 34 (non fig. 35)

1965 *Anomalina danica* (BROTZEN); POZARYSKA: p. 128, pl. 24, figs 1–3, (?fig. 2)
1966 *Gavelinella danica* (BROTZEN); HOFKER: pl. 84, figs 218, 220–222
1968 *Anomalina danica* (BROTZEN); POZARYSKA & SZCZECHURA: p. 86, pl. 14, figs 6–11

Description

In the Greenland material the test is trochospiral, biconvex. Spiral side evolute with the earlier whorls covered by secondary shell material. Umbilical side involute with deep and open umbilicus. About 8 chambers in the final whorl. The latest 3–4 chambers moderately inflated on both sides. Outline slightly lobate. Periphery angular. In general the periphery of the last chamber is more rounded than that of the earlier part. Sutures on the spiral side curved and depressed. The sutures between the earlier chambers obscured by deposition of secondary shell material. Sutures on the umbilical side curved and depressed between the latest chambers, but not in the earlier part. Aperture interiomarginal, peripheral-umbilical in position. The slit-shaped aperture continues into the earlier umbilical apertures below an overhanging lip. The surface in the earlier part has a granulated appearance. Test wall composed of granulate, perforate calcite. Septa bilamellar. Average pore-diameter 2.5 μ.

Discussion

As the test of *Gavelinella danica* is heavily thickened by deposition of secondary calcite layers, the proloculus is invisible even when the test is cleared with e.g. aniseed oil. The majority of specimens from Greenland are not preserved well enough to allow measurements. Therefore a population from the Selandian beds in Basballe in Jylland was used instead. The population which consisted of 110 specimens was cleared by HF treatment (UPSHAW et al., 1957). The tests, which consisted of fluorite after this treatment, were viewed in transmitted light, and the proloculus diameter could be measured when viewed from the umbilical side. It was neither possible to count the total number of chambers nor the number of chambers in the final whorl with sufficient accuracy.

Of the measured 110 specimens 4 are considered microspheric while the remainder all are supposed to be megalospheric (fig. 37).

44 % of the population are dextrally coiled; among these are the microspheric forms.

HOFKER and SCHMID referred the species to the genus *Gavelinella* in contrast to e.g. BROTZEN, who placed it in *Anomalinoides*. The genus *Gavelinella*, as represented by its type species *Gavelinella pertusa* (MARSSON) (pl. 28, fig. 1) has no apertural openings on the spiral side as has the type species of *Anomalinoides*. This character definitely places the species *G. danica* in the genus *Gavelinella*.

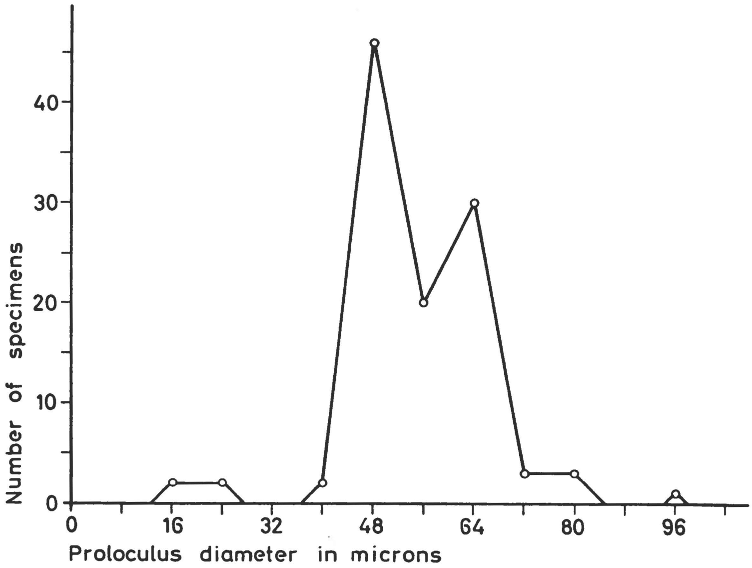

Fig. 37. Size-frequency distribution of proloculus diameters of 110 specimens of *Gavelinella danica* (BROTZEN) from Basballe (Selandian).

Affinities

When describing the species in 1940 BROTZEN mentioned that there is a transition from *G. bosqueti* (MARSSON) to *G. danica.* These forms occur together in the Upper Maastrichtian beds, but the thicker and coarser *G. danica* continues into the Danian. Later BROTZEN (1948, p. 87) stated that: "The Paleocene specimens do not differ from the Danian ones, except that the structure of the wall is coarser".

HOFKER (1955a, b) paid special attention to the development of the pores of *G. danica.* He found a development of the pore diameter starting with that of 4 μ in the Upper Maastrichtian, 5 μ in the Danian, 6 μ in the "Me" and "Md" and 7–8 μ in the "Paleocene and Montian".

The author investigated the pore diameter of *G. danica* from different stratigraphical ages by aid of electron microscope. In one specimen from Vestre Gasværk (Lower Selandian) the pore diameter in the final 10 chambers could be measured in the transmission electron microscope. The diameter remained constant throughout (2.6 μ). The pore diameter likewise remained constant in other specimens from other stratigraphical levels.

It was not possible to substantiate HOFKER's find of larger pore diameters in stratigraphically younger specimens. The pore diameter remained constant (about 2.5 μ) in all specimens studied independent of stratigraphical level.

The secondary thickening of the test of *G. danica* and its younger development stages is very pronounced. The thickening causes a funnel

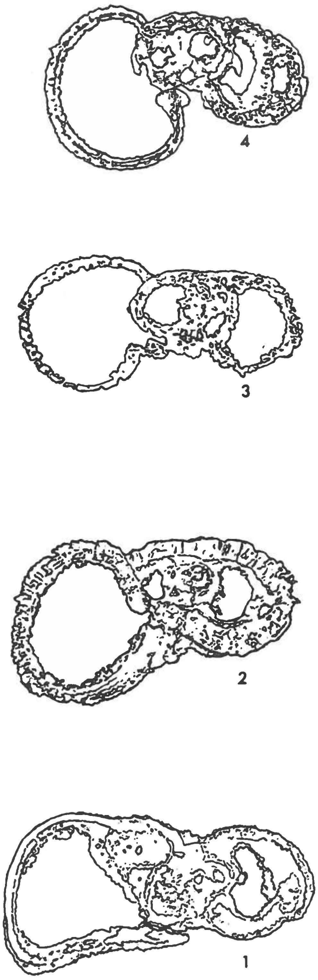

Fig. 38. *Gavelinella danica* (Brotzen). Development of periphery of specimens from Upper Maastrichtian (1), Upper Danian (2), Lower Selandian (3) and Lower Eocene (4). All 60×.

shaped widening of the pores on the test surface thus giving the impression of a very large pore diameter; the true diameter can be measured on the inner surface of the test. Hofker measured the pore diameter using a light microscope and, as shown by Haynes (1954, p. 188), this method may easily lead to errors.

Hofker (1955a, p. 12) used the pore diameter of *G. danica* to assign a Lower Paleocene age to the Vincentown Formation of New Jersey. Loeblich & Tappan (1957a) used planktonic foraminifera to determine an Upper Paleocene age for this formation.

The evolution of *G. danica* in Denmark can be followed from the Upper Maastrichtian to the Lower Eocene.

The Upper Maastrichtian form has a subangular periphery of the final part of the test. Through the Danian the periphery gradually becomes more and more rounded, while the forms from the Lower Selandian and Landenian have a subcircular periphery. The Ypresian form has a strongly inflated final chamber and an almost circular periphery (fig. 38; pl. 28, figs 2–5).

Material: 46 specimens.

Occurrence

Paleocene, Denmark, Sweden, Poland, Austria, Holland, Egypt; Vincentown Formation, New Jersey, USA.

Genus *Karreria* RZEHAK, 1891

Karreria sp.
pl. 13, figs 7–9; pl. 28, fig. 6

Description

Test planoconvex, trochospiral. Spiral side evolute and plane, umbilical side convex, involute with closed umbilicus. General outline slightly to moderately lobate. Periphery rather sharply angled with a pore-free border. Sutures on the spiral side curved, narrow, distinct and depressed. Chambers on the umbilical side inflated but not strongly so. Aperture areal to almost interio-marginal, an oval to subcircular opening with a slightly protruding, encircling thickening. Wall composed of granulate, finely perforate calcite. Septa bilamellar. In the earlier part of the test, wall usually smooth; in the later part often with a somewhat rough finish, faintly resembling an arenaceous wall.

Discussion

None of the specimens from Greenland had the final part of the test preserved. The uncoiling part, characteristic of the genus *Karreria*, has in the present material been observed only in one specimen. This specimen is, however, also fragmentary but makes it probable that the form from Greenland was uncoiling.

Material: 67 damaged specimens.

Genus *Melonis* MONTFORT, 1808

Melonis nobilis (BROTZEN, 1948)
pl. 14, figs 8–10; pl. 29, figs 1–2

1948 *Anomalinoides nobilis* BROTZEN: p. 89, pl. 14, fig. 5
1966 *Gavelinonion nobilis* (BROTZEN): p. 336, pl. 85, figs 225–227 (non pl. 14, fig. 76)

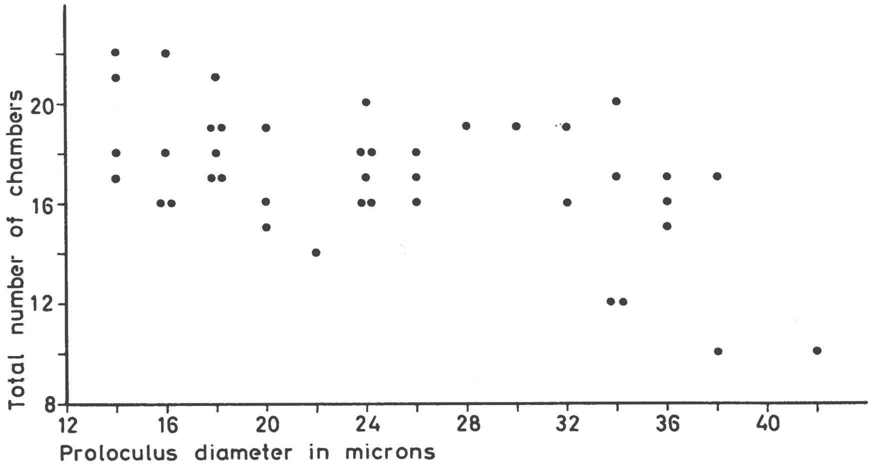

Fig. 39. The relationship between proloculus diameter and number of chambers in 41 specimens of *Melonis nobilis* (Brotzen) from Vestre Gasværk (Lower Selandian).

Description

Tests of the Greenland specimen almost planispiral involute and biumbilicate. General outline hardly lobate. Periphery broadly rounded. Sutures on both sides slightly curved, almost radial; broad and transparent and very slightly depressed between the latest chambers. Aperture a low interiomarginal, equatorial arch continuing into both umbilici under slightly twisted small, thickened, umbilical flaps. Aperture with a distinct rounded lip. Test wall composed of granulate, perforate calcite.

Variation

In order to investigate the variation of this species a large number (210 specimens) was picked from a sample from the Lower Selandian of Vestre Gasværk. The majority were filled with pyrite in the initial part of the test and could not be measured for the desired parameters. Only 41 specimens were not filled and they were measured for proloculus diameter, number of whorls, and number of chambers in the final whorl.

It was not possible in this small amount of material to distinguish between microspheric and megalospheric individuals. The proloculus diameter varied from 14 to 42 μ. The total number of chambers varies from 10 to 22. In general the individuals with the highest number of chambers have the smallest proloculi but exceptions to this were found. The diameter of the tests varies from 128 to 360 μ. The specimens with the smallest proloculus diameter have the highest number of whorls i.e. more than 2.0 whorls. The limited material is not conclusive for delimitation of generations. In fig. 39 the relationship between proloculus and number of chambers is shown.

Discussion

As the test of this species is involutely coiled and has the aperture in both umbilici, the species must be referred to the genus *Melonis*. The genus *Gavelinonion* erected by HOFKER is here, in agreement with LOEBLICH & TAPPAN (1964), regarded as a synonym of the genus *Melonis*.

The specimen from Greenland is not identical with the specimen depicted by HOFKER from the Maastrichtian of the Netherlands. HOFKER recorded this form as an early evolutionary stage of *M. nobilis*. The present author has not been able to find such forms in the Maastrichtian White Chalk of Denmark. In the Selandian of Denmark the species is very constant in its general appearance, and the specimen from Greenland is identical with that form, and not with the one from the Maastrichtian.

HOFKER mentioned the species from his zone D. From Denmark he recorded it from the *Pseudotextularia* zone, Danian and Selandian in his range chart on p. 305, while it is not found on the range charts on p. 304 (Danian) and p. 322 (Selandian).

Material: 1 specimen.

Occurrence

Selandian, Sweden and Denmark; Danian, Denmark; Maastrichtian, the Netherlands and Denmark.

Superfamily **Robertinacea** REUSS, 1850
Family **Ceratobuliminidae** CUSHMAN, 1927
Genus *Ceratobulimina* TOULA, 1915

Ceratobulimina (*Ceratobulimina*) *perplexa* (PLUMMER, 1926)
pl. 14, figs 1–2

1926 *Rotalia perplexa* PLUMMER: p. 156, pl. 12, fig. 2
1927 *Ceratobulimina perplexa* (PLUMMER); CUSHMAN & HARRIS: p. 173, pl. 29, fig. 2
1936 *Ceratobulimina perplexa* (PLUMMER); PLUMMER: p. 460, text figs 1–4
1937 *Ceratobulimina perplexa* (PLUMMER); GLAESSNER: pp. 20, 23, pl. 1, figs 2–3; pl. 2, fig. 25
1942 *Ceratobulimina perplexa* (PLUMMER); CUSHMAN & TODD: p. 41, pl. 7, figs 23–24
1946 *Ceratobulimina perplexa* (PLUMMER); CUSHMAN: p. 108, pl. 17, figs 3–5
1960 *Ceratobulimina perplexa* (PLUMMER); OLSSON: p. 39
1964 *Ceratobulimina perplexa* (PLUMMER); NOGAN: p. 36, pl. 3, figs 12–13

1966 *Ceratobulimina perplexa* (Plummer); Hofker: p. 339, fig. 177
1966 *Ceratobulimina (Ceratobulimina) perplexa* (Plummer); McGowran: p. 79, text fig. 3 (fig. 6)

Description

Test of the Greenland specimens trochospiral, biconvex, general outline smooth or slightly lobate. Periphery broadly rounded. 6 chambers in the final whorl. Sutures on the umbilical side radial, narrow and depressed. Sutures on the spiral side broad, curved and slightly thickened, with a lobe about midway between proloculus and periphery caused by the attachment of the internal tooth-plate. Umbilicus open and deep. Aperture bordered by attachment to the previous whorl and by apertural furrow where the tooth-plate is attached. The tooth-plate is ceratobulimine. Test wall composed of radiate, perforate aragonite. Septa bilamellar.

Discussion

The inner structure of *Ceratobulimina perplexa* was described in detail by Plummer (1936). She concluded that the internal partition is attached to the "dorsal suture". McGowran (1966) quoted Plummer's investigation.

Hofker (1966) studied the tooth-plate of *Ceratobulimina perplexa* from one of Plummer's localities and placed the species in the genus *Ceratobulimina*, as he found the tooth-plate attached to the spiral wall. He called attention to the track externally on the spiral side caused by the attachment of the tooth-plate. This track appears as an extra sinus on the distal part of the sutures. This structure is also found in the two specimens from Greenland.

According to the investigations by Hofker, the species *C. perplexa* must be referred to the subgenus *Ceratobulimina* (*Ceratobulimina*) as done by McGowran (1966).

C. (*Ceratobulimina*) *perplexa* has not been found in northern Europe. *C. perplexa* described by Brotzen (1948) from the Paleocene of Scania was placed in synonymy with *C.* (*Ceratolamarckina*) *tuberculata* Brotzen by Troelsen (1954).

Hofker (1966) regarded Brotzen's *C. perplexa* as a new species, which he named *Lamarckina pseudoperplexa*.

Material: 2 specimens.

Occurrence

Porter's Creek Formation, Alabama; Will's Point Formation, Texas; Midway Formation, Texas; Hornerstown Formation, New Jersey; Aquia and Brightseat Formations, Maryland, U.S.A.

Ceratobulimina (*Ceratolamarckina*) *troelseni* n. sp.

fig. 40; pl. 14, figs 11–13; pl. 29, figs 3–6

Diagnosis

A *Ceratolamarckina* with 7 chambers in the final whorl, slightly lobate outline and ovoid periphery. Umbilicus large, open, deep and tuberculate. Sutures narrow and depressed.

Description

Test trochospiral and umbilicate. General outline slightly lobate. Spiral side slightly convex. Periphery ovoid. Sutures on the umbilical side radial, slightly depressed, becoming somewhat broader towards umbilicus. Sutures on the spiral side gently curved and slightly depressed. Chambers on both sides slightly inflated. The aperture is umbilical, limited distally by the attachment to the previous whorl and proximally by the attachment of the internal partition or tooth-plate. The internal partition is situated within the final chamber and is fixed along the umbilical edge of the elliptical, secondarily, resorbed foramen, placed in the distal part of the wall of the penultimate chamber. It does not extend to the spiral wall. The internal partition is further fixed to the proximal, umbilical part of the last chamber and forms a small platform. The distal part of this attachment can be seen as a small, poorly developed apertural notch. The free edge of the internal partition is slightly serrated and bends towards the aperture. The umbilical aperture of the penultimate chamber is closed by a thin plate and only the aperture of the last chamber remains open into the umbilicus. Inside the penultimate chamber the internal partition is attached to the umbilical, distal part of the youngest foramen and is also attached to the umbilical wall of the chamber, thus delimiting a vestibulum. It constitutes a floor connecting successive foramina. This structure has also been found in the antepenultimate chamber, and it is supposed that it continues into the older chambers with no further modifications (fig. 40). The surface of the test is smooth. The test is thin and vitreous. Test wall composed of radiate, perforate aragonite. Septa bilamellar.

Dimensions of holotype:

Diameter 217 μ. Thickness 88 μ.

Differential diagnosis

Ceratobulimina (*Ceratolamarckina*) *troelseni* n. sp. differs from earlier described species referable to the genus *Ceratobulimina* by its open coiling, chamber form and ovoid periphery.

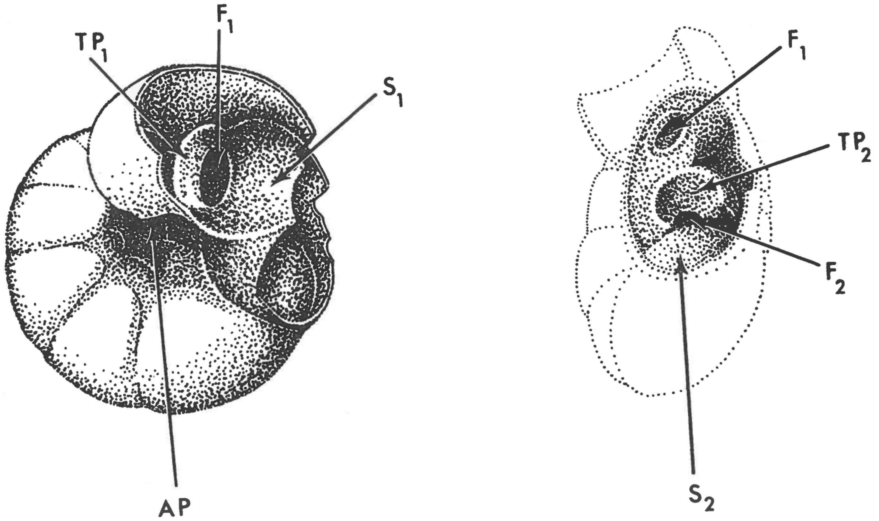

Fig. 40. *Ceratobulimina* (*Ceratolamarckina*) *troelseni* n. sp. AP. Aperture; F_1. Foramen between ultimate and penultimate chamber; F_2. Foramen between penultimate and antepenultimate chamber; S_1. Septum between ultimate and penultimate chamber; S_2. Septum between penultimate and antepenultimate chamber; TP_1. Tooth-plate in final chamber; TP_2. Tooth-plate in penultimate chamber.

Remarks

X-ray analysis of the test in a Guinier camera was kindly carried out by E. Krogh Andersen in the X-ray laboratory of the Geological Institute of the University of Copenhagen. The analysis showed that the test is composed of pure aragonite with no traces of calcite. This supports the statement by Todd & Blackmon (1956) that the calcareous, hyaline tests are composed either of pure aragonite or pure calcite. Mixtures of these two components have so far not been found in tests belonging to the above mentioned category. *C.* (*Ceratolamarckina*) *troelseni* n. sp. must be referred to the subgenus *Ceratolamarckina* as the internal partition is not attached to the spiral wall, and as it does not possess the deep apertural notch which characterises the subgenus *Ceratobulimina* (*Ceratobulimina*).

Type locality: Agatdalen, Nûgssuaq, West Greenland.

Type level: Upper Danian.

Holotype: MMH 10596 (pl. 14, figs 11–13)

Derivatio nominis

The new species is named in the honour of Dr. J. C. Troelsen, who established the subgenus *Ceratolamarckina* and described its inner structures in detail.

Material: 6 specimens.

Genus *Lamarckina* Berthelin, 1881

Lamarckina rugulosa Plummer, 1926
pl. 30, figs 1–4

1926	*Lamarckina rugulosa* Plummer: p. 140, pl. 9, figs 3a–c
1926	*Lamarckina rugulosa* Plummer; Cushman: p. 8, pl. 3, figs 6a–c
1951	*Lamarckina rugulosa* Plummer; Cushman: p. 49, pl. 13, fig. 24
?1960	*Lamarckina rugulosa* Plummer; Olsson: p. 37, pl. 6, figs 5–6
1965	*Lamarckina rugulosa* Plummer; McGowran: p. 57, pl. 5, fig. 6
1965	*Lamarckina rugulosa* Plummer; Pozaryska: p. 116, pl. 24, fig. 4a–c
1966	*Lamarckina rugulosa* Plummer; McGowran: p. 97, pl. 8, fig. 1, text figs 1, 2, 10
1968	*Lamarckina rugulosa* Plummer; Pozaryska & Szczechura: p. 93

Description

The individual from Greenland lacks the main part of the final whorl. The tuberculate surface of the spiral side is distinct. On the other side the characteristic tuberculate umbilicus is preserved.

An X-ray diffraction analysis was made. The diffraction curve showed one peak at $2\,\theta = 26°15$, which is the main reflex of aragonite. No calcite reflection was found.

Discussion

Olsson (1960) recorded from the Maastrichtian of New Jersey under the name of *Lamarckina rugulosa* specimens which according to his illustration had a very small polished umbilical portion. Olsson's material most likely represents an early form of *L. rugulosa*, but is slightly different from specimens of *L. rugulosa* from Plummer's locality no. 23 present in the author's collection (pl. 30, figs 2 and 4).

In general the species is most commonly found in deposits belonging to the stratigraphical intervals represented by the two zones characterised respectively by *Globorotalia angulata* and *Globorotalia velascoensis*.

Pozaryska (1965, p. 116) wrote of its stratigraphical occurrence: "Never to be found in Danian. This species represents an excellent foraminiferal index species of Montian". Pozaryska & Szczechura (1968, p. 93) stated: "This species is a good index species for the Paleocene, Selandian type beds".

Several authors have drawn attention to the fact that foraminifera with tests of aragonite may easily recrystallize and disappear in limestones or in marls rich in calcite. This phenomenon does not only affect foraminifera, but all kinds of aragonitic fossils as e.g. gastropods.

This offers an explanation of the absence of the aragonitic *Lamarckina rugulosa* from Danian deposits in Scania, Poland, the Limburg area and Caucasus. In these areas the Danian deposits are developed as calcareous rocks.

The presence of *L. rugulosa* in the Maastrichtian of New Jersey and in the Danian of Nûgssuaq disproves the statements by Pozaryska and by Pozaryska & Szczechura.

Moreover, *L. rugulosa* is not found in the Selandian type beds.

Material: 1 specimen.

Occurrence

Maastrichtian-Paleocene in the Gulf Coastal area, USA; Middle Paleocene in Poland, Caucasus, Austria and Australia.

DANSK SAMMENDRAG

I afhandlingens første del beskrives kort en række lokaliteter (figs 1–2, 4), der demonstrerer relationen mellem Kangiliaformationen og den overliggende Agatdalformation. Skematiske fremstillinger af de målte profiler er vist som figs 3, 5–7, medens et skematisk korrelationsdiagram er vist som fig. 8. 57 af de 58 beskrevne foraminiferarter stammer fra Agatdalformationen fra den centrale del af Nûgssuaq. Faunaen er fremkommet ved nedknusning af fossile snegle, der hovedsageligt stammer fra Sonja-linsen. Bjergarten, der opbygger Sonja-linsen, er undersøgt i tyndsnit, og punkttællinger af disse viste, at bjergarten må klassificeres som en fossilførende subarkose.

En nylig fundet lokalitet, Marrait kitdlît, hvorfra nogle dårligt bevarede foraminiferer stammer, omtales kort.

I det efterfølgende afsnit diskuteres danien-stratigrafi baseret på planktoniske foraminiferer. Det konkluderes, at der næppe findes danienaflejringer beskrevet, som er ældre end de i Danmark forekommende. Langt de fleste af de beskrevne forekomster må henføres til øvre danien på grund af tilstedeværelsen af *Globigerina compressa* i disse aflejringer.

I den systematiske del af afhandlingen beskrives og afbildes 57 arter af foraminiferer fra Agatdalformationen samt en enkelt art fra Kangiliaformationen.

Den sidstnævnte form, *Cornuspiroides primigenia*, blev beskrevet af Ravn (1918) som den ældste repræsentant for heteropod slægten *Atlanta.*

Af de 57 arter fra Agatdalformationen er 8 beskrevet som nye. Formerne er klassificeret efter den af Loeblich & Tappan (1964) foreslåede systematik. Arterne fordeler sig med 8 agglutinerende, 2 porcelænsskallede, 44 kalcitisk hyaline samt 3 aragonitiske.

Slægten *Spiroplectammina* opfattes, efter Nørvang's emendation af slægten *Textularia*, som et synonym af denne.

I de tilfælde, hvor antallet af eksemplarer fra Grønland har været stort nok, er der på de enkelte arter foretaget biometriske undersøgelser hovedsagelig angående generationsfordelingen. I de fleste tilfælde har det grønlandske materiale talmæssigt været for ringe, hvorfor materiale af de samme arter fra danske, nedre tertiære lokaliteter er blevet benyttet.

Baseret på et materiale af 126 hele individer af *Nodosaria latejugata* fra Sundkrogen vises tilstedeværelsen af to generationer. Forholdet mellem skallængden og kammerantallet hos de to generationer kan benyttes til at sandsynliggøre, at de fragmentariske grønlandske individer stammer fra megalosfære eksemplarer. Proloculus synes at have flere ornamentale ribber end slutkammeret.

To nye arter af slægten *Lenticulina* kan bl. a. adskilles på grundlag af fordelingen af proloculus diameter i den megalosfære generation og i antallet af kamre i den yngste vinding.

Hos *Spirobolivina scanica* kan tilstedeværelsen af kun én generation påvises i de to undersøgte populationer, ligesom det kan vises, at KUSELEVA's (1964) megalo- og mikrosfære eksemplarer ligger i hver sin ende af den her viste fordeling, hvorfor de ikke kan anses for adskilte generationer.

Bulimina midwayensis er kun repræsenteret ved få individer fra Grønland, medens arten er hyppig i det danske paleocæn, hvorfor biometriske undersøgelser kunne foretages på populationer bestående af mere end 100 individer.

Ligesom hos *Nodosaria latejugata* er antallet af kamre i forhold til længde større hos den mikrosfære generation end hos den megalosfære. Totalantallet af kamre er ligeledes højere hos de mikrosfære former.

På grundlag af proloculus diameter fordelingen hos *Bulimina rosenkrantzi*, *Bulimina trigonalis* og *Bulimina thanetensis* kan det vises, at de to førstnævnte arter er veladskilte fra den sidstnævnte. *Bulimina rosenkrantzi* og *Bulimina trigonalis* er adskillelige i andre karakterer. HAYNES' (1956) og HOFKER's (1966) angivelser af de tre arters identitet kan således stærkt betvivles.

Bulimina rugifera er så godt repræsenteret i det grønlandske materiale, at der kan påvises to generationer.

Det kan ud fra proloculus diameter fordelingen vises, at de af BROTZEN (1948) angivne to generationer af *Praeglobobulimina ovata* ikke repræsenterer de to generationer af denne art, men må tilhøre hver sin art.

Asterigerina norvangi vises at være identisk med *Asterigerina primaria*, som antydet af TROELSEN (1954).

Det vises ved hjælp af scanning elektronmikroskopi, transmissions elektronmikroskopi og lysmikroskopi, at *Globigerina triloculinoides*, der er typeart for slægten *Subbotina*, må betragtes som veladskilt fra slægten *Globigerina* ved at mangle de af BROTZEN & POZARYSKA (1961) angivne pigge og pigbaser. Slægten *Subbotina* må derfor opretholdes. En lignende vægstruktur er fundet hos *Globigerina pseudobulloides*, som derfor også henføres til slægten *Subbotina*.

Baseret på studiet af paratyper af *Pallaimorphina ruckerae* kan det konstateres, at slægten *Pallaimorphina* ikke kan være identisk med slægten *Quadrimorphina* som angivet af LOEBLICH & TAPPAN (1964). Det konstateres endvidere, at slægten *Allomorphina* (sensu LOEBLICH & TAPPAN, 1964) er inhomogen, men at forfatterens materiale er for begrænset til at tillade en revision af slægten.

Hos arten *Pallaimorphina minuta* n. sp. kan påvises både en mikrosfær og megalosfær generation.

Hos arten *Alabamina rosenkrantzi* n. sp. er fundet en sekundær, delvis tillukning af foramina. Dette er ikke tidligere påvist inden for slægten *Alabamina*. Det konstateres derudover, at de danske nedre tertiære former af slægten *Alabamina* ligesom *Alabamina rosenkrantzi* n. sp. viser overvejende venstresnoning.

Den gruppe af granulate arter, der hidtil i litteraturen har været anført under slægtsnavnet *Eponides*, f. eks. *Eponides lunata*, henføres til en ny slægt *Paralabamina*. Slægten placeres i familien Alabaminidae.

Slægten *Gyroidina* og *Gyroidinoides* vises at være veladskilte også hvad angår aperturale karakterer. Slægten *Gyroidina*, som beskrevet af LOEBLICH & TAPPAN (1964), er baseret på en forkert typeart, idet disse forfattere har beskrevet "*Gyroidina*" *soldanii* i stedet for *Gyroidina orbicularis*. Gruppen af arter, der morfologisk knytter sig til "*Gyroidina*" *soldanii*, kan ikke henføres til nogen eksisterende slægt. Aperturkaraktererne adskiller imidlertid denne gruppe af arter fra både slægten *Gyroidina* og *Gyroidinoides*.

Slægten *Gyroidinoides* må henføres til familien Anomalinidae, da den har granulat vægstruktur samt bilamellære septer. Den kan ikke opretholdes inden for familien Osangulariidae, da den ikke besidder en "murus reflectus".

Gyroidinoides octocamerata fra Grønland må henføres til slægten *Gyroidinoides* og ikke som tidligere til *Gyroidina*. I et materiale af *Gyroidinoides octocamerata* fra Vestre Gasværk synes det muligt at adskille to generationer, selvom det målte materiale er for lille til at tillade slutninger angående generationsforskelle. 17 målte eksemplarer fra Grønland synes alle at tilhøre den megalosfære generation.

I en population af *Gavelinella danica* på 110 individer fra Basballe i Jylland er der fundet to generationer repræsenteret. Ud fra undersøgelser i transmissions elektronmikroskop kan det konstateres, at den af HOFKER anførte evolutionsmæssige udvikling af porediameteren hos *Gavelinella danica* ikke kan bekræftes. Periferien hos udviklingsrækken gående fra *Gavelinella danica* til *Gavelinella grosserugosa* viser en jævnt tiltagende afrunding.

Ud fra artssammensætningen kan det konstateres, at foraminiferfaunaen viser større affinitet til europæiske faunaer end til amerikanske. Faunaens alder må på grundlag af planktoniske former ansættes til øvre danien.

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Færdig fra trykkeriet den 14. december 1970.

PLATES

Plate 1

Fig. 1. Thin section of the Sonja lens showing mainly quartz grains and centrally the wall of a gastropod shell. 1 nicol. 2 ×.

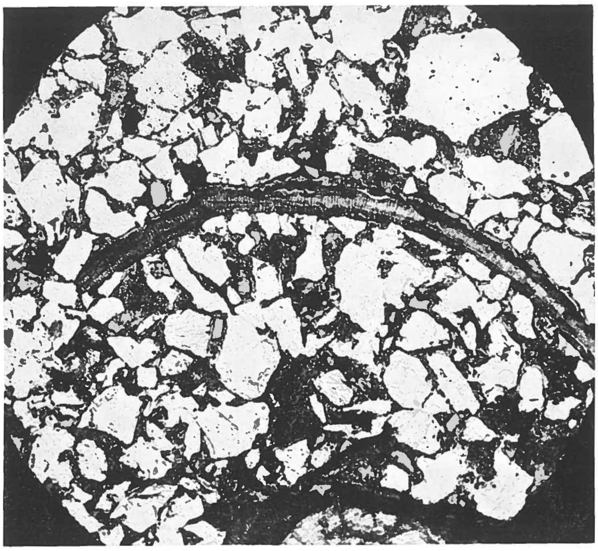
Fig. 2. *Textilina plummerae* (LALICKER, 1935). Thin section. Crossed nicols. 110 ×.

Fig. 3. *Sigmomorphina wilcoxensis* CUSHMAN & PONTON, 1932. X-ray micrograph. 120 ×. MMH 10653.

Fig. 4. *Bulimina trigonalis* DAM, 1944. Axial section of specimen from the Selandian Kerteminde Marl. 200 ×.

Fig. 5. *Bulimina rosenkrantzi* BROTZEN, 1948. Axial thin section of specimen from Vestre Gasværk (Lower Selandian). 200 ×.

Fig. 6. *Subbotina triloculinoides* (PLUMMER, 1926). Thin section of specimen from the Midway Formation, Texas (PLUMMER's locality no. 23). 1000 ×.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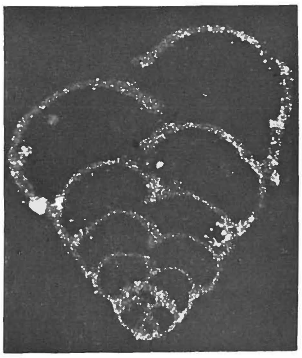
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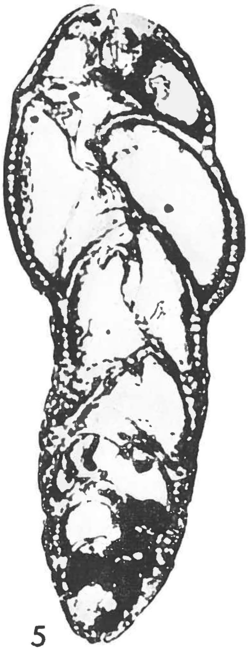
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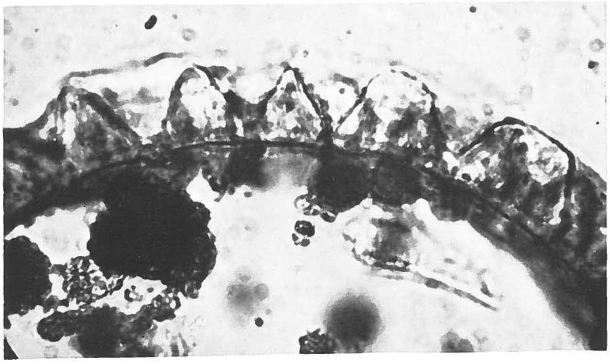
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Plate 2

Fig. 1. *Glomospira* sp. 210×. MMH 10610.

Figs 2–3. *Trochammina* sp. 2. MMH 10667.
    Fig. 2. Spiral view. 118×.
    Fig. 3. Umbilical view. 118×.

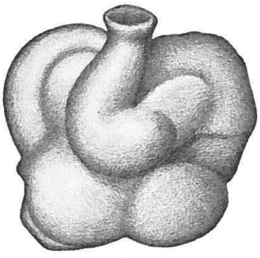
Fig. 4. *Haplophragmoides sewellensis* OLSSON, 1960. Side view. 91×. MMH 10615.

Figs 5–6. *Trochammina* sp. 1. MMH 10666.
    Fig. 5. Spiral view. 176×.
    Fig. 6. Umbilical view. 176×.

Figs 7–8. *Textularia wilcoxensis* (CUSHMAN & PONTON, 1932). MMH 10665.
    Fig. 7. End view. 58×.
    Fig. 8. Side view. 58×.

Figs 9–10. *Textilina plummerae* (LALICKER, 1935). MMH 10664.
    Fig. 9. End view. 66×.
    Fig. 10. Side view. 66×.

Figs 11–12. *Gaudryina geometrica* HOWE, 1939. MMH 10608.
    Fig. 11. End view. 100×.
    Fig. 12. Side view. 100×.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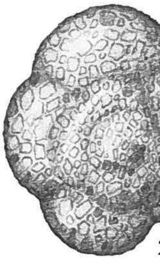
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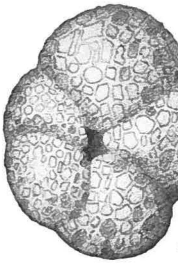
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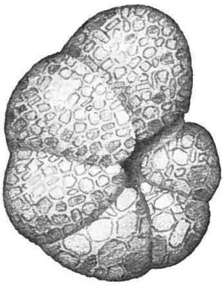
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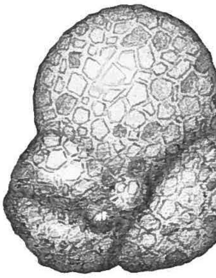
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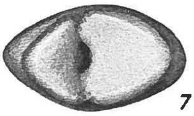
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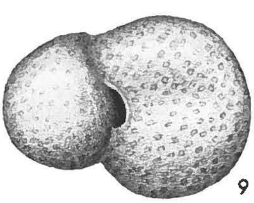
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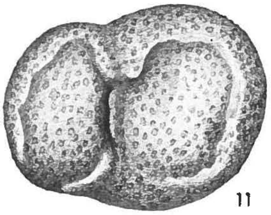
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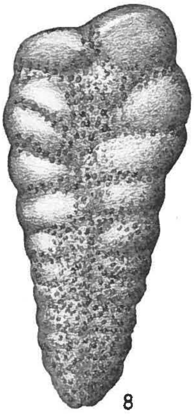
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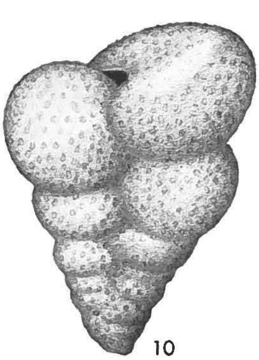
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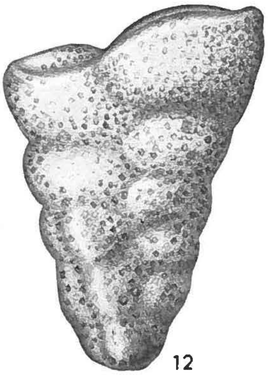
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Plate 3

Fig. 1. *Reophax* sp. Side view. 86 ×. MMH 10645.

Figs 2–3. *Nodosaria latejugata* GÜMBEL, 1868.
  Fig. 2. Side view. 22 ×. MMH 10629.
  Fig. 3. Side view. 22 ×. MMH 10628.

Figs 4–5. *Quinqueloculina naheolensis* CUSHMAN, 1947. MMH 10642.
  Fig. 4. Side view. 153 ×.
  Fig. 5. Side view. 153 ×.

Figs 6–7. *Quinqueloculina plummerae* CUSHMAN & TODD, 1942. MMH 10644.
  Fig. 6. Side view. 80 ×.
  Fig. 7. Side view showing apertural tooth. 80 ×.

Figs 8–9. *Lankesterina* sp. MMH 10623.
  Fig. 8. End view. 106 ×.
  Fig. 9. Side view. 106 ×.

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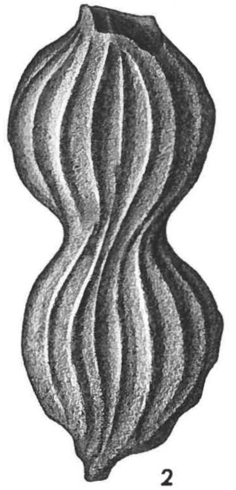

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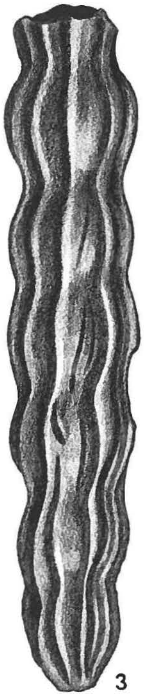

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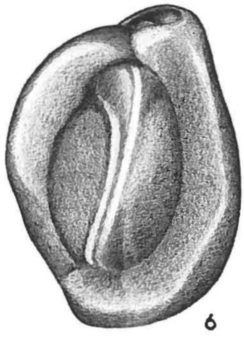

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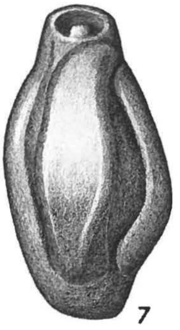

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Plate 4

Fig. 1. *Cornuspiroides primigenia* (RAVN, 1918). Lower Danian from Alianaitsúnguaq, south coast of Nûgssuaq. Holotype MMH 1737. 40 ×.

Fig. 2. *Cornuspiroides primigenia* (RAVN, 1918). Lower Tertiary, Spitsbergen. Specimen deposited in Bonn. 20 ×.

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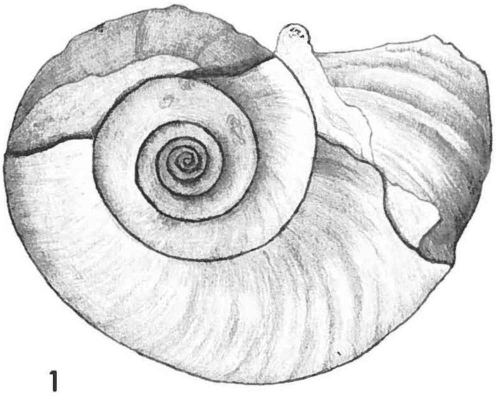

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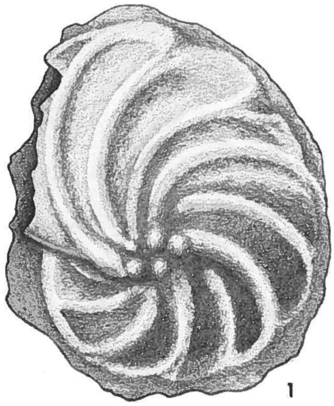
Plate 5

Figs 1–2. *Lenticulina centrotuberculata* n. sp. Holotype. MMH 10626.
    Fig. 1. Side view. 24 ×.
    Fig. 2. Apertural view. 24 ×.

Fig. 3. *Lenticulina macrocentra* n. sp. Paratype. Apertural view. 24 ×. MMH 10625.

Figs 4–5. *Lenticulina macrocentra* n. sp. MMH 10624. Holotype.
    Fig. 4. Side view. 24 ×.
    Fig. 5. Apertural view. 24 ×.

Figs 6–7. *Lenticulina klagshamnensis* (BROTZEN, 1948). MMH 10627.
    Fig. 6. Side view. 24 ×.
    Fig. 7. Apertural view. 24 ×.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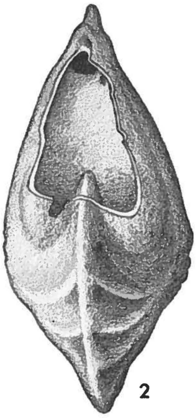
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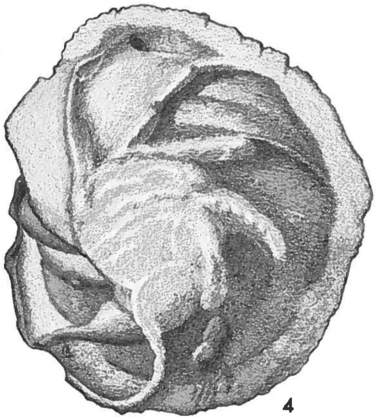
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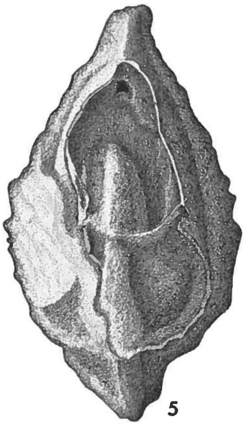
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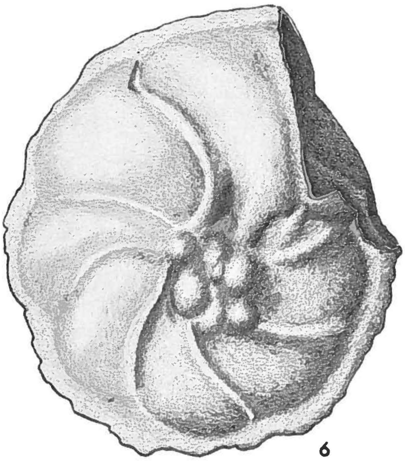
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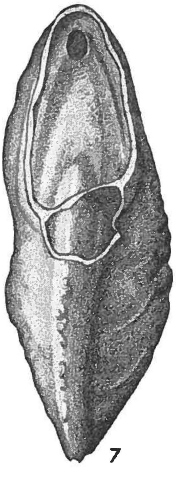
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Plate 6

Fig. 1. *Oolina* sp. Side view. 200×. MMH 10619.

Fig. 2. *Lagena* aff. *apiopleura* LOEBLICH & TAPPAN, 1953. Side view. 160×. MMH 10620.

Fig. 3. *Lagena* sp. Side view. 200×. MMH 10621.

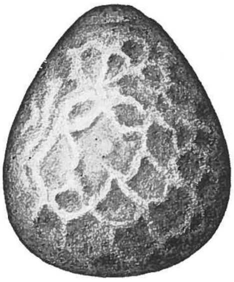
Figs 4–5. *Amphimorphina* sp. MMH 10588.
  Fig. 4. Apertural view. 89×.
  Fig. 5. Side view. 89×.

Figs 6–7. *Guttulina communis* D'ORBIGNY, 1826. MMH 10614.
  Fig. 6. Apertural view. 90×.
  Fig. 7. Side view. 90×.

Fig. 8. *Sigmomorphina wilcoxensis* CUSHMAN & PONTON, 1932. Side view. 52×. MMH 10654.

Figs 9–10. *Sigmomorphina wilcoxensis* CUSHMAN & PONTON, 1932. MMH 10655.
  Fig. 9. Side view. 103×.
  Fig. 10. Side view. 103×.

Figs 11–12. *Sigmomorphina wilcoxensis* CUSHMAN & PONTON, 1932. MMH 10653.
  Fig. 11. Side view. 70×.
  Fig. 12. Side view. 70×.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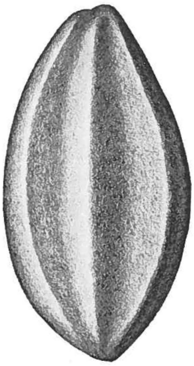
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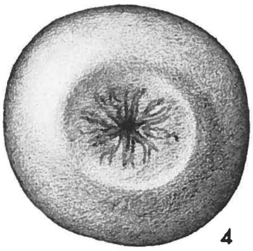
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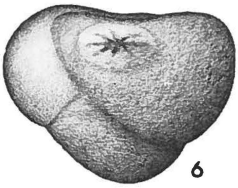
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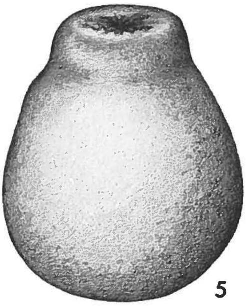
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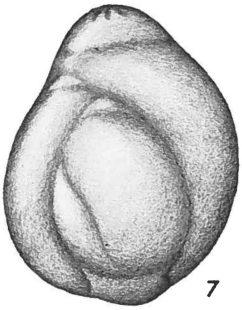
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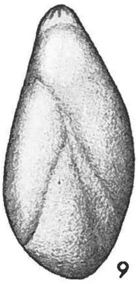
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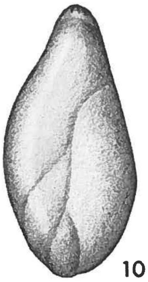
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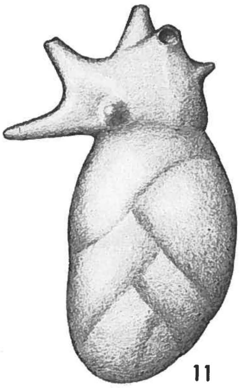
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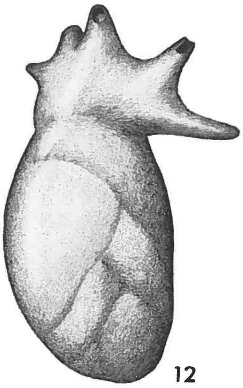
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Plate 7

Fig. 1. *Bulimina midwayensis* Cushman & Parker, 1936. Side view. 242 ×. MMH 10590.

Fig. 2. *Bulimina midwayensis* Cushman & Parker, 1936. Side view. 242 ×. MMH 10591.

Figs 3–4. *Bulimina rugifera* Glaessner, 1937. MMH 10593.
  Fig. 3. End view. 94 ×.
  Fig. 4. Side view. 94 ×.

Fig. 5. *Fissurina prolongata* n. sp. Paratype. Opened specimen showing internal tubus. 146 ×. MMH 10602.

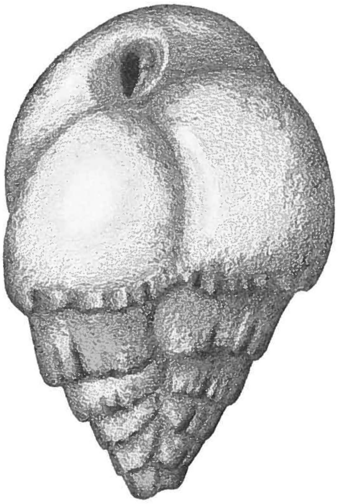
Figs 6–7. *Fissurina prolongata* n. sp. Holotype. MMH 10601.
  Fig. 6. Apertural view. 146 ×.
  Fig. 7. Side view. 146 ×.

Fig. 8. *Fissurina sonjae* n. sp. Paratype. Opened specimen showing internal tubus. 154 ×. MMH 10604.

Figs 9–10. *Fissurina sonjae* n. sp. Holotype. MMH 10603.
  Fig. 9. Apertural view. 154 ×.
  Fig. 10. Side view. 154 ×.

Fig. 11. *Fissurina* sp. Opened specimen showing internal tubus. 141 ×. MMH 10606.

Figs 12–13. *Fissurina* sp. MMH 10605.
  Fig. 12. Apertural view. 141 ×.
  Fig. 13. Side view. 141 ×.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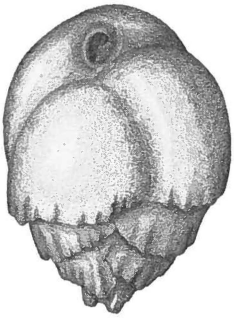
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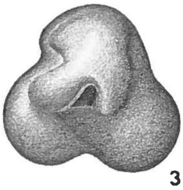
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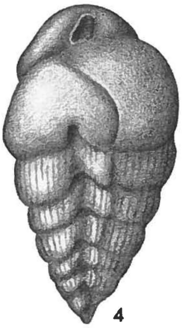
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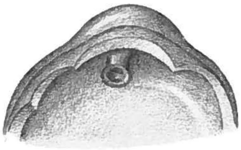
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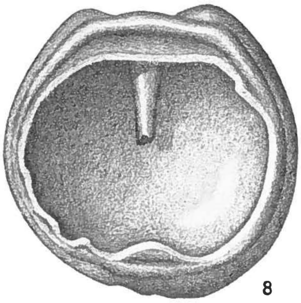
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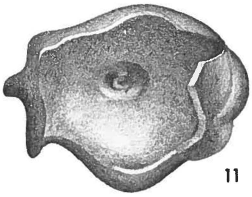
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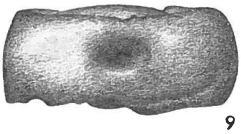
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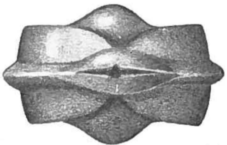
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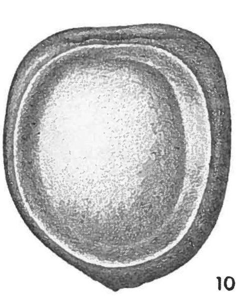
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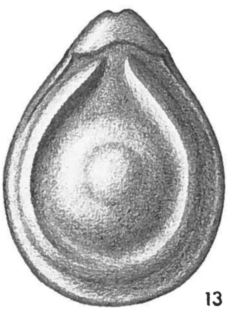
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Plate 8

Figs 1–2. *Spirobolivina scanica* (Brotzen, 1948). MMH 10659.
  Fig. 1. Apertural view. 222 ×.
  Fig. 2. Side view. 222 ×.

Figs 3–4. *Chiloguembelina crinita* (Glaessner, 1937). MMH 10598.
  Fig. 3. Side view. 278 ×.
  Fig. 4. Oblique apertural view. 278 ×.

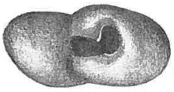
Fig. 5. *Bulimina rosenkrantzi* Brotzen, 1948. Side view. 157 ×. MMH 10592.

Fig. 6. *Praeglobobulimina ovata* (d'Orbigny, 1846). Side view. 151 ×. MMH 10634.

Fig. 7. *? Siphogerinoides* sp. Side view. 99 ×. MMH 10656.

Fig. 8. *Spirillina ? recta* Brotzen, 1940. Side view. 220 ×. MMH 10658.

Figs 9–11. *Rosalina elegans* n. sp. Holotype. MMH 10648.
  Fig. 9. Spiral view. 111 ×.
  Fig. 10. Peripheral view. 111 ×.
  Fig. 11. Umbilical view. 111 ×.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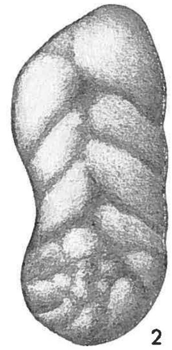
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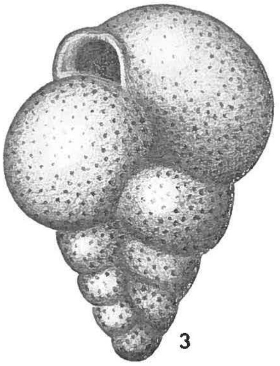
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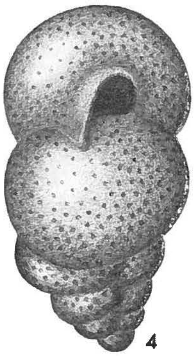
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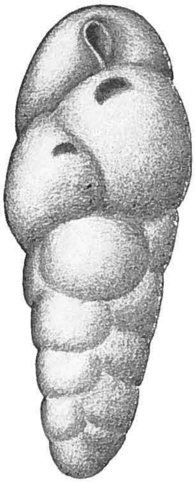
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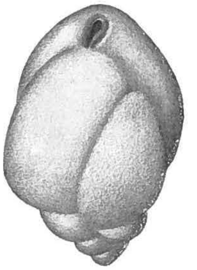
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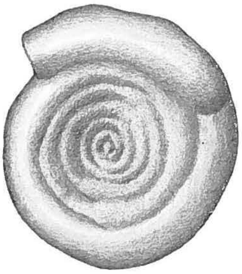
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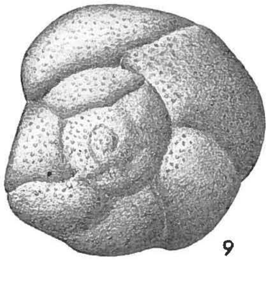
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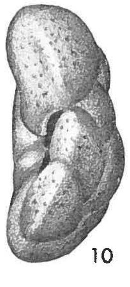
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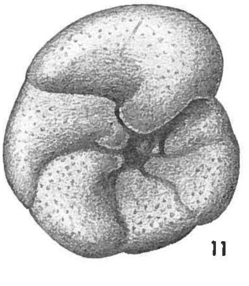
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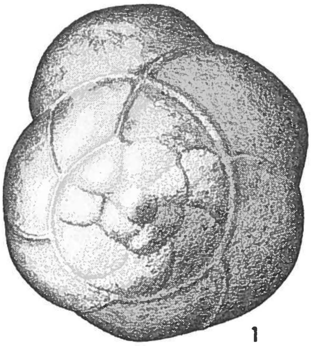
Plate 9

Figs 1–3. *Asterigerina primaria* PLUMMER, 1926. MMH 10589.
  Fig. 1. Spiral view. 196 ×.
  Fig. 2. Peripheral view. 196 ×.
  Fig. 3. Umbilical view. 196 ×.

Figs 4–6. *Pararotalia tuberculifera* (REUSS, 1862). MMH 10641.
  Fig. 4. Spiral view. 102 ×.
  Fig. 5. Peripheral view. 102 ×.
  Fig. 6. Umbilical view. 102 ×.

Figs 7–9. *Cibicides ekblomi* BROTZEN, 1948. MMH 10599.
  Fig. 7. Umbonal side. 145 ×.
  Fig. 8. Peripheral view. 145 ×.
  Fig. 9. Apertural side. 145 ×.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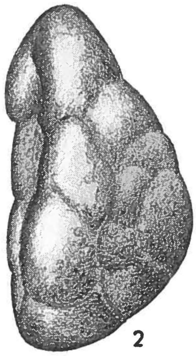
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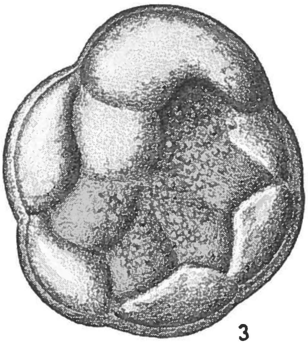
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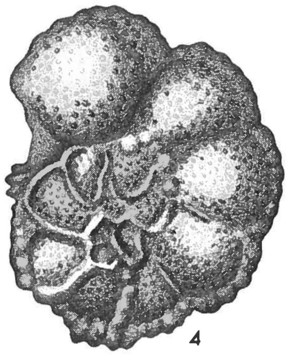
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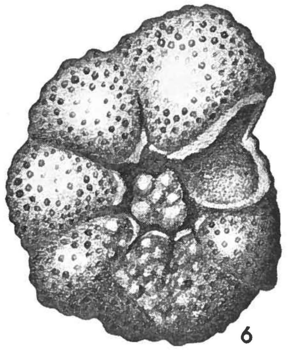
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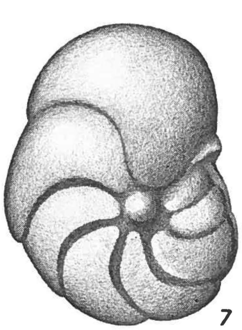
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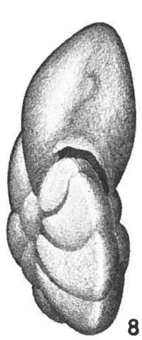
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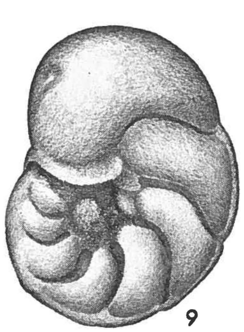
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Plate 10

Figs 1–3. *Globoconusa daubjergensis* (BRÖNNIMANN, 1953). MMH 10612.

Fig. 1. Spiral view. 200×.
Fig. 2. Side view. 200×.
Fig. 3. Umbilical view. 200×.

Figs 4–6. *Subbotina triloculinoides* (PLUMMER, 1926). MMH 10663.

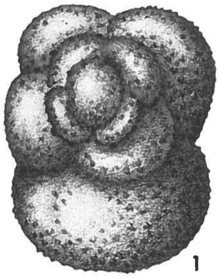
Fig 4 Spiral view 150×
Fig 5. Side view. 150×.
Fig. 6. Umbilical view. 150×.

Figs 7–9. *Subbotina pseudobulloides* (PLUMMER, 1926). MMH 10662.

Fig. 7. Spiral view. 150×.
Fig. 8. Side view. 150×.
Fig. 9. Umbilical view. 150×.

Figs 10–12. *Pallaimorphina minuta* n. sp. Holotype. MMH 10637.

Fig. 10. Spiral view. 150×.
Fig. 11. Side view. 150×.
Fig. 12. Umbilical view. 150×.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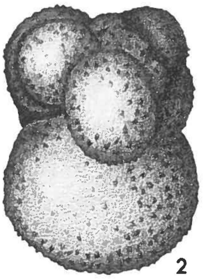
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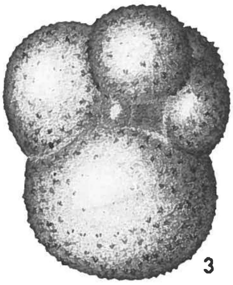
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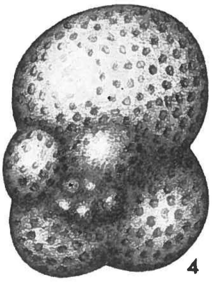
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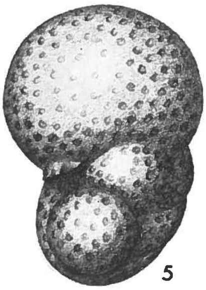
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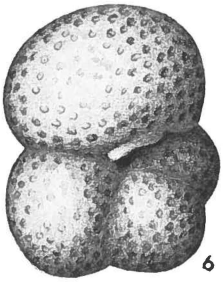
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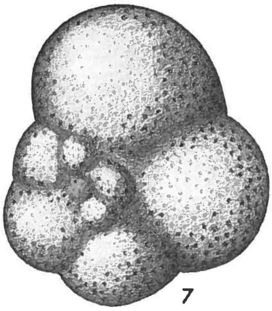
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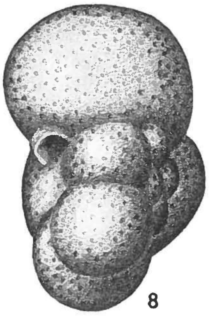
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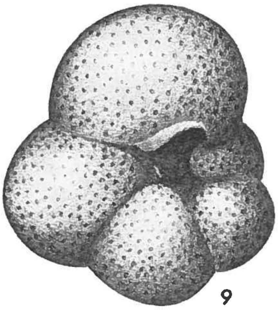
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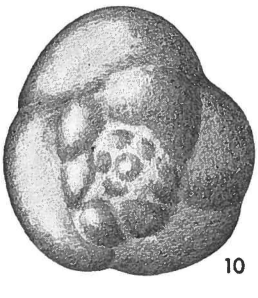
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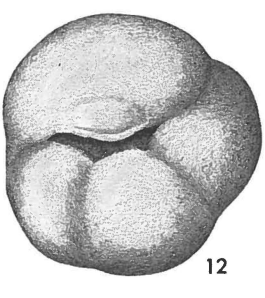
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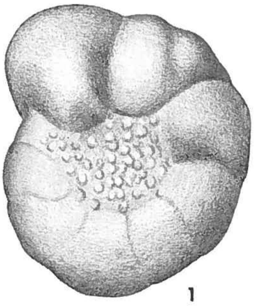
Plate 11

Figs. 1–2. *Nonion graniferum* (TERQUEM, 1882). MMH 10630.
  Fig. 1. Side view. 155 ×.
  Fig. 2. Apertural view. 155 ×.

Fig. 3. "*Allomorphina*" *paleocenica* CUSHMAN, 1948. Apertural view. 170 ×. MMH 10583.

Figs 4–5. *Alabamina rosenkrantzi* n. sp. Paratype. MMH 10582.
  Fig. 4. Opened specimen showing secondary deposits in foramen. 88 ×.
  Fig. 5. Specimen showing indentation and secondary deposits in foramen. 88 ×.

Figs 6–8. *Alabamina rosenkrantzi* n. sp. Holotype. MMH 10581.
  Fig. 6. Apertural view. 88 ×.
  Fig. 7. Umbilical view. 88 ×.
  Fig. 8. Spiral view. 88 ×.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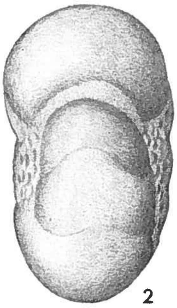
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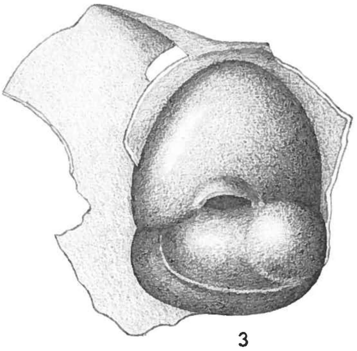
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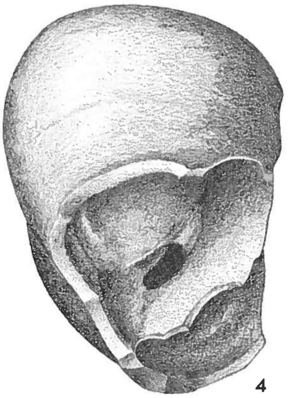
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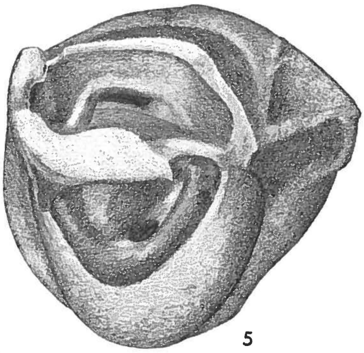
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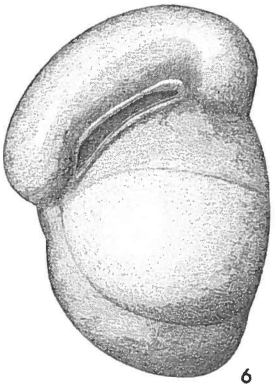
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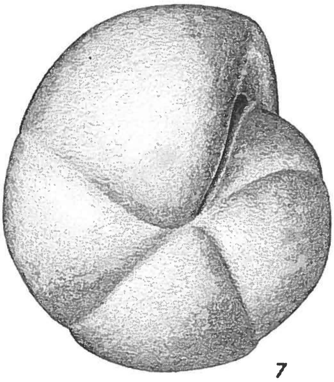
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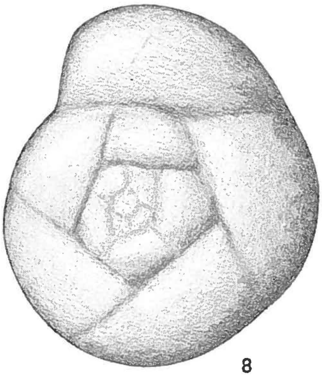
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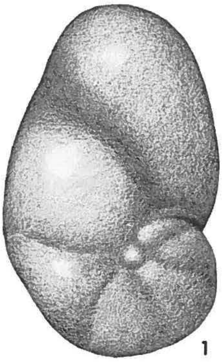
Plate 12

Figs 1–3. *Nonionella ovata* BROTZEN, 1948. MMH 10632.
- Fig. 1. Spiral view. 260×.
- Fig. 2. Apertural view. 260×.
- Fig. 3. Umbilical view. 260×.

Figs 4–6. *Anomalinoides howelli* (TOULMIN, 1941). MMH 10585.
- Fig. 4. Umbonal view. 95×.
- Fig. 5. Apertural view. 95×.
- Fig. 6. Spiral view. 95×.

Figs 7–9. *Anomalinoides howelli* (TOULMIN, 1941). MMH 10586.
- Fig. 7. Umbonal view. 95×.
- Fig. 8. Apertural view. 95×.
- Fig. 9. Spiral view. 95×.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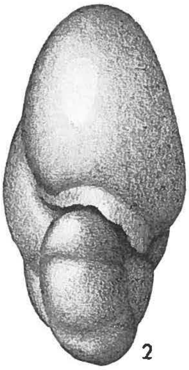
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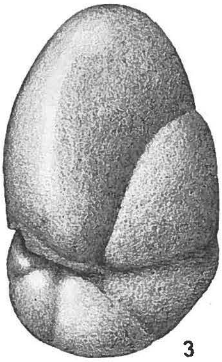
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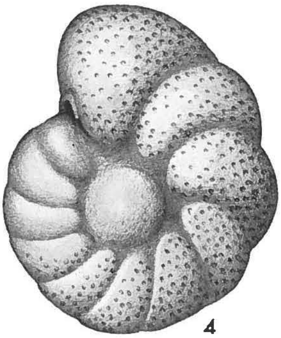
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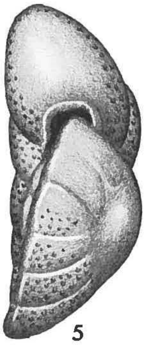
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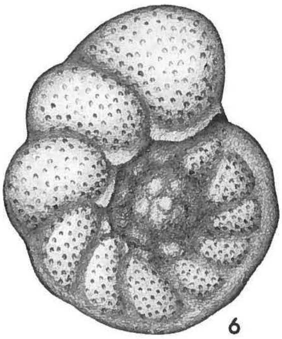
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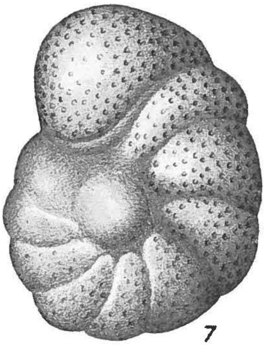
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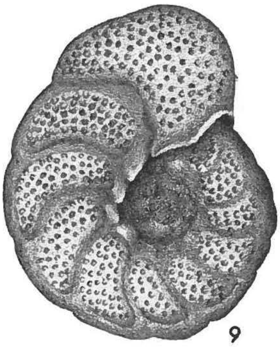
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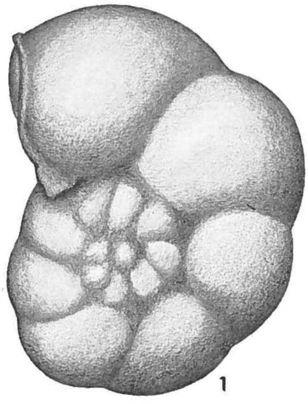
Plate 13

Figs 1–3. *Gyroidinoides octocamerata* (Cushman & Hanna, 1927). MMH 10611.
- Fig. 1. Spiral view. 175 ×.
- Fig. 2. Peripheral view. 175 ×.
- Fig. 3. Umbilical view. 175 ×.

Figs 4–6. *Gavelinella danica* (Brotzen, 1940). MMH 10609.
- Fig. 4. Umbilical view. 65 ×.
- Fig. 5. Peripheral view. 65 ×.
- Fig. 6. Spiral view. 65 ×.

Figs 7–9. *Karreria* sp. MMH 10617.
- Fig. 7. Umbilical view. 100 ×.
- Fig. 8. Peripheral view. 100 ×.
- Fig. 9. Spiral view. 100 ×.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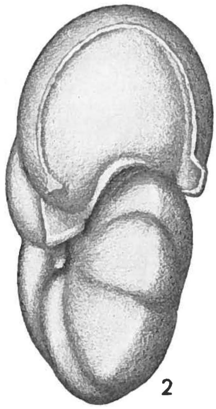
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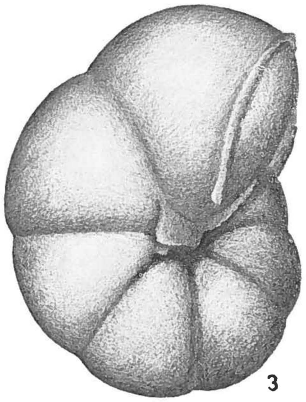
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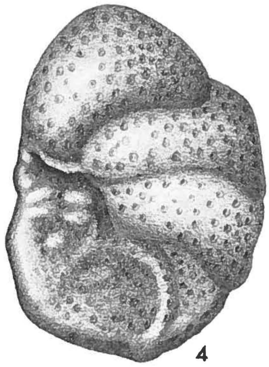
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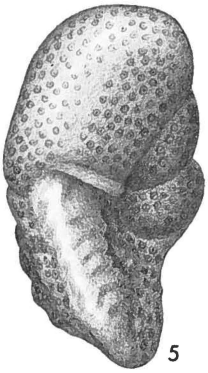
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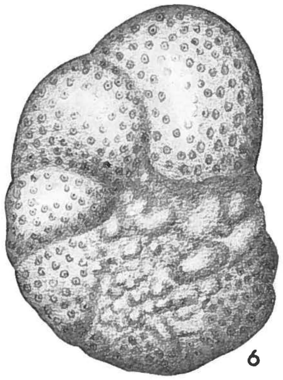
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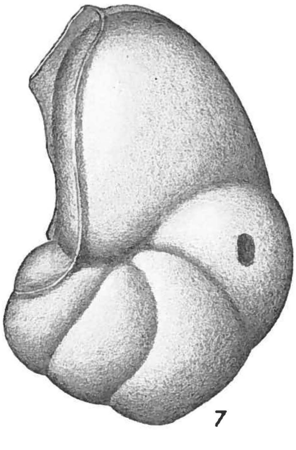
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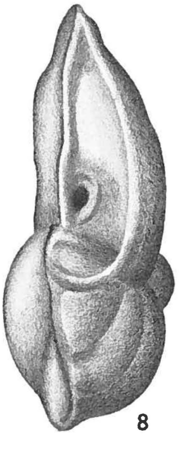
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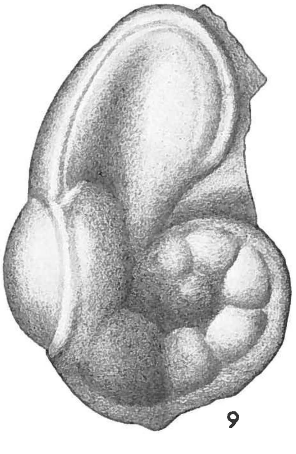
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Plate 14

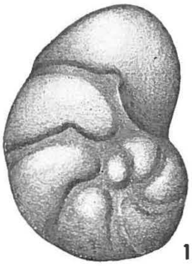
Figs 1–2. *Ceratobulimina* (*Ceratobulimina*) *perplexa* (PLUMMER, 1926). MMH 10597.
- Fig. 1. Spiral view. 150 ×.
- Fig. 2. Umbilical view. 150 ×.

Figs 3–4. *Stainforthia* sp.
- Fig. 3. Side view. 150 ×.
- Fig. 4. Apertural view. 150 ×.

Figs 5–7. *Paralabamina lunata* (BROTZEN, 1948). MMH 10635.
- Fig. 5. Spiral view. 140 ×.
- Fig. 6. Peripheral view. 140 ×.
- Fig. 7. Umbilical view. 140 ×.

Figs 8–10. *Melonis nobilis* (BROTZEN, 1948). MMH 10584.
- Fig. 8. Umbilical view. 140 ×.
- Fig. 9. Peripheral view. 140 ×.
- Fig. 10. Umbilical view. 140 ×.

Figs 11–13. *Ceratobulimina* (*Ceratolamarckina*) *troelseni* n. sp. Holotype. MMH 10596.
- Fig. 11. Spiral view. 170 ×.
- Fig. 12. Opened penultimate chamber showing tooth-plate connecting two foramina. 170 ×.
- Fig. 13. Umbilical view showing tooth-plate and papillate umbilicus. 170 ×.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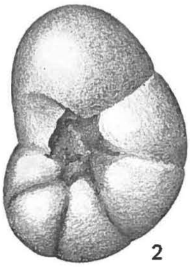
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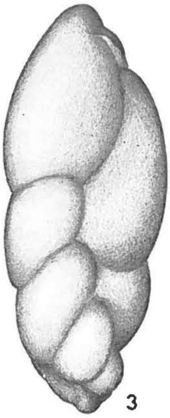
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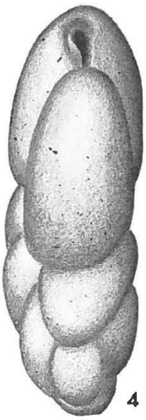
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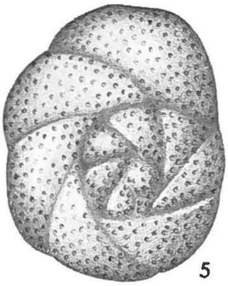
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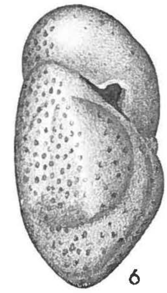
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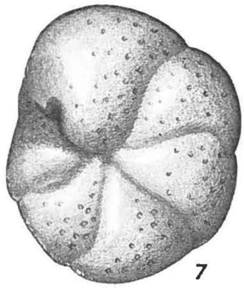
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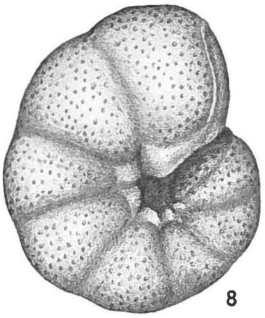
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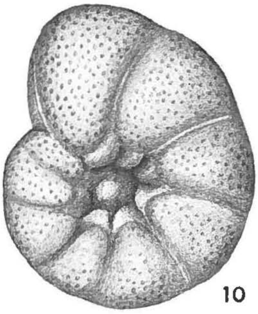
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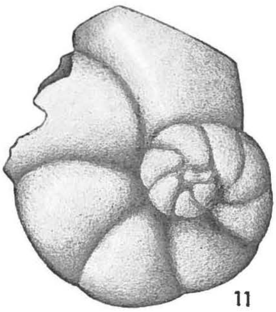
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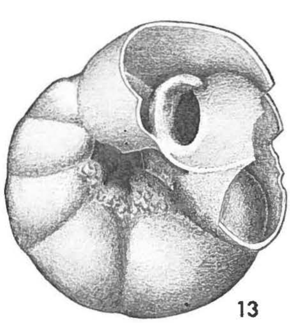
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Plate 15

Fig. 1. *Textilina plummerae* (LALICKER, 1935). Detail showing pores. 1000 ×. MMH 10664.

Fig. 2. *Quinqueloculina plummerae* CUSHMAN & TODD, 1942. Side view showing apertural tooth and truncate periphery. 99 ×. MMH 10643.

Fig. 3. *Haplophragmoides sewellensis* OLSSON, 1960. Oblique side view. 202 ×. MMH 10616.

Fig. 4. *Trochammina* sp. 2. Spiral view. 202 ×. MMH 10667.

Fig. 5. *Lankesterina* sp. Oblique view showing radial aperture and truncate periphery. 192 ×. MMH 10623.

Fig. 6. *Oolina* sp. Oblique side view. 270 ×. MMH 10619.

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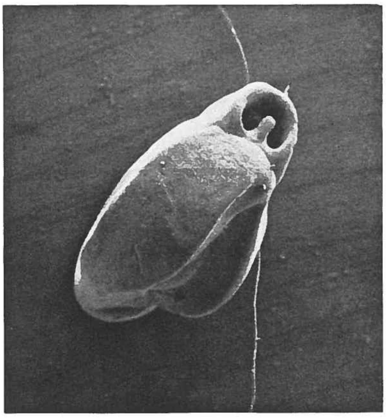

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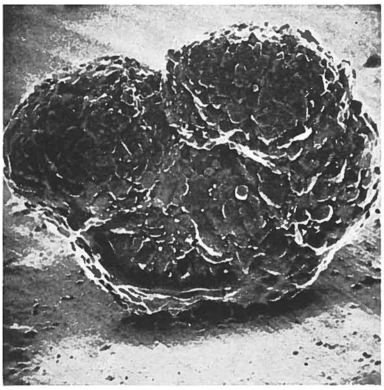

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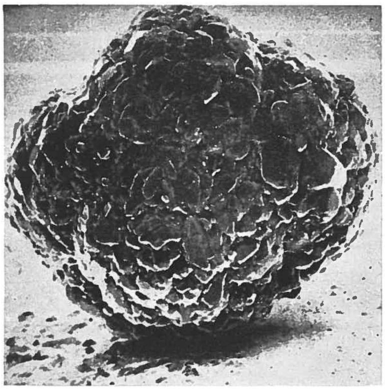

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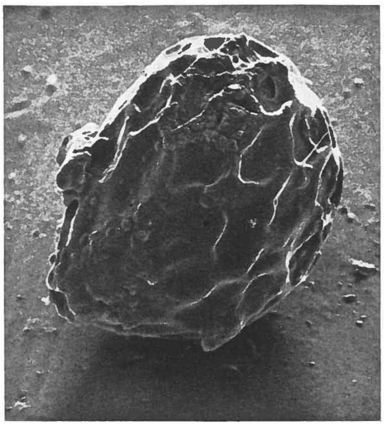

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Plate 16

Fig. 1. *Amphimorphina* sp. Oblique apertural view. 240 ×. MMH 10588.

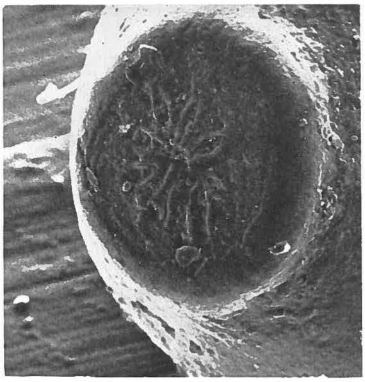
Fig. 2. *Fissurina prolongata* n. sp. Opened specimen showing internal tubus. The grains inside the chamber are composed of pyrite. 256 ×. MMH 10602.

Fig. 3. *Fissurina sonjae* n. sp. Opened specimen showing internal tubus. Note the broken part of tubus in the upper left part of chamber. 213 ×. MMH 10604.

Fig. 4. *Fissurina sonjae* n. sp. Oblique apertural view. Aperture slightly obscured by excess of mounting medium. 224 ×. MMH 10603.

Fig. 5. *Fissurina* sp. Oblique side view. 213 ×. MMH 10607.

Fig. 6. *Fissurina* sp. Opened specimen showing remnants of small interior tubus. 213 ×. MMH 10606.



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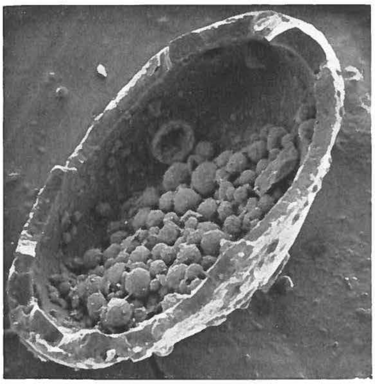

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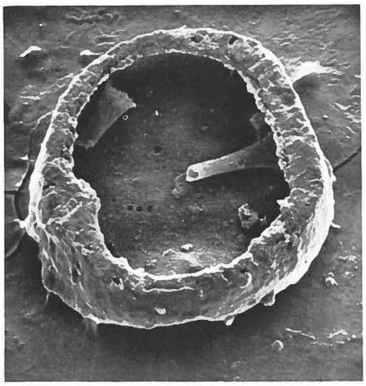

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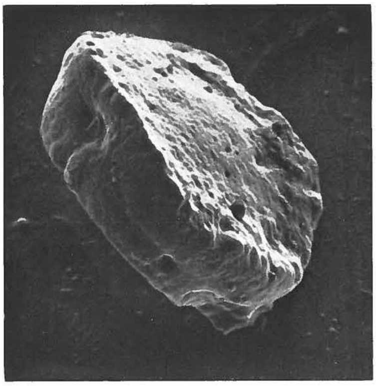

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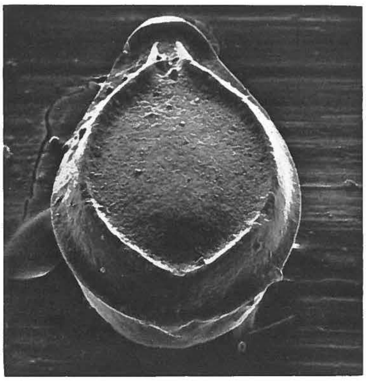

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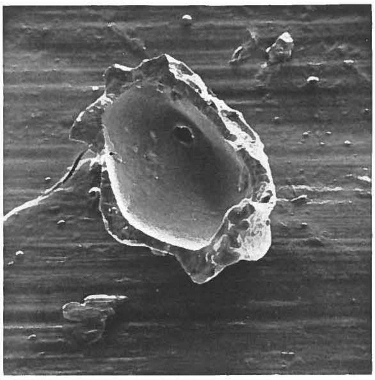

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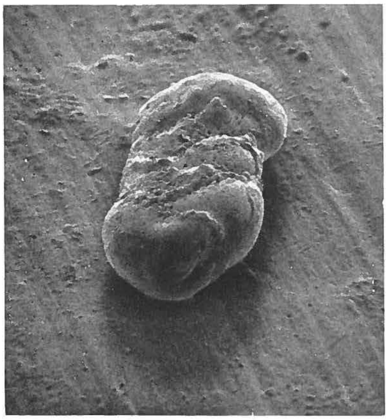
Plate 17

Figs 1–3. *Spirobolivina scanica* (BROTZEN, 1948). MMH 10660.

- Fig. 1. Oblique view of specimen showing exfoliation of secondary lamels. 258 ×.
- Fig. 2. Surface of penultimate chamber. 2340 ×.
- Fig. 3. Surface of penultimate chamber showing rounded ends of radiating calcite crystal units in the wall. 23400 ×.

Figs 4–6. *Spirobolivina scanica* (BROTZEN, 1948). MMH 10661.

- Fig. 4. Opened specimen showing position of the tooth-plates. 261 ×.
- Fig. 5. Alternating position of the tooth-plates. 870 ×.
- Fig. 6. Tooth-plates. 804 ×.



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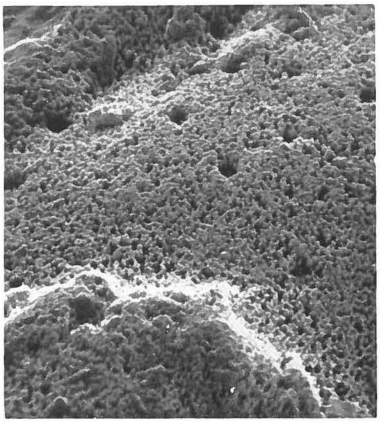

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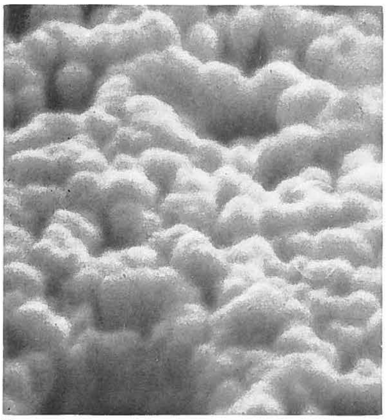

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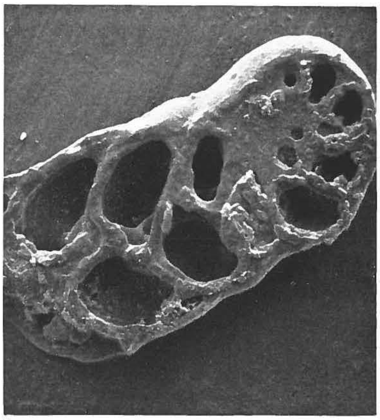

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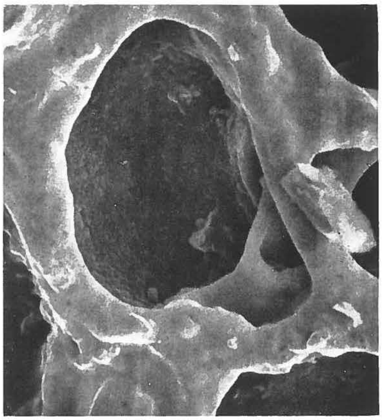

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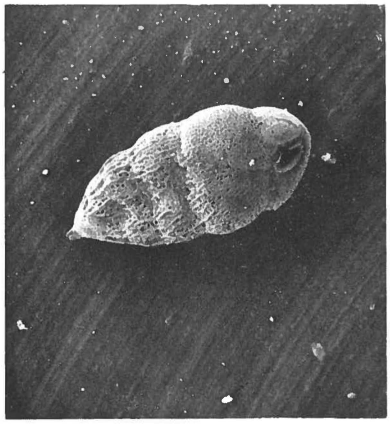
Plate 18

Figs 1–2. *Bulimina rugifera* GLAESSNER, 1937. MMH 10594.
  Fig. 1. Side view of megalospheric specimen. 95 ×.
  Fig. 2. Detail showing aperture. 756 ×.

Figs 3–4. *Bulimina rugifera* GLAESSNER, 1937. MMH 10595.
  Fig. 3. Opened specimen showing tooth-plate. 252 ×.
  Fig. 4. Detail showing test surface. 900 ×.

Figs 5–6. *Bulimina midwayensis* CUSHMAN & PARKER, 1936. Upper Maastrichtian Kjølby Gaard Marl. "Dania", Jylland.
  Fig. 5. Side view of opened specimen. 110 ×.
  Fig. 6. Detail showing tooth-plate. 330 ×.



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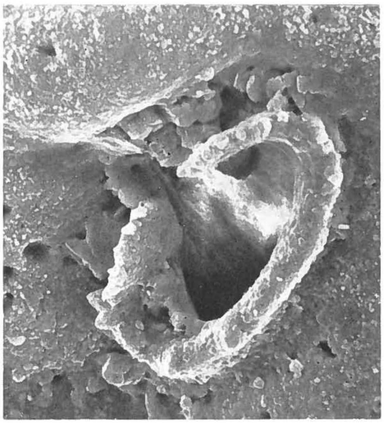

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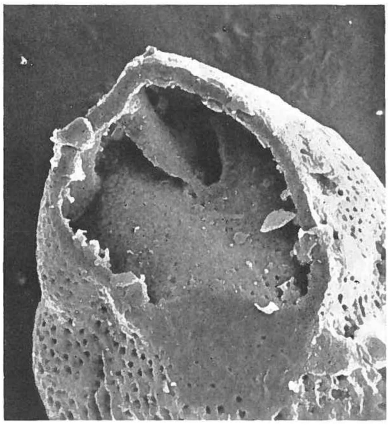

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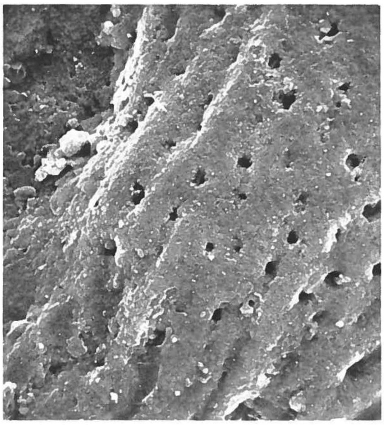

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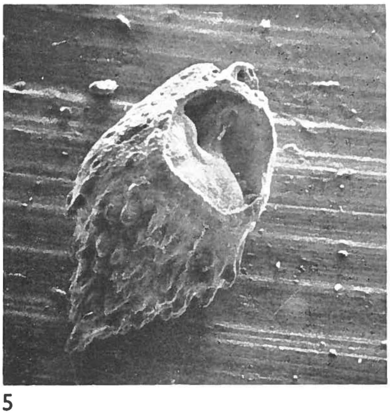

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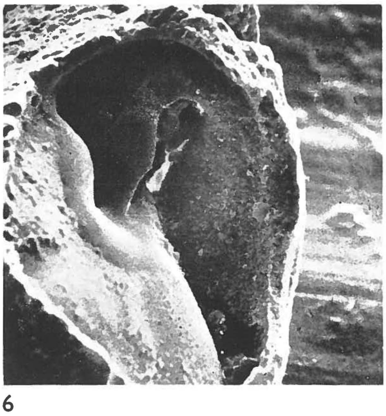

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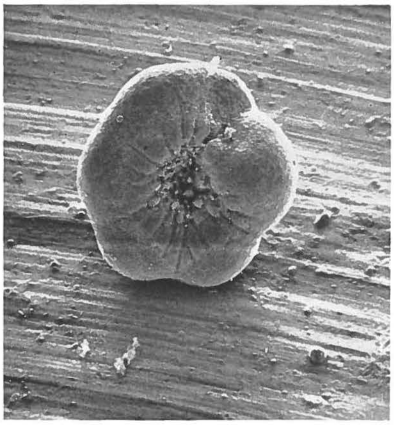
Plate 19

Figs 1–2. *Rosalina ystadiensis* BROTZEN, 1948. MMH 10646.
  Fig. 1. Umbilical view. 228 ×.
  Fig. 2. Detail showing umbilicus. 756 ×.

Fig. 3. *Rosalina ystadiensis* BROTZEN, 1948. MMH 10647. Oblique view of spiral side. 318 ×.

Fig. 4. *Asterigerina primaria* PLUMMER, 1926. MMH 10589. Oblique view of umbilical side. 272 ×.

Figs 5–6. *Spirillina striatogranulosa* TERQUEM, 1882. MMH 10657.
  Fig. 5. Grooved side. 272 ×.
  Fig. 6. Tuberculate side. 255 ×.



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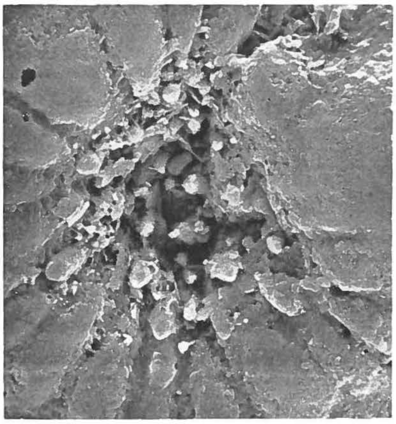

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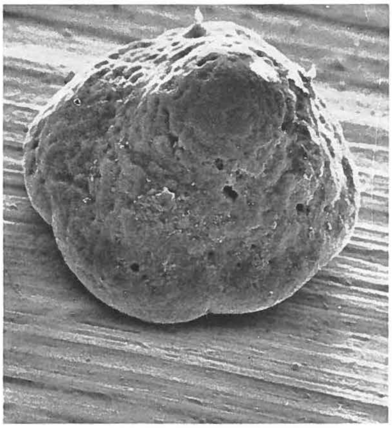

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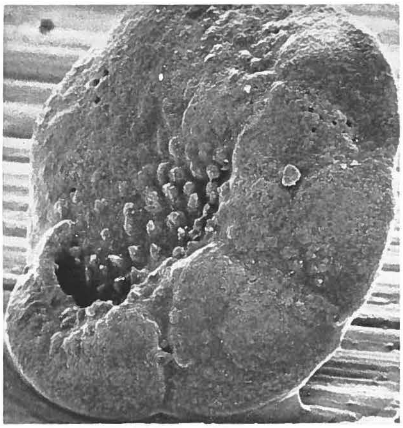

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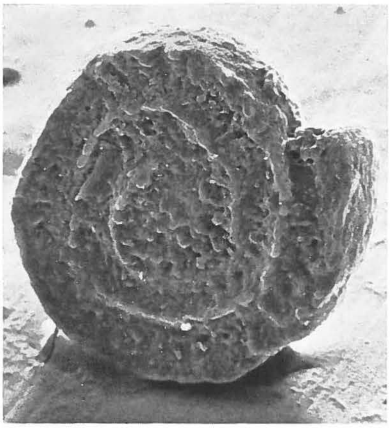

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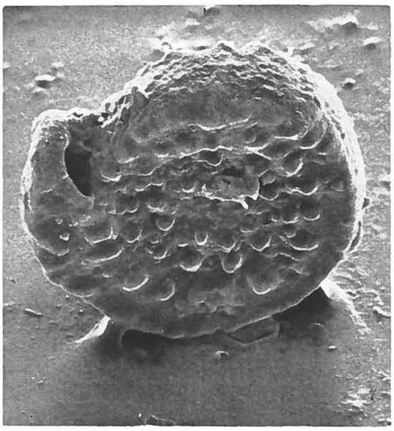

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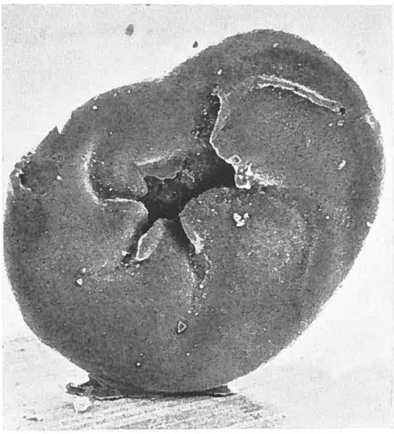
Plate 20

Figs 1–3. *Rosalina elegans* n. sp. MMH 10649.
- Fig. 1. Umbilical view of specimen lacking the two latest chambers. 135 ×.
- Fig. 2. Spiral side. 125 ×.
- Fig. 3. Peripheral view. 130 ×.

Figs 4–5. *Rosalina elegans* n. sp. MMH 10650.
- Fig. 4. Oblique view of damaged specimen showing slightly limbate sutures. 120 ×.
- Fig. 5. Detail of central part of spiral side. 252 ×.

Fig. 6. *Rosalina elegans* n. sp. MMH 10651. Umbilical view of abnormal specimen with a much enlarged umbilical flap. 97 ×.



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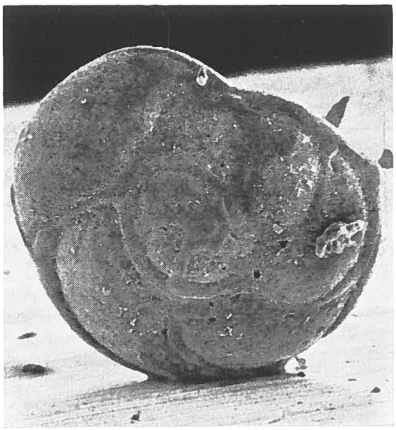

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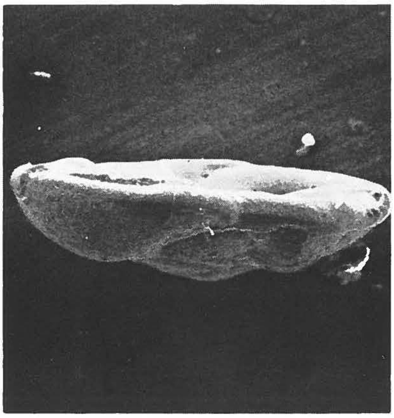

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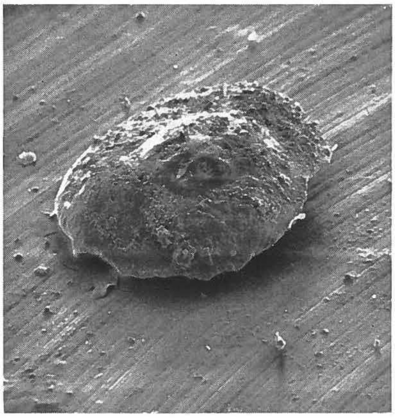

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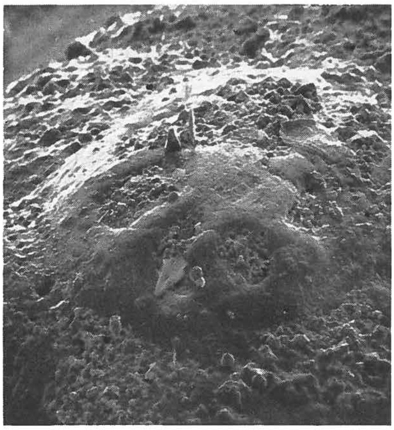

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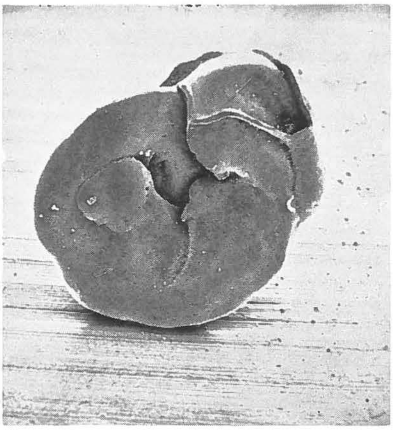

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Plate 21

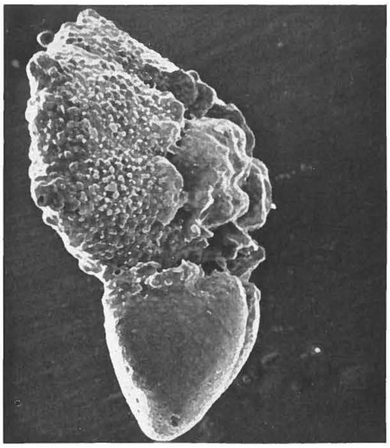
Figs 1–2. *Pararotalia tuberculifera* (Reuss, 1862).
- Fig. 1. Oblique peripheral view. 204 ×.
- Fig. 2. Spiral view. 192 ×.

Fig. 3. *Subbotina pseudobulloides* (Plummer, 1926). Surface structure of a specimen from the Midway Formation, Texas (Plummer's locality no. 23). 750 ×.

Fig. 4. *Subbotina triloculinoides* (Plummer, 1926). Surface structure of a specimen from the Midway Formation, Texas (Plummer's locality no. 23). 738 ×.

Fig. 5. *Subbotina pseudobulloides* (Plummer, 1926). MMH 10662. Umbilical view. 234 ×.

Fig. 6. *Chiloguembelina crinita* (Glaessner, 1937). MMH 10598. Oblique side view. 288 ×.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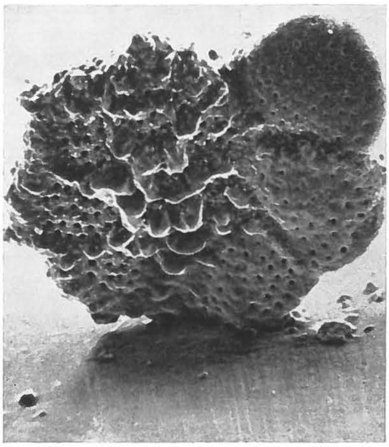
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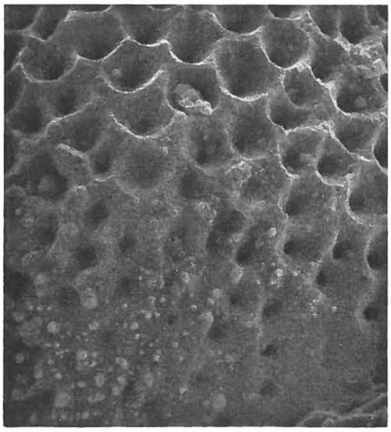
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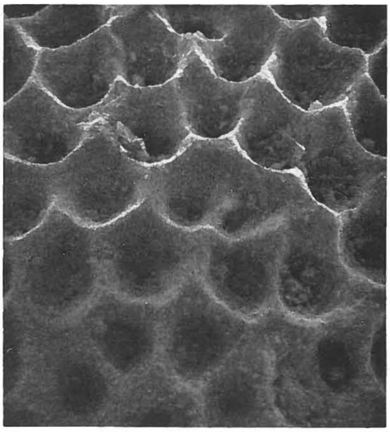
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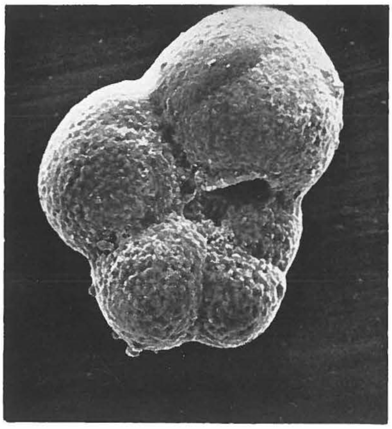
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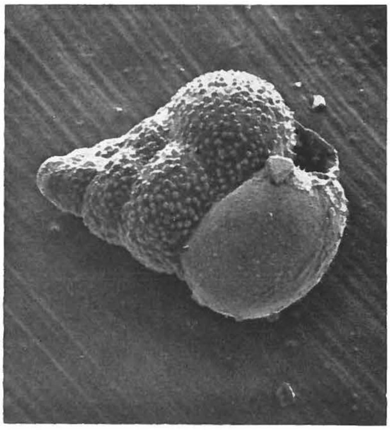
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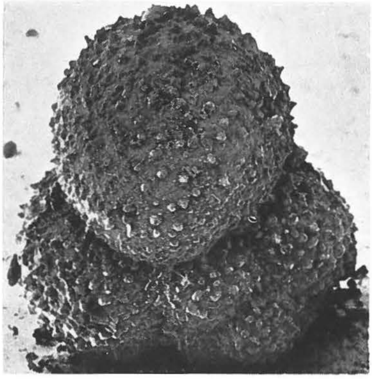
Plate 22

Figs 1–2. *Globoconusa daubjergensis* (BRÖNNIMANN, 1953). MMH 10613.
- Fig. 1. Oblique spiral view. 293 ×.
- Fig. 2. Umbilical view. 240 ×.

Figs 3–6. *Globoconusa daubjergensis* (BRÖNNIMANN, 1953).
- Fig. 3. Oblique spiral view. 219 ×.
- Fig. 4. Detail showing surface structure of penultimate chamber. 540 ×.
- Fig. 5. Detail showing smooth final chamber and aperture. 540 ×.
- Fig. 6. Detail showing surface structure of antepenultimate chamber. 1620 ×.



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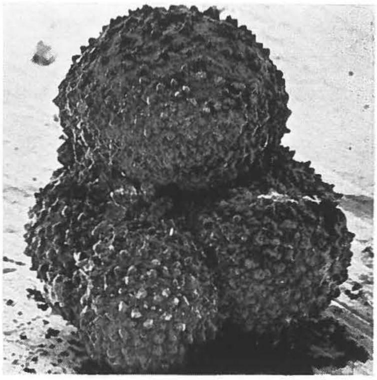

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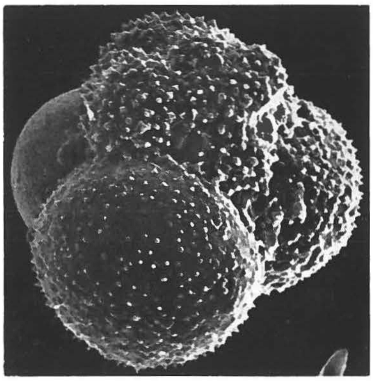

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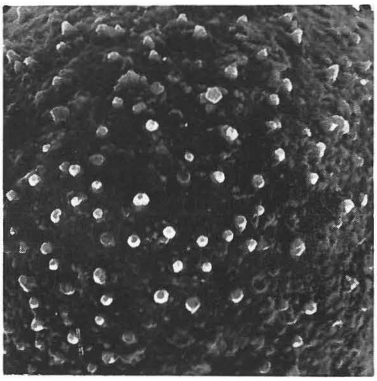

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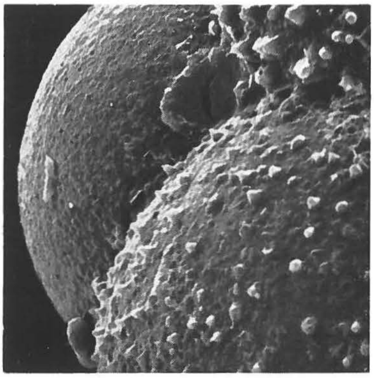

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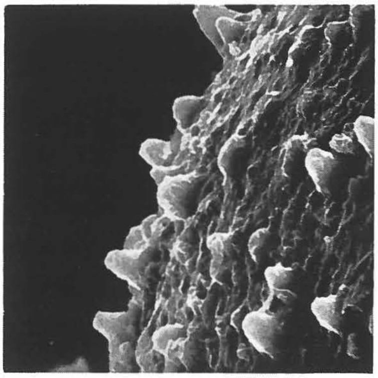

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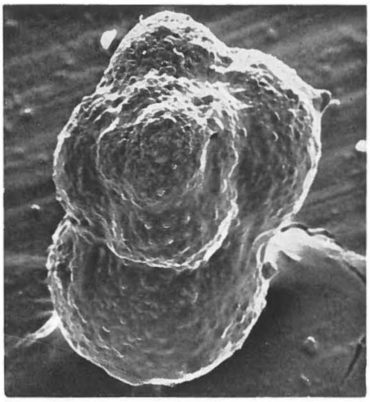
Plate 23

Figs 1–2. *Globoconusa daubjergensis* (BRÖNNIMANN, 1953). MMH 10612.
    Fig. 1. Spiral view. 288 ×.
    Fig. 2. Oblique umbilical view. 301 ×.

Fig. 3. *Globigerina bulloides* D'ORBIGNY, 1826. Recent. Off Portugal. Detail showing surface structure. 1640 ×.

Figs 4–6. *Cibicides succedens* BROTZEN, 1948. MMH 10600.
    Fig. 4. Spiral side. 249 ×.
    Fig. 5. Peripheral view. 276 ×.
    Fig. 6. Oblique umbilical view. 276 ×.



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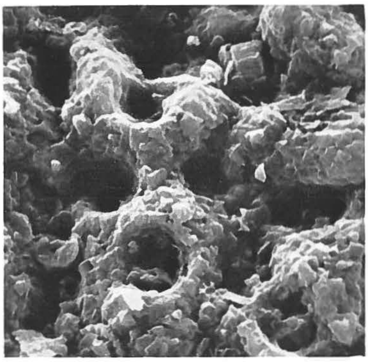

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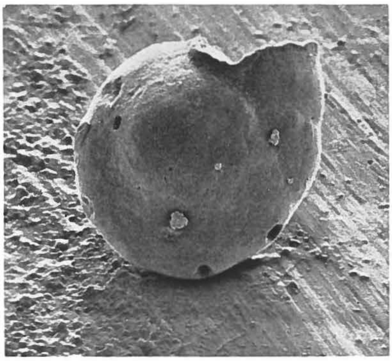

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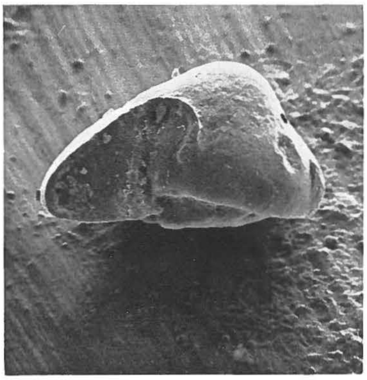

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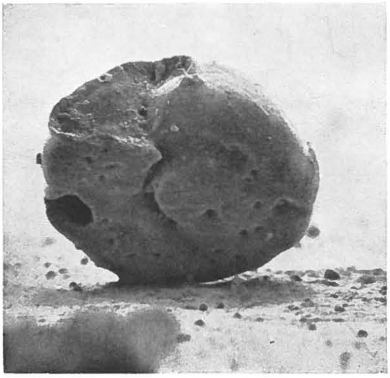

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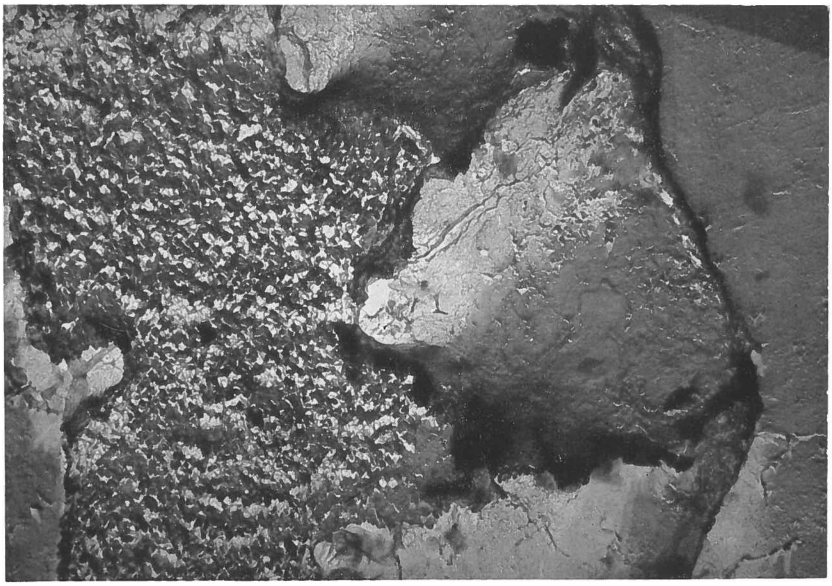
Plate 24

Fig. 1. *Subbotina triloculinoides* (PLUMMER, 1926). Midway Formation, Texas, U.S.A. (PLUMMER's locality no. 23). Carbon-shadowed replica of very slightly etched section of chamber wall showing pore-entrances and pitted surface. 4600 ×.

Fig. 2. *Globorotalia menardii* (D'ORBIGNY, 1826). Recent, Galathea expedition station no. 281, depth 3310 m. Carbon-shadowed replica of polished, etched section through the antepenultimate chamber wall showing finely laminated crust of the incisional type. Cavity of chamber in lower right side of micrograph. 2800 ×.



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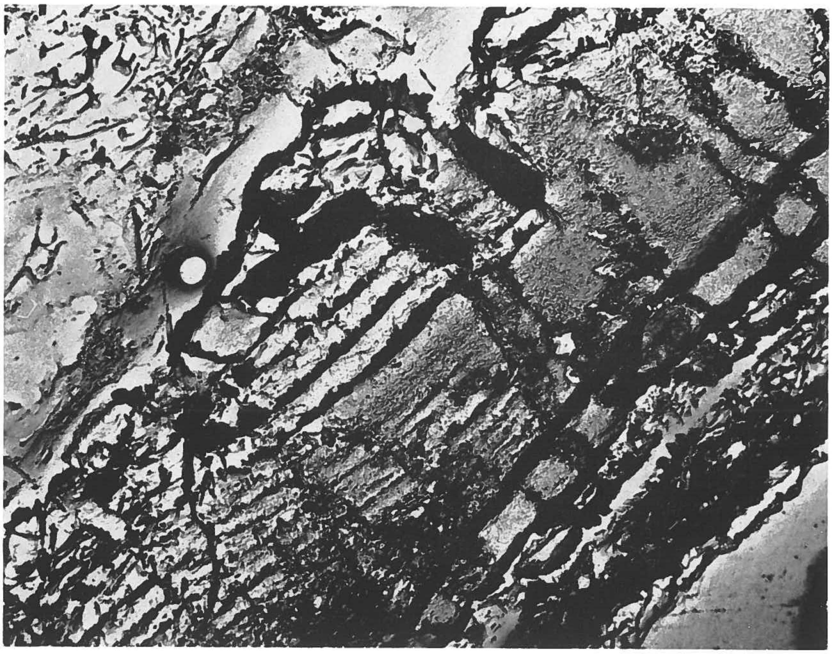

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Plate 25

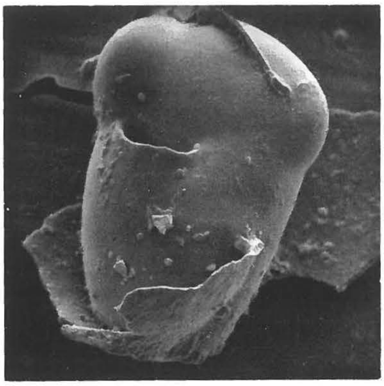
Fig. 1. *"Allomorphina" paleocenica* Cushman, 1948. MMH 10583. Damaged specimen. Oblique apertural view. 245 ×.

Fig. 2. *Pallaimorphina minuta* n. sp. MMH 10638. Opened megalospheric specimen showing foramen between penultimate and antepenultimate chamber. 207 ×.

Figs 3 and 5. *Pallaimorphina minuta* n. sp. MMH 10640.
  Fig. 3. Spiral view showing limbate sutures. 213 ×.
  Fig. 5. Detail showing exfoliation of secondary calcite layers on chamber wall. 2130 ×.

Fig. 4. *Pallaimorphina minuta* n. sp. MMH 10639. Umbilical view of megalospheric specimen. 279 ×.

Fig. 6. *Nonionella ovata* Brotzen, 1948. MMH 10633. Oblique view. 354 ×.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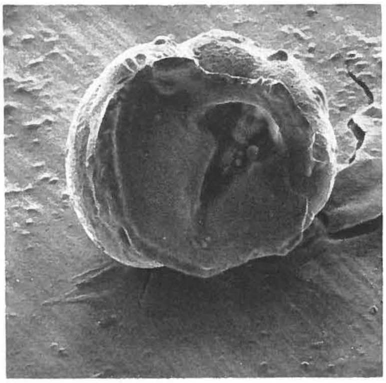
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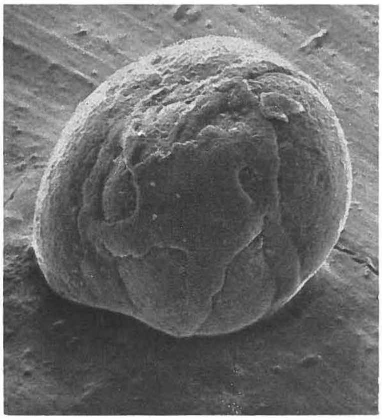
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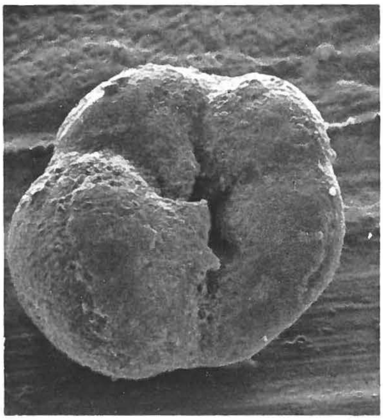
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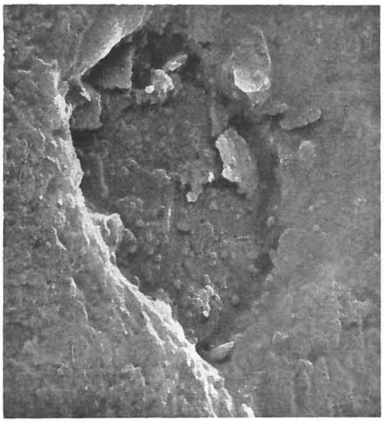
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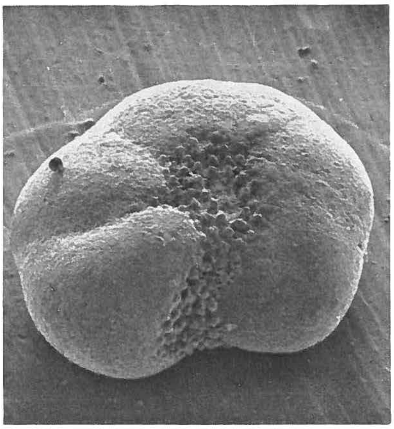
Plate 26

Figs 1–2. *Nonion graniferum* (Terquem, 1882). MMH 10631.

- Fig. 1. Oblique umbilical view. 240 ×.
- Fig. 2. Detail showing tuberculate umbilicus. 798 ×.

Figs 3–6. *Alabamina rosenkrantzi* n. sp. MMH 10582.

- Fig. 3. Opened specimen showing foramina and indentation. 91 ×.
- Fig. 4. Detail showing indentation. 210 ×.
- Fig. 5. Detail showing secondary closure of foramen and threshold in front of foramen. 207 ×.
- Fig. 6. Detail showing umbilical part of secondary closed foramen. 690 ×.



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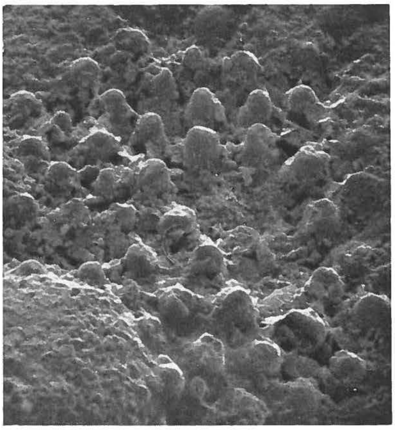

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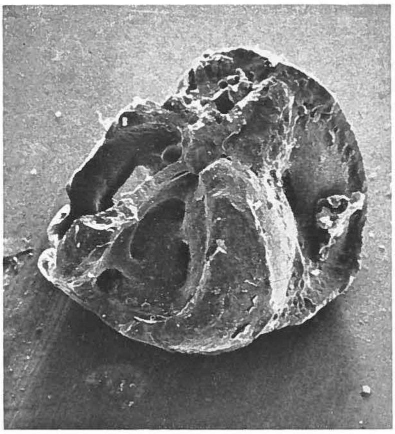

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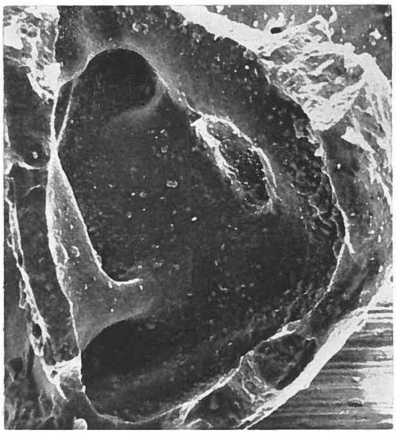

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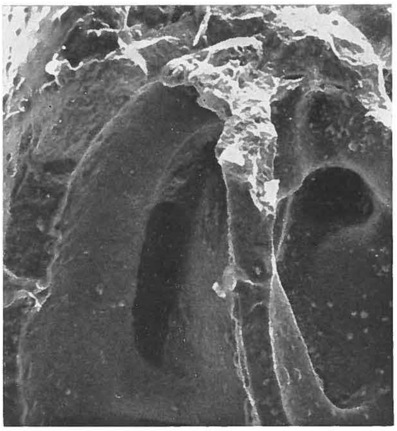

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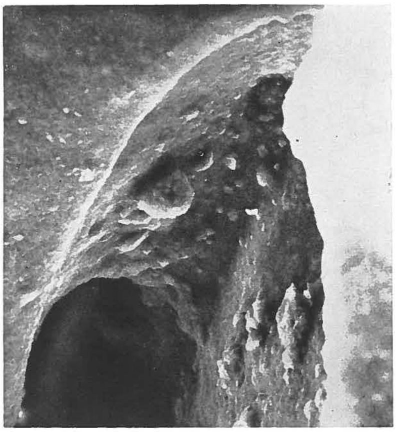

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Plate 27

Figs 1–2. *Paralabamina lunata* (Brotzen, 1948). MMH 10636.

Fig. 1. Detail of spiral side showing large pores with smaller ones between. 792×.

Fig. 2. Oblique view of spiral side. 243×.

Figs 3–4. *Anomalinoides howelli* (Toulmin, 1941). MMH 10587.

Fig. 3. Oblique spiral view. 156×.

Fig. 4. Apertural view. 160×.

Fig. 5. "*Gyroidina*" *soldanii* (d'Orbigny, 1826). Recent, Rimini, Italy. Oblique umbilical view. 120×.

Fig. 6. *Gyroidinoides nitida* (Reuss, 1844). Lower Cretaceous, Köpingsberg, Sweden. Opened specimen showing latest foramen and open umbilical part of aperture. 186×.

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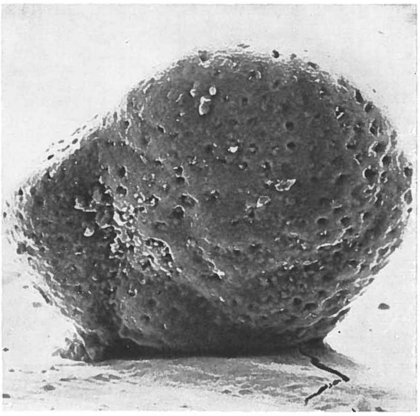

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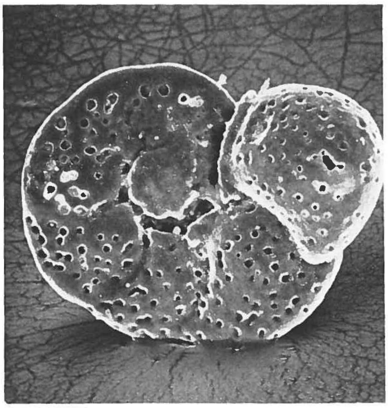

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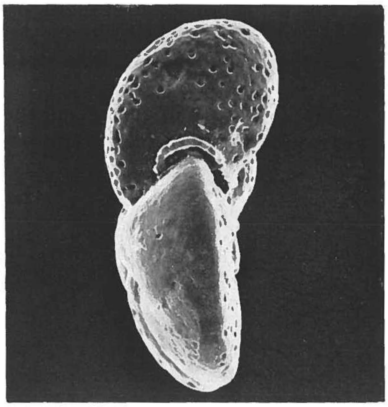

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Plate 28

Fig. 1. *Gavelinella pertusa* (MARSSON, 1878). Upper Maastrichtian, Mariager, Jylland. Oblique umbilical view. 90 ×.

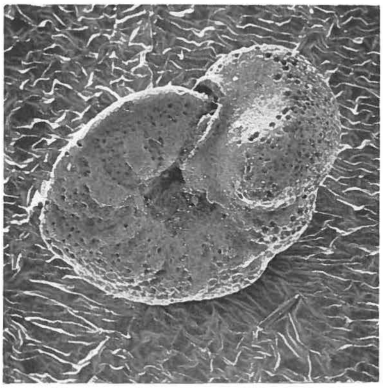
Fig. 2. *Gavelinella danica* (BROTZEN, 1940). Upper Maastrichtian, Mariager, Jylland. Peripheral view. 90 ×.

Fig. 3. *Gavelinella danica* (BROTZEN, 1940). Danian, zone of Tylocidaris bruennichi, Fakse, Sjælland. Peripheral view. 137 ×.

Fig. 4. *Gavelinella danica* (BROTZEN, 1940). Lower Selandian, Klagshamn, Sweden. Peripheral view. 78 ×.

Fig. 5. *Gavelinella grosserugosa* (GÜMBEL, 1868). Lower Eocene, Røsnæs, Sjælland. Peripheral view. 144 ×.

Fig. 6. *Karreria* sp. MMH 10618. Oblique peripheral view. 85 ×.



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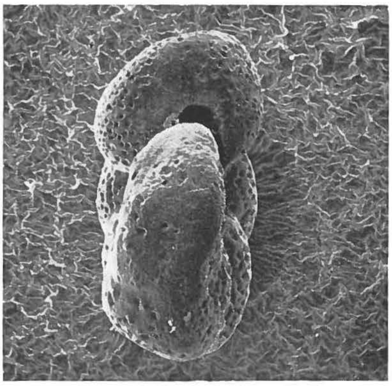

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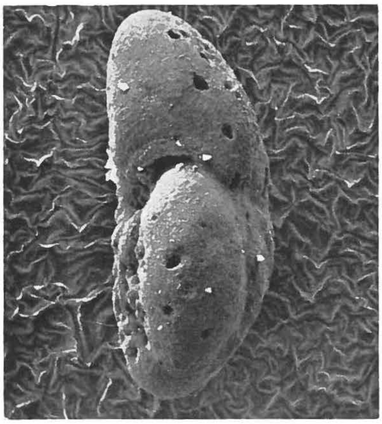

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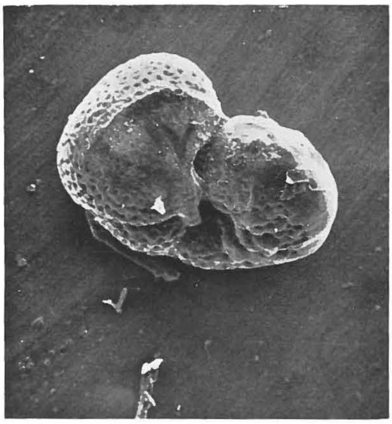

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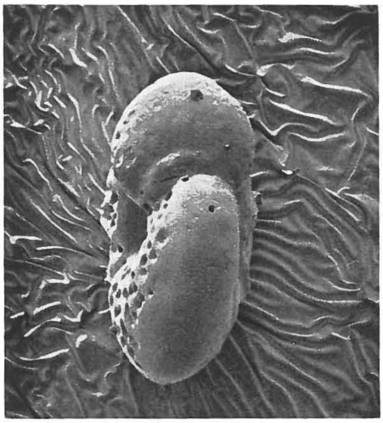

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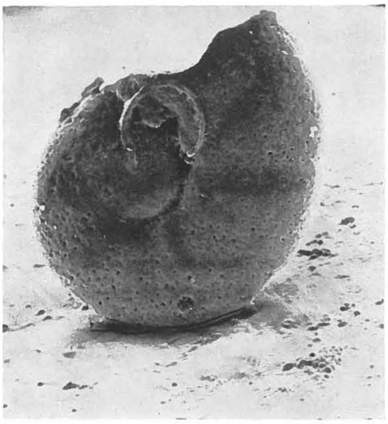
Plate 29

Figs 1–2. *Melonis nobilis* (Brotzen, 1948). MMH 10584.

- Fig. 1. Oblique view of damaged specimen showing umbilical flaps with older apertures remaining open beneath. 192 ×.
- Fig. 2. Opposite side showing umbilical flaps with older apertures remaining open beneath. 204 ×.

Figs 3–6. *Ceratobulimina* (*Ceratolamarckina*) *troelseni* n. sp. Holotype. MMH 10596.

- Fig. 3. Umbilical view. 138 ×.
- Fig. 4. Detail showing tooth-plate of final chamber. The bright material in the foramen is excess of mounting material. 210 ×.
- Fig. 5. Detail showing tooth-plate of penultimate chamber. 252 ×.
- Fig. 6. Detail showing tuberculate umbilicus. 600 ×.



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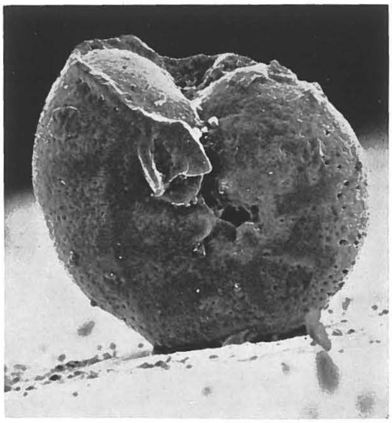

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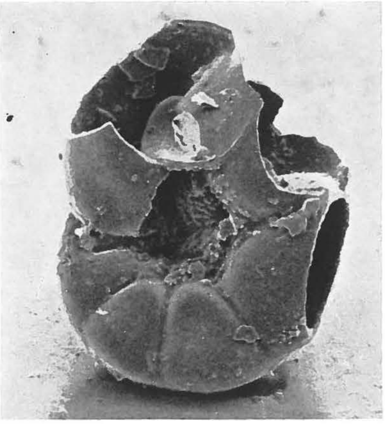

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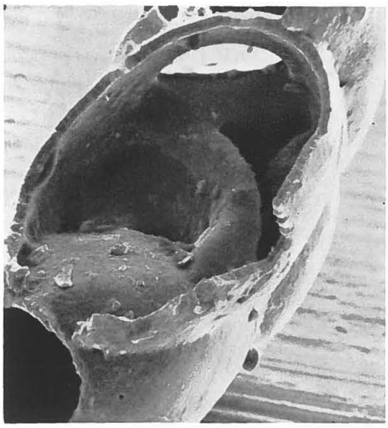

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6

Plate 30

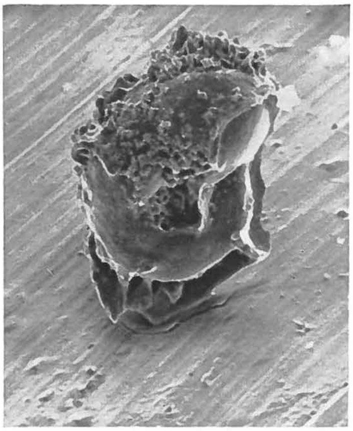
Fig. 1. *Lamarckina rugulosa* Plummer, 1926. MMH 10622. Oblique umbilical view. 186 ×.

Fig. 2. *Lamarckina rugulosa* Plummer, 1926. Paleocene, Midway Formation, Texas, U.S.A. (Plummer's locality no. 23). Umbilical view. 186 ×.

Fig. 3. *Lamarckina rugulosa* Plummer, 1926. MMH 10622. Spiral view. 216 ×.

Fig. 4. *Lamarckina rugulosa* Plummer, 1926. Paleocene, Midway Formation, Texas, U.S.A. (Plummer's locality no. 23). Spiral view. 216 ×.

Figs 5–6. *Stainforthia* sp. MMH 10652.
  Fig. 5. Apertural view. 210 ×.
  Fig. 6. Oblique view showing tooth-plates. 258 ×.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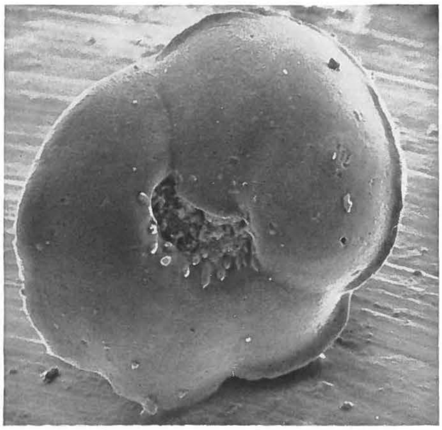
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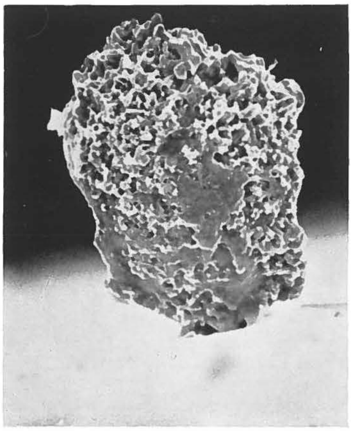
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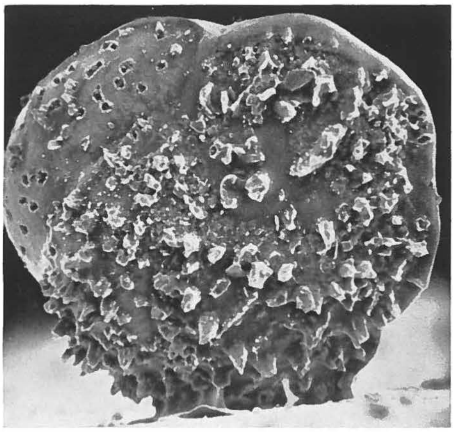
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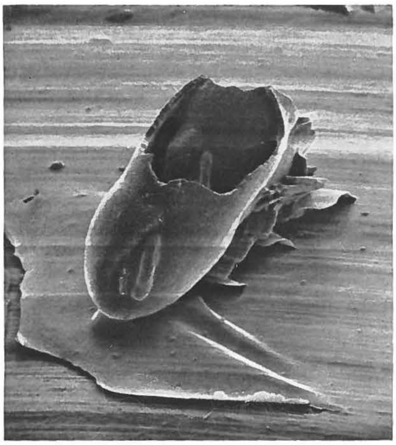
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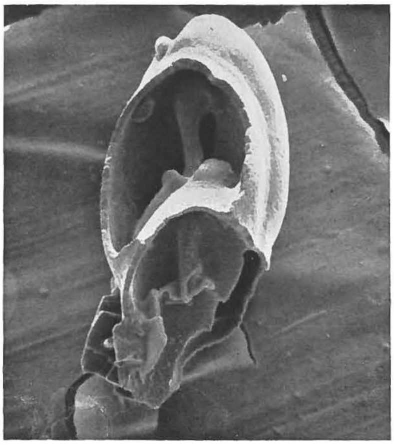
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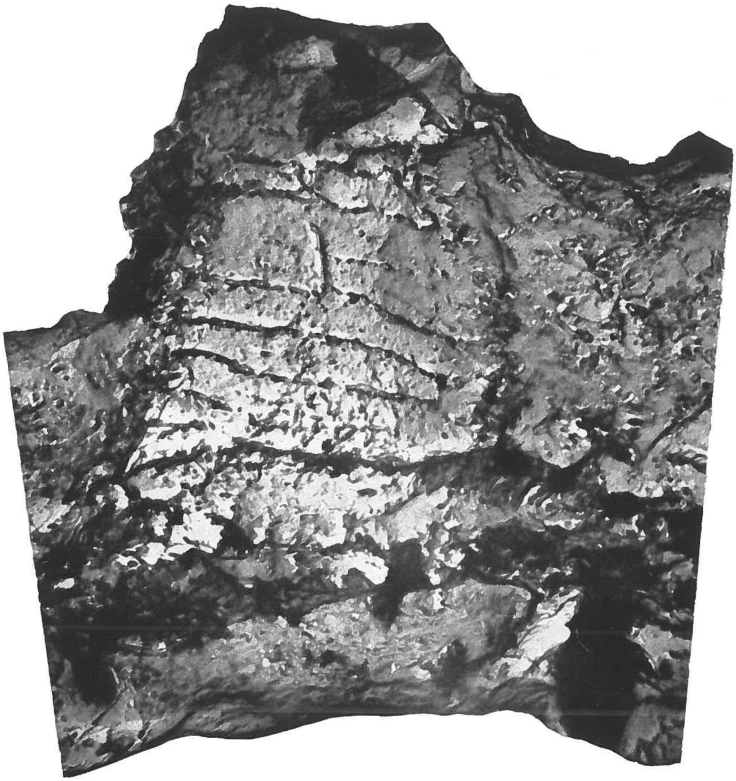
Plate 31

Fig. 1. *Subbotina triloculinoides* (PLUMMER, 1926). Paleocene, Midway Formation, Texas (PLUMMER's locality no. 23). Second carbon-shadowed replica of slightly etched section of the latest chamber. Transmission electron micrograph. 7500 ×.

Fig. 2. *Subbotina triloculinoides* (PLUMMER, 1926). Paleocene, Midway Formation, Texas (PLUMMER's locality no. 23). Carbon-shadowed replica of outer surface of penultimate chamber. Transmission electron micrograph. 5000 ×.



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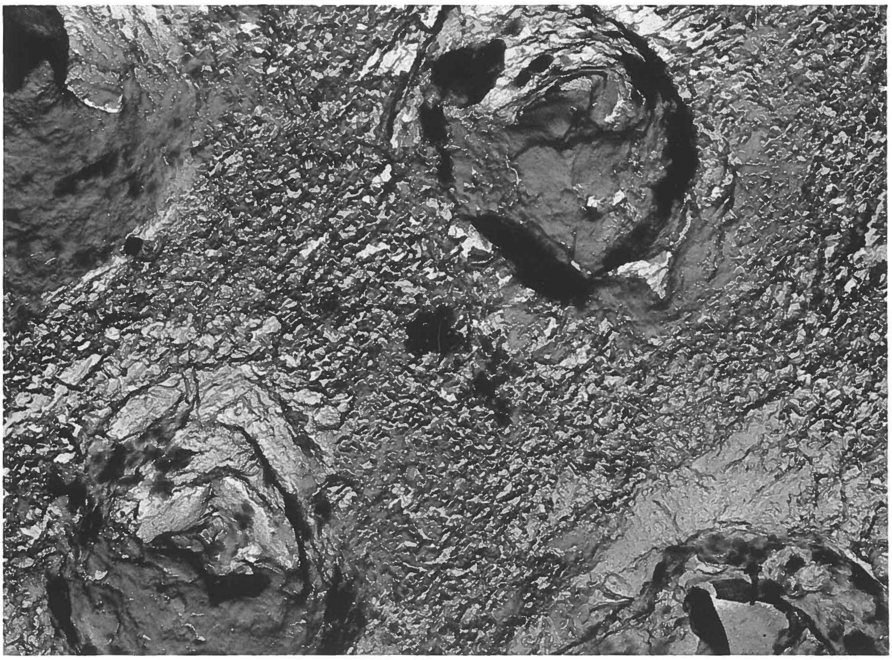

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Plate 32

Figs 1–2. *Praeglobobulimina ovata* (D'ORBIGNY, 1846). Lower Selandian, Basballe, Jylland. Carbon-shadowed replica of unetched inner surface. Transmission electron micrograph. 3330 ×.

Fig. 2. Detail. 13330 ×.

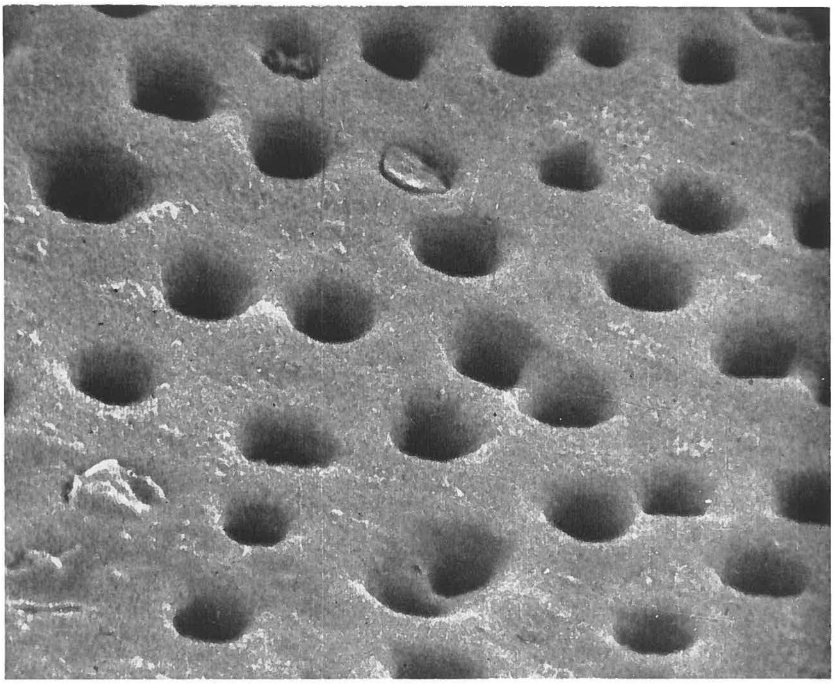
1

2

Plate 33

Fig. 1. *Praeglobobulimina ovata* (D'ORBIGNY, 1846). Lower Selandian, Basballe, Jylland. Inner surface of unetched specimen. Scanning electron micrograph. 4800 ×.

Fig. 2. *Praeglobobulimina ovata* (D'ORBIGNY, 1946). Miocene, Vienna Basin. Outer surface with elongate pores. Scanning electron micrograph. 558 ×.



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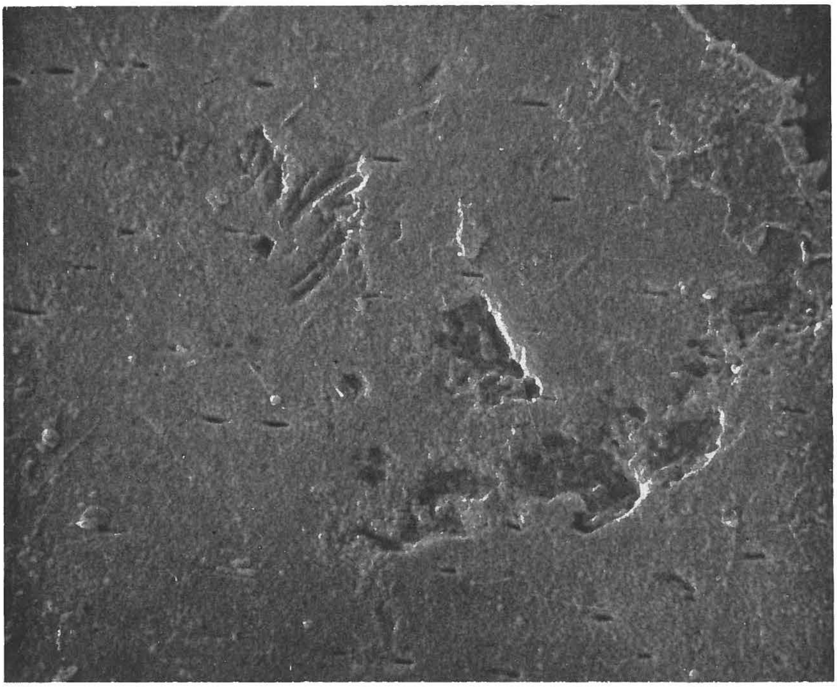

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