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# THE SWEDISH PALEOCENE AND ITS FORAMINIFERAL FAUNA

BY

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WITH 19 PLATES

*Pris 4 kronor*

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## Introduction.

Paleocene deposits have hitherto been known in Sweden as bedrocks only in the quarry of Klagshamn, about 10 km south of Malmö, and as erratic boulders from the southern and eastern part of the province of Scania (Skåne). The Paleocene at Klagshamn was discovered by Holst and described by Holst and Grönwall in 1907. The occurrence of Paleocene boulders was noted by Holst, Grönwall and Sandegren (1902, 1904, 1907 and 1913). Earlier Paleocene boulders were determined as Tertiary and noted by Beyrich (1857) and Lundgren (1882). In 1932 Hadding treated the structure of Paleocene rocks in his monograph on glauconite and glauconitic rocks in Sweden. Fossils are not described in these papers. The majority of the fossils of the Klagshamn beds are redeposited from the Danian and the few mollusc shells are too badly preserved for an exact determination. In 1907 Grönwall listed some fossils and in 1913 Sandegren published a list of Paleocene species from boulders found in a sand pit near Maglehem, south-east Scania.

Since Sandegren's publication in 1913 new finds of Paleocene have not been published. A great number of Paleocene boulders are deposited at the Swedish Geological Survey, collected as early as 1869 by Erdmann. Another large collection of these boulders was made by Dr R. Hägg, the State Museum of Nat. History, Stockholm, in 1913, and is deposited in the Paleozoological Department of the State Museum. Both these collections contain a very complete mollusc fauna, the preservation state of which is very fine. A description of these fossils is reserved for the future. Generally the boulders were found in the Quaternary of Ystad and its surroundings. New Paleocene localities were discovered in connection with prospecting for oil and salt in Scania during the years 1938—1947, directed by the Swedish Geological Survey. All the new localities were found by water borings and samples were collected by Lic. E. Mohrén and by the author.

A preliminary study of all Swedish Paleocene rocks discloses a rich foraminiferal fauna, which permits of a good comparison with fauna described from Denmark, England, Germany, Holland, and Russia. It is also very similar to the foraminiferal fauna from the Paleocene of the Gulf States of North America, especially in many characteristic species.

Permission to elaborate and publish a description of the new localities of the Swedish Paleocene and its foraminiferal fauna was received from Director P. Geijer of the Geological Survey, for which the author is greatly indebted to him.

Generally all preparations and all studies were carried out in the Paleozoological Department of the State Museum of Nat. History in Stockholm. The author is most grateful to Prof. E. Stensiö, the Director of the Paleozoological Department, for his kindness in allowing me to use the Department and for all his interest.

Dr H. Ödum, the Director of the Danish Geological Survey in Copenhagen, has been kind enough to determine the Paleocene moluscs from Ystad (see p. 15) and to help the author with samples from the Danish Paleocene, for which I tender my sincere thanks.

I am indebted to Lic. E. Mohrén of Lund, who collected the larger part of the new Paleocene samples and placed them at my disposal.

The author is greatly obliged to Prof. J. A. Cushman, Sharon, Mass., Prof. Chr. Poulsen, Copenhagen, and to Mrs. H. J. Plummer for topotypes of Paleocene foraminifera and samples, which have been of utmost value for comparisons. The necessary lingual corrections of the manuscript were made by Mr. B. Norbelie. Mrs. P. Brotzen carried out the preparation of the samples and foraminifera and Mr. S. Ekblom undertook the retouch of the drawings. To Mr. Norbelie, Mrs. Brotzen and Mr. Ekblom I wish to express my sincere thanks for their helpful work.

The collection of specimens and samples described is deposited in the Museum of the Swedish Geological Survey.

## Distribution of the Paleocene Deposits in Sweden.

Remains of Paleocene deposits are preserved in three regions, where their more or less loose sediments are lying in tectonic depressions and therefore protected against glacial erosion. The oldest known locality of the Paleocene in the original sequence over the uppermost Danian is found in the quarry at Klagshamn, south of Malmö. This locality is one of many isolated occurrences which extend in a west-east direction from the coast of Öresund to the village of Tygelsjö (see fig. 1). The thickness of the Paleocene in the Klagshamn region varies from a few centimetres up to 3 or 4 metres. The area of the individual occurrences varies from only a few m² to some hundred metres in each direction. Only one section is visible in the quarry at Klagshamn and all the other localities have been found in shallow water-borings below the Quaternary. Systematic researches to find the isolated remains of the Paleocene have not been carried out as yet.

Another Paleocene region is situated around the town of Ystad. The Paleocene is there preserved in the same way as in the Klagshamn region. A shallow but very distinct syncline extends from north-west to south-east across Scania, north of Malmö to the Baltic some kilometres west of Ystad. The surface of the prequaternary rocks is depressed about 60 to 70 m below the sea level. Older geologists explained this depression as the erosion valley of a prequaternary river. Stratigraphical examinations of several wells reaching into the prequaternary rocks show that this syncline is a real tectonic depression, and generally uppermost Danian sediments formed the surface of the prequaternary rocks. This depression was called »the Alnarp river» but a better name is the Alnarp depression (fig. 2). The western border of this depression is steep, the eastern border dips slowly. Paleocene boulders occur abundantly in the Quaternary of the southern part of the eastern border of the Alnarp depression and have been known as Tertiary since 1857 (Beyrich, Zeit. d. d. Geolog. Gesell. Vol. 9). Lundgren, Holst and Grönwall discussed the possibility of Paleocene bedrocks occurring in this part of the province of Scania. The first finds of Paleocene bedrock were made in 1939 in a water boring near Balkåkra, about 8 kilometres north-west of Ystad. In the uppermost limestones of the Danian there were mixed some Paleocene foraminifera, together with foraminifera from the uppermost Danian. It was thus possible that rests of the Paleocene might occur there, but the samples were too badly collected to distinguish the Quaternary clays from the Paleocene ones.

In 1942 Lic. E. Mohrén collected samples from a water-boring in the western part of the town of Ystad, in the garden of the factory »Ystads Gjuteri AB». The profile of this boring was published by the author in 1943 in GFF vol. 65, and disclosed two different layers of the Paleocene in the original sequence over an uppermost Danian limestone. It seems very probable that in the future more Paleocene bedrocks will be found in this region.

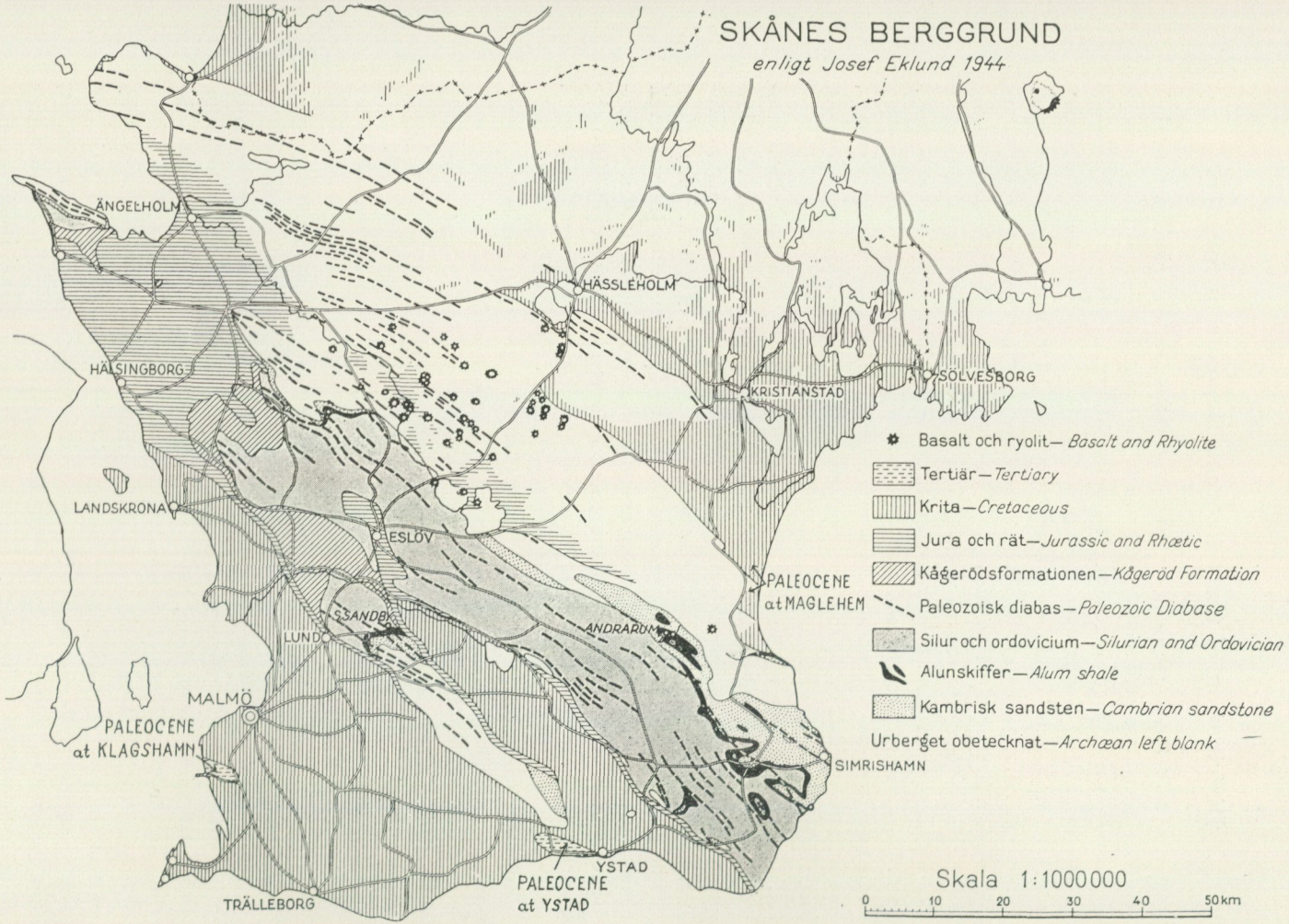



Fig. 1. Geological map of Scania with the distribution of the Paleocene.

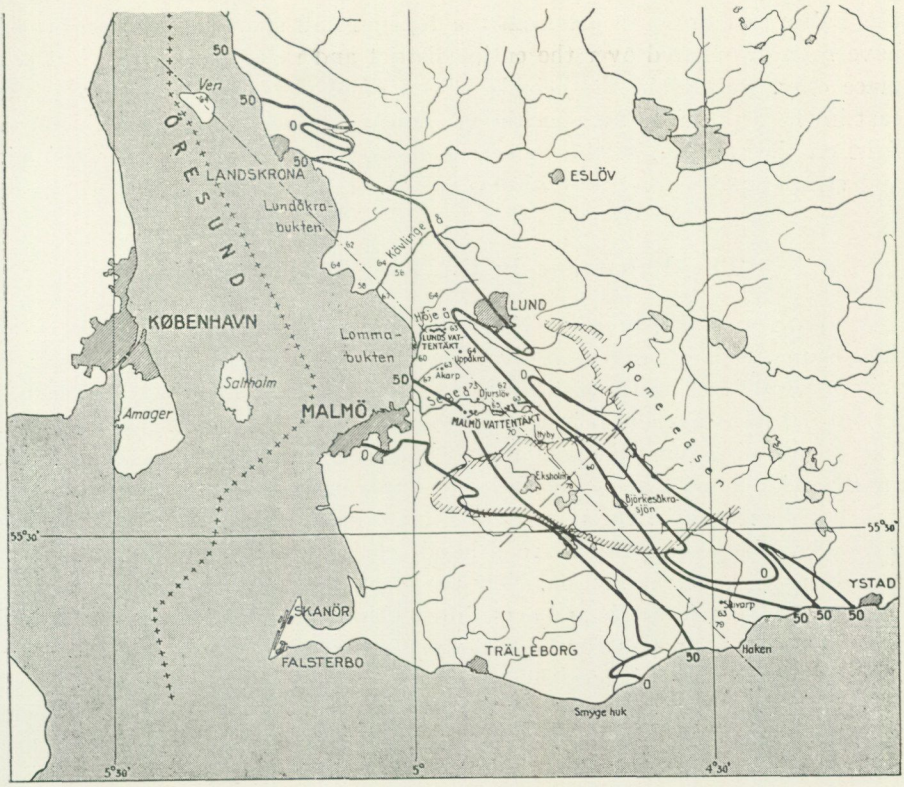



Fig. 2. The Alnarp depression (acc. W. v. Greyerz 1937).

An occurrence of Paleocene boulders in the Quaternary at Maglehem was published by Sandegren in 1913. Maglehem is situated about 45 km north-north-east of Ystad. The locality for the Paleocene boulders is about 2 km west of Maglehem, near the small village of Lillehem.

The prequaternal geology of the surroundings of Maglehem is but little known. Presumably Maglehem and Lillehem lie on a gneiss plateau, which is limited by two faults, one in the south in the direction NE—SW, and one in the north in the direction NW—SE. In the north is situated the Cretaceous syncline of Kristianstad and in the south a basin may be present, filled with young sediments from the Cretaceous and Tertiary.

Grönwall, Sandegren and Lundegren suppose that the Paleocene boulders of Ystad and Maglehem (Sandegren and Lundegren) were transported from the southern part of the Baltic, east of Maglehem and Bornholm. Lundegren (1934) stated that all occurrences of Paleocene boulders are concentrated to the surroundings of Maglehem and that these Paleocene boulders are lacking at all other places in the Cretaceous syncline of Kristianstad. This would seem to demonstrate very clearly that the bedrock of the Maglehem Paleocene cannot be far away from the recent locality. If the boulders were transported from

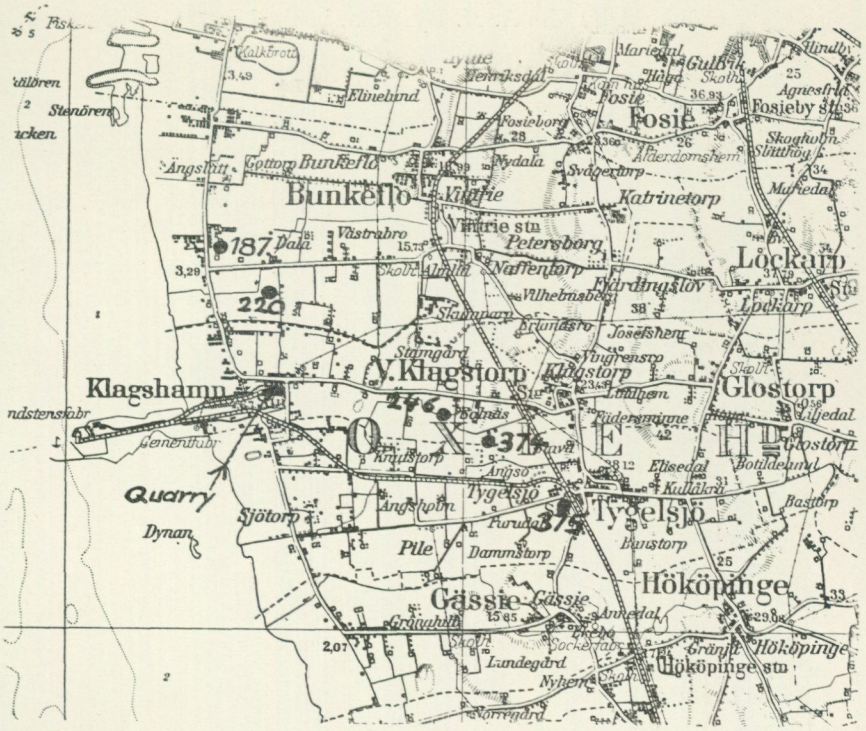
the Baltic east or southeast from the Kristianstad syncline, boulders would have been distributed over the entire district and never concentrated at one place only. Borings in the neighbourhood of Maglehem and farther to the east in the depressions between the prominent igneous outcrops should throw light on the problem of the Paleocene bedrocks and also on other tectonic and stratigraphical problems in this region.

## The Paleocene in the Klagshamn Region.

An outcrop of Paleocene is visible in the southern wall of the quarry at Klagshamn. This occurrence is the same as that published in 1907 by Holst and Grönwall. During the last few years the quarry has filled with water and a new lake has developed instead of the deep and large quarry before 1939. The steep walls around the lake disclose the ground to be partly prequaternal. In the middle and eastern part below the Quaternary beds lies the Paleocene in a flat depression of the uppermost Danian limestones. The Paleocene beds are well visible even from the road beside the lake and with a small boat it is possible to visit the section. Now the Paleocene extends in the west-east direction about 100 metres and according to Holst the Paleocene deposits were found about 150 metres south of the present northern wall. All these sediments were pulled out before Holst visited the place. Boreholes some hundred metres north of the quarry have not disclosed Paleocene but reached the Danian immediately below the Quaternary. In the middle of the visible depression the Paleocene in the quarry is 60 to 70 cm thick and on the borders it disappears slowly. The sequences in the northern wall are shown in the following profile:

| | |
|---|---|
| Quaternary beds | 4—5 metres |
| Glauconitic sands or clayish sands with many calcareous grains from the Danian. Dark-green in a new section | 50—65 cm |
| Glauconitic conglomerate with pebbles of Danian limestone, phosphatic nodules, bone fragments, fish teeth and fossils redeposited rrom the Danian | 5—10 cm |
| Danian limestones or limesands. | |

The contact between the Paleocene conglomerate and the uppermost Danian is not conformable in all places, but the unconformity is not important and the angle between the beds is too small for measuring. Cavities and fissures in the upper half metre of the Danian limestones are filled with Paleocene matter and such matter has penetrated horizontally between the limestone banks. This explains the fact that Paleocene foraminifera are found mixed with Danian ones in samples from percussion drillings. In some localities the very loose Paleocene sediments are disturbed by glacial erosion, but the uppermost Danian limestones were too hard for erosion, and the Paleocene foraminifera from the fissures in the limestone thus show that also at these places the Paleocene was present before the glacial period. The surface of the Danian below the Paleocene is generally corrugated and small depressions and dis-


Bunkeflo
Fosie
Löckarp
Klagshamn
V. Klagstorp
Glostorp
Tygelsjö
Hököpinge
Gässie
Quarry
Dynan
Pile
Petersborg
Katrinetorp
Vilhelmsberg
Josefsberg
Elisedal
Kullaberg
Basthorp
Lundegård
Nyhem
Hököpinge stn
Vilhelmsro
Ängsholm
Gottorp
Elineland
Fosieborg
Alderdomshem
Svågertorp
Mariedal
Gullvik
Agnesfrid
Fosieby
Skogholm
Slottsköp
Mullerdal
Dala
Västrabro
Naffentorp
Lördinglöv
Skampark
Stamgård
Klagstorp
Solnäs
Tygelsjö
Kullaberg
Botildelund
Grönlit
Sockertäb
Grevegård
Fisk
Kalkbrott
Stenören
Gementhab
Sjötorp
Dammstorp
Grävhult
Ängsholm
Anfso
Kurudd
Ljungtorp
Anrudal
Ljungbyhed
Mariedal
Hilma
Skolh
Gröna
Ljungbyhed
Lilla
Lilla
Lilla

pebbles was carried out by Mrs A. M. Byström, in the laboratory of the Swed. Geol. Survey.

$CO_2$ ..... 14 %
$P_2O_5$ ..... 19.2 %
CaO ..... 46.3 %.

The absence of quartzitic grains indicates the possibility that the phosphatic pebbles were formed before the glauconite sandstone was sedimented. This is also illustrated by the fossils in the conglomerate. Grönwall in 1907 listed the following species from the conglomerate (in Holst and Grönwall 1907):

Teeth and bone-fragments of fishes
Fragments of decapoda
Pollicipes or Scalpellum
Ostrea vesicularis and Ostrea lateralis
Dentalium sp
Mollusc fragments, generally phosphatical
Terebratula lens,
Crania tuberculata
Crania posselti (Crania larva acc. Grönwall)
Bryozoa-fragments
Serpula sp. sp.
Ananchytes sulcata
Cidaris sp. sp.
Fragments of Ophiura and Goniaster
Fragments of Bourgueticrinus, Rhizocrinus and Pentacrinus
Graphylaria and other corrals
Large foraminifera from the genera:
Nodosaria, Cristellaria, Vaginulina, Polymorphina,
Lagena and Frondicularia

All these species have also been found in the author's collections and besides them: Scalpellum steenstrupi and Ditrupa schlotheimi. Many of these fossils have been redeposited from the uppermost Danian. But such forms as Ostrea, Decapodes, Crania tuberculata and Crania posselti, which occur abundantly in the Paleocene conglomerate, are lacking in the Danian limestone at Klagshamn or are extremely rare. The decapodes, brachiopodes and nuclei of gastropodes and lammellibranchiata are preserved as phosphates, so that they must have been redeposited from other beds than Danian. This indicates that between the bottom conglomerate and the highest layers of the Danian in Sweden there may have been beds of the Danian or Paleocene, characterized by a very rich fauna, and that they were eroded before the bottom conglomerate was formed. Their fossils have been redeposited and phosphoritized in the conglomerate.

In the profiles of the Danish Paleocene of Copenhagen there occur, below the conglomerate with phosphatic pebbles, sandy and glauconitic limestone

and greensand, both rich on fossils. These fossils resemble those in the conglomerate, so it is possible that these layers were present and destroyed again in one of the first periods of the Paleocene [cf. Rosenkrantz 1920].

The conglomerate is sandy and glauconitic and changes gradually into the beds without pebbles and phosphatic nodules. The higher beds are dark greeish or greyish and contain coarse quartzitic grains mixed with much glauconite and clayish matter. Foraminifera occur abundantly; partly they are also redeposited from the Danian but generally they are restricted to these beds. Grönwall found only single and very badly preserved specimens of moluscs, which have not been redeposited. Very large samples contain only two or three badly preserved gastropodes, whose preservation stage resembles those of the Tertiary and not those of the fossils from the Danian.

Grönwall (1907) noted the following fossils from the glauconitic sandstones:

Otolithus (Trachini) seelandicus Koken
Teeth and bones of fishes
Pollicipes(?)
Pectunculus corneti v. Koenen (?)
Nucula? sp.
Leda?
Mytilus or Modolia
Astarte?

None of these fossils can be used as guide fossils. But their character and their state of preservation show that they belong to the same age as the fossils from the glauconitic sand deposits over the Danian in Denmark, which stratigraphical range is stated to be Paleocene.

The other occurrences in this region are situated in shallow depressions of the uppermost Danian. The largest area of Paleocene sediments is found a few kilometres west of Klagshamn in the surroundings of the village of Tygelsjö. Others have been found north of the quarry of Klagshamn. Samples of the greensand and clays were collected only from some points, but many farmers in this district say that they have seen such green sediments when boring their water wells.

In the north of Klagshamn the Paleocene occurs about one or two kilometres from the quarry. The first samples in our collection are from the farm »Dahlberg» at Naffentorp (collect. No. 187). This farm is situated 800 metres south of Ängslätt and 350 metres east of the fixed point 3.29 on the road from Klagshamn to Limhamn (fig. 3). The profile was:

Quaternary ..... 0—5 metres
Paleocene sand..... between 5 and 6 metres.

The Paleocene sand is clayish, very dark green; besides the quartz and glauconite it contains many grains of limestone from the Danian. Fossils are rare, except foraminifera. Generally the fossils are broken and redeposited from the

Danian, but some fragments show the typical characters of the Tertiary molluscs.

Another profile with Paleocene layers was found at Naffentorp, in the garden of the farmer »Sigfr. Nilsson» (collect. No. 220). This farm is situated about 2.5 km WSW of the railway station Vintrie (Malmö—Trelleborg). The farm lies about 7 m above the sea level and the profile is as follows:

| | |
|---|---|
| Quaternary | 0 —6.5 m |
| Paleocene | 6.5—8.75 m |
| Uppermost Danian drilled to 10.5 m | — below 8.75 m |

The Paleocene consists of green-greyish, clayish sand with numerous grains of Danian limestone. The colour of this sand is more greyish than at Klagshamn and Naffentorp »Dahlberg». The sample from the Paleocene contains fragments of Paleocene gastropodes and lammellibranchiata, which occur more abundantly here than in the greensand of Klagshamn. It would be very valuable to have larger samples from these localities for studies of the mollusc fauna. Fossils redeposited from the Danian are abundant and they are distinguished from the Paleocene fossils by the non-transparent shells. The shells of the Paleocene fossils are transparent or hyalin, filled with glauconite or grains of sand. Fish remains, such as bones and teeth, are generally phosphatic, dark brownish and glossy. In the small sample of the Paleocene I found

| | |
|---|---|
| Teeth of sharks | phosphatic, Paleocene? |
| Ostrea sp. | Danian |
| Shell-fragments of Lammellibranchiata and Gastropods | Paleocene |
| Spines and plate fragments of Echinodermata | Danian & Paleocene |
| Foraminifera abundant | Danian & Paleocene. |

Besides these fossils the Paleocene sand contains small brown or black ellipsoidal phosphorites with a length of about 0.5—2 mm. These small concretions were described by Grönwall from the Lowest Paleocene of Denmark as coprolites. Grönwall found them »i ofantligt stor mängd» (in enormous quantities) in the conglomerate at Klagshamn. In the collection of the Swedish Geological Survey they occur also in the conglomerate at Klagshamn but not very abundantly. They are typical for certain Paleocene boulders (cf p. 16) and are shown in Pl. 2, fig. 2. Such small coprolites are well-known fossils from various geological stages and from recent marine sediments. In 1929 Voigt summarized the literature on these fossils and explained that they must be coprolites of echinodermata, especially of echinides. They generally occur in conglomerates with glauconitic facies and are secondarily concentrated (Jh. Halleschen Verb. Erforsch. Vol. 8. N. F. 1929).

About two kilometers west of Klagshamn, on the railway Malmö—Trelleborg, is the village of Tygelsjö. In the surroundings of Tygelsjö, Paleocene is found in several wells. The Paleocene near Tygelsjö seems to have a larger

area than at Klagshamn and Naffentorp. The thickness of the beds also seems larger here than in the east and in the north. Samples from three places are included in our collection.

One locality was found during drilling operations for the Swedish Geological Survey in 1939. The drillhole was about 2.5 km east of the quarry at Klagshamn and about 500 meters west of the railway station Västra Klagstorp. This place belongs to farmer Nils Nilsson: the name of the farm is »Solnäs». The drillhole was about 250 m south of the farmhouse.

The profile:

| | |
|---|---|
| Quaternary | 0—9 metres |
| Paleocene | about 9 metres from the level |
| Danian? | about 10 metres from the level. |

In our collection we have two samples (No. 246, 9 m and No. 246, 10 metres). The samples are mixed with Quaternary matter. The Paleocene is a very dark clay with grains of limestone redeposited from the Danian, quartz and glauconite. In the residue of washing, the grains of the limestone dominate and the glauconite grains are rare. Foraminifera from the Paleocene occur together with fossils from the Danian and are generally distinguished by their stage of preservation. A small number of fragments of Paleocene gastropods in only a small sample demonstrates the occurrence of these fossils. It is to be hoped that future drillings will disclose larger samples so it will be possible to study the species of the gastropods and other mollusc fossils. The occurrence of the Danian below this Paleocene clay is questionable. The sample shows a clayish and calcareous matter, which contains quartz and granitic grains. The sample seems to represent a boulder clay with remains of the Danian. It is possible that the Paleocene clay does not lie in its original sequence and has been moved from its bedrock. It is likewise possible that during the drilling Quaternary matter was mixed in the Danian sample. If the Paleocene clay was transported by ice, it cannot be far from the original bedrock, which has also been found with its original sequence in this district.

The next locality is only 250—500 metres east-southeast of »Solnäs» in the garden of farmer Vadst, Tygelsjö. From this place we possess two samples (No. 374, 14—15.4 m and No. 374, 15.4—16.4 m).
The profile:

| | |
|---|---|
| Quaternary | 0 —14 m |
| Paleocene | 14 —15.4 m |
| Danian | 15.4—16.4 m. |

The Paleocene is a greyish limestone with some quartz and glauconite. This rock is characterized by the many glossy dark coprolites, described on p. 12 as coprolites of echinoidea. This rock resembles the greensand limestone of the Lower Paleocene at Copenhagen in all details and this facies is very different to the Paleocene at Klagshamn. In the sample from 14.0—15.4 m occur many

pieces of a hard white limestone from the Upper Danian, which demonstrates that the Danian begins at a depth between 14.0 and 15.4 m and that the greensand limestone lies directly upon the Danian. The sample of the greensand contains abundant foraminifera, generally Paleocene ones.

The sample from the underlying Danian limestone also contains Paleocene foraminifera. This can only be explained by the Paleocene occurring in fissures of the Danian limestone, as it does in the Danian at Klagshamn.

The last profile with Paleocene in the region of Tygelsjö was observed in a drillhole for water in the garden of the farm »Göran Svensson, stathus» (No. 375 in our collection), situated about 100 m south of the railway station Tygelsjö and about 1.2 km SSE of the locality »Vadst, Tygelsjö». The upper sample contains only fine sand from the Quaternary and the other a typical dark greensand from the Paleocene. The greensand contains very abundant foraminifera and fragments of Paleocene gastropods and lammellibranchiata. Besides these fossils there occur fragments of echinoidea, as is typical in the bottom conglomerate at Klagshamn. Pebbles in this greensand consist of flints, limestone from the Danian, phosphatic nodules and the greyish glauconitic limestone with phosphatic echinoderm coprolites, which were also observed at the locality »Vadst, Tygelsjö».

Drillers for water have observed the typical greensand at other places in the surroundings of Tygelsjö but samples have not been collected.

## The Paleocene in the Ystad Region.

The Paleocene in the Ystad region includes the boulders in the Quaternary, the remains of the Paleocene in the Danian at Balkåkra and an intact Paleocene sequence in the well »Gjuteri AB» (Foundery factory) at Ystad. The Paleocene at »Gjuteriet» is also of tectonic interest as all wells farther east only reach the Danian below the Quaternary. Samples of the Danian are known from wells near the port, the railway station, and from the northern and eastern part of Ystad. The surface of the Danian is generally one to three metres higher in all these wells than in the Paleocene well »Gjuteriet». The Paleocene contact to the Danian is preserved in a well beside the port shed. Here the surface of the Danian is at the 17 metres level. It is a coarse and grained limestone with numerous fragments of Echinoderms, grains of quartz and glauconite and quantities of the small phosphatic coprolites described before as echinoderm coprolites. At the »Gjuteriet» well these contact beds are at the 23 metre level. Some kilometres east and north-east of Ystad the Danian disappears and Campanian or Lower Maastrichtian sandstones (Köpinge sandstone) lie below the Quaternary.

The thickness of the Danian near the port is about 40 metres and it begins with a conglomerate over the Köpinge sandstone. It is thus possible to conclude that all layers near Ystad dip from northwest to south-east. The normal sequence is:

| Quaternary | | Observed "Gjuteriet" 20 m | Observed near the port ± 17 m |
|---|---|---|---|
| Paleocene | greenish clay with glauconite and sand..... | 1 m | |
| | dark greensand with clayish intercalations ... | | |
| | conglomerate with echinoderm fragments and phosphorites ..... | about 2 m | remains of conglomerate |
| Danian | fine-grained limestones with fissures filled with Paleocene matter ..... | 1 m | 1—2 m |
| | fine-grained limestone with flint nodules and flint layers ..... | — | about 40—50 m |
| | conglomerate with echinoderm fragments .... | — | about 1 m |
| Campanian | calcareous sandstones | | thickness unknown |

Like the Paleocene at Klagshamn and Tygelsjö the Paleocene here fills fissures and cavities in the Danian limestone, so Paleocene rocks are mixed in the sample from the Danian. The Paleocene bottom conglomerate has not been found isolated in the few samples from Ystad. Phosphorites and echinoderm fragments in the lower level of the Paleocene and in the uppermost Danian samples demonstrate the occurrence of that conglomerate. The lower level of the Paleocene consists of a clayish greensand, distinguished from that in the Klagshamn region by a rich mollusc fauna. Danian and Paleocene foraminifera occur together. The observed thickness of the Paleocene is about three metres. The fauna was determined by Dr. H. Ödum and the following species have been found (the foraminifera excepted):

| | upper clay | lower greensand |
|---|---|---|
| Sphenotrochus latus v. Koenen ..... | — | 4 |
| Cucullaria voigti Roedel ..... | — | 3 |
| Pectunculus corneti v. Koenen ..... | — | abundant |
| Limopsis monbergi Ravn ..... | — | 1 |
| Venericardia roedeli Ravn ..... | — | 5 |
| Astarte trigonula v. Koenen ..... | — | 1 |
| Crassatella hauniensis Ravn ..... | — | 1 |
| Corbula koeneni Cossm. ..... | — | 2 |
| Ostrea sp. redeposited from the Danian ..... | — | 1 |
| Exogyra canaliculata Sow. redeposited ..... | — | 1 |
| Dentalium undiferum v. Koenen ..... | — | 1 |
| Natica sp. (some species, young specimens) ..... | × | × |
| Alvania hauniensis Ravn ..... | — | 1 |
| Turritella nana v. Koenen 1) ..... | abundant | abundant |
| Turritella sp. 2) ..... | 1 | 2 |
| Mathildia (Acrocoelum) gracilis v. Koenen ..... | — | 2 |
| Metacerithium hauniense v. Koenen ..... | 1 | — |
| Cerithiopsis hauniensis Ravn 3) ..... | — | 3 |
| Pleurotoma (Eopleurotoma) selandica v. Koenen ..... | 1 | — |
| Surcula rosenkrantzi Ravn ..... | 1 | — |

| | upper clay | lower greensand |
|---|---|---|
| Actaeonidea (Crenilabium) cf. elata v. Koenen 4) | — | 1 |
| Valvatina sp. | 1 | — |
| fragments of Natica and Turritella | × | × |
| fragments of Dentalium | — | × |

Some other mollusc fragments, too badly preserved for determination, occur in the sample »lower greensand».

1) The three specimens from the sample lower greensand possess the characteristic spiral ornament. Von Koenen and Ravn stress the variability of this species. The test may be almost smooth, so there is no doubt that the large number of smooth Turritella species must belong to this species.

2) The shape of this species resembles that of Turritella nana, but it is smooth except for the very fine spiral furrows, 12 on the last whorl of the large specimen.

3) Only small specimens with distinct initial ornament.

4) A small badly preserved specimen, whose whorls are a little more slender and flatter than is usual in this species. The columella — as far as can be observed — with a slight fold. Von Koenen described: Die Spindel trägt keine Spur einer Falte, sondern nur eine ganz flache und undeutliche Anschwellung.

Dr. H. Ödum concluded:

»The fauna from Ystad is not materially different from the fauna occurring in the sand, glauconitic sand and clay of the Paleocene at Copenhagen. Some species that are abundant at Copenhagen have not been found at Ystad, but this is of no stratigraphical importance.»

The samples available for these studies were small and only a few fragmentary species have been found. But on the other hand the samples of some hundred grammes show that a fauna rich in individuals and species occurs in this region of the Paleocene.

This rich fauna is also characteristic of the Paleocene boulders from the Ystad region. Fossils of these boulders have only been listed by Grönwall 1904 (Forsteningsförende Blokke fra Langeland, Sydfyen og Ärö). The boulders contain a mollusc fauna that is very similar to the fauna from the Paleocene at Copenhagen and the fauna described from erratic boulders in the German Quaternary by Roedel 1935 and 1937. But besides these small shells larger ones are abundant.

According to Dr. R. Hägg (personal communication) the boulders occur abundantly in the ground of the port. In 1913 such boulders were brought out when dredging the port, and they were collected by Dr. Hägg. On the shore about 2 km west of the port and in the boulder clay north of the port Tertiary boulders were also found in large quantities. All these boulders belong to the same types as described by Grönwall from the Danish islands. The following three types predominate:

1) rust-coloured sandstones
2) greyish glauconitic marls
3) glauconitic echinoderm conglomerate.

This shows the original sequence, beginning with the bottom conglomerate. This conglomerate does not differ from the conglomerate type at Klagshamn. The mastrix is a glauconitic clayish sandstone containing pebbles of limestone, phosphoritic nodules and coprolites of echinoderms and fish remains. The co-

lour of these facies is generally light greenish. In the bottom of one of these boulders is preserved the remains of brownish limestone with echinoderm faeces and a few glauconitic grains. This limestone type is described by Grönwall as »Crania limestone» and pebbles of the facies occur in the bottom conglomerate in the region of Klagshamn, especially in the surroudings of Tygelsjö. Boulders from the conglomerate layers are rare. Besides the fish remains, generally phosphatically preserved, only fragments of echinodermes are abundant. These fragments belong to Echinoidea, such as Echinocorys, to Crinoidea, such as Pentacrinus and Bourgueticrinus, and isolated plates of Asteroidea. All echinodermata fragments are redeposited from the Danian or from the so-called Crania limestone. Mollusc fossils occur rarely and I could only observe single specimens of Crania tuberculata and Dentalium sp.

The next type of boulders are such as consist of glauconitic marls. The rocks of this type change slowly from the conglomerate so that it is possible to observe all variant rocks from the conglomerate to the typical glauconitic marls. These boulders are characterized by the richness of fossils (Pl. 3, fig. 1. Pl. 4, fig. 1). If the boulders are undecomposed their colour is greyish with distinct green glauconitic grains and white shales. In the decomposed stage they are brownish and the glauconitic grains are indistinct, but the fossils are very distinct against the dark background on account of their white colour. Grönwall has listed 36 large fossils from these kind of boulders, but the boulders from the Ystad region seem to contain many more species of Lamellibranchiata and Gastropods. Arca, Cucculaea, Leda, Pectunculus, Tellina, Corbula and related forms dominate, gastropods are rare, except a smooth Turrilina, which resembles Turritella nana v. Koenen. This small gastropod is abundant and fills the surface of certain layers (Pl. 4, fig. 2). Sphenotrochus latus v. Koenen generally occurs as a rare species, but in several boulders it dominates and is concentrated as in Pl. 4, fig. 1. On some future occasion the author will try to describe this fauna in the boulders, especially that in this greyish marl type. In our collections this type is most common, about a hundred boulders.

It is necessary to distinguish two types of rust-brownish boulders. One of them is very porous, filled with fossils and containing decomposed grains of glauconite. This facies in many respects resembles the greyish marls just described and they have the same fauna. The other facies is also a sandstone but it is a loose one without glauconite, and its fauna is characterized by gastropods, such as Turritella and Cerithium. Grönwall in 1904 supposed this type of boulders to belong to the Eocene, but presumably they are also Paleocene, possibly a little younger than the foregoing ones. The concentration of Paleocene boulders at Ystad must be very large. Dr. Hägg observed that the majority of the Paleocene boulders from the bottom of the harbour, which were brought up during the dredging, were sunk again at another place. According to Grönwall and Sandegren's theory the bedrocks of the Paleocene boulders were situated east or north of Bornholm. If this theory is correct, the boulders must be distributed over a large area. The concentration of boulders at Ystad and their absence elsewhere demonstrates that they were transported

only a short distance and were sedimented at Ystad as a local moraine. Therefore it would seem reasonable to assume that the bedrocks of the boulders are immediately south of the shore of Ystad. The facies of the boulders is partly similar to the greensand in the profile »Gjuteriet», partly it belongs to some younger layers.

As stated on p. 5 remains of the Paleocene were observed at Balkåkra, about 7 km west of Ystad. The Paleocene remains have been found in a well on the farm of Per Andersson, 1.5 km south-west of Ruuthsbo and 0.6 km west of Sköndal. The sample from 40—41 m contains limestone mixed with quartz and glauconite grains. Danian foraminifera dominate but typical Paleocene ones also occur. A greensand seems to have been present in this profile, but the drillers did not take samples from these layers. The occurrence of Paleocene deposits west of Ystad inspires hopes that the Paleocene may be preserved also at other places along the border of the Alnarp depression.

## The Paleocene in the Maglehem Region.

In 1913 Sandegren described in detail three boulders with fossils from a sand pit situated about 2 km west of Maglehem. More correctly this pit is situated near the small village Lillehem on the road Maglehem—Lillehem (fig. 4). Boulders of the same character have been found by G. De Geer at the same place. They were labelled by him »Kritkalk med ovanligt väl bibehållna Lammellibranchier. Block 1 km NV om Lillehem».

NO om Nr 11 Maglehems socken
18 25/8 86 Kristianstads län
G. De Geer blad *Vidtsköfle*

..... »Cretaceous limestone with uncommonly well preserved Lammellibranchia. Boulder» (name of locality).

Later Dr. R. Hägg of Stockholm and Dr. A. Lundegren collected these light greyish boulders and deposited them in the State Museum of Natural History in Stockholm, Paleozoological Department.

During a short visit in August 1947 P. Geijer, Director of the Geological Survey, and the author found that these Paleocene boulders are not rare in the sand pit. Generally the sand in the pit is very fine and isolated layers contain gravels and boulders. The pit makes a cut in a broad hill and in its uppermost part, immediately below the surface of the plateau, there are larger boulders. They are all of almost the same dimensions, independent of their structure or age. Granite, Cambrosiluric, Cretaceous and Paleocene boulders are rarely larger than 15 cm in each direction. One of the soft Paleocene boulders is 6 : 11 : 19 cm.

In the boulders described by Sandegren the glauconite grains are very distinct, but in the boulders collected by De Geer the glauconite grains are small and uniformly distributed. The first type is light grey, the other is darker.

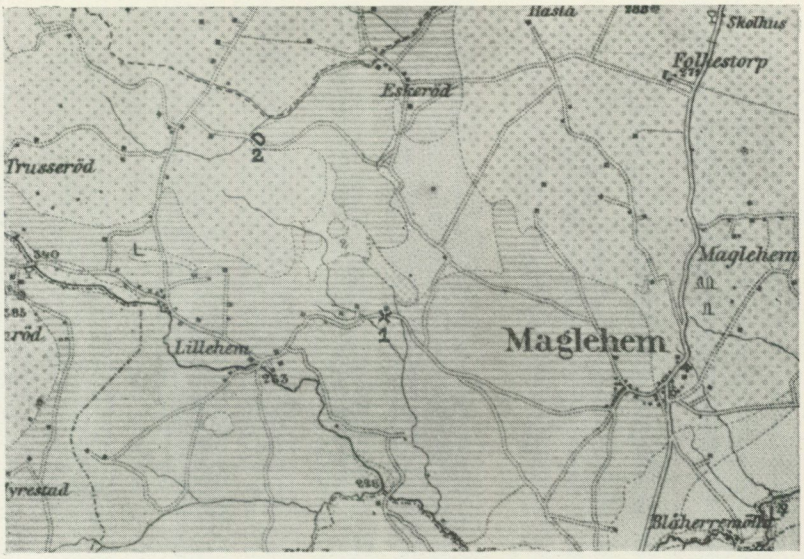



Fig. 4. Occurrence of Paleocene boulders in Maglehem Region.
1. Sand pit near Lillehem.
2. Sand pit »Trusseröd».
Horizontal striped area = fluvial glacial sediments.
dotted area = moraine.
Finely dotted area = postglacial sand.
From the geological map 1 : 50 000, sheet Vidtsköfle.

The two types occur together and we found boulders of both types with and without macrofossils.

The broad sandy hills of this region are described as fluvial glacial deposits and possibly the boulder layers below their surfaces are secondary enrichments by erosion.

The plain bearing the fluvial glacial hills is a moraine and contains other types of boulders. Paleocene boulders seem to be lacking in the lower moraine. The author could not find any Paleocene boulders in the sandy hills north and east of Lillehem, which are of the same geological range as the hills with the Paleocene boulders. On the other hand the sand in the pit of Lillehem-east is almost free from $CaCo_3$, but in a pit north of Lillehem near the farm Trusseröd, about one km north of the first point, the sand contains 27—30 % $CaCO_3$ in the shape of fine fragments of cretaceous fossils. These facts and the very soft material of the Paleocene boulders indicate the possibility that their original bedrocks were not far from the recent occurrence. Such bedrocks may also be preserved near Lillehem below the Quaternary deposits.

The macrofossils of these boulders resemble the fauna from the Ystad boulders. The number of species is larger than noted by Sandegren, this because the collection of boulders has increased.

Sandegren noted following species: Cucullaea sp., Pectunculus corneti v. K. Nucula sp., Leda biarata. v. K., Leda crassistria v. K., Leda ovoides v. K.,

Leda symmetrica v. K. Astarte sp., Tellina sp., Corbula cf. regulbiensis Morr., Dentalium rugiferum v. K., Dentalium undiferum v. K., Gadila intumescens v. K., Natica sp., Scalaria sp., Turritella nana v. K., Cerithium cimbricum Grönw., Aporrhais sp., Bulla clausa v. K., Cylichna discifera v. K.

Under the microscope the sections show a fine matrix with many fossil fragments, glauconite, some quartz grains, and a fine-crystalline filling in small cavities, e. g. foraminiferal chambers or cavities between fossil fragments. This filling consists of $SiO_2$, which on polarisation shows a spherical or very fine-grained structure (7—12 $\mu$ diameter) with an undulatory and irregular extinction. The occurrence of this $SiO_2$ filling in small cavities in the more coarse-grained sediment of Ystad demonstrates that the principles of sedimentation were the same in the same stage with different facies.

The stratigraphical range of the Maglehem boulders will be discussed in the next chapter.

## Stratigraphical and Ecological Analysis of the Foraminifera.

The macrofossils of the Paleocene have hitherto been very incompletely known. The molluscs from the Danish Paleocene recently published by Ravn (1939) are of no use for comparisons with fossils from other Paleocene occurrences, except the Swedish and North German ones. During the last twenty years very detailed descriptions have been published on American foraminifera from the Paleocene, and the Paleocene foraminifera of England, the Netherlands, North Germany, Denmark, Austria and Russia are also well known. On the whole it may be stated that the small foraminifera species of these various regions are very similar and many of them well distinguished from the Danian and Eocene species. On the other hand many of the Danian species also occur in the Paleocene, and Paleocene species reach into the Eocene. An analysis of the Swedish Paleocene foraminiferal fauna is therefore necessary for stratigraphical comparisons.

The method used here began with the determination and description of the species. Later larger samples of different layers were washed and fractionated. The size of the samples examined was 0.15—0.5 mm grain diameter. Fractions more than a half millimetre contain only big Lenticulina, Nodosaria and Polymorphina species, whose stratigrafical value is insignificant, and fractions below 0.15 mm grain diameter contain many young foraminiferal specimens that cannot be determined exactly.

My method for correlation is based on a count of the foraminifera in the fraction 0.15—0.5 mm. This method was described earlier in 1936, 1940, 1942. The technique is very simple: parts of the washed sample were spread out on glass plates engraved with a square net, each square 2 × 2 mm. The glass plate is moved under a Grenough microscope by a mechanical stage, so that the observer can count and determine all the foraminifera in a square. Each specimen observed is noted on a form containing the names of all foraminifera

species known and with space for new or very rare species. Normally 300 specimens are enough for stratigraphical correlations of large profiles. In special cases, when determining the occurrence of very rare species, the author counted about 1000 specimens in each sample.

The total number of specimens is counted with the aid of a small and handy apparatus, an *electrical message register* (fig. 5).

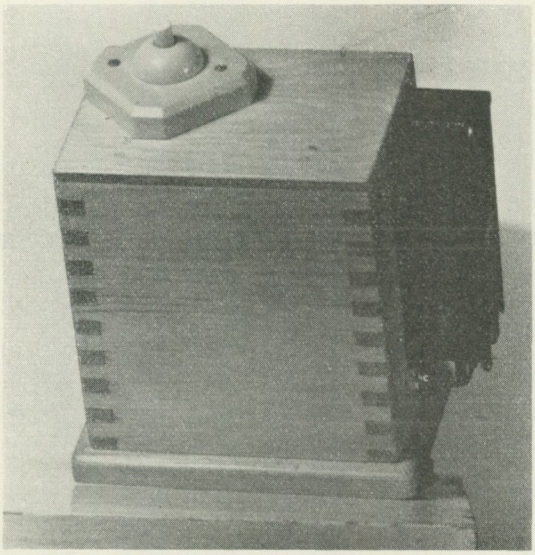


Fig. 5. Electrical counting apparatus, constructed by L. M. Eriksson, Sweden.

The observer can thus finish counting as soon as the desired total is reached. Assistents can do the counting if figures are provided of all species, and in doubtful cases they can pick out the specimens for control.

To begin with it should be stated that all the foraminifera species observed in the Swedish Paleocene also occur in the Paleocene at Copenhagen and Lellinge in Denmark. Their quantitative distribution in the various layers of the Danish Paleocene has not yet been studied in detail.

*Species with Arenaceous Tests:* Only 8 species of this group occur in the Swedish Paleocene. The others have been redeposited from the Danian and their number is unimportant (Tables I and II).

No specimens of this group occur in the calcareous samples from Maglehem. In the other samples the frequency varies between 11 and 38 per mille. This frequency would seem to be very small, for all the sediments are very arenaceous. Possibly the sediment grains were too large for the building of the tests, and it is stated that in the clayish sediments the frequency of arenaceous species and specimens increases.

Two of the eight species are known before from the Paleocene and are restricted to that formation:

**Table II**

*Frequency of Foraminiferal Groups in the Swedish Paleocene*

Arenobulimina cuskleyae .... known before from the Hornerstown formation
Bermudezina danica ..... known before from the Danish Paleocene and Northern Germany.

Spiroplectammina cf. laevis and Ataxophragmoides frankei are described from the Danish Paleocene and both occur already in the Danian in Denmark and Sweden.

Spiroplectammina wilcoxensis occurs in the Wilcox (lower Eocene) and in the Midway of Texas and Alabama and in the Hornerstown formation of New Jersey.

In the Danian, Paleocene and Eocene there has been found only Pseudoclavulina anglica, which is known from the Swedish Danian, North German

Paleocene, Danish Paleocene, Dutch Paleocene and Eocene, English Eocene, and from the »Paleocene» of the Caucasus region.

Arenobulimina mohréni is hitherto confined to the Swedish Paleocene. The occurrence of Pseudoclavulina anglica in the Paleocene is typical for the lowest zone in Denmark, the Netherlands and North Germany. In Sweden it occurs only in the higher clayish zone at Tygelsjö. Spiroplectammina wilcoxensis occurs very abundantly at all Swedish Paleocene localities and Arenobulimina cuskleyae is lacking only in the »Solnäs» clay. Bermudezina danica has not been found in the Ystad Paleocene, but this species is very characteristic for the Swedish, Danish and North German fauna.

To summarize it may be said that arenaceous foraminifera are rare in the Swedish Paleocene; their species occur from the Danian to the Eocene. They are described from Northern Europe and the Gulf states of North America, especially the Midway formation or formations of the same stratigraphical range. Arenobulimina cuskleyae and Bermudezina danica are characteristic for the Paleocene.

*The Family Miliolidae* is represented by four species only in the samples from the drilling »Gjuteriet» at Ystad. The frequency is small, only 15 specimens in the greensand and 13 in the clayish layer. All the species are known from the Eocene of the Paris basin, and one was described before from the lowest Paleocene at Copenhagen. In spite of the small frequency of the Miliolidae, their stratigraphical value is important. In the Upper Cretaceous of Northern Europe Miliolidae occur very rarely and only Spiroloculina and Quinqueloculina were recorded; in the Danish and Swedish Danian no Miliolidae occur. Miliolidae are, however, typical in all European Tertiary deposits. They are recorded from the Dutch and Caucasian Paleocene, and from the Paleocene of the Gulf states. The Paleocene species reach to the Eocene and become more predominant, and many new species are developed. Another interesting fact is the occurrence of Miliolidae only in the Paleocene of Ystad. All the samples available were studied carefully and many thousands of foraminifera were determined. The author can therefore state as a fact that Miliolidae are lacking at the other Swedish Paleocene localities. The stratigraphical range of the Ystad Paleocene is more or less the same as in the Klagshamn region, and in Denmark the same Miliolidae occur in the corresponding zones of the Lower Paleocene. The sedimentary characters are similar in the Ystad, Klagshamn and Copenhagen region. The occurrence or absence of such groups as Miliolidae in our samples can only be explained by the local restriction of several foraminifera groups, as in recent seas one species can be concentrated at one spot and be lacking only a few metres from there. This fact was very well described recently by H. Höglund: Foraminifera in the Gullmar Fjord and the Skagerak 1947.

*The Frequency of Lagenidae* in our samples varies between 12 and 60 per mille. A maximum number of species and specimens is observed in the clay of »Solnäs» and a minimum in the boulder of Maglehem. With our present knowledge a determination of Lagenid species is very difficult. Many of the species are in-

completely described and their stratigraphical range is doubtful. In my opinion groups of Lagenidae must be studied in a very large number of specimens from different horizons and different regions. The Lagenidae from our Paleocene samples are too few for such studies. A few big Robulus and Astacolus species are characteristic for the Paleocene and are described in the taxonomic chapter. Their frequency is not very great, but in a washed sample they are distinctly seen between other macrofossils. (Robulus klagshamnensis, Robulus discus, Astacolus paleocenicus.)

Species of the genus Lagena are very different in the sample from »Solnäs». The state of preservation is excellent and generally the species are not like those described before. All the forms described in H. W. Matthes's monograph (Die Lagenen des Deutschen Tertiärs, Palaeontographica. Bd 90, 1939) are quite different from the Lagena species of Solnäs. Other types known from the Cretaceous, especially from the Danian, are lacking in the Paleocene or those found in the Paleocene have been redeposited from the Danian.

Like the large Robulus and Astacolus species, a large and thick Palmula (Flabellina) is typical for the conglomerate layer at Klagshamn. Possibly this fossil is also redeposited in the Paleocene conglomerate, but not from the underlying Danian. These foraminifera have presumably been redeposited from the »Upper Crania Limestone» or calcareous layer of the same age, which is preserved in the region of Copenhagen.

Only one of the Lagenidae is of value as a good guide fossil for the Paleocene: Citharina plummoides. This species was erected from the Texas Midway; it is recorded from the Midway of Alabama and Arkansas, the Paleocene of Trinidad, Denmark, the Netherlands, Northern Germany, and possibly its geographical distribution is still wider. To sum up it may be said that

1) the Lagenidae have hitherto generally been of but little value for correlations;
2) exceptions are the large ornamented species of Robulus and Astacolus, which are local forms in the Swedish Paleocene;
3) one single Lagenid species is of value as a guide fossil: Citharina plummoides; it has been observed in the Paleocene of the United States, in Trinidad and Northern Europe.

*The Polymorphinidae:* The frequency of this group varies between 17 and 88 per mille; the number of species determined is 19. The fractions of washed samples with more than 0.5 mm grain diameter contain large specimens of Globulina, Guttulina and Pseudopolymorphina, except the samples from Maglehem. Polymorphinidae are also rare there in the samples below 0.5 mm. The highest frequency in the fraction 0.15—0.5 is observed in the clay of the Ystad well; in the greensand of the same well the frequency is 82 per mille.

The number of Polymorphinidae species increases rapidly in the uppermost Danian. 7 species of the Swedish Paleocene occur already in the Danian, 12 have been found in the Eocene or in younger formations. 3 species are confined to the Paleocene; they have been erected as new ones and possibly they have a larger stratigraphical distribution.

Thus it may be said that

1) the Polymorphinidae occur abundantly in the Swedish Paleocene;
2) they are a typical Tertiary element in the foraminiferal fauna of the Paleocene;
3) their geographical distribution and their stratigraphical range is very wide;
4) no species typical for the Paleocene have been found.

*The Buliminidea:* The author has made this group include the genera Bolivinopsis, Gümbelina, Bolivinita, Bulimina, Pyramidina, Angulogerina, Virgulina, Bolivina, and Loxostoma. Other authors have used other systems for these genera, but here this group is not a taxonomic one; it is used as an ecological unit and as a group for stratigraphical comparisons. Only the relationship of Bolivinopsis and Gümbelina to the other genera is questionable. The position of Bolivinopsis is very problematical and possibly the majority of the Gümbelina specimens are redeposited from the Danian.

Generally this group includes a great proportion of all the specimens in the samples, only exceeded in quantity by the Rotaliiformes. In the Tygelsjö region the Buliminidea are most numerous at »Solnäs», 154 per mille, and at »Vadst», 156 per mille. They are least numerous in the Ystad well, 33 and 52 per mille.

Gümbelina cf. globosa and Bolivinita selmensis occur already in the Maastrichtian and the latter reach into the Eocene. Closely related species of Bulimina rosenkrantzi, Bulimina paleocenica, Pyramidina crassa, Angulogerina wilcoxensis, Bolivina paleocenica, and Loxostoma applinae, are known from the uppermost Danian. Bulimina cf. ovata is possibly a species occurring in the lower and upper Tertiary, and Angulogerina wilcoxensis is abundant in the Upper Midway and Lower Wilcox of the Gulf states. Bulimina midwayensis also occurs in the Midway and possibly in higher formations; it is very closely related to species known from the Eocene and younger stages.

Angulogerina europea is found in the Thanet beds and in the Paloecene of the Paris basin; it also occurs in the Paleocene of the Caucasus. Loxostoma applinae is a guide fossil in the Upper Midway of the Gulf states.

Briefly it may be said of the Buliminidae that

1) they are an important part of the Paleocene fauna;
2) they are related to species of the uppermost Danian, some of them to the Eocene ones;
3) many of the Swedish Paleocene Buliminidae are distributed in the European, Caucasian and Gulf States Paleocene and demonstrate very well the communications between the various sedimentation regions in that period.

The last group of foraminifera, *the Rotaliiformes*, is the most frequent and, from a stratigraphical and facial point of view, the most important group. Between 73 and 90 per cent of all foraminifera in our samples belong to the Rotaliiformes. Two facies-groups are present and show the great difference between the Maglehem samples and all the others. The number of bentonic species is only 308 or 500 per mille in the Maglehem boulders, and only one of all the other localities contains less than 700 per mille bentonic specimens.

The Globigerinidae are the typical planktonic forms and only those are counted here as planktonic ones. The Globigerinidae occur abundantly in the Maglehem samples, between 40 and 56 per cent; in the other samples only 1—6 per cent. The fact that Globigerinidae are predominant, the arenaceous foraminifera lacking and the number of species is poorer than at other localities prompts the supposition that the sediment of the Maglehem boulder was sedimented in deeper water than at the other localities. This is also demonstrated by the fewer quartz and glauconitic grains in the Maglehem boulders.

Among the bentonic Rotaliiformes the Cibicides species predominate, especially Cibicides succedens, Cibic. proprius, and Cibic. simplex. The frequency of Cibicides and Anomalinoides varies from 38—62 per cent (excluding the frequency in the Maglehem samples).

The geological and geographical distribution of the several Rotaliiformes species varies strongly.

The Spirillinidae occur very abundantly in the uppermost Danian. They are also present in the Paleocene, but their number is very small. One of them, Spirillina nodifera, has a very wide distribution in the Paleocene and Eocene of Western Europe and in the Gulf states. Nonionidae are common in the Swedish Paleocene. This family is very rare in the Campanian, Maastrichtian and Lower Danian; in these formations the occurrence of the genus Nonion and Elphidium is very uncertain. Nonion and Eliphidiella occur rarely in the uppermost Danian and become abundant in the Paleocene. The Nonion in the Swedish Danian and Paleocene is very similar to Nonion graniferum from the Paris Eocene, but it may be another species. Elphidiella prima occurs in the Dutch, Danish and Swedish Paleocene and possibly also in the Paleocene of Northern Germany.

Species of the »Discorbis» group (Family Rotaliidae Brotzen 1942) are rare in all the samples and their species are of no consequence for the stratigraphy and facies (only valid for the Swedish Paleocene).

The frequency of Valvulinerinae may increase to 10 per cent. Only two of the nine species, Gyroidinoides octocammerata and Eponides toulmini, are known from the Upper Midway and lowest Wilcox of the Gulf states. Valvulineria laevis occurs in the Swedish Maastrichtian and Danian, Gavelinella bullata is very characteristic in the entire Danian, especially in its uppermost part. Possibly the few specimens of this species in the Paleocene are redeposited from the Danian. Gavelinella lellingensis has been found in the greensand of Lellinge (Denmark). Eponides lunata has the greatest frequency of all Valvulinerinae. In the upper Midway of Texas a closely related species, Truncatulina tenera Plummer, occurs very frequently. Perhaps »Eponides haidingeri» Ten Dam from the Dutch Paleocene is closely related to the Swedish species.

The great frequency of the Cibicidinae has already been commented upon. Their geological distribution is very varied. The types with the largest frequency are very closely related to Danian species, such as Cibicides proprius, Cib. constricta, Cib. succedens, Cib. voltziana; Cibicides simplex occurs also in the Danian. These species are recorded from the Dutch Paleocene, and

Cib. succedens from the Midway of the Gulf states. The other Cibicides species are not so characteristic, but they are generally very closely related to species from the Midway, Honerstown formation and Lower Wilcox in the U. S. A. Species of the genus Anomalinoides are not so frequent as the Cibicides species, but Anomalinoides danica is typical for all Danian and Paleocene localities in Sweden and Denmark. This fossil can be found in the fraction of washed samples over 0.5 mm grain diameter and is very easy to determine. Possibly it occurs also in the Dutch Paleocene. It is very common in the North German Paleocene (determined by Staesche and Hiltermann 1940 as Anomalina aff. grosserugosa Gümbel). Closely related species occur in the lowest Eocene of Germany.

Anomalinoides acuta and Anom. midwayensis occur in the Swedish-Danish Danian-Paleocene and in the Midway in Alabama and Texas; Anomal. aspera, which is very characteristic by its ornament, has been found only in the Ystad and Maglehem Paleocene.

The Globigerina species are well known from the Danian and they are very widely distributed in the Paleocene; they also occur in the Wilcox formation of the Gulf states. None of these Globigerina forms occurs in the Maastrichtian.

The Epistominidae are represented by 11 genera and 16 species in the Swedish Paleocene. The species Alabamina midwayensis, Alabamina dorsoplana, Coleites reticulosus, Coleites danicus and Karreria fallax occur already in the Danian, and two of them, Alab. midwayensis and Karreria fallax, only in its uppermost part. All the other are characteristically confined to the Paleocene. From the Danish Paleocene were recorded:

Höglundina scalaris
Alabamina midwayensis
Karreria fallax
Allomorphina halli.

Alabamina and Höglundina are recorded from the Thanet beds in England. The Alabamina species, studied on topotypes, is different from the Swedish ones, the Höglundina species possibly belongs to Högl. scalaris, but topotypes must be studied carefully. In the samples available from the Thanet beds Ceratobulimina tuberculata has been found, which demonstrates the communication between the Swedish-Danish and English Paleocene.

Epistominidae from the Dutch Paleocene are not easily compared with the Swedish ones, and Eponides gratus, described by Ten Dam, is possibly the same species as Alabamina solnäsensis or Alabamina midwayensis; Siphonina obliquecamerata Ten Dam is very closely related to Pulsiphonina elegans; Allomorphina trigona Ten Dam is not figured, but the Dutch Paleocene species seems to be like Allomorphina halli in the Swedish and American Paleocene.

The German Paleocene foraminifera are very incompletely described. The few species figured by Staesche and Hiltermann in 1940 are very difficult to determine, but Pulvinulina grata seems to belong to Alabamina midwayensis. This, however, must be controlled on topotypes.

A comparison between the Caucasian and Swedish Paleocene Epistominidae is not easy either. Glaessner in 1937 recorded:

Eponides exigua var. obtusa without figure
Lamarckina wilcoxensis
Siphonina prima without figure
Coleites reticulosus without figure.

The last species is undoubtedly the same as that occurring in Sweden, but the possibility exists that also the Alabamina (Eponides exigua var. obtusa) and Siphonina prima belong to forms known from Sweden.

It is surprising that especially the Epistominidae are very similar in the Gulf states and in the Danish-Swedish Paleocene. The following species from the Midway formation or formations of the same age have been observed in Sweden:

| | Lower Midway (Kincaid) (acc. H. J. Plummer) | Upper Midway (Will Point) (acc. H. J. Plummer) |
|---|---|---|
| Höglundina scalaris | — | very frequent |
| Epistominoides midwayensis | — | observed |
| Alabamina midwayensis | very rare | common |
| Siphonina prima (closely related to Pulsiphonina elegans.) | » » | frequent |
| Coleites reticulosus | — | very rare |
| Lamarckina naheolensis | — | Naheola formation (Upper Midway) *index fossil* |
| Ceratobulimina perplexa | — | very frequent also Naheola formation |
| Asterigerina prima, very closely related to Asterigerina nörvangi | — | very rare |
| Allomorphina halli | — | Hornerstown formation. |

Seven species are the same in the Midway and in the Swedish Paleocene and two of the Midway species are very closely related to Swedish ones. Six of these Midway species are confined to the Upper Midway and two of them must be regarded as guide fossils:

Lamarckina naheolensis
Ceratobulimina perplexa.

Here follows a brief summary of our knowledge of the Rotaliiformes:

1) They have the greatest frequency in the foraminiferal fauna of the Swedish-Danish Paleocene.
2) Two types of fauna have been observed: the fauna with a predominant frequency of Globigerinidae in the Maglehem boulder and the fauna with a predominant frequency of Cibicides and Anomalina species at all the other localities.
3) Many species of the Rotaliiformes are known from the Dutch, English, Caucasian, and Gulf states Paleocene.

4) The close relationship between the Rotaliiformes in the Swedish and American Paleocene is demonstrated by the Epistominidae. Their very specialized types are index fossils in the Swedish Paleocene and in the Upper Midway formation or formations of the same age as the Naheola formation. The author concludes that the Swedish Paleocene must be correlated with the Upper Midway formation in Texas.

## The Stratigraphical Range of the Swedish Paleocene.

The study of the Paleocene localities discloses that the Paleocene in Sweden as preserved is a few metres thick. At the bottom of the profiles there are generally conglomerates, higher up follow greensand and a dark clayish sediment. Remains of layers between the uppermost Danian and Paleocene conglomerates are preserved in the conglomerate. These remains consist of a greyish greensand limestone with fossils known from the Crania limestone in the Copenhagen region. The boulders from Ystad show a facies more or less like the greensand and the boulders from Maglehem contain a foraminiferal fauna like that in the Ystad Paleocene. The range of the different layers must be:

| | |
|---|---|
| Glauconitic Globigerina rocks or glauconitic sandstones | Ystad and Maglehem boulders |
| dark glauconitic and sandy clay | Ystad and Solnäs |
| glauconitic sandstone or sand | all localities and boulders |
| phosphatic conglomerate | Klagshamn, Ystad and boulders |
| glauconitic limestone with Crania tuberculata | Uppermost Danian, preserved only as remains in the conglomerate |

*The Danish Paleocene:* Correlations between the Danish and Swedish Paleocene are very easy. The entire Danish Paleocene may be up to 160 m thick. Studies of the fauna have mainly been published from the lower parts. The facies changes quickly from greensands to calcareous greensand and to limestones. Clayish layers are observed in the lower greensand series. A stratigraphy based on fossils has hitherto been lacking. The lowest part of the Danish Paleocene is known from the Copenhagen region. There only a few metres are preserved and their sequence is similar to that of the Swedish Paleocene. The macro- and microfauna is very much the same in Sweden and Denmark.

Thanks to the kindness of Dr. H. Ödum and Dr. H. Gry the author has been able to study the foraminifera of the »Kerteminde marls» and samples of a boring near Korsör (Gry 1935 p. 119). The foraminiferal fauna of the Kerteminde marls is very different from the foraminiferal fauna of Copenhagen and of the Swedish Paleocene. Besides the known species, many new ones occur and others have disappeared.

The Paleocene in the boring Hulby, near Korsör, is more than 100 m thick.

Gry noted: »All the Paleocene samples are typical, light-grey Kerteminde marl, with pyrite in small spheres and in the form of diatoms, usually the samples contain some sponge spicules. At some depths the rocks are partly silicified». The foraminiferal fauna in samples from the level 150—159 m is mixed with many Danian foraminifera. Higher in the profile occur Globigerina species, Cibicides proprius, Cibicides succedens, Pseudovalvulineria parvula (Ten Dam), Parrella expansa Toulmin, Allomorphina halli, and Alabamina midwayensis. Allomorphina halli becomes more abundant in the samples from the levels higher than 130 m and Textulariella varians Glässner occurs in all samples from the depth 130 m to the depth 50. Bulimina midwayensis and Bulimina trigonalis Ten Dam must be looked upon as index fossils for the upper part of the profile. This profile does not contain the index species of the lowest Paleocene (Ceratobulimina perplexa, Bolivina applinae); in its middle and upper parts the foraminiferal fauna is very similar to the Dutch Paleocene fauna. The various facies of the Danish Paleocene cannot yet be definitely correlated by their foraminiferal fauna. Probably the profile is:

| East Zealand | West Zealand & Fünen | Jutland |
|---|---|---|
| Cut out by erosion | Kerteminde marl | Clay (according to S. A. Andersen 1944) |
| Greensand with clayish layers | | |
| Phosphoritic conglomerate | missing | ? |
| Glauconitic limestone Uppermost Danian | | Bryozoa limestone |

Only the lower zones are represented in Sweden.

The Paleocene and its foraminiferal fauna in *the Netherlands* was very completely described by Ten Dam (1944, 1945). According to Ten Dam the sea transgressed, regressed and transgressed again during the Paleocene in the Netherlands. The composition of the foraminiferal fauna is different from the Swedish fauna, but many typical species occur both in the Swedish and in the Dutch Paleocene. Especially such types occur in both regions as are described from the entire Paleocene and not such as are confined to the lower zones. On the other hand the foraminiferal fauna of the Dutch Paleocene is very similar to the higher Paleocene in Denmark.

1. The Dutch Paleocene belongs to the same sea that transgressed over Denmark and Southern Sweden.

2. The foraminiferal fauna of the lowest Paleocene has not been found in the Netherlands.

3. Possibly the transgression began later in the Netherlands than in the Danish-Swedish region.

In 1940 Staesche & Hiltermann published a short description of the *German Paleocene* and its subdivisions, based on the foraminiferal fauna. This paper and its plates was intended to be used for practical stratigraphic work. Therefore detailed descriptions of the foraminifera were not given and the plates show the composition of the fauna in the various zones, and single species of

local stratigraphical interest. This work has been completed by a paper by Bettenstaedt, which likewise does not describe the foraminiferal species. The occurrence of several index foraminifera in the Swedish as well as the German Paleocene was demonstrated in the preceding chapter. The facies in the North German Paleocene is clayish and its thickness is up to 160 m. The deepest layer is a bottom conglomerate (Müller 1937) but the fauna of the lowest Paleocene has not been found in this layer. Also here the main transgression seems to have begun later than in southern Scandinavia. The upper part can be correlated with the higher zones of the Danish and Dutch Paleocene.

The lowest *English Paleocene* is different from the Swedish. The Thanet sand contains a foraminiferal fauna demonstrating the connections between the Scandinavian, German, Dutch and British seas. The Paleocene sea did not transgress into the British region until the Thanetian, and the Lower Paleocene with the Swedish foraminiferal fauna is lacking.

A correlation of the Paleocene in the *Basin of Paris* and in the *Belgian* depression with the Swedish Paleocene is very difficult. In a review Ten Dam (1947 Journal of Paleontol. Vol. 21, nr 2, p. 188) stated that the foraminiferal fauna of the French and Belgian Montian (lowest Paleocene) is like the fauna of the Bunde Limestone in the Netherlands. The foraminifera from the Bunde Limestone were described in 1946 by van Bellen (Foraminifera from the Middle Eocene in the Southern Part of the Netherlands Province of Limburg, Mededeelingen Geologisch Stichting, Series C. V. IV o. 4). As the title shows van Bellen considered that the Bunde Limestone must belong to the Middle Eocene. It is quite possible that the foraminiferal fauna is the same in the Montian and in the Bunde Limestone, but in that case the stratigraphical range of the »Montian» must be younger than Lower Paleocene. No typical Paleocene species are described from the Bunde Limestone but many of them occur in the Eocene, as stated by van Bellen. Samples of the »Sable de Bracheux» from the Paris basin contain a foraminiferal fauna with many species known from the Swedish Paleocene and some new species (Cibicides proprius, Cibicides succedens, Cibicides simplex, Anomalinoides acuta, Nonion cf. graniferum, Alabamina midwayensis and Angulogerina europaea). Thanet greensands from La Calonne, Belgium, studied by samples in the State Museum, Stockholm, contain well known foraminifera from the Swedish-Danish Paleocene:

Spiroplectammina wilcoxensis
Globulina gibba
Guttulina communis
» problema
» roemeri
Bolivinita selmensis
Bulimina cf. ovata
» » aspero-aculeata
» » rosenkrantzi
» » paleocenica
Nonion cf. graniferum
Valvulineria ravni
Cibicides succedens
» simplex
» rheinholdi
Alabamina midwayensis
Pulsiphonina sp.
Karreria n. sp. (lower and broader than Karreria fallax)
Asterigerina n. sp.

**Table III**

| | | Russia Caucasus | Russia Volga | Germany | Sweden | Denmark East ← → West | Netherlands North → South | Belgium | England | New Jersey | Alabama | Texas | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EOCENE | Lower | Eocene | Upp. Saratovian | Eocene | Missing | Lower Eocene | Lower Eocene | Ypersian | London Clay | | | | |
| PALEOCENE | Landenian / Thanetian | Flysch Goryatschij Kljutsch beds. | Low. Saratovian / Upp. Syranian | Clay | represented as erratic blocks | Kertminde marl / Clay | Kertminde facies / Marine transgressions | Landenian | Woolwich & Reading beds | Vincetown | Lower Wilcox form. | Lower Wilcox form. | |
| | | | | Conglomerate | | | | Heersian glauconitic sand | Thanet sand | | | | |
| | Seelandian | Pecten Zone | Low. Syranian | Missing | Clay / Greensand / Conglomerate | Lellinge greensand / Conglomerate | Kertminde facies / Continental facies | ? | Missing | Hornerstown form. | Naheola form. | Will Point form. | Midway form. |
| DANIAN | Upper | Danian ? | ? | Missing | Lime sands | Crania limestone Bryozoa chalk | Missing | Missing | Missing | ? | Sucarnoochee clay / Clayton | Kincaid form. | |

Foraminifera from the Paleocene near *Saratou* (*Russia*) have not been described, but already Archanguelsky pronounced that the molluscs from these layers are very similar to the Danish ones. It will be interesting to compare the foraminifera from these layers with those from our Paleocene. The Caucasian foraminiferal fauna was discussed in the preceding chapter.

In 1932 F. B. Plummer compared the *Midway group in Texas* with the Swedish-Danish Paleocene. In 1934 G. Scott discussed the age of the Midway group and compared the Midway with the Danian in Europe. In the present paper these problems cannot be discussed from other points of view than the correlation of the foraminiferal fauna. The following facts demonstrate the correlation between the European and the American Paleocene:

1. The foraminifera of the Swedish-Danish Danian are divided into two stratigraphical groups: The Lower and the Upper Danian. The Lower Danian group is characterized by Parrella lens and Cibicides voltziana. Both species are predominant in the Lower Danian, but they also occur in the highest zones of the Swedish-Danish Maastrichtian. The Midway Globigerinidae, Globigerina pseudo-bulloides and Globigerina triloculinoides, occur in the Lower Paleocene but are absent in the Maastrichtian in Sweden. In the Upper Danian, the »limesands of Klagshamn»and »Crania limestones», occurs a fauna very similar to the Paleocene in Sweden and to the Lower Midwayan of the Gulf States, characterized by Citharina plummoides, Pyramidina curvisuturata, Angulogerina wilcoxensis, Bolivina applinae, Bolivinita selmensis, Nonion cf. graniferum, Karreria fallax, Alabamina midwayensis.

2. In the Paleocene in Sweden and Denmark occur Elphidiella prima, Ceratobulimina perplexa, Höglundina scalaris, Epistominoides midwayensis, Lamarckina naheolensis and Allomorphina halli. All these forms are lacking in the uppermost Danian, and in the Gulf states they are confined to the upper part of the Midway.

3. The mollusc faunas in the erratic boulders of Ystad and in the Paleocene in Sweden and Denmark, on the one hand, and in the Paleocene of Saratow and in the Midway formation, on the other, seem to be more closely related than has hitherto been considered.

4. The Kincaid (Lower Midway) or formations of the same age in the Gulf states must apparently be correlated with the Upper Danian in Northern Europe.

5. The Will Point and the Naheola Formations or formations of the same age in the Gulf states must be correlated with the Swedish-Danish Lower Paleocene or Zealandian.

The relations of the Paleocene in the various regions are shown in Table III.

## Description of Foraminifera.

**Spiroplectammina cf. laevis** (Roemer).

Fig. 6, 1, (p. 38).

1840 Textularia laevis Roemer, Versteiner. d. norddeutschen Kreide, p. 97, Pl. 15, fig. 17.

Description.

Test subtriangular; rounded at the initial end; angle between the margins about 50°; transverse section thick, relation between thickness and breadth 1.0 : 1.8. Margins angular, but unflanged; chambers depressed; sutures fairly distinct, slightly curved; apertural face flattened; wall finely arenaceous, fairly smooth; chambers at the initial end arranged in a very small distinct spiral; variation of the specimens is slight.

Relations.

This species is characterized by the thickness, the broad angle between the margins, the depressed chambers and the smooth outside. It is similar to certain Cretaceous species, especially to Spiropl. laevis (Roemer), but it is very different from the species described from the Tertiary. Cushman 1940 and Cushman & Todd 1942 report Spiropl. laevis (Roemer) var. cretosa Cushman from the Midway of Alabama (C. C. L. Vol. 16, p. 52, Pl. 9, fig. 3. — C. C. L. Vol. 18, p. 25, Pl. 5, fig. 1). Those types belong to the same group as those from the Swedish Paleocene.

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[1] Table III, p. 32, shows that Eocene is lacking in Sweden. But in a lecture at »Geologiska sectionen in Upsala» on December 2nd (1947) Docent Hessland and Fil. dr. A. Cleve Euler demonstrated the occurrence of Eocene bedrocks near Åhus, Kristianstads län. Eocene clays with a thickness of 30 metres lie on Cretaceous sandstones. The occurrence of these Eocene bedrocks also supports the assumption that Paleocene bedrocks occur in the Kristianstad basin, as the author supposed on p. 19 with reference to the state of preservation of the Paleocene boulders in the Maglehem region.

Occurrence.

This type occurs rarely in the basal conglomerate and in the greensand at Ystad. At Klagshamn several specimens have been found in the bottom conglomerate and only a few in the greensand. In the clay at Tygelsjö it seems to be lacking. It is possible that specimens of this type are redeposited from the Upper Danian, which contains an abundance of Spiroplectammina species.

### Spiroplectammina wilcoxensis Cushman & Ponton.

Fig. 6, 2, (p. 38).

Spiroplectammina wilcoxensis Cushman & Ponton, 1932, C. C. L., Vol. 8, p. 51, Pl. 7, fig. 1 — Cushman & Garrett 1939, 1. c. Vol. 15, p. 78, Pl. 13, figs. 1, 2. — Toulmin, 1941, Journ. of Paleont. Vol. 15, p. 571, Pl. 78, fig. 1 — Cushman, 1944, Americ. Journ. of Science, Vol. 242, p. 8, Pl. 1, figs. 1, 2. — Cushman 1944, C. C. L. Vol. 20, p. 19, Pl. 3, figs. 26, 27. — Cushman, 1. c. Vol. 20, p. 29, Pl. 5, fig. 1 — Spiroplecta sagittula f. deperdita Franke, 1927, Danmarks Geol. Undersögelse, R. II. No. 46, p. 9, Pl. 1, fig. 5.

Remarks.

Types from the Swedish Paleocene are remarkably like the well described and figured species from the American Wilcox formation. But all the Swedish specimens are a little larger than those from the American Wilcox. The species from the Danish Paleocene, figured by Franke, has the same length and breadth as the Swedish one, but according to the figure by Franke it is more delicate, more compressed in the transverse section, and the last chambers are more depressed than the type. The Danish specimens agree essentially with those from Sweden and may be determined also as Sp. wilcoxensis.

Occurrence.

This species occurs in Sweden in all Paleocene localities, its frequency being about 2—3 %. In the samples of the Danish Lower Paleocene the frequency was found to be the same. This species is recorded in America from the Midway formation to the Wilcox formation.

### Arenobulimina cuskleyae Jennings.

Pl. 6, fig. 2.

Arenobulimina cuskleyae Jennings, 1936, Bull. Americ. Pal. Vol. XXIII, p. 13, Pl. 1, fig. 8.

Remarks.

The species is characterized by the elongate test, the last two whorls of which form the largest part of it, and by the obliquely depressed spiral suture. The Swedish specimens appear to be identical to those described by Jennings. In the same way as on the American species the wall is smoothly arenaceous with much cement, so that in some cases it is difficult to distinguish the arenaceous structure.

Occurrence.

The type occurs in the Honerstown formation of New Jersey. In Sweden it is quite a rare species in the conglomerate and in the greensand. The greatest

frequency is observed in the conglomerate at Klagshamn (1 %). The species is not found in the clay at Tygelsjö.

### Arenobulimina mohréni n.sp.

Pl. 6, fig. 1.

Diagnosis.

Test subglobular, like that of Ataxophragmium, initial end broad, rounded; apertural face large, slightly concave, parallel to the longitudinal axis of the test; first whorls indistinct, very small; the last whorl makes up the largest part of the test; sutures fairly distinct, only the last slightly depressed; wall smooth, with moderately large grains of sand; chambers simple without partitions.

Variation.

In the early stages the test is globular and cannot be distinguished from that of Ataxophragmium; in the later stages the specimens are more or less elongate and acquire the typical shape.

Relations.

The genetic position of this species is uncertain. In the early stages the chambers are arranged as in Ataxophragmium or in Ataxogyroidina Marie (Mem. Mus. Nation. d'Hist. Natur. Paris. N. S. tome XII. fac. 1, 1941, p. 53). In the adult the chambers form an elongate spiral, in which the test resembles that of Arenobulimina. In the early stage the aperture is rounded and in the adult rectangular. As regards the form of the aperture the species is very closely related to the genus Ataxogyroidina. The spiral arrangement of the chambers suggests that the species belongs to the genus Arenobulimina. It is one of the youngest representatives of this genus.

Occurrence.

This species occurs principally in the greensand and very rarely in the clay at Ystad.

Holotype: S. G. U. No. 13; Clay at Ystad.

### Ataxophragmoides nov. gen.

Diagnosis.

Test globular or subglobular, chambers undivided, without secondary partitions, arranged in a spiral. Aperture septal, interiomarginal, rounded or elongate, not virguline. Wall arenaceous.

Relations.

The genus is closely related to the genus Ataxophragmium Reuss and is distinguished from that genus by the undivided chambers, and by the lack of a uniserial stage. The new genus is distinguished from the genus Ataxogyroidina Marie 1941 by the simple wall, which never has septae into the chambers, and by the shape of the aperture, which in all cases is an elongate or rounded interiomarginal opening without ramifications.

Genotype: Ataxophragmoides frankei n.sp.
Occurrence: Upper Maastrichtian, Danian and Paleocene.

### Ataxophragmoides frankei n.sp.

Pl. 5, fig. 6 a—c.

Bulimina variabilis Franke, 1927, Danmarks Geol. Undersögelse, II. R. No. 46, p. 11, Pl. I fig. 7.

Diagnosis.

Test globular, fairly flattened, last whorls with 4—5 chambers, sutures distinct, slightly depressed. Apertural face flat or slightly convex, aperture rounded or crescent-shaped, wall coarse or smooth, mostly with solitary large grains of sand.

Variation.

This species varies mostly in the structure of the wall. One form has a very coarse wall with large grains of sand and only little cement between the grains. The wall of the others is smooth with much cement and but few large grains of sand.

Relations.

The shape of this species is only slightly different from the shape of the involute species of the genus Ataxophragmium e. g., Ataxophragmium compactum Brotzen or Ataxogyroidina crassa (D'Orb). It is distinguished from all species of the Campanian or older layers principally by the undivided chambers. Specimens from the Danian and Paleocene belong to the same species.

Occurrence.

This species occurs in the Swedish and Danish Danian and is comparatively abundant in certain layers. It is found in the Paleocene at Ystad, Klagshamn, Naffentorp and Tygelsjö. The same species occurs also in the uppermost Danian, so some specimens in the Paleocene bottom conglomerate may be redeposited from the Danian.

Holotype: S. G. U. No. 21. Ystad Gjuteriet 21 m.

### Bermudezina danica (Franke).

Pl. 5, fig. 3.

Gaudryina danica Franke, 1927, Danmarks Geol. Undersögelse, R. II, No. 46, p. 10, Pl. 1, fig. 4.
Gaudryina cf. danica Staesche & Hiltermann, 1940, Abh. Reichsstell. f. Bodenforschung N. F., Heft 201, Pl. 1, fig. 7.

Diagnosis.

Test begins triserial, triangular in the transverse section with distinct angles. Adult portion with 6—9 biserial chambers. Triserial portion short, 1/3—1/4 of the length. Chambers in the biserial portion increase very slightly in breadth and the margins are almost parallel. The cross section flat-oval. Sutures indistinct in the early part, depressed in the biserial part. Aperture

rounded with a short neck, directed obliquely upwards from the apex of the final chamber. Wall smooth and formed of very fine detritus.

Remarks.

Franke described this species as Gaudryina, but it is distinguished by the apertural neck from that genus and must therefore belong to the genus Bermudezina Cushman 1937. In his monograph on the Foraminiferal Family Valvulinidae, Cushman describes a species from the Eocene London Clay as Karreriella danica (Franke), (Cushm. Lab. Foram. Research, Spec. Publ. No. 8, p. 122, Pl. 14, figs. 20—22). This species is well distinguished from the Paleocene one by its valvulinide early portion, by the elongate aperture with an indistinct neck lying near the bottom of the final chamber, and by the broadly rounded section of the biserial part. The name of this English species must be »Karreriella danica Cushman», the holotype of which is the specimen figured in Pl. 14, fig. 20, Cushman 1937, from the Eocene Clay, Beddington Lane, Surrey, England.

Bermudezina danica (Franke) is similar to the genotype Berm. cubensis Palmer & Bermudez, which has a longer triserial part and the biserial portion of which is not so greatly compressed as that portion of the Danish species. My collection includes many topotypes of »Gaudryina danica» and I was able to study Franke's originals in the collection of the Danish Geological Survey. The specimens of this species are alike in Sweden and Denmark and their initial stage is triserial, not valvulinide.

Occurrence.

According to Franke this species occurs very rarely in the clay facies of the Danish Paleocene (Sundkrogen). It occurs rarely also in the Swedish Paleocene and only a few specimens have been found in the greensand at Klagshamn and in the clay at Tygelsjö (Solnäs). Length of the types 0.4—0.5 mm, breadth 0.20—0.23 mm.

### Pseudoclavulina anglica Cushman.

Pl. 5, figs. 1, 2.

1886 Clavulina communis Sherborn & Chapman Journ. Roy. Soc. Ser. 2. Vol. 6, p. 743, Pl. 15, fig. 1.
1927 Clavulina parisiensis Franke, Danmarks Geol. Undersögelse, R. II, No. 46, p. 10, Pl. I, fig. 6.
1936 Pseudoclavulina anglica Cushman, Spec. Publ., No. 6, Cushm. Foram. Lab., p. 18, Pl. 3, fig. 5.
1937 ——— Cushman, Monograph Foram. Fam. Verneuilinidae p. 111, Pl. 15, fig.s 26, 27.
1937 Clavulina parisiensis Gläßsner, Problems of Paleont. Vol. II, p. 353.
1940 Clavulina communis Staesche & Hiltermann, Abh. Reichs. Bodenforschg. N. F. H. 201 Pl. 4, fig. 3, Pl. 36, figs. 2, 4, 5.
1944 Pseudoclavulina anglica Ten Dam, Med. Geol. Stichting, Ser. C. V. 3, p. 84.

Remarks.

Specimens from the Danish and Swedish Paleocene are but slightly different from those of the English Eocene according to Cushman's description and figures. They may be larger and the sutures more depressed than on the specimens from the London Clay.

Occurrence.

This species seems to have a wide stratigraphical range. Typical forms of it occur in a clayish facies of the Swedish Upper Danian. In the Paleocene I have found this species only in the clayish greensand at Solnäs-Tygelsjö. In the Danish Paleocene clay this species occurs very abundantly; also in the German Paleocene clay it seems to occur commonly; in the Dutch Paleocene it is rare.

**Pseudoclavulina sp.**

Specimens of a large Pseudoclavulina with a coarse wall, chambers which do not increase in breadth, and very indistinctly depressed sutures are not rare in the bottom conglomerate of the Paleocene at Klagshamn. They are redeposited from the Danian and belong to a species resembling rough forms of Pseudoclavulina clavata Cushman from the Taylor formation. Besides this species also other arenaceous foraminifera occur in the bottom conglomerate, undoubtedly redeposited from the underlying Danian. These forms belong to Marssonella oxycona (Rss), Arenobulimina n.sp., Eggerella n.sp., and Gaudryina cf. faujasi (Rss).

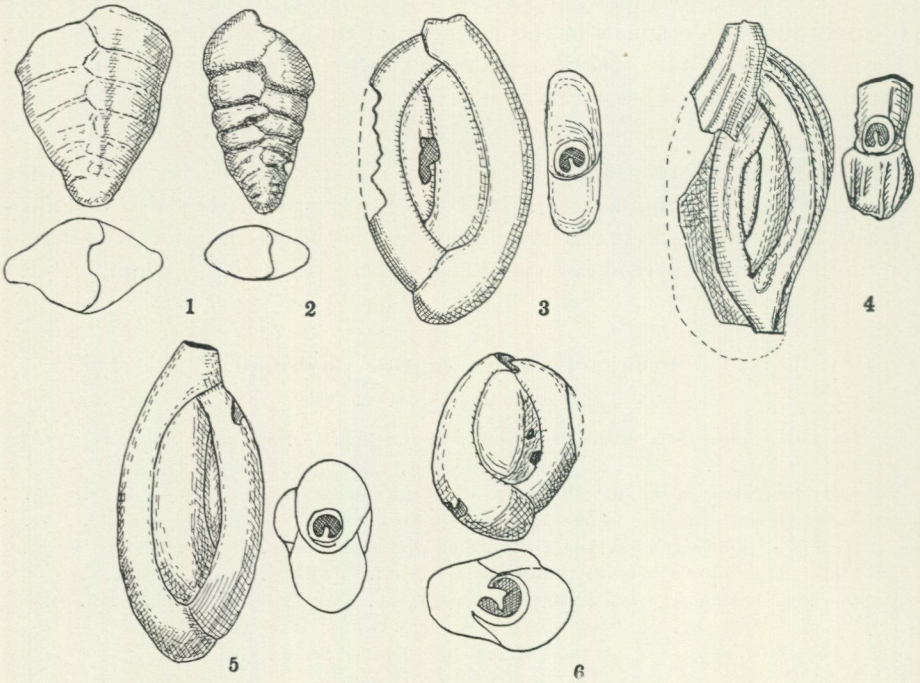


Fig. 6.

1. Spiroplectammina cf. laevis R. Ystad gjuteriet 21 m.
2. Spiroplectammina wilcoxensis Cush. & Pont. Ystad gjuteriet 20 m.
3. Spiroloculina inflata Terquem. Ystad gjuteriet 20 m.
4. Spiroloculina tricarinata Terquem. Ystad gjuteriet 21 m.
5. Quinqueloculina cf. plana D'Orb. Ystad gjuteriet 21 m.
6. Triloculina inflata D'Orb. Ystad gjuteriet 21 m. All figures 50 ×.

**Spiroloculina inflata Terquem.**

Fig. 6, 3.

Spiroloculina inflata Terquem (part) Mém. Soc. Geol. France, Ser. 3. 1882, Vol. 2, p. 156, Pl. 16, fig. 7. — Cushman & Todd, Cushm. Lab. Spec. Publ. No 11, 1944, p. 8, Pl. 2, figs. 13—16.
Spiroloculina proboscidea Schwager, Paleontographica, Vol. 30, 1883, p. 84, Pl. 24, fig. 3.

Remarks.

Specimens from the Swedish Paleocene do not correspond to the species illustrated in Terquem, fig. 7. But they are very closely related to the species figured by Cushman & Todd and by Schwager. The Paleocene species varies in proportions and also in regard to the shape of the neck.

Occurrence.

The type occurs in the Eocene of the Paris Basin and in the Libyan Desert (Lower Eocene). The occurrence in the Lower Oligocene at Brandhorst, Germany, is uncertain. In the Swedish Paleocene it is rare in the clay and greensand at Ystad.

**Spiroloculina tricarinata Terquem.**

Fig. 6, 4.

Spiroloculina tricarinata Terquem, Mém. Soc. Geol. France, ser. 3. Vol. 2, 1882, p. 158, Pl. 16, figs. 19—21. — All other synon. by Cushman & Todd, Cushm. Lb. Spec. Publ. No. 11, 1944, p. 10, Pl. 1, fig. 10, Pl. 2, figs. 19—23.
Miliolina ferussacii Franke, Danmarks Geol. Unders. 1927, II. R., No. 46, p. 8, Pl. 1, fig. 2.

Remarks.

The specimens available seem to correspond well to the figures by Cushman & Todd. The ridges on the chambers are fine and normal. In the adult the chambers present one or two costae between the ordinary ridges. The shape of the test is not different from the types figured by Terquem. The figure given by Franke of a specimen from the Danish Paleocene, named Miliolina ferussacii, evidently belongs to Spiroloculina tricarinata Terquem.

Occurrence.

The type occurs in the Lower Eocene of France; the species is abundant in the clay and in the greensand at Ystad; it is rare at Sundkrogen, Denmark.

**Quinqueloculina cf. plana D'Orb.**

Fig. 6, 5.

Terquem, Mém. Soc. Geol. France, 1882, Ser. 3. Vol. 2, p. 174, Pl. XVIII, figs. 20, 21.

Remarks.

The specimens of the Swedish Paleocene vary between slender and broad types, like those figured by Terquem. They have apertures with a simple tooth on their inner margin, which is lacking in Terquem's figures. Cushman & Garrett (C. C. L. Vol. 15, p. 78, Pl. 13 fig. 4) figure a Quinqueloculina sp. which seems to be closely related to those of the Swedish Paleocene, but the transverse

section has never been figured. Cushman & Garrett state that this species from the Wilcox of Alabama resembles Quinqueloculina lucens Schwager, a type without a tooth in the aperture and with a thicker transverse section than the specimens from the French Eocene and the Swedish Paleocene.

Occurrence.

This species is not uncommon in the greensand and the clay at Ystad.

**Triloculina inflata D'Orb.**

Fig. 6, 6.

Terquem, Mém. Soc. Geol. France., 1882, Ser. 3, Vol. 2, p. 165, Pl. XVII, figs. 4—6.

Remarks.

This simple species varies in the outline between rounded and elongate types. The tooth in the inner margin of the aperture rises directly from the wall of the last chamber but one. The position and the shape of the tooth are characteristic of this species. Types related to Tr. inflata are described from the Midway (T. laevigata Plummer) and from the Louisiana Eocene (T. mindenensis Howe).

Occurrence.

This species occurs rarely in the greensand and in the clay at Ystad.

**The species of the family Lagenidae.**

Many species of this family are described from the Cenozoic System, but only a few can be used as guide fossils. For a locally limited region they may be of stratigraphical value, because the Lagenidae are greatly dependent upon the characters of the sediments. It is often difficult to determine the Lagenidae, for their variation is generally great and they are incompletely studied. The use of the genetic names is different, too; e. g. Cushman made a definite distinction between Lenticulina, Robulus, Planularia, and Saracenaria, but used Marginulina for very different types of Lagenidae. On the other hand, in his »Manual» 1933 Galloway erected two genetic lines of Lagenidae and reintroduced many invalid names. The revision of the genera Marginulinopsis, Vaginulonopsis and Hemicristellaria by Thalmann in 1937 is of interest, as also the introduction of the new family Enantiomorphinidae by P. Marie in 1941.

Many European palaeontologists have attempted a simplification and used the collective name Cristellaria for all coiled and coiled-linear forms. It seems to me that a revision of the Lagenidae is necessary, and it is best to begin with the old forms from the Permian, Trias or Jura, for in these formations the Lagenidae dominate, studies of their variations are easy to make, and most of their recent genera occur already in this stage of evolution.

Lagenidae occur abundantly in the Swedish Paleocene; their frequency in the foraminiferal fauna fluctuates between 2.3 and 5.7 %. But most of them are much alike and very difficult to determine. The majority of the species resemble the Tertiary ones; only some of them are closely related to Cretaceous

ones. In the following are described only a few and well characterized forms. The other species belong to groups described as:

Lenticulina multiformis (Franke)
» oblonga »
» (Robulus?) beyrichi (Roemer)
Robulus inornatus (D'Orb.)
Vaginulinopsis(?) crepidula (according to the interpretation of Burrows and Holland in 1897)
Dentalina communis D'Orb.
» obliqua Linné
Nodosaria affinis Reuss
» raphanistrum (Linné)
» polygona Reuss.

The frequency of the species of Lagena is great and their state of preservation is excellent in the clayish sediment of the region of Tygelsjö.

**Robulus klagshamnensis n.sp.**

Pl. 7, figs. 1, 2.

1885 Cristellaria cf. clypeiformis Koenen, Abh. Kgl. Ges. Wiss. Göttingen, Vol. 32, p. 108, Pl. 5 fig. 14.
1927 Cristellaria osnabrugensis Franke, Danmarks Geol. Unders., R. II, No. 46, p. 27, Pl. 2, fig. 14.

Diagnosis.

Test large, diameter up to 4 mm, strongly depressed, peripheral margin distinctly winged. Centre plug small, fairly elevated, often divided into small tubercles. Chambers 7—12 in the last whorl, sutures distinct, raised near the centre, diminishing towards the periphery, curved. Aperture long, radiate, wall smooth.

Remarks.

This flat and winged form varies in the number of chambers, in the raising of the sutural ribs and in the form of the peripheral wing. In the young the specimens have fewer chambers in the last whorl than have the adults. The raising of the ribs is strongest in the middle part of the specimens, they are more indistinct in the initial stage, and on many large specimens they are not so strongly raised between the last chambers. The winged periphery is a good character of this species, but the wing may be lacking in the last stage. There is no doubt but that the very compressed type described by Koenen as Cristellaria cf. clypeiformis from the Danish Lower Paleocene is of the same species as those occurring in the same stratigraphical range in Sweden. Robulina clypeiformis D'Orb is not related to this form. Franke's determination of these large, strongly compressed and costated forms as Cristellaria osnabrugensis v. Mst is easy to understand, because the Oligocene species is very closely related to the Paleocene one. According to Reuss's description and his figures, the Oligocene species has more elevated ribs, the periphery is not so strongly winged, and the centre is a different shape. As regards the generic

range Cushman reintroduced the genus name Planularia Defrance in 1824. According to Cushman this genus is characterized by the compressed test, and consequently most of the Paleocene types belong to this genus. But it is not easy to distinguish between Robulus and Cristellaria, on the one hand, and Planularia, on the other, because forms such as Robulina klagshamnensis and Robulus discus are quite convex in the initial stage and acquire the flat shape as adults.

Occurrence.

This species occurs very rarely in the greensand and conglomerate at Klagshamn. It is only found in a large material and only in the fractions over 0.5 mm. It is possible that it occurs also at the other localities, but the samples from there were small. According to Franke this species is not uncommon in the Danish Lower Paleocene.

Holotype: S. G. U. No. 2234 Klagshamn, conglomerate.

**Robulus discus n.sp.**

Pl. 7, fig. 3—5; text-fig. 7.

Diagnosis.

Test large, diameter up to 4 mm, convex in the young, strongly compressed in the adult. Peripheral margin acute or slightly keeled, generally lobated at the last sutures. Umbo distinctly elevated, small. Chambers 6—9 in the last whorl. Sutures distinct, curved, transparent, not or only very slightly depressed, rarely finely costated. Aperture long, radiate at the upper end. Wall smooth, rarely with solitary ridges crossing the sutures.

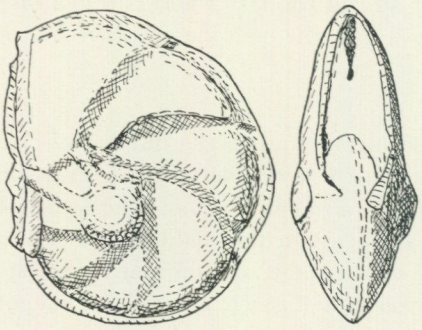

Fig. 7. Robulus discus n.sp. Ystad gjuteriet 20 m. 22,5 ×.

Remarks.

This species varies in the shape of the peripheral margin, which may be more or less keeled, in the number of chambers and in the form of the sutures. The umbo is very variable in the degree of elevation; in certain specimens it is only slightly elevated over the rest of the test and in others it is a well-marked plug of transparent matter. This species is very closely related to the preceding species, Robulus klagshamnensis, but its character is well distinguished; Robulus discus has never a winged peripheral margin, the margin is often

incised, a character never observed in Robulus klagshamnensis. The sutures of this species are never so well costated and there are generally fewer chambers in the last whorl than in R. klagshamnensis.

It is possible that Cristellaria depauperata Franke 1927 belongs partly to this species, except the specimens, figured in Pl. II, fig. 1. Cristellaria depaupera Reuss is a compressed species from the Oligocene, which according to Reuss is more involute and possesses fewer chambers than R. discus. The type figured by Franke cannot either belong to Cristellaria depaupera Reuss.

Occurrence.

Robulus discus is also a rare species in the Paleocene samples and is found only among fractions of grains with a diameter of more than 0.5 mm. Specimens are found in all layers of the Klagshamn and Ystad Paleocene, in the greensand at Naffentorp and in the clay at Tygelsjö. This species is not uncommon in the uppermost Danian, but in this formation it generally has fewer chambers in the last whorl.

Holotype: S. G. U. No. 2226 Klagshamn, conglomerate.

**Astacolus paleocenicus n.sp.**

Pl. 7, fig. 7 a, b; text-fig. 8.

Diagnosis.

Test large, up to 5 mm, flattened, breadth more or less uniform in the adult, inner margin slightly concave, truncated, periphery slightly convex or truncated, with a thin narrow keel. Sutures transparent, the last ones fairly depressed. Wall with numerous, fine elongate and raised ridges running across the sutures, often interrupted over the sutures, on the last chambers the ridges disappear.

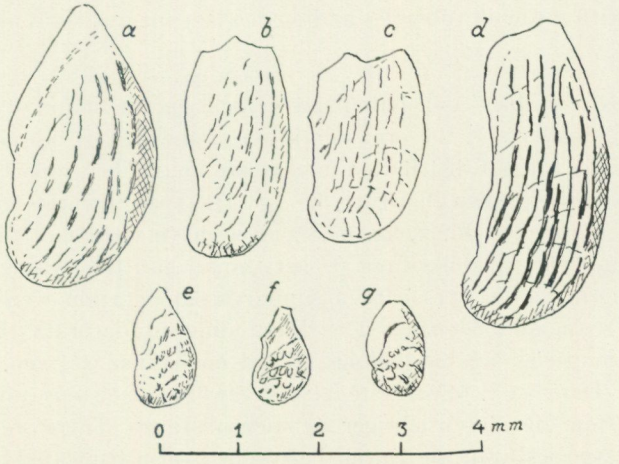


Fig. 8.

a—d. Astacolus paleocenicus n.sp.
a, c, d. Klagshamn conglomerate.
b. Ystad gjuteriet 21 m.

e—g. Astacolus gryi n.sp.
e, f. Klagshamn greensand.
g. Ystad gjuteriet 21 m.

Relation.

This species is one of the group »Cristellaria asperula Gümbel». To this group belong flat ornamented types, such as Cristellaria asperula Gümbel, Eocene (Abh. Bayr. Akad. Wiss. Vol. 10, 1868), Cristellaria subaculeata Cushman var. tuberculata Plummer (Univ. Texas Bull. 2644, 1926) and Cristellaria asperuliformis Nuttal (Journ. Pal. Vol. 4, 1930). Astacolus palaeocenicus is distinguished from the other forms by the rows of ridges on the wall, by the truncated inner margin and by the keeled periphery. All other species have rows of tubercles on the chambers, but never thin elongate ridges. No Eocene specimens of Cristellaria fragraria (according to Burrows & Holland 1897) ever show the same ornamentation as the new species. Another character of this species is the strongly flattened shape. The specimens vary in the form of the ridges and in the dimensions of the tests (Text-fig. 8 a—d).

Occurrence.

One specimen has been found in the greensand at Ystad. At Klagshamn the species is not uncommon in the conglomerate. Numerous specimens have already been found in the uppermost Danian at Ystad and Klagshamn.

Holotype: S. G. U. No. 37, Ystad, gjuteriet 21 m.

**Astacolus gryi n.sp.**

Pl. 7, fig. 6; text-fig. 8.

Diagnosis.

Test elongate oval, spiral stage biconvex, three or four chambers in the broad compressed and flattened linear stage. The inner margin of the linear stage truncated and the periphery also truncated and with a narrow keel. Sutures distinct, in the beginning transparent, with single tubercles, in the linear stage with a row of tubercles and on the last sutures fairly raised ridges.

Remarks.

This species resembles Astacolus palaeocenicus in the shape of the test. It is very much smaller and the ornamentation of the wall is not so prominent and the tubercles are not distributed in elongate lines. The proportion between these two species is shown in figure 8 e—g. The species varies in ornament. The holotype figured in Pl. 7, fig. 6, is one with very distinct tubercles. On other specimens the tubercles may be very small and the raising of the last sutural ribs indistinct. Types with a similar ornamentation were figured by Ten Dam in 1944 and determined as Vaginulinopsis decorata (Reuss). The figures of this species are more elongate and no section is given. In his description Ten Dam said: »Stirnseite etwas gewölbt, meistens mit niedrigen lateralen Leisten aus durchsichtiger Schalensubstanz.» Therefore, it is possible that the species from the Dutch Paleocene is also truncated on the inner margin of the elongate linear stage, and then it is the same species as the one found in the Swedish Paleocene. The type of Cristellaria decorata Reuss was found in a marl, the age of which Reuss determined to be Upper Cretaceous.

According to recent studies the marl with Cristellaria decorata Reuss in northern Germany belongs to the Upper Eocene and thus Crist. decorata is closely related to Cristellaria fragraria Gümbel. These types are not truncated on the inner margin of the linear state.

Occurrence.

The small and typical species is rare in the Paleocene conglomerate and greensand at Klagshamn and it is very rare in the greensand at Ystad. The author is of opinion that Astacolus gryi is a species that has evolved from Astacolus palaeocenicus.

Holotype: S. G. U. No. 2239 Klagshamn, conglomerate.

### Citharina plummoides (Plummer).

Pl. 5, figs. 4, 5.

Vaginulina plummoides Plummer, 1926, Univ. Texas Bull. 2644, p. 120. Pl. 5, fig. 4. — Cushman, C. C. L. Vol. 16, 1940, p. 61, Pl. 9, fig. 26. Cushman & Renz, C. C. L. Vol. 18, 1942, p. 6, Pl. 1, fig. 6. — Cushman & Todd, C. C. L. Vol. 22, p. 55, Pl. 9, fig. 20. Vaginulina strigillata Franke, 1927, Danmarks geol. Unders. R. II, Pl. 19, Pl. 1, fig. 29. — Staesche & Hiltermann, Abh. Reichsstelle f. Bodenforsch. N. F. Heft. 201, Pl. 45, fig. 5. — Ten Dam, 1944, Mededeel. geol. Stichting, ser. C—V—3, p. 100, Pl. 1, fig. 3.

Remarks.

This species is very typical in Paleocene sediments and is characterized by the fine marking on the surface and by the narrow chambers. Its outline varies, but the concave initial end distinguishes the species from closely related forms. Many specimens of the Swedish Paleocene have the same outline as the type figure. The specimen Pl. 5, fig. 4, 5 is narrower than the type. Specimens of the Danish Paleocene do not differ from the topotypes from the Midway.

Occurrence.

This species occurs as a rare form in the uppermost Danian and in the entire Swedish Paleocene. It has not been found hitherto in the sediments at Ystad, possibly the samples studied were too small. According to Franke the species is not rare in the Lower Danish Paleocene; in Holland it occurs in the upper part of the Paleocene (Ten Dam).

### Palmula (Flabellina) robusta n.sp.

Pl. 8, figs. 4, 5; text-fig. 9.

Diagnosis.

Test large, up to 6 mm, breadth: length = 1 : 1.3 up to 1 : 1.8. Outline oval, greatest breadth near the middle. Sides almost plane, sutures very distinct, generally fairly raised. The initial end like that of Frondicularia, only a rest of a spiral; proloculum globularly elevated, with two or three distinctly raised ribs.

Remarks.

This large and flat species resembles Palmula elliptica (Nilsson), but most of the specimens are not so elongate; they are broader than the Cretaceous species. A distinct character, which distinguishes this species from Palmula elliptica, is the globularly raised and ornamented proloculum. Generally the specimens have the same initial stage as Frondicularia and no spiral stage. On a few specimens the aperture of the proloculum lies laterally to the middle axis and the next chamber is not symmetric, so that two or three chambers

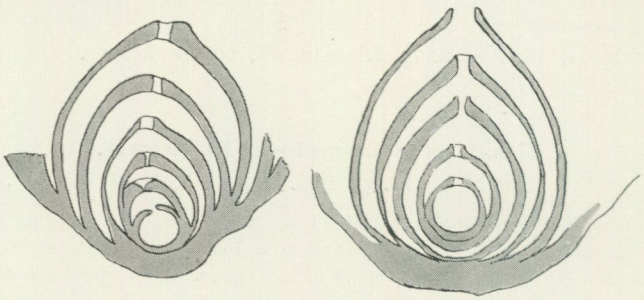

Fig. 9. Palmula robusta n.sp. Klagshamn conglomerate. 25 ×.

remain as a spiral. Microspheric types like those reported by the author in 1937 as Palmula elliptica from the Swedish Danian are not present among the species of the Paleocene.

Occurrence.

This species is only found in the conglomeratic layer at Klagshamn. A half-litre-sample seems to yield one specimen. In very large samples of the upper greensand at Klagshamn I could not find this species, so it may be a guide fossil for the lowest part of the Swedish Paleocene.

Holotype: S. G. U. No. 2249 Klagshamn conglomerate.

### The family Polymorphinidae.

Species of the family Polymorphinidae are abundant in the sample from Ystad. They are exceptionally well preserved. Many specimens are redeposited from the Danian but their state of preservation shows that the same species was living in the Danian and Paleocene. When a species is described in Cushman & Ozawa (Proc. Unit. Stat. Nat. Mus. Vol. 77, art. 6, 1930), it is only mentioned here with reference to that work. Their occurrence in Sweden will be seen Table I.

#### Globulina gibba D'Orb 1826.

Fig. 10, 1, 2.

Cushman & Ozawa, 1930, p. 60, Pl. 16, figs. 1—4.

#### Globulina inaequalis Reuss.

Cushman & Ozawa, 1930, p. 73, Pl. 18, figs. 2—4.

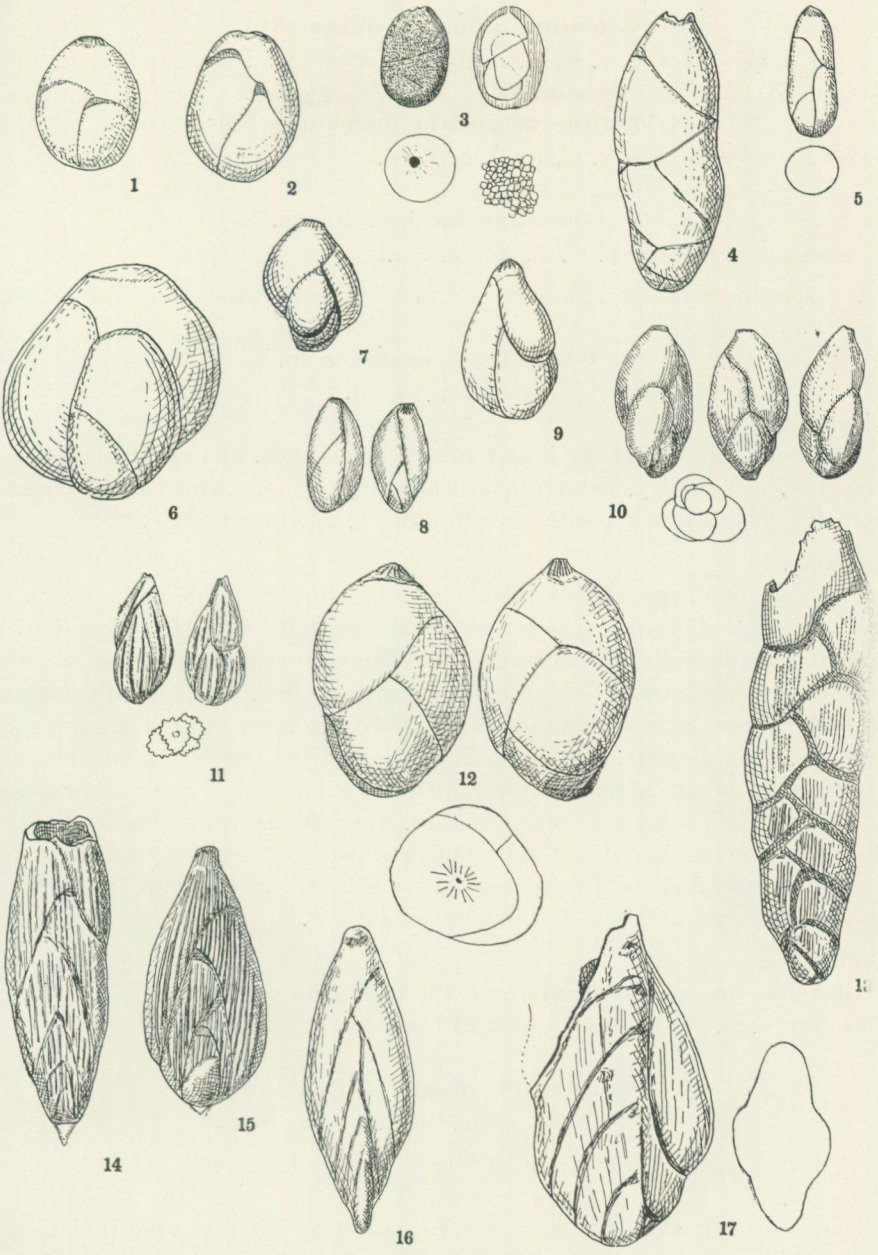

Fig. 10.

1, 2. Globulina gibba D'Orb. Ystad gjuteriet 20 m. — 3 a—d. Globulina arenacea n.sp. Ystad gjuteriet 21 m. — 4. Pyrulina fusiformis Roemer. Ystad gjuteriet 20 m. — 5. Pyrulina cf. thouini D'Orb. Ystad gjuteriet 21 m. — 6. Guttulina communis D'Orb. Ystad gjuteriet 20 m. — 7. Guttulina problema D'Orb. Ystad gjuteriet 20 m. — 8. Guttulina lactea Walker & Jacob. Ystad gjuteriet 20 m. — 9. Guttulina hantkeni Cush. & Ozawa. Ystad gjuteriet 20 m. — 10, 11. Guttulina spicaeformis. Roemer. Ystad gjuteriet 20 m. — 12. Guttulina roemeri Reuss. Ystad gjuteriet 20 m. — 13. Pseudopolymorphina paleocenica n.sp. Ystad gjuteriet 20 m. — 14. Pseudopolymorphina geijeri var. angusta. Ystad gjuteriet 20 m. — 15. Pseudopolymorphina geijeri n.sp. Ystad gjuteriet 20 m. — 16. Sigmomorphina soluta n.sp. var. lata. Ystad gjuteriet 20 m. — 17. Sigmomorphina pseudoregularis Cush. & Thomas. Ystad gjuteriet 20 m.
All figures 30 ×.

**Globulina ampulla Jones** 1852.

Cushman & Ozawa, 1930, p. 79, Pl. 19, fig. 9.

**Globulina rotundata Borneman** 1855.

Cushman & Ozawa, 1930, p. 86, Pl. 21, figs. 3—4.

**Globulina lacrima Reuss.**

Cushman & Ozawa 1930, p. 77, Pl. 19, figs. 1, 2.

All specimens in the Paleocene are possibly redeposited from the Danian.

**Globulina arenacea n.sp.**

Fig. 10, 3 a—d.

Diagnosis.

Test oval, rounded at the initial and apertural ends, almost circular, chambers few, generally 3, sutures not depressed, often indistinct, wall covered with fine grains of sand with smooth outside, aperture radiate.

Remarks.

The walls of all specimens available have the same structure and are covered with fine grains of sand. The grains are almost uniform in size. They have a smooth outside and form a mosaic. The cement between the grains is siliceous and beneath the grains the wall has a calcareous layer. Treated with muriatic acid the inner layer of the test dissolves but the layer of sand grains is immutable. It is possible that the grain-coating of the test is a product of the fossilization, but it is remarkable that no other foraminifera or other fossils in this formation have a similar surfaee. This species has the same shape of the test as certain variations of Globulina gibba D'Orb, apart from the structure of the wall and the arrangement of the chambers. The spiral of the chambers is more elongate than that in Globulina gibba.

Occurrence.

Globulina arenacea occurs only in the greensand of Ystad.

Holotype: S. G. U. No. 53. Ystad Gjuteriet 21 m.

**Pyrulina cf. thouini D'Orb** 1826.

Fig. 10, 5.

Cushman & Ozawa 1930, p. 57, Pl. 14, fig. 6 a—c.

Remarks.

One specimen available from the greensand of Ystad is very typical and well distinguished from P. cylindroides Roemer by its slender elongate shape.

**Pyrulina fusiformis Roemer** 1838.

Fig. 10, 4.

Polymorphina nodosaria Franke, Danmarks Geol. Undersögelse, R. II, 1927, p. 35, Pl. III, fig. 18.

Cushman & Ozawa, 1930, p. 55, Pl. 13, figs. 3—8.

Remarks.

This species is very variable. Many specimens resemble Pyrulina cylindroides Roemer, but their chambers are not so elongate.

**Guttulina communis D'Orb 1826.**

D'Orbigny, Ann. Sc. Nat. Vol. 7, p. 266, No. 15, Pl. 12, figs. 1—4.

Remarks.

Cushman & Ozawa 1930 do not distinguish G. communis D'Orb and G. problema D'Orb. In many samples of the Cretaceous and Tertiary only the short and broad type of Guttulina communis occurs, but never the elongate and more developed G. problema. In the samples from Ystad the broad type of G. communis has the length: breadth proportions = 0.87 (0.90), and for the elongate G. problema this proportion is 0.55—0.60. Therefore I have distinguished the two species.

**Guttulina problema D'Orb. 1926.**

Fig. 10, 7.

Cushman & Ozawa 1930, p. 19, Pl. 2, figs. 1—6.

**Guttulina problema D'Orb var. costata n.v.**

This variant differs from the type only by the fine costae.

Occurrence.

Some specimens occur in the Klagshamn conglomerate.

**Guttulina hantkeni Cushman & Ozawa.**

Fig. 10, 9.

Cushman & Ozawa 1930, p. 33, Pl. 5, figs. 4—6.

**Guttulina lactea Walker & Jacob 1784.**

Fig. 10, 8.

Cushman & Ozawa 1930, p. 43, Pl. 10, figs. 1—4.

**Guttulina roemeri Reuss 1855.**

Fig. 10, 12.

Cushman & Ozawa 1930, p. 41, Pl. 9, fig. 3.

Remarks.

In the samples from Ystad young specimens resemble G. rotundata Roemer, but in the adult all specimens are closely related to the Oligocene G. roemeri Reuss.

**Guttulina spicaeformis Roemer 1838.**

Figs. 10, 10. 11.

Cushman & Ozawa 1930, p. 31, Pl. 5, figs. 1, 2.

Remarks.

The specimens from the Swedish Paleocene are typical in the shape of the test and in the arrangement of the chambers. Types with a smooth wall and others with very fine or strong costae occur together.

Occurrence.

Guttulina spicaeformis occurs rarely in the clay of Ystad and in the greensand at Klagshamn. Cushman & Ozawa record this species from the English Thanetian, the Texas Midwayan and Claibornian.

**Pseudopolymorphina paleocenica n.sp.**

Fig. 10, 13. Fig. 11.

Diagnosis.

Test elongate, compressed, margins early parallel or slightly convex, chambers numerous, longer than wide, arranged at the initial end in a short quinqueloculine series, becoming rapidly biserial. Sutures transparent, slightly or not depressed, wall smooth or with fine longitudinal costae.

Remarks.

This species varies very much, but all the specimens have the elongate slender and compressed shape. The spiral part of the test is short and not always distinct. Only three or five chambers in the spiral. Specimens with a distinct spiral begin mostly with a very small proloculum and probably belong to the microspheric form. The length/breadth proportion of the tests varies on the holotype 47/100, others show 40/100, 35/100. The transverse section of the species with a large proloculum is more rounded, their tests are more elongate and contain few chambers in the biserial part. Those specimens can be more than 2 mm long (fig. 11, 14—16). The wall of many species is smooth; other specimens have fine longitudinal stripes only visible when the light strikes the wall at a certain sloping illumination. Specimens similar to the holotype have distinct, fine costae.

No differences could be observed between the specimens from the clay and the greensand at Ystad. The specimens from the greensand at Klagshamn are mostly more delicate than those from Ystad.

Pseudopolymorphina paleocenica is related to Ps. obscura Roemer, Ps. ishikawaensis Cushman & Ozawa, and Ps. doanei Galloway and Wissler. Ps. paleocenica is well distinguished from all these formes by the broad and numerous chambers, by the elongate slender shape and by the structure of the wall.

Occurrence.

Ps. paleocenica occurs very abundantly in the Paleocene at Ystad and in the greensand and conglomerate at Klagshamn. This species is one of the most characteristic types of the lower part of the Swedish Paleocene.

Holotype: S. G. U. No. 78 Clay, Ystad, gjuteriet.

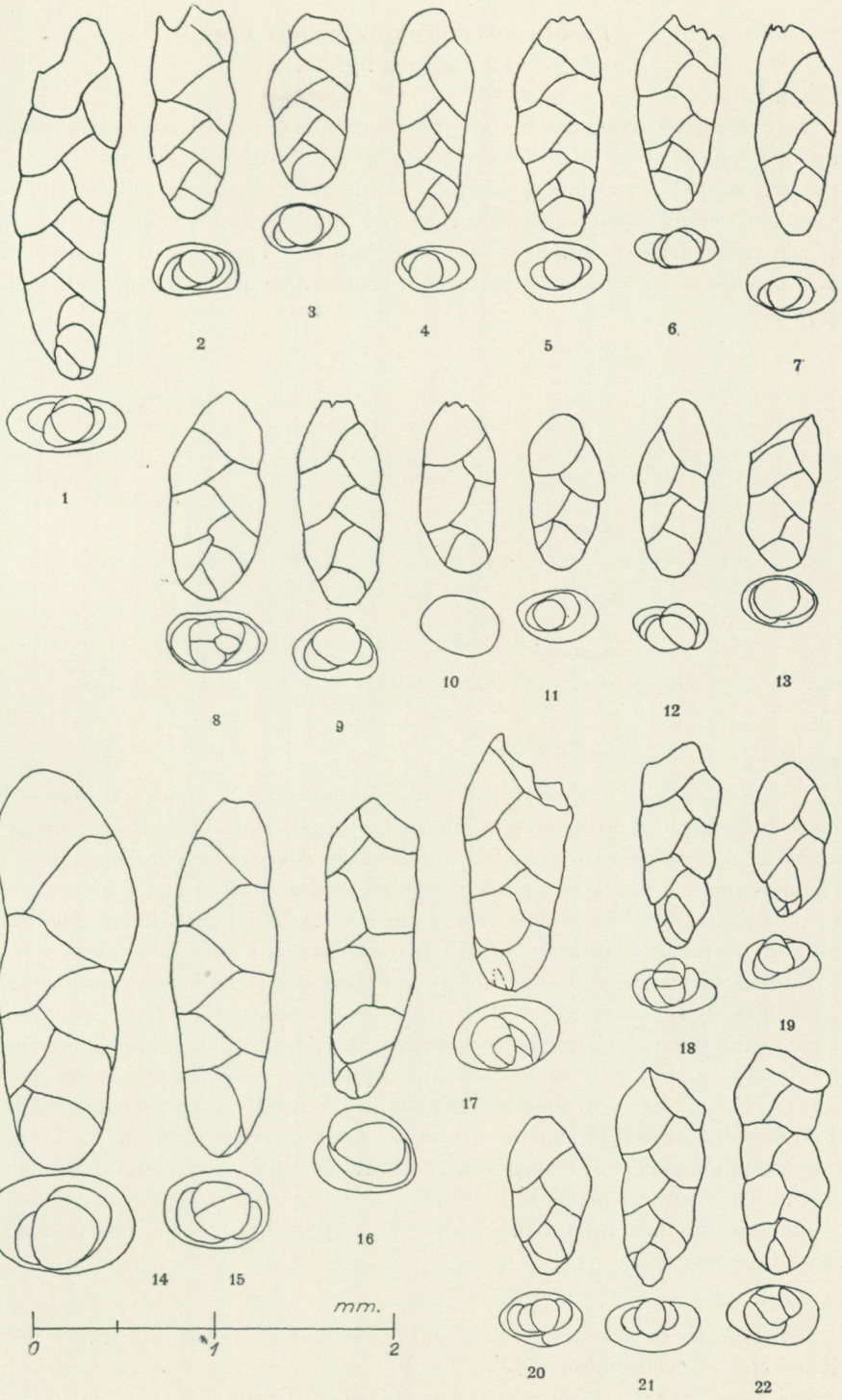


Fig. 11. Pseudopolymorphina paleocenica n.sp. variations. Ystad gjuteriet 20, 21 m. 25 ×.

**Pseudopolymorphina geijeri n.sp.**

Fig. 10, 15; fig. 12.

Diagnosis.

Test elongate, oval, much compressed, greatest breadth above the middle, breadth/length about 1 : 2. Acute towards the initial and apertural ends, on the initial end sometimes a distinct basal spine, chambers curved elongate, each succeeding chamber slightly removed from the basis, chambers arranged in the young triloculine and in the adult biserial. The margins rounded. The wall has distinct fine longitudinal costae. Sutures distinct, transparent, slightly depressed.

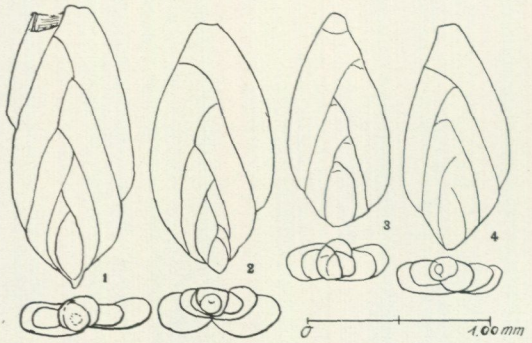


Fig. 12. Pseudopolymorphina geijeri n.sp. variations. 1, 4. Klagshamn conglomerate. 2. Ystad gjuteriet 21 m. 3. Ystad gjuteriet 20 m.

Remarks.

The tests vary in outline from broad to more elongate types, the former are more rounded, the latter more acute at the initial end. The sutures run at an angle of 20—25 degrees from the middle axis. The spiral arrangement of the chambers in the young is mostly indistinct and in many cases not developed, so it is difficult to determine these forms as Pseudopolymorphina. The longitudinal costae are distinct on all specimens and are typical for this species.

Besides the broad types of this species there are slender and more elongate specimens. It is possible that they are a special generation of the species, but I have described them in the following as a variant of the type. This species is closely related to Polymorphina longistriata Cushman & Ozawa (1930, p. 115, Pl. 30, fig. 5) from the Thanetian of Pegwell Bay in England and to Polymorphina alleni Cushman & Ozawa (1930, p. 116, Pl. 30, fig. 7). Pseudopolymorphina geijeri is distinguished from these species by the more oval shape and by the distinct costae on the wall.

This species has been named after P. Geijer, Director of the Geological Survey of Sweden.

Occurrence.

This species occurs in the clay and greensand at Ystad and rarely in the Paleocene at Klagshamn.

Holotype: S. G. U. No. 114. Clay at Ystad, Gjuteriet.

**Pseudopolymorphina geijeri n.sp. var. angusta.**

Fig. 10, 14; Figs. 13.

Diagnosis.

Test elongate, slender, acute at the ends, much compressed, greatest breadth near the middle. Chambers elongate, compressed, arranged in a biserial series, sutures distinct, slightly depressed, slightly curved, running from the middle axis at an angle of about 25 degrees. Wall with distinct longitudinal costae.

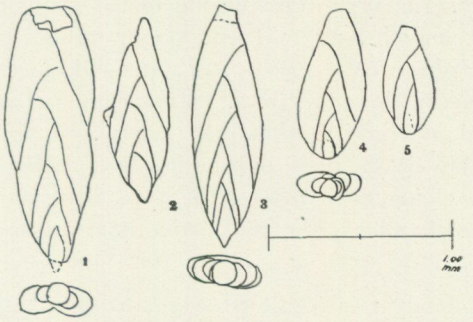


Fig. 13. Pseudopolymorphina geijeri n.sp. var. angusta n.v. variations. 1, 2, 5. Ystad gjuteriet 20 m. 3, 4. Ystad gjuteriet 21 m.

Remarks.

The breadth/length portion ca. 1 : 3.6. Large specimens are more slender. It is possible that this variety is the megalospheric form of Pseudopolymorphina geijeri typica. This form lacks a distinct triserial arrangement in the initial stage. From the beginning to the last chamber it is biserial and the arrangement of the chambers tends to be sigmoidal. Thus, the systematic position is uncertain. The closest relations to this series are to be found among such specimens as are triloculin + sigmoidal.

Occurrence.

This variety is rare in the same layers as the type.

Holotype: S. G. U. No. 120. Ystad, Gjuteriet, 20 m.

**Sigmomorphina soluta n.sp.**

Pl. 8, figs 6—10; text-fig. 10, 16.

Diagnosis.

Test large, strongly compressed, outline variable, elongate or rhomboidal. Chambers elongate, the last two more than half of the length of the test, at first sigmoid, later biserial; sutures distinct, fairly to strongly depressed. Wall smooth, rarely with fine costae.

Remarks.

This species includes elongate and narrow forms and forms of broad and strongly compressed types. The sutures of the narrow and elongate specimens are distinctly depressed; in the broad and flat forms the sutures are only fairly depressed. The narrow specimens with the distinctly depressed sutures are the type-forms of this species; the broad ones will be called var. lata. In the types

the arrangement of all the chambers is distinctly sigmoid, but in the var. lata only the initial stage is sigmoid, later the chambers are biserial. Single specimens of the type-form and the var. lata are so different that it is easy to interpret them as different species. In a large material of this species all intermediate forms occur and there is no doubt but that the extreme shapes are variations of the same species.

As in the case of Pseudopolymorphina geijeri the systematic position of this species is uncertain. The type-forms belong to the genus Sigmomorphina but the broad variant may belong to Pseudopolymorphina or to Polymorphina to which Cushman refers if the species has a sigmoid stage in the young and a biserial arrangement in the adult (e. g. Polymorphina charlottensis Cushman, Polymorphina schlumbergeri Cushman & Ozawa).

This species is closely related to Pseudopolymorphina geijeri and is distinguished by the elongate chambers, the typical sigmoid character of the arrangement of the chambers, and the distinctly depressed sutures.

Occurrence.

This species or closely related forms seem to occur already in the uppermost Danian. In the Lower Paleocene it occurs abundantly, but it is never found in the upper part of the Swedish Lower Paleocene near Tygelsjö.

Holotype: S. G. U. No. 2302 Klagshamn, Greensand.

### Sigmomorphina pseudoregularis Cushman & Thomas.

Fig. 10, 17.

Cushman & Ozawa, 1930, p. 125, Pl. 32, fig. 8.

Remarks.

The specimens available are very similar to those figured by Cushman & Ozawa, differing only from those in unimportant details. The Swedish specimens are more rounded at the base and the wall has fine and indistinct longitudinal lines. The characteristic median ridge is the same as on the species figured by Cushman & Ozawa.

Occurrence.

The type occurs in the Claibornian of Texas and has hitherto not been recorded from any other locality; it occurs rarely in the clay and in the greensand at Ystad and in the conglomerate at Klagshamn.

### Bolivinopsis (Spiroplectoides) scanica n.sp.

Pl. 6, fig. 3; textfig. 14.

Diagnosis.

Test minute, $2^1/_2$ times as long as broad, compressed. Margins of the test almost parallel, rounded. Spiral as broad as in the biserial series, many chambers in the spiral, in the biserial part few chambers (5—10), generally higher than broad in the adult, slightly inflated, sutures slightly curved, transparent, slightly depressed between the last chambers. Wall distinctly perforated, length up to 0.28 mm.

Remarks.

Two types occur together. 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.

Fig. 14. Bolivinopsis scanica n.sp. Ystad gjuteriet 20 m.

This species is well distinguished from the Cretaceous Bolivinopsis by its minute test and the high chambers in the biserial part. It is closely related to Boliv. curta Cushman 1933 (C. C. L. Vol. 9, p. 11, Vol. 10, p. 43) and differs from Boliv. curta by the rounded margins and the high chambers.

Occurrence.

This species is not uncommon in the Paleocene at Ystad, Klagshamn and Tygelsjö.

Holotype: S. G. U. No. 129. Clay at Ystad, Gjuteriet.

**Gümbelina cf. globulosa (Ehrenberg).**

Fig. 15.

Remarks.

Single specimens of Gümbelina resemble G. globulosa Ehrb. and do not differ from the Cretaceous species. Some specimens show a smooth wall and others have very fine longitudinal costae. It is possible that all specimens of Gümbelina in the Paleocene at Ystad are redeposited from the Cretaceous. Other specimens resemble G. wilcoxensis Cushman & Ponton (C. C. L. Vol. 8, 1932, p. 66, Pl. 8, fig. 16—17), which is characterized by the great expansion of the last few chambers and the pedicular papilate surface. The last character could not be observed on the Swedish Paleocene specimens.

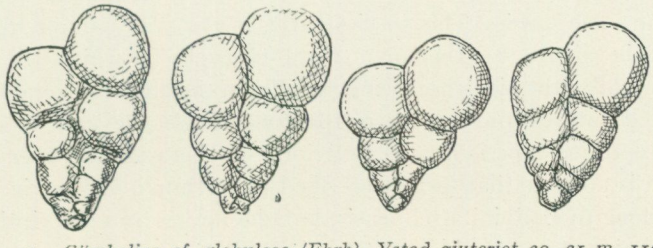

Fig. 15. Gümbelina cf. globulosa (Ehrb). Ystad gjuteriet 20, 21 m. 110 ×.

## Bolivinita selmensis Cushman.

Pl. 9, fig. 7. Text-fig. 16.

1933 Bolivinita selmensis Cushman, C. C. L. Vol. 9, p. 58, Pl. 7, figs. 3, 4.
1936 Bolivinita crawfordensis Jennings, Bull. Amer. Paleont. Vol. 23, no 78, p. 28, Pl. III, fig. 14.
1937 Bolivinita exigua Glässner, Probl. of Paleont. II—III, p. 339, Pl. II, fig. 12.
1937 Bolivinita costerifera Cushman, C. C. L. Vol. 13, p. 105, Pl. 15, fig. 15.

Probably synonyms

1940 Eouvigerina excavata Cushman, C. C. L. Vol. 16, p. 66, Pl. 11, fig. 18.
1942 Eouvigerina excavata Cushman & Todd, C. C. L. Vol. 18, p. 35, Pl. 6, fig. 20, 21.
1944 Eouvigerina excavata Cushman, Amer. Journ. of Science, Vol. 242, p. 10, Pl. 1, fig. 18.
1944 Eouvigerina excavata Cushman, C. C. L. Vol. 20, p. 42, Pl. 7, fig. 7.
1946 Eouvigerina excavata Cushman & Todd, C. C. L., Vol. 22, p. 58, Pl. 10, fig. 16.

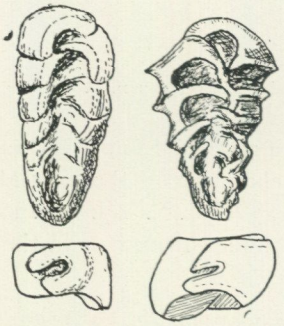

Fig. 16. Bolivinita selmensis Cushm. Ystad gjuteriet 20 m. 100 ×.

Diagnosis.

Test minute, tapering to the initial end, rhomboid or rectangular in transverse section, broad faces distinctly concave, narrow sides convex or truncated; chambers distinct, increasing gradually in size as added, early ones flattened and compressed, later ones concave on the broader faces and convex on the periphery; sutures distinct, slightly curved in the early stages, more prominently so in the adult, slightly limbate; in the adult each chamber has a sharp angle, which may be slightly raised or developed into a strongly raised costa-like ridge.

Remarks.

The new diagnosis differs from the original diagnosis of Cushman 1937. By studing many specimens from the Maastrichtian, Danian, and Paleocene the author has arrived at the conclusion that all forms named in the synonym-list belong to the same species. This species varies in the same sample from narrow types (like the figure by Cushman 1933) to types in which the chambers increase gradually, the sides not being parallel in the adult. Several types have only limbated sutures and on others the basal angles develop to costae-like ridges. One extreme type is named Bolivinita costifera and another Bolivinita selmensis. It is possible that forms described by Cushman as Eouvigerina excavata also belong to Bolivinita selmensis, but the figures and descriptions afford insufficient guidance as to their systematic position.

Occurrence.

Already in 1937 Glässner stated that B. exigua = B. selmensis occurs from the uppermost Maastrichtian into the Paleocene. The geological distribution of this species in Sweden confirms his assertion. The oldest specimen in Sweden has been found in the borehole at Höllviken I (cf. Brotzen 1945, S. G. U. årsbok 38) on the 210 m level in the Upper Maastrichtian (about 160 m below the Danian). This species rarely occurs in the Danian, but in each sample of the Swedish Danian its frequency in the foraminiferal fauna is 1—2 %. In the Paleocene clay and greensand of Ystad, Klagshamn and Tygelsjö some specimens have been collected.

The occurrence of B. selmensis is known to be as follows:

| Sweden | Central Europe | Caucasus | U. S. A. |
|---|---|---|---|
| | | | Wilcox form. Eocene |
| Paleocene | | Paleocene | Hornerstown form. Paleocene<br>Naheola form. Paleocene |
| Danian | Bruderdorf | Danian | Lower Midway. Danian |
| Maastrichtian | Maastrichtian | Maastrichtian | Selma form.<br>Navarro form. } Maastrichtian. |

**Buliminella parvula n.sp.**

Pl. 10, figs. 3, 4.

Diagnosis.

Test very small, about one and a fourth times as long as broad; chambers arranged in three to four whorls, four in each whorl. The last whorl forming 3/4 or 4/5 of the test. Sutures not or distinctly depressed, wall smooth and glossy.

Remarks.

This very small species varies in proportions (length: breadth). Its sutures can often be distinctly depressed and the chambers inflated or the depression of the sutures is very indistinct. The species is related to Buliminella laevis Beissel from the Maastrichtian. It is distinguished by the much smaller test and the broader outline. Small specimens of Bul. laevis have not depressed sutures and the test is more closed. Buliminella robertsi (Howe and Ellis), described by Howe in 1939 from the Louisiana Eocene, is also a very small Buliminella and is distinguished from the Swedish Paleocene species by the shortness of the last whorl.

Occurrence.

This species occurs very rarely in the Paleocene at Klagshamn and becomes more frequent in the clay at Tygelsjö. But also here it is very rare. In the Paleocene at Ystad only one specimen has been found.

Holotype: S. G. U. No. 2318 Solnäs 9 m.

**Buliminella constrictula n.sp.**

Pl. 10, figs. 1, 2.

Diagnosis.

Test very small, cylindroid, acute at both ends. Chambers arranged in three whorls. The last whorl increases only a little and forms 2/3 of the test. Four chambers in each whorl, fairly inflated. Sutures not or slightly depressed. Wall smooth and glossy.

Remarks

This species is related to the foregoing Buliminella parvula. It is well dis-.tinguished by the cylindroid test, the lower last whorl and the breadth of the chambers.

Occurrence.

Buliminella constrictula occurs very rarely in the lower part of Ystad Paleocene.

Holotype: S. G. U. N: 2324 Ystad, Gjuteriet 20 m.

**Bulimina midwayensis Cushman & Parker.**

Pl. 10, fig. 8.

1926 Bulimina aculeata Plummer, Univ. Texas Bull 2644, p. 73, Pl. 4, fig. 3.

1936 Bulimina arkadelphiana Cushman & Parker var. midwayensis Cushman & Parker, C. C. L. Vol. 12, p. 42, Pl. 7, figs. 9, 10.

1937 Bulimina midwayensis Glaessner Problems of Paleont. Vol. II—III, p. 370.

1944 (Bulimina aff. aculeata Ten Dam, Mededeel. Geol. Stichting, Ser. c. v. 3, p. 111, Pl. 3, fig. 12.)

Remarks.

In 1936 Cushman & Parker erected a new variety to the Cretaceous species B. arkadelphiana Cushman & Parker (1935). This variety belongs to a group of small Bulimina species, which are characterized by a fine-spined suture on the ground of each chamber. Such forms occur already in the Upper Cretaceous and are widely distributed in the recent oceans. Single specimens are very difficult to determine, but a large number of specimens show typical characters according to their stratigraphical ranges. In all associations the species varies in the number and length of the border spines. The principal characters are therefore not the shape of the spines but the shape of the test and the chambers. In this respect the variety »midwayensis» is so different from Bulimina arkadelphiana that it must be considered an independent species. The differences between Bulimina arkadelphiana and B. midwayensis are more important than the differences between the last species and their closely related forms described as Bulimina stalacta Cushman & Parker or Bulimina denticulata Cushman & Parker. These facts were already pronounced by Glässner in 1937. The specimens available from the Swedish Paleocene could be compared with several tests from the Upper Midway, collected by Mrs. Plummer. Specimens from the Danish Upper Paleocene vary very much in the shape of the spines and extreme shapes have only a few spines on the first borders and

none on the upper part of the test. Such forms resemble the figure and description of Bulimina aculeata published by Ten Dam from the Dutch Paleocene and it is possible that also these specimens belong to the same species. Unfortunately the figure of this species never shows the border spines in the initial stage of the test, but the description discloses this fact (»Gehäusewand in den älteren Kammern nur verhältnismässig wenig verziert mit Stachelchen»).

Occurrence.

In the Swedish Paleocene this species occurs but very rarely in the clay of Tygelsjö. In the Danish Paleocene it is frequent in the upper part. According to Plummer it is also frequent in the Upper Midway of Texas. Plummer's statement that this species occurs already in the Navarro of Texas is questionable; possibly it is the closely related species »B. arkadelphiana».

Holotype: The figure of Cushman & Parker (Cushman coll. No. 23. 136)

**Bulimina aff. ovata D'Orbigny.**

Pl. 10, figs. 9, 10.

1927 Bulimina pupoides + Bul. affinis. Franke, Danmarks geolog. unders. II Raekke, No. 46, p. 11, Pl. I, figs. 8, 9.

1932 Bulimina ovata, Cushman & Ponton, C. C. L. Vol. 8, p. 67, Pl. 9, figs. 1, 2. — 1941 Toulmin, Journ. of Paleont., Vol. 15, p. 597, Pl. 80, figs. 25, 26. 1944 Ten Dam, Med Geol. Stichting Ser. C, v. 3, p. 111, Pl. 3, figs. 10—11. 1944 Cushman C. C. L. Vol. 20, p. 24, Pl. 4, figs. 21, 22.

Remarks.

The specimens from the Swedish Paleocene greatly resemble those figured from the American Wilcox and the Aquia Formation and types figured by Ten Dam (types like Pl. 3, fig. 10, not like Pl. 3, fig. 11). The authors determined all these forms as Bul. ovata D'Orbigny from the Miocene of the Vienna Basin. The figures of D'Orbigny (1846) and the topotypes figured by Cushman in 1937 (C. C. L. Vol. 13, Pl. 6) are not so elongate and narrow as those from the Paleocene and Eocene. The Miocene specimens are more fusiform and the Paleocene ones are more cylindriform. It was not possible to compare topotypes of B. ovata D'Orb. and so the Swedish Paleocene specimens are provisionally determined as B. aff. ovata.

Glaessner (1937) (Problems of Paleont. Vol. II—III, p. 371) united several species from the Upper Cretaceous and the Miocene ones to B. ovata, D'Orb. He described specimens of this species from the Paleocene of the Caucasian Region and compared them with topotypes, but he does not figure types or variations from the different formations. Ten Dam (1944) has the same opinion on the variability of this species and its vertical geological distribution. But it seems as if the cylindrical types are confined to the Paleocene and Lower Eocene.

Occurrence.

In the Swedish Paleocene this species occurs only in the clay at Tygelsjö (Solnäs).

**Bulimina aspero-aculeata n.sp.**

Pl. 6, fig. 4, Pl. 10, figs. 6, 7.

Diagnosis.

Length up to 0.5 mm, breadth up to 0.17 mm, tapering at the initial end, the upper third not increasing in breadth, transverse section triangular in the tapering part with distinctly depressed sides, in the upper part more or less rounded; chambers numerous, arranged in 5 to 6 whorls, inflated, a little higher than broad, sutures curved, strongly depressed, generally a distinct spine on the initial end; wall coarsely perforated, on the lower two or three whorls very finely and irregularly costated.

Remarks.

Specimens of this species vary in the ornament and in the proportions. Generally the specimens show the typical ornament on the initial end, but some are only very indistinctly costated. The abdominal spine is large except in a few forms from the Ystad Paleocene, which resemble the types but lack the spine.

Two different forms occur together, an elongate and narrow one with a very strong and large abdominal spine, and another somewhat shorter and broader type, of which the abdominal spine is not so long. The sutures of the first type are more depressed than in the other. Closely related forms are

Bulimina versa Cushman & Parker, France, Paleocene (Montian) (C. C. L. Vol. 16, p. 47, Pl. 8, figs. 15, 16).

Bulimina cacumenata Cushman & Parker U. S. A. Paleocene (Midway, Naheola For. Arkansas) (C. C. L. Vol. 16, p. 47, Pl. 8, figs. 3 a—c.)

Bulimina jarvisi Cushman & Parker, Trinidad Eocene (Lower Marl) (C. C. L. Vol. 12, p. 39, Pl. 7, figs. 1 a—c).

Bulimina microcostata Cushman & Parker, California Eocene (C. C. L. Vol. 12, p. 39, Pl. 7, figs. 2 a—c).

The two first species from the Paleocene are generally smaller than the Swedish one. Bul. versa is very closely related to Bul. aspero-aculeata, but its section is distinctly triangular also in the upper portion. Bul. cacumenata is rounded in the transverse section, its costae are more distinct and its shape is generally finer than that of Bul. aspero-aculeata.

The two Eocene species are characterized by the more distinct costae and their sutures are not so deeply depressed as those of the Swedish Paleocene species.

Occurrence.

Only a few specimens have been found in the Paleocene at Ystad, some at Klagshamn, and in the clay at Tygelsjö this species occurs abundantly (its frequency increases to two per cent of the foraminiferal fauna). Typical specimens are also common in the Danish Lower Paleocene.

Holotype. S. G. U. No. 2332 Tygelsjö, Solnäs.

**Bulimina rosenkrantzi n.sp.**

Pl. 9, fig. 1; Pl. 10, fig. 5.

Diagnosis.

Test elongate, about 3—3.5 times as long as broad, rounded in the transverse section, except a number of specimens which are triangular at the initial end; chambers numerous, 5—6 whorls, the last one forming nearly half of the test, only the initial part increasing intensely in breadth, later the breadth is more or less uniform; chambers fairly inflated, sutures distinct, slightly depressed; wall smooth, finely perforated.

Remarks.

This species varies in proportions, but all specimens are elongate and very slender. As stated in the diagnosis, the initial portion may be triangular in the transverse section, but nearly half of all the specimens are rounded from the beginning. Bulimina rosenkrantzi is characterized by the elongate and slender test and is thus well distinguished from the broader Bul. aspero-aculeata, which has more inflated chambers and an abdominal spine. Bulimina (Reussella) paleocenica n.sp. described below is also a slender and elongate species, but its transverse section is always triangular and the last whorl forms less than half of the test.

The slender test and the high chambers in the late whorl make this species resemble certain primitive Virgulinae. No typical biserial arrangement of the chambers is observed in the late part of the test, and therefore the species must belong to the genus Bulimina. This species has been named in honour of Prof. A. Rosenkrantz of Copenhagen.

Occurrence.

Bulimina rosenkrantzi occurs abundantly in the Paleocene at Ystad, it is frequent at Klagshamn and Tygelsjö.

Holotype: S. G. U. No. 2338 Klagshamn, greensand.

**Bulimina (Reussella) paleocenica n.sp.**

Pl. 6, figs. 5, 6.

Diagnosis.

Test elongate, acute at the initial end and increasing slowly in breadth, triangular in transverse section. Angles rounded, sides fairly concave, chambers numerous, as high as long or higher than long. Sutures distinct, between the last chambers slightly depressed. Wall smooth, distinctly perforated.

Remarks.

This species varies in its proportion and in the transverse section. Some specimens increase more rapidly in breadth than the holotype and their angles are generally more rounded. The margins may be strongly projected, straight or slightly twisted. Young specimens of Bulimina rosenkrantzi greatly resemble this species, but their chambers are generally higher and more inflated than those of Bul. paleocenica. In the adult the two species are quite distinct. Buli-

mina trigonalis Ten Dam 1944 from the Dutch Paleocene increases more in breadth and its chambers are strongly inflated. Also young specimens of Bulimina trigonalis are very similar to Bulimina paleocenica. Bulimina trigonalis Ten Dam is frequent in the upper part of the Danish Paleocene. This Swedish species is closely related to »Tritaxia» minuta Marsson 1878, and is distinguished by the more elongate shape, the larger length, the slightly depressed sutures and the more distinctly perforated wall. It is possible that Reussella aff. minuta Glaessner (Problems of Paleont. Vol. II—III 1937, p. 370, Pl. 2, fig. 18) from the lowest Tertiary in the Caucasus (Paleocene) also belongs to Bulimina paleocenica. Bulimina paleocenica and »Tritaxia» minuta Marsson (= Bulimina marssoni Cushman & Parker 1940) possibly belong to the genus Reussella. This genus is characterized by the sharp angles and the triangular transverse section. Such species as these two Paleocene ones are intermediate forms between Bulimina and Reussella.

Occurrence.

Bulimina paleocenica occurs as a rare form from the uppermost Danian into the Paleocene. It is very rare in the clay at Tygelsjö.

Holotype: S. G. U. No. 138, Ystad, Gjuteriet.

## The Genus Pyramidina Brotzen 1940.

Genotype: Bulimina(?) curvisuturata Brotzen.

Syn.: Pyramidina Brotzen, Sveriges geol. undersökning. Årsbok 34, p. 29.
Bulimina part, Reussella part of authors.

Diagnosis.

Test triserial; triangular or nearly triangular in the transverse section, tapering. Margins generally rounded or truncate; aperture in the initial stage lop-shaped, elongate, directed from the suture into the apertural face in the young, in the adult almost terminal or terminal, elongate or rounded.

Relations.

Initial stage like Bulimina or Reussella, in the adult it is distinguished by the position of the aperture. The aperture in the initial stage is elongate at the base of the apertural face as in Bulimina. In the following stage the apertural opening will be contacted near the base and the apertural opening acquires a more terminal position. In this stage a distinct suture is visible between the base and the apertural opening (fig. 17).

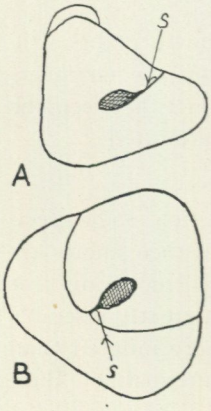


Fig. 17. Pyramidina curvisuturata Brotzen. Klagshamn Danian.
A. Terminal apertural face.
B. Preceding apertural face of the same specimen.
S. Suture between the margin and the aperture.

In the last stage the aperture is terminal, elongate or rounded, and the suture between the base and the apertural opening may disappear. In typical large specimens it is possible to prepare the change of the position stage by

stage. The author described the apertural form in 1936 on Reussella cushmani and in 1940 on Bulimina(?) curvisuturata. An apertural neck is lacking and therefore this genus is well distinguished from the genus Angulogerina.

Occurrence.

The genus Pyramidina is recorded from the Senonian to the Paleocene.

### Pyramidina crassa n.sp.

Pl. 6, fig. 8.

Diagnosis.

Test tapering, twice as long as broad, greatest breadth towards the apertural end, triangular in the transverse section, sides fairly depressed, 5—6 whorls; chambers increase rapidly, inflated, broader than long. Sutures curved, in the initial stage transparent, later distinctly depressed, aperture terminal, apertural suture distinct. Wall finely perforated.

Remarks.

This species is related to Pyramidina curvisuturata (Brotzen) (Sver. geol. unders. Årsbok 34, 1940, p. 29). The Paleocene species is never as large as the Danian one, its chambers are more inflated and the shape increases in breadth more rapidly than in P. curvisuturata.

Occurrence.

Pyramidina crassa n.sp. occurs commonly in the Paleocene at Ystad and Klagshamn. In the conglomerate at Klagshamn it is found together with P. curvisuturata, redeposited from the Danian.

Holotype: S. G. U. No. 143. Clay at Ystad, gjuteriet.

### Angulogerina wilcoxensis Cushman & Ponton.

Pl. 6, fig. 7.

Angulogerina wilcoxensis Cushman & Garrett, C. C. L. Vol. 15, 1939, p. 84, Pl. 14, figs. 24, 25. Toulmin, Journ. of Paleont. Vol. 15, 1941, p. 599, Pl. 80, fig. 30. — Cushman, C. C. L. Vol. 20, 1944, p. 44, Pl. 7, fig. 18?

Pseudouvigerina wilcoxensis Cushman & Ponton, C. C. L. Vol. 8, 1932, p. 66, Pl. 8, fig. 16 — Glässner, Problems of Paleont., Vol. II—III, p. 374, Pl. II, fig. 18.

Remarks.

The close relationship between Angulogerina wilcoxensis and Angulogerina (Pseudouvigerina) cristata Marsson was stressed by Glässner in 1937. Topotypes from Alabama and Rügen are distinguished as:

| Angulogerina cristata<br>Rügen, Maastrichtian | Angulogerina wilcoxensis<br>N. Ozark, Wilcox |
|---|---|
| clumsy shape | slender shape |
| margins broad | margins narrow |
| keels on each chamber strongly curved | keels on each chamber fairly straight |
| keels interrupted on the sutures | keels not interrupted on the sutures |

The variation of Angulogerina cristata is larger than that of Angul. wilcoxensis, which is more uniform. The wall mostly smooth, only a few specimens with short costae at the sides or with small spines at the initial end.

Angulogerina wilcoxensis must be very closely related to »Pseudouvigerina» naheolensis Cushman & Todd. The differences between these two species seem to be very indistinct. (Cushman & Todd 1942, C. C. L. Vol. 18, p. 36, Pl. 6, figs. 18, 19, and C. C. L. 1946, Vol. 22, p. 59, Pl. 10, fig. 17).

Occurrence.

This species is an index fossil in the uppermost Midway and Wilcox of Alabama. It occurs in the Paleocene in the Caucasus and is a common form in the greensand at Ystad and Klagshamn.

**Angulogerina cuneata n.sp.**

Pl. 6, fig. 10.

Diagnosis.

Test fusiform, broadest above the middle, triangular in transverse section. Margins truncated with double keels; chambers broad, inflated. Sutures distinct, curved, in the adult depressed and slightly lobate. Wall smooth, at the initial end with small spines or short costae, aperture terminal, elongate with a short neck.

Relations.

This species is closely related to Pyramidina crassa n.sp. but its aperture is terminal in all chambers and the truncate margins have distinct double keels In the adult the keels may be low and indistinct, in the initial stages they are high and distinct. This species has some relationship also with Angulogerina (Pseudouvigerina) cristata Marsson and it is distinguished by the different shapes of the chambers, the lower keels and by the lack of a typical neck. It differs from Pseudouvigerina(?) naheolensis Cushman & Todd (C. C. L. Vol. 18, 1942, p. 36. — Cushman, Americ. Journ. Science, Vol. 242, 1944, p. 11) by the lacking neck and its short test. All chambers of this species are arranged triserial, so it must belong to the genus Angulogerina.

Occurrence.

This species is very rare in the Paleocene at Ystad and in the conglomerate at Klagshamn.

Holotype: S. G. U. No. 151 Clay, Ystad, gjuteriet.

**Angulogerina europaea Cushman & Edwards.**

Pl. 6, fig. 9.

Angulogerina europaea Cushman & Edwards, C. C. L. Vol. 13, 1937, p. 61, Pl. 8, figs. 17, 18.
Pseudouvigerina selseyensis var. sculpta Glässner, Probl. of Paleont. Vol. II—III, p. 373, Pl. II. fig. 20.

Remarks.

This species is very variable, the chambers can be much removed from each other and project more or less on the margins. Each chamber of one type is

removed a little from the succeeding one; on another type the chambers are deeply excavated at the base. The first type has been figured by Cushman and Edwards, the second by Glässner. Types from the Swedish Paleocene vary between these two extremes. Cushman & Edwards described this species from the Montian, France. In the collection of the Museum of Nat. History in Stockholm Angulogerina europaea is found in samples from the »sand of Bracheux» (Thanetian). These specimens do not differ from the Swedish ones.

Occurrence.

Angulogerina europaea occurs as a rare form in the Swedish Danian and Paleocene, in the Thanetian and Montian of the Paris Basin and in the Paleocene of the Caucasus. According to Glässner it is also found in the Eocene, but those specimens may belong to the closely related Angulogerina muralis Terquem.

**Virgulina sandegreni n.sp.**

Pl. 9, fig. 2.

Diagnosis.

Test small, initial part spirally arranged, short, biserial part slightly compressed. Chambers as high as long, increasing rapidly in height, sutures distinct, slightly or not depressed.

Remarks.

This species is characterized by the broadly oval transverse section and the high chambers. It is closely related to Virgulina navarrana Cushman (Mon. of the Fam. Virgulinidae 1937) and is distinguished by the short spiral part and the Bolivina-like aperture. It is also related to Virgulina wilcoxensis Cushman & Ponton (see Monogr. of Fam. Virgulinidae), but the Swedish species is broader than the species from the Wilcox of Alabama.

Occurrence.

Virgulina sandegreni n.sp. occurs rarely in all Swedish Paleocene localities. This species is named after Fil. Dr. R. Sandegren of Stockholm.

Holotype: S. G. U. No. 163 Clay at Ystad, Gjuteriet.

**Bolivina ödumi n.sp.**

Pl. 9, fig. 3, 4.

Diagnosis.

Test triangular, rounded at the initial end, slowly increasing in breadth (breadth/length = 1/1.6—1.8). Margins acute; chambers compressed, sutures broad, distinctly transparent, slightly depressed, curved and in the adult slightly lobate.

Relations.

This species resembles Bolivinoides texana Cushman (C. C. L. Vol. 13, p 104, 1937). All chambers are arranged biserial, so this species belongs to the genus Bolivina. It differs from B. texana by the broader and more compressed test, by the few chambers and by the sutures being lobate only in the adult.

Occurrence.

Bolivina ödumi n.sp. occurs rarely in the greensand and clay at Ystad and in the greensand at Klagshamn.

This species is named after Director H. Ödum of Copenhagen.

Holotype: S. G. U. No. 2357 Clay, Ystad, gjuteriet.

**Bolivina paleocenica n.sp.**

Pl. 9, fig. 5.

Diagnosis.

Test small, compressed, generally rhomboid in the front view, almost as broad as high, the largest breadth about the middle of the length. Margins acute, distinctly depressed on the sutures, chambers numerous, sutures distinct, transparent or slightly depressed, wall in the middle part of the front view covered with a network of raised ribs.

Remarks.

This species is characterized by the broad outline of the test and by the network of raised ribs in the middle part of the front views, which never reach the lateral parts of the test. The network is variable, strongly raised and often distinct only in favourable illumination. Bolivina paleocenica belongs to the group of ornamented forms known from the Upper Cretaceous to recent. In Cushman's Monograph on the Family Virgulinidae he described the following species of this group:

B. velascoensis Cushman, Velasco Formation (Upper Maastrichtian?)
B. reticulata Hantken Upper Eocene
B. byramensis Cushman Lower Oligocene
B. fastigia Cushman Upper Oligocene
B. scalprata Schwager, var. retiformis Cushman, Miocene
B. subreticulata Parr recent.

The new species is most closely related to R. byramensis and is distinguished by the ornament, which is not so compact as that on the Oligocene form. Bol. velascoensis has an ornament that is fairly raised and more indistinct than that of the new species.

Occurrence.

Only a few specimens have been found in the clay and the greensand at Ystad, in the greensand at Klagshamn and in the clay at Tygelsjö.

Holotype: S. G. U. No. 2361 Clay, Ystad.

**Loxostoma applinae (Plummer).**

Pl. 10, fig. 11.

Bolivina applinae Plummer, Univ. Texas Bull. 2644, 1926, p. 69, Pl. 4, fig. 1.

Loxostoma applinae Cushman, Spec. Publ. No. 9, C. C. L., 1937, p. 173 Pl. 20, fig. 20. — Cushman, C. C. L. Vol. 16, 1940, p. 68, Pl. 11, fig. 23, — Cushman & Todd, C. C. L., Vol. 22, 1946, p. 60, Pl. 10, fig. 22.

Remarks.

The Swedish specimens are always finer than topotypes from the Upper Midway. Their sutural crenelation is generally indistinct, but also on the topotypes the crenelation varies. The specimens from the greensand and conglomerate of Klagshamn are larger and the crenelation more distinct than on those from the clay at Tygelsjö. I suppose a relation to exist between the sediment and the shapes of the tests, so the Swedish species has been determined as Loxostoma applinae.

Occurrence.

Loxostoma applinae occurs in the Paleocene of Klagshamn and Tygelsjö as a common species, but it is never found in the samples from the Ystad Paleocene. It is also common in the Paleocene from Copenhagen.

### Spirillina nodifera Terquem.

Pl. 10, fig. 12.

Spirillina nodifera Terquem, Mém. Soc. Geol. France, 1882, Ser. III, Vol. II, p. 34, figs. 32 a, b
Spirillina selseyensis Heron-Allan & Earland, Journ. Roy. Micr. Soc. 1909, p. 440, Pl. 18, fig. 6, 7. — Halkyard, Mém. Proc. Manchester Lit. Philos. Soc. Vol. 2, 1918, p. 105, Pl. 6, fig. 6, Pl. 7, fig. 7 — Cushman & Garrett, C. C. L., Vol. 15, 1939, p. 84, Pl. 14, figs. 28, 29. — Cushman & Todd, C. C. L., 1942, Vol. 18, p. 38, Pl. 7, fig. 2. — Cushman, C. C. L. 1944, Vol. 20, p. 45, Pl. 7, fig. 20.

Remarks.

Several badly preserved specimens have ben found in the clay at Tygelsjö but they show the typical ornament. The specimens described as Spirillina selseyensis by Heron-Allan and Earland and other authors must belong to the same species, described by Terquem in 1882. His figure is not fully correct but it shows all the characters of this species and is completed by his diagnosis. This very characteristic Spirillina is widely distributed in the Paleocene and Eocene as a rare species.

### Spirillina vivipara Ehrenberg.

Ehrenberg, Abh. d. Akad. d. Wissensch. Berlin 1841, p. 442, Pl. III, fig. 41.

Some single specimens were found in the conglomerate of Klagshamn, certainly redeposited from the uppermost Danian. In the uppermost Danian this species occurs very abundantly.

### Spirillina recta Brotzen.

Brotzen, S. G. U. Årsbok 34, 1940, p. 28, figs. 5, 6.

Remarks.

Typical specimens occur in the Paleocene of Ystad, Klagshamn and Maglehem. They are redeposited from the uppermost Danian and their state of preservation is the same as of those in that layer.

**Pullenia aff. americana Cushman.**

Pl. 8, fig. 3.

P. americana Cushman, C. C. L., Vol. 12, 1936, p. 76, Pl. 13, figs. 4, 5. — Cushman & Todd, C. C. L., Vol. 19, 1943, p. 7, Pl. 1, fig. 16. — i. c. the references.

P. sphaeroides, Franke, Danm. Geol. Undersögelse, II. Raekke, nr. 46, 1927, p. 40, Pl. 4, fig. 8.

Remarks.

The Pullenia specimens available vary only a little in their proportions. Their periphery is broadly rounded, slightly lobate, the test compressed, the sutures fairly depressed. Those types were earlier determined as P. sphaeroides. In their revision of the genus Pullenia Cushman & Todd (1943) state: »The characters and other data are so obscure that it seems best to allow the name sphaeroides as applied to Pullenia to lapse.»

It is difficult to determine the Swedish Pullenia specimens as one of the species by Cushman and Todd, but it does not seem necessary to erect a new species for them, so they are provisionally determined as P. americana. Even the geological distribution makes it questionable whether the Cretaceous and Paleocene specimens belong to the same species. The Ratio A (according to Cushman & Todd: Ratio A = length/width in the apertural view, Ratio B = height of the last chamber: height of the apertural face) ranges from 1.5—1.8 and Ratio B = ca 2. The following species of Pullenia have these indices (according to Cushman and Todd):

Pullenia americana, Cushman,
Pull. jarvisi Cushman,
Pull. quinqueloba var. angusta Cushman & Todd.

Pullenia jarvisi is larger than the Paleocene specimens. The sutures of Pull. jarvisi and Pull. americana are more depressed and their periphery is more lobate than on the Swedish ones. Pullenia quinqueloba var. angusta is characterized by the acute periphery. Generally the specimens available resemble Pullenia americana and to indicate a difference they may be named var. paleocenica. Types from the Danish Paleocene must belong to the same species.

Occurrence.

Such types are found already in the Swedish Danian. In the Paleocene they occur rarely at Klagshamn, Solnäs and in the boulder of Maglehem.

**Nonionella ovata n.sp.**

Pl. 10, figs. 13, 14.

Diagnosis.

Test small, ovate in its outline, about one half as long as broad, equally biconvex, width: length in the apertural view about 1 : 1.8; periphery rounded or acute, not lobate; chambers few, five or six in the whorl last formed, on the spiral side arranged round a narrow central plug, on the umbilical side the last chamber extending about five sixths of the entire length, sutures indistinct, not depressed, wall smooth.

Remarks.

Several of the specimens available are very small, the length observed 2.5 mm. They are characterized by their large width and by the elongate last chamber on the umbilical side. They resemble Nonionella jacksonensis Cushman from the Jackson Eocene, Alabama, but they are distinguished by the narrow lower part of the last chamber on the umbilical side, the more biconvex shape and the not depressed sutures.

Occurrence.

This species occurs rarely in the entire Paleocene at Klagshamn. It is not found at the other localities.

Holotype: S. G. U. No. 2382, Klagshamn conglomerate.

**Nonion cf. graniferum (Terquem).**

Pl. 8, fig. 1.

Nonionina granifera Terquem, Mém. Soc. Geol. France, Ser. III, Vol. 2, 1882, p. 42, Pl. 2, figs. 8, 9.

Description.

Test somewhat compressed, umbilical region large, forming up to 2/3 of the diameter, slightly or not depressed, periphery rounded or acute, chambers distinct, slightly inflated, 6—10 in the last coil, sutures distinct, depressed near the umbilical region, transparent towards the periphery, umbilical region covered with finely grained secondary shell material, filling out parts of the pressed sutures. Aperture single, interiomarginal, rounded.

Remarks.

Two types of this species were observed. The first is broader than the other and its sutures are not depressed, its umbilical area is not sharply limited. The other type is finer, the umbilical area well limited, the sutures between the last chambers distinctly depressed. The diameter of the first type can be 0.6 mm, the others generally smaller.

This species is closely related to N. graniferum Terquem, but one of the figures of Terquem has spines on the periphery. Also the topotypes figured by Cushman (1939) are a little different from the specimens from the Swedish Paleocene. Without a comparison with the topotypes the systematic position of the Swedish form is uncertain.

Nonion sublaeve ten Dam (1944, Medd. geol. Stichting, Serie C. V—3, p. 109) is very closely related to the Swedish species. It seems to be distinguished only by the shape of the aperture, the number of the chambers and the diameter of the umbilical region. Types of Nonion sublaeve occur in the clay of Tygelsjö, but they are very small and difficult to examine.

Species of the genus Nonion and of the genus Elphidium with a granulated umbilical area are closely related. Such types occur from the Danian to recent. The geologically older forms show simple and short apertures. Types from the Eocene or younger have elongate, interior marginal apertures or an interior

marginal line of small rounded openings. Secondary openings on the sutures — the characters of the genus Elphidium — can occur on some specimens and be lacking on others of the same species of this group.

Occurrence.

This species occurs abundantly in the Paleocene at Ystad and Klagshamn. It is very rare in the clay at Tygelsjö and only a single specimen has been found in Maglehem.

**Elphidiella prima (ten Dam).**

Pl. 8, fig. 2, text-fig. 18.

Elphidium primum ten Dam, 1944, Medd. geol. Stichting, Ser. C—V. —3, p. 109, Pl. 5, fig. 15.

Description.

Test smooth, strongly convex on the sides, periphery rounded or slightly acute, umbilical regions with distinct elevated umbo, chambers distinct in the youth and indistinct in the adult, 13—16 in the last whorl. Sutures transparent, not or only slightly depressed, with two rows of pores. Aperture a row of pores at the base of the last septum.

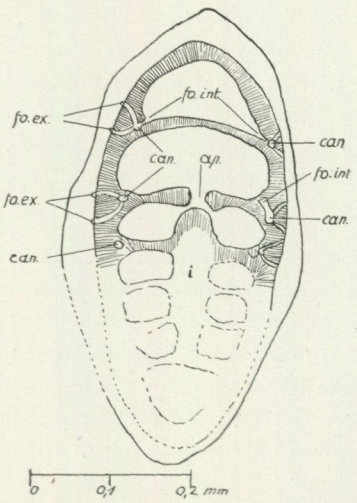


Fig. 18. Elphidiella prima (ten Dam). Ystad gjuteriet 20 m. ap. = foramen septale. can. = sutural canal. fo. ex. = foramina exteriora. fo. int = foramina interiora.

Remarks.

Tests vary slightly in height and breadth, the number of chambers in the whorl, the dimensions of the umbilical plugs and the number of pores at the sutures. The rows of pores on the sutures are very indistinct on most specimens, but they are very well visible by staining with Methylene blue and upon being stained subsequently washed with alcohol.

Sections of the test (fig. 18) show a canal in the angles between the septal wall and the side wall, lying parallel to the sutures — the sutural canal = »can»

in figure 18. The sutural canal communicates by ramifications with the chamber, lying after the septum in the direction of the apertural face of the test. These ramifications are »fo. int.» = foramina interiora in fig. 18. From the rows of pores on the outside of the test small canals run to the sutural canal (»for. exteriora»). This system of canals resembles those in the tests of the recent Elphidiella arctica Parker & Jones.

The aperture of Elphidiella prima consists of several small openings at the base of the last septum; in the inner part the aperture is reduced to one large opening (fig. 18 »ap»). This species is erected for specimens from the Dutch Paleocene. According to the description and figure by Ten Dam there are no differences between specimens from Sweden and the Netherlands. The relation to E. smithi Cushman & Dusenbury is noted by ten Dam. Elphidium smithi occurs in the Poway conglomerate, the stratigraphical range of which is not determined for certain. Possibly it belongs to the middle or upper Eocene and contains many foraminifera redeposited from the Cretaceous.

Occurrence.

Elphidiella prima occurs commonly in the clay and in the greensand at Ystad and it is also common in the Danian below the Paleocene at Ystad. This species is rare in the Danian and Paleocene at Klagshamn, in the clay at Tygelsjö and in the boulder of Maglehem.

**Patellina sp.**

Pl. 9, fig. 6.

Remarks.

A single, well preserved specimen of Patellina was found in the greensand at Ystad. Its diameter is about 0.29 mm and the height not more than 0.08 mm. The test is subconical and transparent. In the test whorl there are three chambers; their internal septa are undivided and very short. It is similar to P. dentata Terquem 1882 and is only distinguished by the short internal septa. It is of interest that also from the American Paleocene Patellina there is described one single specimen from the Upper Midway (Cushman 1944, C. C. L. Vol. 20, p. 45) and also one specimen from the Lower Wilcox (Toulmin 1941, Journ. of Paleont. Vol. 15, p. 599).

**Conorbina sp.**

Pl. 9, fig. 8.

Remarks.

A single specimen of Conorbina was found in the greensand of Ystad and another in the conglomerate at Klagshamn. They are well preserved and their tests are transparent. They are distingusihed from Conorbina conula Brotzen by the Patellina-like umbilical side.

Typical specimens of Conorbina conula Brotzen are not rare in the conglomerate and greensand of Klagshamn and in the greensand and clay of Ystad, but they are redeposited from the Danian limestone.

## Genus Rosalina D'Orbigny 1826.

Discorbis (part) of authors (Cushman, Galloway).
Discorbina Parker & Jones 1862.

Genotype: Rosalina globularis D'Orbigny.

Diagnosis.

Test convex or plano-convex. All whorls visible on the spiral side; umbilical side flat or concave: chambers on the spiral side generally sickle-shaped, extended in length, on the umbilical side they cover each other more or less, the last with a lobate inner margin, periphery mostly radiate; aperture under the lobate margin of the last chamber.

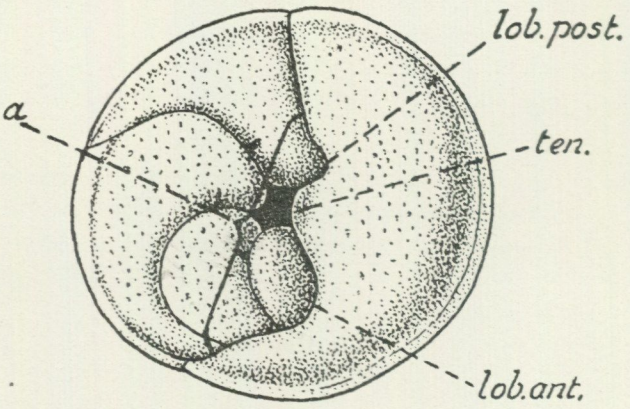


Fig. 19. Rosalina orbicularis (Terquem). aft. Brady. a = situation of the aperture; lob. ant. = anterior lobus; lob. post = posterior lobus; ten = tenon.

Remarks.

The genotype of the genus Discorbis has not been determined for certain. It was very badly figured by Lamarck and the topotypes given by Cushman in his »Foraminifera, their classification and economic use, 1927, 1933, 1940» are not definitely identical with Lamarck's figure. Therefore, I consider that the name of the genus Rosalina must also replace the name Discorbina Parker & Jones. The genus Rosalina is best characterized by the shape of the aperture. The inner suture of the last chamber on the umbilical side is lobate in an anterior and posterior lobe (fig. 19 »ant. lob.» — »post. lob.»). A more or less distinct tenon pushes forwards between the lobes (fig. 19 »ten.»). The aperture lies below the posterior lobe and can extend under the tenon. Rosalina is distinguished from Conorbina Brotzen by the umbilical region and aperture, and the plano-convex or convex spiral side.

### Rosalina ystadiensis n.sp.

Pl. 9, fig. 9.

Diagnosis.

Test forms a convex spire; in the youth, height about 1/2 of the diameter, in the adult it becomes flatter; umbilical side fairly concave in the middle; peri-

phery acute with distinct radial marks, apex rounded; chambers in the beginning short, become longer in the second whorl, in the adult whorl 5—6 sickle-shaped chambers; on the umbilical side only the last whorl visible, umbilicus slightly depressed, covered with small tubercles; the lobes of the last chamber shallow; the tenon short. Sutures on the spiral side transparent, on the umbilical side slightly depressed. Aperture below the posterior lobe and the tenon. Remarks and occurrence.

This species occurs very rarely in the clay at Ystad, in the conglomerate at Klagshamn and in the clay at Tygelsjö. It also seems to occur in other layers. It is well preserved and characterized by the tubercles in the middle of the umbilical side. Closely related species occur in the Danian and Maastrichtian of Sweden.

Holotype: S. G. U. No. 2410 Clay of Solnäs.

**Rosalina koeneni n.sp.**

Pl. 9, fig. 11.

Diagnosis.

Test small, spiral side fairly elevated, height about 1/3 of the diameter; apex pointed; umbilical side slightly depressed; periphery acute with a broad, transparent margin; chambers 6 to 7 in the adult whorl, broad sickle-shaped not covering each other on the umbilical side, last chamber with an indistinct anterior lobe, short and deep posterior lobe and a broad and short tenon. Sutures on the spiral curved, transparent, not depressed, on the umbilical side fairly depressed with narrow area, forming a star-shaped figure; umbilical plug small, distinctly elevated, aperture below the anterior lobe and tenon, wall finely perforated.

Remarks.

This species is characterized by the slightly elevated spiral, the star-shaped sutures and the plug on the umbilical side. The spiral side resembles that of Rosalina vilardeboana D'Orb, but their umbilical sides are well distinguished.[1]

Occurrence.

This species occurs as a rare form in the Paleocene at Ystad and Solnäs.

Holotype: S. G. U. No. 2414, Greensand at Ystad.

**Valvulineria laevis Brotzen.**

Pl. 9, fig. 12.

Valv. laevis Brotzen, Sver. geol. undersökning, Årsbok 34 (1940) No. 5, p. 23, fig. 7.

Remarks.

The typical specimens of this species are small in the Paleocene. They are only distinguished from the specimens of the Danian by their state of preserv-

[1] Bandy (1944, Journ. of Paleont. Vol. 18, p. 372) erected the genus Rotorbinella for »Discorbis» with an umbilical plug, but the genotype Rotorbinella colliculus Bandy and the closely related Rotalina caloosahatcheensis Cole have »reentrants» apertures and may be related to the genera Rotalipora Brotzen and Cymbaloporella Cushman (see Brotzen 1942, Sver. Geol. Unders., Årsbok 36, No. 8).

ation. The test of the Paleocene species is generally transparent, in the Danian it is compact.

Occurrence.

Single specimens occur in the Paleocene at Ystad and Klagshamn.

### Valvulineria ravni n.sp.

Pl. 9, fig. 13.

Diagnosis.

Test almost equally biconvex, inner whorls on the spiral side plain or a little depressed; periphery fairly acute, slightly lobate in the last portion of the test; chambers 9—10 in the last whorl, flattened except the last, which is often slightly inflated on the spiral side; sutures distinct, transparent and very slightly depressed between the last chambers; umbilicus narrow, covered by small, narrow lips, depressed in the umbilical region.

Remarks.

This species differs from Valvulineria laevis by the equally biconvex test, by the depressed inner whorls on the spiral side and by the small and narrow lips in the umbilicus. Valvulineria aequilateralis Plummer (= Rotalia aequil. 1926, Bull. Univers. Texas, No. 2644, p. 155) is very similar to the Swedish species, but it is smaller, more compressed, and the central part of the spiral side more distinct. Valvulineria aequilateralis described by Cushman and Todd as Gyroidina subangulata (1942, C. C. L. Vol. 18, p. 40) seems to be closely related to Val. ravni. »Gyroidina» aequilateralis Cushman 1944 (C. C. L. Vol. 20, p. 45) is figured without lips in the umbilical region and it is consequently impossible, without topotypes, to determine its systematical position.

Valvulineria scrobicula Cushman and Ponton (non Schwager, 1932, C. C. L. Vol. 8, p. 70 and Cushman and Garrett 1939, C. C. L. Vol. 15, p. 85) belongs to the genus Gyroidinoides and is distinguished from Valvulineria ravni by the open umbilicus and the numerous visible lips.

This species is named after Prof. J. P. Ravn, Copenhagen.

Occurrence.

Valvulineria ravni occurs rarely in the Swedish Paleocene localities.

Holotype: S. G. U. No. 2426, Ystad, gjuteriet 21 m.

### Gavelinella bullata Brotzen.

Brotzen, Sver. geol. unders. Årsbok 36, 1942, Ser. C, No. 451, p. 45, Pl. 1, figs. 4, 5.

Remarks.

Only a few specimens have been observed in the conglomerate at Klagshamn. They are typical forms of the Danian species and are undoubtedly redeposited from the Danian layers. They occur together with Gavelinella lellingensis n.sp., which is an especial species of the Paleocene.

**Gavelinella lellingensis n.sp.**

Pl. 11, figs 1, 2; text-fig. 20.

Diagnosis.

Spiral side flat or slightly convex; final whorl generally higher than the early ones, chambers seven or eight in the final whorl, the last 2—6 chambers inflated and their sutures strongly depressed, the early chambers and sutures only transparent; umbilical side with a large umbilicus, chambers in the beginning of the last whorl transparent, then inflated and their sutures also strongly depressed; peripheral margin in all stages broad-rounded, lobate; apertural lips in the umbilicus triangular, large, on the final chambers also overlapping the interior marginal aperture; wall coarsely perforated.

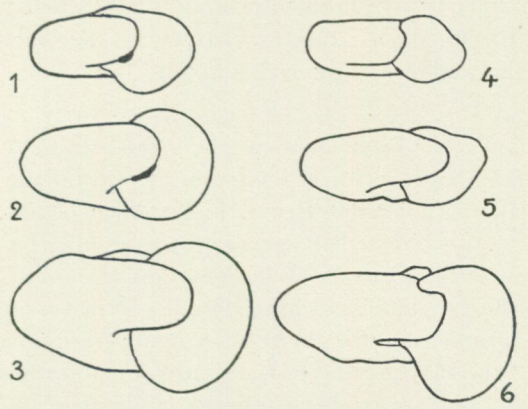


Fig. 20. Comparisons between Gavelinella lellingensis and Gåvelinella pertusa.
1—3. Gavelinella lellingensis.
1, 2. Solnäs 9 m; 3, Klagshamn greensand.
4—6. Gavelinella pertusa. Höllviken well.
Uppermost Maastrichtian.

Remarks.

This species is closely related to Gav. bullata Brotz. and differs by the more inflated chambers, the larger umbilicus in the adult, the strongly rounded peripheral margin and the coarsely perforated wall. Young specimens of Gav. bullata resemble those of Gav. pertusa Marsson, their peripheral margin is acute, their test is flat and the umbilicus large. Gav. lellingensis, on the contrary, has also in the youth an umbilicus, which is proportionally narrow, but the peripheral margin is broad-rounded and the test is thicker than the tests of Gav. pertusa and G. bullata with the same diameter. In the adult these species differ by the strongly inflated chambers on the spiral side of the Paleocene specimens and the flatter chambers of the Danian or Senonian specimens.

The smooth test without relief in the young agrees with the evolution of Gavel. pertusa and Gavel. bullata and consequently it must have derived from these species and not from Gavelinella moniliformis, G. tumida or other species with depressed sutures in the initial stages.

Occurrence.

This species occurs rarely in all Swedish Paleocene localities. At Tygelsjö its frequency is greater than at the other localities. Gavelinella lellingensis is very typical in the Paleocene sediments at the outcrop on the Lellinge river in Denmark, which explains the name »lellingensis».

Holotype: S. G. U. No. 2435, Black clay, Lellinge river, Denmark.

**Gavelinella (?) sp.**

Pl. 9, fig. 10.

Description.

Test convex on the spiral side, concave on the umbilical side; periphery broadly rounded; 2—3 whorls visible on the spiral side, umbilical side with a wide and deep umbilicus; five inflated chambers in the last whorls, each with a narrow lip in the umbilicus, sutures distinct, in the last whorl depressed; aperture under the umbilical lips; wall smooth.

Remarks.

Only one specimen has been found in the greensand at Ystad. Its generic position is uncertain, but it is closely related to such Rotaliidae, as well described as Valvulina allomorphinoides Reuss. Finlay 1939 (Trans. Roy. Soc. New Zealand, Vol. 69, p. 325) erected the genus Rotomorphina for such forms. The Cretaceous species of this genus varies between test with umbilicus and without umbilicus. Only the last umbilical lip is visible on all Cretaceous species and therefore many authors describe them as »Valvulineria». The arrangement of the chambers and the shape of the test are different from those of typical Valvulineria. Many of them are related to the Valvulinerinae and not to Chilostomellidae. Finlay's diagnosis of Rotomorphina does not include forms with a wide and deep umbilicus. The single specimen from Ystad is therefore only provisionally determined as Gavelinella.

**Gyroidinoides soldanii (D'Orbigny) var. octocamerata (Cushman & Hanna).**

Pl. 11, fig. 3.

(For references see Toulmin 1941 Journ. Paleont. Vol. 15, p. 600.)

Remarks.

Specimens of this species are very typical and do not differ from those described from the American Paleocene and Eocene.

Occurrence.

This variant occurs rarely in the Paleocene at Ystad and in the conglomerate at Klagshamn.

**Gyroidinoides pontoni n.sp.**

Pl. 11, figs 4, 5.

Diagnosis.

Test almost biconvex, spiral side being faintly convex, umbilical side more convex, on the spiral side two and a half or three whorls; peripheral margin

rounded; chambers about ten in the final whorl, sutures on the spiral side curved, in the initial stage transparent, between the last two or three chambers strongly depressed, on the umbilical side the sutures radial, transparent except the last three or two, which are depressed; also the spiral suture in the last part depressed; umbilicus narrow, lips distinct, very large on the final chambers; wall smooth, pores indistinct.

Remarks.

Gyroidinoides pontoni is very similar to Gyroidinoides aequilateralis (= Rotalia aequilateralis Plummer 1926) and Gyroidinoides scrobicula (Valvulineria scrobicula Cushman & Ponton 1932 — not Schwager). It is distinguished by the high umbilical side, the strongly depressed sutures and the larger tests. It is distinguished from the group of Gyroidinoides soldani by the more biconvex shape and the convex spiral side. The shape of this species is intermediate between the forms with a high convex umbilical side and the flat spiral side, such as G. soldani, and the almost biconvex types such as G. aequilateralis and G. scrobicula.

Occurrence.

This species has been found in all localities of the Paleocene in Sweden.

Holotype: S. G. U. No. 2448. Conglomerate at Klagshamn.

**Eponides lunata n.sp.**

Pl. 10, figs. 17, 18.

Diagnosis.

Test small, both sides conoidal, spiral side not as high as the umbilical side, with a somewhat more sharply elevated central part. Peripheral margin sharply acute and generally somewhat lobate; chambers 6—7 in the final whorl, on the spiral side crescent-shaped, sutures transparent, the last two or three a little depressed, on the umbilical side chambers slightly inflated, sutures curved, depressed, umbilicus lacking. Aperture under a narrow lip; wall smooth, very finely perforated, diameter up to 0.25 mm.

Remarks.

This small species is characterized by the conoidally elevated sides and the sharply acute peripheral margin. Specimens with a low spiral side dominate. It is closely related to Truncatulina tenera Plummer 1926 (not Brady 1884) from the Upper Midway formation. Plummer's species is more elevated and convex on both sides, not conoidal as the Swedish species, and the margin of Eponides lunata is more acute. Closely related species occur also in the Danian and Maastrichtian in Sweden and they seem to belong to the same species.

Occurrence.

Eponides lunata occurs rarely in all Swedish Paleocene localities, except in the greensand at Ystad, where the species has not been found hitherto.

Holotype: S. G. U. No. 2455, Greensand at Klagshamn.

**Eponides toulmini n.sp.**

Pl. 10, fig. 16.

1941 Eponides boueana Toulmin Journ. Paleont. Vol. 15, p. 601, Pl. 81, figs. 6, 7.

Diagnosis.

Test biconvex, umbilical side more strongly convex than the spiral side, peripheral margin acute, carinate; chambers 6 to 8 in number in the final whorl, increasing regularly in size as added; sutures distinct and curved, on the spiral side often marked by broad bands of clear shell material; on the umbilical side fairly depressed; apertural slit under a narrow lip; wall coarsely punctated on the spiral side and smooth on the umbilical side. Diameter not more than 0.3 mm.

Remarks.

This species is characterized by its coarsely punctated wall and the raised sutures on the spiral side. The sutures vary, they can be broad and elevated, but often they are only transparent, narrow lines. On several specimens the spiral side is only slightly elevated.

The Swedish specimens agree in all respects with those described by Toulmin as Eponides boueana from the lowest Eocene of Alabama. Rotalina boueana D'Orbigny from the Miocene of Basin of Vienna, according to the original descriptions and figures, is well distinguished from the Paleocene and Eocene species by the large diameter (up to one millimeter), the strongly elevated sutures and the finely perforated wall on the spiral side and the distinct umbilicus on the umbilical side. It thus seems to be necessary to erect a new species for the Paleocene form.

Occurrence.

This species occurs rarely at all Swedish Paleocene localities.

Holotype: Toulmin 1941, Pl. 81, fig. 6.

**Cibicidoides proprius n.sp.**

Pl. 12, figs. 3, 4.

1941 Cibicides praecursorius Toulmin, Journ. Paleont. Vol. 15, p. 610, Pl. 81, figs. 19, 20.
1944 Cibicides cryptomphalus ten Dam, Med. geol. Sticht. Ser. C—V—3, p. 132, Pl. 1, fig. 4.

Diagnosis.

Test planoconvex, spiral side moderately convex or nearly flat, with distinct central plug; the central plug slightly elevated or generally equal with the convexity of the spiral side, seldom in a flat depression; chambers eight or nine in the final whorl, the last one slightly inflated; sutures in the young transparent, curved, in the adult depressed. Umbilical side convex, 2—3 whorls visible, the inner two like a broad elevated plug with transparent sutures, in the beginning of the last whorl the sutures are also transparent and between the last chamber the sutures are distinctly oblique and depressed, also the spiral suture depressed in the final part. Peripheral margin acute, slightly lobate. In the young

the wall on both sides smooth and glossy, in the adult on the spiral side finely and on the umbilical side coarsely perforated. Interior marginal part of the aperture short and broad, the umbilical part continuing on 2—4 chambers.

Remarks.

The flat biconvex test varies in its shape and in all details. The umbilical side is generally more elevated than the spiral side, but the convexity can be equal and the spiral side is seldom higher than the umbilical side. In the young the central plug of the spiral side is equal with the convexity of the test. In the adult the plug acquires a more elevated shape and often the last whorl is a little higher than the central part, so the plug lies in a level depression (see Pl. 12, fig. 3). On the umbilical side the last chambers are limited by depressed and distinctly oblique sutures, if the diameter is large; the sutures on young and median tests are curved and not depressed. The relatively large central part on the umbilical side is characteristic for the species and its shape is more or less constant.

This new species belongs to a group of Cibicidoides, which are characterized by the almost biconvex tests. Such forms are known from the Turonian, described as C. turonica 1945 by the author; they occur abundantly in the Senonian and are described as Rotalina constricta Hagenow 1842, possibly it is the same species as Cibicides voltziana (D'Orbigny) var. denticulata P. Marie (1941). Cibic. voltziana occurs in all Danian sediments in Sweden and is relatively large. This form occurs also in the Paleocene at Klagshamn and is undoubtedly redeposited from the Danian. Cibicidoides proprius is distinguished from the Cretaceous forms by the flat biconvex test, the narrow last whorl on the umbilical side, its oblique sutures and the large central part. The sutures of the Cretaceous species are depressed only on large specimens, but specimens of Cibicidoides proprius with a small diameter show depressed sutures between the last chambers. A closely related species — Cibicides praecursorius Cushman & Ponton (not Schwager, C. C. L. 1932, Vol. 8, p. 72) — is described from the American Paleocene and Eocene. It is distinguished from the Swedish species by the plain umbilical side (typical for the genus Cibicides).

Toulmin described from the Lowest Eocene of Alabama Cibicides praecursorius, which conforms in all details with Cibicidoides proprius and must belong to the new species. Ten Dam (1944) described from the Dutch Paleocene also a Cibicides species, which specimens partly belong to C. proprius. He determined it as Cibicides cryptomphalus Reuss. Cibicides cryptomphalus Reuss is described from the »Tegel» of the Vienna Basin (Miocene) and according to the original diagnosis it is characterized by its flat shape, almost plain umbilical side and a large central plug on the spiral side; the number of the chambers is generally about 10. According to the description the Dutch Paleocene species also has 10 chambers in the last whorl, but not so in the figure of the typical form, and on the var. acutimargo ten Dam the number of chambers is not more than eight. The shape is biconvex and in all details like the Swedish species and not like the Miocene Cibicides cryptomphalus Reuss.

Occurrence.

Cibicidoides proprius is one of the most frequent species in the Swedish Paleocene; it is found at all localities and its frequency is more than 10 % of all foraminifera in the samples. The same large frequency has been observed by ten Dam in the Dutch Paleocene. It would seem that Cibicidoides proprius is one of the guide fossils in the European Paleocene.

Holotype: S. G. U. No. 2467 Ystad, gjuteriet, 20 m.

### Cibicides succedens n.sp.

Pl. 12, figs. 1, 2; text-fig. 21.

1944 Cibicides cryptomphalus (Reuss) var. hercegovinensis ten Dam Med. Geol. Sticht. Ser. C—V—3, p. 132, Pl. 5, fig. 9.

Diagnosis.

Spiral side cone-shaped (height: diameter = 1.5—1.3), distinct central plug, strongly elevated, sutures distinct, curved transparent, the last one is occasionally slightly depressed. Peripheral margin acute, sometimes fairly keeled. Umbilical side flattened or slightly convex, central plug distinct, the diameter of the plug $^1/_5$—$^1/_2$ of the diameter of the test, sutures transparent, strongly curved. Aperture interiomarginal and umbilical, short, only on the last chamber. Wall glossy, very fine perforations.

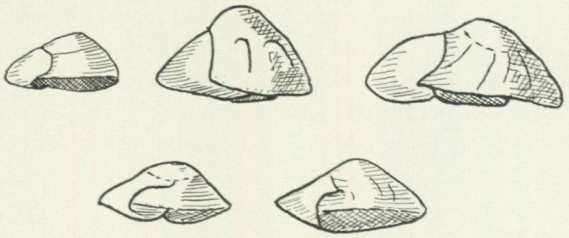

Fig. 21. Cibicides succedens n.sp. Ystad gjuteriet 21 m.

Remarks.

This species is very closely related to Cibicides voltziana D'Orbigny from the Senonian and Danian. Single specimens cannot be distinguished from the Senonian species, only the population of this new species is different from a population of Cibicides voltziana. All the young specimens resemble Cib. voltziana. In the adult the tests are never so high and the umbilical plug larger than the plug of Cib. voltziana. Two different types exist, possibly representing generation forms. Specimens as figured in Pl. 12, fig. 1 with a relatively low spiral side are common. The plugs of the spiral and umbilical sides are small and only slightly elevated. Such forms are very well distinguished from Cibicides voltziana, but the other type with a high conoidal spiral side and with very large and strongly elevated plugs are more like the Senonian species. Such a type is figured Pl. 12 fig. 2. It seems that the Cibicides succedens must have derived from Cibicides voltziana and that it is the Paleocene representative of the high and conoidal forms of the genus Cibicides.

These conoidal Cibicides species occur since the Emscherian and in the same layers there are generally very similar forms, different by their biconvex test and smaller plugs. Also in the Senonian these two forms occur together: Cibicides voltziana D'Orbigny and Cibicidoides constricta Hagenow, representing closely related species, and in the Paleocene have been found the Cibicides succedens and Cibicidoides proprius. Each species has different shapes of prolocula and they must be two species and not generation forms of one species. In 1944 ten Dam described the conoidal type of Cibicides from the Dutch Paleocene as Cibicides cryptomphalus (Reuss), var. hercegovinensis de Witt Puyt. This species resembles Cibicides succedens and must belong to the same species. It was impossible for me to procure de Witt Puyt's publication in 1941 (a dissertation on: Geologische und Paleontologische Beschreibung der Umgebung von Ljubuski. Utrecht).

Cibicides praecursorius Cushman and Renz 1942 (C. C. L. Vol. 18, p. 13, Pl. 3, fig. 9) differs in all details from the Cibicides praecursorius Schwager (1883), which is a flat species without a spiral plug, but it seems to belong to the same species as the conoidal forms from the Swedish Paleocene.

Occurrence.

This species occurs in all Paleocene localities in Sweden and its frequency is very large in the lower parts (generally more than 10 %); it becomes rare in the upper part (Solnäs only 3.5 %). Single specimens of the Danian Cibicides voltziana occur together with the Paleocene species in the lower parts of the Paleocene; they are generally redeposited.

Holotype: S. G. U. No. 2475, Ystad, gjuteriet, 20 m.

**Cibicides mammillatus n.sp.**

Pl. 10, fig. 15.

Diagnosis.

Test small (diameter max. 0.25 mm), biconvex or conoid, periphery acute; spiral side three or three and a half whorls, distinctly visible, the centre plug elevated over the other whorls; sutures distinct, transparent, only between the last chambers very slightly depressed, chambers 7—9 in the final whorl; umbilical side flat or slightly convex, with distinct umbilical plug, sutures distinct, slightly curved, the last ones fairly depressed; wall smooth.

Remarks.

This small species differs from the closely related Cibicides voltziana D'Orbigny and related forms by the visible inner whorls on the spiral side and the depressed sutures on the umbilical side. The depressed sutures on so small specimens are a good character for this species. Cibicides mammillatus shows very little variety and varies only in the proportions of height and diameter.

Occurrence.

Cibicides mammillatus occurs as an abundant form at all Swedish Paleocene localities.

Holotype: S. G. U. No. 2505 Ystad, gjuteriet, greensand.

**Cibicides reinholdi ten Dam.**

Pl. 13, figs 1.

1944 ten Dam Med. Geolog. Stichting Serie C—V—3, p. 135, Pl. 5, fig. 6.

Remarks.

The specimens available resemble the description and figures of ten Dam. This species belongs to a group of forms adhered to plants and characterized by several distinct whorls on the umbilical side. The prominent representative of this group is Cibicides lobatulus Walker & Jacob. The difference between the recent species and the fossil members of this group are unimportant and often it is impossible to distinguish the closely related forms.

Occurrence.

Single specimens have been found at Klagshamn and Solnäs (Tygelsjö) and generally only young individuals occur.

**Cibicides ekblomi n.sp.**

Pl. 13, figs 2.

Diagnosis.

Test small (diameter up to 0.3 mm, generally less), slightly convex on the spiral side, almost flat on the umbilical side. Peripheral margin acute; chambers numerous, 9—12 forming the last whorl, sutures distinct, broad, transparent areas, strongly curved, giving the tests the characteristic appearance. On the spiral side a small central plug, on the umbilical side a slightly depressed, small umbilicus. Wall smooth, finely perforated on the spiral side and more perforated on the umbilical side.

Remarks.

Cibicides ekblomi belongs to a group with slightly elevated spiral side and almost flat umbilical side. It is characterized by the numerous chambers in the whorl and by the strongly curved sutures. The specimens vary in the number of chambers, in the diameter of the central plug on the spiral side and in the breadth of the sutural areas. Generally there are nine chambers in the final whorl, seldom more. The spiral plug is very small, when it is not lacking, and only one specimen in the collection shows a small and indistinct inner whorl on the spiral side. No closely related forms could be found in the literature. This species has been named in honour of Mr. S. Ekblom of Stockholm, who has assisted me in drawing foraminifera for many years.

Occurrence.

Cibicides ekblomi occurs commonly in the clay at Tygelsjö, in the greensand at Ystad and in the Lower Paleocene at Copenhagen (Sundkrogen and Västra Gasverk).

Holotype: S. G. U. No. 2510 Solnäs (Tygelsjö).

**Cibicides simplex n.sp.**

Pl. 13, figs 4, 5.

Diagnosis.

Spiral side moderately convex, plain in the centre with a distinct, narrow central disk, peripheral margin acute, angled or rounded, umbilical side flat or slightly concave, umbilicus narrow, slightly depressed, often indistinct; chambers 6—10 in the final whorl, flat or fairly inflated on the umbilical side; sutures distinct, transparent in the young, later slightly depressed on the spiral side. Aperture continued on the umbilical side on two to three chambers, may be covered by a narrow lip. Wall smooth on the spiral side, strongly perforated on the umbilical side.

Remarks.

This species is related to Cibicides howelli Toulmin 1941. It is distinguished by the umbilicus, which is lacking in all variants of the American Paleocene species. Cibicides simplex varies very much and two different types were observed. The first type is characterized by the flat chambers on the umbilical side, more or less indistinct umbilicus and angled peripheral margin. 8—10 chambers in the final whorl. The second type varies in the number of chambers in the final whorl, from six to ten; in the adult the chambers are inflated on both sides, the sutures depressed and the peripheral margin lobate. The umbilicus is generally more distinct than on the first type and the peripheral margin is more rounded. Cibicides simplex is distinguished from the other related Cibicides species in the Swedish Paleocene as follows:

*Cibicides simplex n.sp.*

diameter generally larger than 0.25 mm
chambers in the final whorl 6—10
sutures between the last chambers fairly depressed
in the central part of the spiral side always a distinct disk.

the central disk on the spiral side not elevated or marked by a depressed suture
umbilicus fairly depressed without elevated plug

*Cibicides ekblomi n.sp.*

diameter seldom more than 0.25 mm
chambers in the final whorl 9—12, generally 10
sutures never depressed

central disk indistinct or lacking

*Cibicides burlingtonensis Jennings* 1936.

diameter generally about 0.25 mm.
chambers in the final whorl five or six
sutures distinctly depressed
central disk relatively large, distinctly elevated over the final whorl
characterized by a not depressed umbilicus with a very narrow but elevated plug.

*Cibicides umbilicata n.sp.*

on the spiral side an early whorl visible.
peripheral margin broadly rounded
umbilicus distinct, strongly depressed.

Occurrence.

Cibicides simplex occurs in all Swedish Paleocene localities and its frequency is generally large. The first type with flat chambers on the umbilical side occurs

at Ystad, Klagshamn and Maglehem, the second type with the slightly inflated chambers on the umbilical side occurs only in the clay at Tygelsjö.

Holotype: S. G. U. No. 2671 Klagshamn, greensand.

**Cibicides burlingtonensis Jennings.**

Pl. 13, fig. 3.

1936 Ph. H. Jennings, Bull. Americ. Paleontology Vol. 23, No. 78, p. 39, Pl. 5, fig. 5.

Remarks.

This small and strongly compressed species is well characterized by its depressed sutures, the distinct elevated central disk on the spiral side and by the few chambers of the final whorl. The Swedish specimens resemble the original from the Hornerstown formation in New Jersey, but a small and slightly elevated plug in the umbilicus region is present on all specimens available. The differences between Cibicides burlingtonensis and the other related Cibicides species in the Swedish Paleocene will be seen from the table on p. 83. Toulmin described a very similar Cibicides as C. burlingtonensis, but that species is much larger and its wall is very strongly perforated on both sides. It is possible that in a certain facies the species develops this large test, but the Alabama forms differ greatly from the Hornerstown forms.

Occurrence.

This species is rare at Tygelsjö, Klagshamn and Ystad.

**Cibicides umbilicata n.sp.**

Pl. 13, fig. 6.

Diagnosis.

Test convex on the spiral side, depressed early whorls, peripheral margin broadly rounded, lobate, umbilical side flat or fairly convex. On the spiral side two or two and a half whorls visible, in the final whorl 9—10 chambers, the last inflated, sutures depressed, strongly curved with broad and transparent areas; on the umbilical side the sutures are only transparent, very strongly curved; umbilicus narrow and deep; wall smooth, strongly perforated on both sides.

Remarks.

The systematical position of this species has not been determined for certain. The broadly rounded peripheral margin, the visible and depressed early whorls on the spiral side and the deeply depressed umbilicus indicate that this species may belong to the genus Anomalinoides. The flat umbilical side and the shape of the test, similar to that other Cibicides species, prompted the author to determine this species as a Cibicides. According to the author's opinion (1942, Die Foraminiferengattung Gavelinella S. G. U. Årsbok 36.) Cibicides and Anomalinoides are very closely related and in many cases it will be difficult to differ between the genera. The differences between this species and other Cibicides species in the Swedish Paleocene is shown in the table on p. 83.

Occurrence.

Cibicides umbilicata n.sp. occurs in the Paleocene clay and greensand at Ystad.

Holotype: S. G. U. No. 2515, Ystad, gjuteriet 21 m.

**Cibicides sahlströmi n.sp.**

Pl. 17, fig. 1.

Diagnosis.

Test small (diameter up to 0.20 mm), spiral side slightly convex, two to three whorls visible, ten to twelve chambers in the final whorl, sutures narrow, distinctly raised, very slightly curved, the last one on very large specimens depressed and the raised ridges disappearing, also the spiral suture raised; peripheral margin angled; umbilical side flat, sutures in the early part slightly raised, later only transparent or very slightly depressed, umbilicus distinct, often depressed, the rest of the early whorls visible; except for the ridges the wall smooth on the spiral side, perforated on the umbilical side.

Remarks.

This species is characterized by its typical raised sutures on the spiral side and is well distinguished from other related forms. Generally the specimens are more compressed than the form figured.

This very characteristic species has been named in honour of Fil. dr. K. E. Sahlström, Secretary of the Geological Survey of Sweden. Dr. Sahlström has edited and corrected all papers by the author published in the series of the Geological Survey.

Occurrence.

This small species occurs already in the uppermost Danian in Sweden. In the Paleocene it was found at all localities as a rare form.

Holotype: S. G. U. No. 2500, Ystad, gjuteriet 21 m.

**Planulina limbata n.sp.**

Pl. 13, fig. 7.

Diagnosis.

Test flat, the spiral side fairly convex, umbilical side concave; periphery acute or keeled; two whorls or two and a half visible on the spiral side, chambers 6 to 7 in the final whorl, slightly inflated; sutures in the young transparent, in the adult slightly raised, also the spiral suture raised; on the umbilical side a shallow and narrow umbo with a small depressed umbilical plug in the centre; sutures transparent, in the adult slightly depressed, the interiomarginal part of the aperture short and broad, the umbilical part continues on three or four chambers; the umbilical part of the aperture covered with small lips extending from each chamber; wall smooth, glossy, very finely perforated.

Remarks.

Species with a similar spiral side have before often been determined as »Discorbis» or related genera. This species has a characteristic Cibicides aperture and is well distinguished from such forms as Discorbis midwayensis var. trinidatensis Cushman and Renz (C. C. L. Vol. 18, 1942, p. 10) and Discorbis havanensis Cushman and Bermudez (C. C. L. Vol. 13, 1937, p. 19). Related Planulina or Cibicides species lack the raised sutures or the periphery is truncate.

Occurrence.

This species occurs as a rare form in the greensand and the clay at Ystad and in the clay at Tygelsjö.

Holotype: S. G. U. No. 2518, Ystad, gjuteriet, 20 m.

### The genus Anomalinoides Brotzen 1942.

Sveriges geologiska undersökning Ser. C, No. 457, Årsbok 36, nr. 8, p. 23.

The genus Anomalinoides was erected for biconvex Cibicidinae with interiomarginal and umbilical aperture. The umbilical part of the aperture continues in the spiral suture below the last chambers. The whorls are wound more or less in the same plane. The species of this genus may be involute or evolute on the spiral and umbilical sides.

The genetic position of the genus is not always certain. Partly the species greatly resemble Cibicides, distinguished only by the biconvex test and the presence of an umbilical plug. Other species are characterized by umbilical lips, covering the umbilical part of the aperture. Such lips occur only on the last chambers, an umbilical plug can also occur on the same species. Types with an umbilical plug and with umbilical lips in many respects resemble Gavelinella and Gyroidinoides species.

The genotype is Anomalinoides pinguis (Jennings 1936) (synonym Anomalina grosserugosa Plummer 1931 = Anomalinoides plummerae Brotzen 1942).

Mrs H. J. Plummer has sent me many topotypes of Anomalinoides pinguis with the following notes:

> »Anomalina grosserugosa (Gümbel) (now A. pinguis Jennings 1936, renamed Anomalinoides plummerae Brotzen 1942). Valid name must be *pinguis*, regardless of the generic position. Since Jennings presented the A. pinguis, new name (not n.sp.) he has made his New Jersey form the holotype, then you might claim that the Texas form designated by me as A. grosserugosa was not identical with the New Jersey form A. pinguis Jennings, and you could have claimed for a new name for my Texas A. grosserugosa. *But* Jennings 1936 gave a *new name* to my Texas form figured and described; consequently you cannot give *another new name* to the Midwayan form. Your new name becomes a synonym.»

The name of the genotype must of course be changed as suggested by Mrs. Plummer. The topotypes available show all the characters of the genus. This species belongs to a group with an involute spiral side, without distinct umbilical lips and a rounded peripheral margin.

In many cases it is very difficult to limit the genera Cibicides and Anomali-

noides. They are closely related and are distinguished only by the concho-spiral (Cibicides) and the planospiral (Anomalinoides) form of the test.

### Anomalinoides danica (Brotzen).

Pl. 14, fig. 1, text-fig. 22.

Anomalina grosserugosa Franke, Danmarks geol. Undersög., R. II, 1927, Nr. 46, p. 37, Pl. 4, fig. 3.

Cibicides danica Brotzen, Sver. geol. undersökn., Ser. C, Nr. 435, Årsbok 34, Nr. 5, p. 31, figs. 7, 2.

Remarks.

The Paleocene specimens do not differ from the Danian ones, except that the structure of the wall is coarser. The height and the peripheral views vary as in the figure.

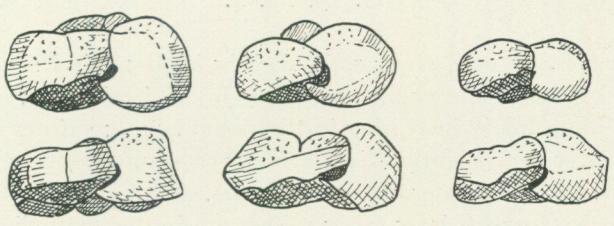

Fig. 22. Anomalinoides danica (Brotzen). Ystad gjuteriet 21 m.

Occurrence.

This species occurs in all samples examined and it is fairly frequent. Anomalinoides danica was found in the uppermost Maastrichtian in Sweden and is common in all strata of the Danian.

Ten Dam 1944 described Anomalina grosserugosa from the Dutch Paleocene and Eocene. It would appear that this species also belongs to Anomalinoides danica, but its peripheral margin is more rounded than on the Swedish forms. If Anomalina grosserugosa Ten Dam (non Gümbel) is a synonym for A. danica, the occurrence of this characteristic species begins in the Maastrichtian and ends in the Eocene.

### Anomalinoides acuta (Plummer)

Pl. 14, fig. 2.

Anomalina ammonoides Reuss var. acuta Plummer, Univ. Texas Bull. No. 2644, 1926, p. 149, Pl. 10, fig. 2.

Anomalina acuta Glässner 1937, Problems of Paleontology, Moscow, Vol. II—III, p. 386, Pl. 5, fig. 39. — Toulmin 1941. Journ. Paleontol. Vol. 15, p. 608, Pl. 82, fig. 9, 10. — Cushman & Renz 942, C. C. L. Vol. 18, p. 12, Pt. 3, fig. 6. — Ten Dam, 1944, Med. Geol. Stichting Ser. C—V—3, p. 129,

Cibicides sp. Cushman & Garrett, 1939, C. C. L.. Vol. 15, p. 88, Pl. 15, figs. 23, 24.

The specimens from the Swedish Paleocene agree very well with the topotypes from the Texas Midway. Forms with more convex sides, such as those figured Pl. 14, fig. 2 are more similar to the types from the Soldano rocks at

Trinidad (Cushman & Renz 1942). As in Trinidad the flat and fairly ornamented forms occur together with more convex and distinctly ornamented ones in the same samples, and therefore the two types must belong to the same species. The type that Gläss̈ner figured is distinguished from the Swedish ones by its indistinct ornament, the depressed sutures and the lack of raised ridges in the sutures. Ten Dam described this species from the Lower Eocene in Holland, but he did not figure the types.

Occurrence.

In Sweden this species occurs as a rare form in the Paleocene at Klagshamn, Ystad and Tygelsjö but it has not been found in the Paleocene boulder at Maglehem.

**Anomalinoides aspera n.sp.**

Pl. 15, fig. 4.

Diagnosis.

Test flat biconvex; periphery acute, slightly lobate; spiral side slightly depressed in the centre, eight or nine chambers in the final whorl, narrow in the spiral course and rapidly increasing in the radial length; sutures in the young transparent, later very slightly raised and in the adult depressed between the last chambers. Umbilical side with a deep umbo, chambers flat, sutures curved, in the young transparent, later fairly raised and in the adult slightly depressed; all chambers with a strong and broad lip over the umbilical aperture, which may cover the entire umbo. Wall smooth with fine perforations, except the beginning of the last whorl on the umbilical side. This part of the test is covered with short radial costae or tubercles.

Remarks.

The author has not been able to find any species like this new one in the literature. It is characterized by the flat biconvex test, the ornament on the umbilical side, the deep umbo and the rapidly increasing number of chambers. There are many variants of this species.

Occurrence.

This species is found in the clay and greensand at Ystad and in the boulders of Maglehem. At both localities it occurs abundantly.

Holotype: S. G. U. No. 2539 Ystad, gjuteriet 21 m.

**Anomalinoides midwayensis (Plummer)**

Pl. 14, fig. 3.

Truncatulina midwayensis Plummer, Univ. Texas Bull. 2644, 1926, p. 141, Pl. 9, fig. 7, Pl. 15, fig. 3.

Anomalina midwayensis, Cushman, C. C. L. 1940, Vol. 16, p. 73, Pl. 12, fig. 18.

Remarks.

The Swedish specimens of this species mainly resemble the topotypes, but are distinguished by several characters. The raised sutures of the young Swed-

ish specimens are very indistinct and the last sutures slightly depressed, in the adult the suture ridges are present only in the beginning of the final whorl, they are slightly elevated and much broader than those of the Midway forms. These various differences between the Swedish and the Midway forms are not so important as the differences between Truncatulina midwayensis Plummer and Truncatulina midwayensis Plummer var., trochoidea Plummer.

Anomalinoides midwayensis belongs to the group with distinct umbilical lips. They are not visible on the original figure, but they occur on all Midway specimens in the adult and on all Swedish ones.

Occurrence.

This typical Midway species occurs as a rare form in Sweden in the conglomerate at Klagshamn, in the Paleocene at Naffentorp, Tygelsjö and Maglehem.

**Anomalinoides nobilis n.sp.**

Pl. 19, fig. 5.

Diagnosis.

Test biconvex, spiral side with a large and slightly depressed central area, peripheral margin rounded in the adult, umbilical side with a small, fairly depressed umbilicus. 8—10 chambers in the final whorl; sutures transparent, slightly or not depressed, fairly curved, generally radial. Aperture below the last two or three chambers covered by umbilical lips. Wall smooth, medially perforated.

Remarks.

This new species is closely related to A. midwayensis Plummer. It is distinguished by the rounded margin in the adult, by no raised sutures and the small umbilicus.

Occurrence.

Anomalinoides nobilis n.sp. occurs rarely in the Paleocene at Klagshamn and commonly in the clay at Tygelsjö.

Holotype: S. G. U. No. 2546 Solnäs 9 m.

**The Genus Globigerina and Related Forms.**

Species of the genus Globigerina and related forms such as Globigerinella and Globigerinoides occur abundantly in the Swedish Paleocene.

They belong to the same species as in the underlying Danian and are generally small. Except those in the calcareous boulders from Maglehem the majority of the Globigerina specimens seem to be redeposited from the Danian and only a few specimens occur autochthonously in the Paleocene.

**Globigerina triloculinoides Plummer.**

Pl. 17, fig. 2.

For references, see Cushman 1944, C. C. L. Vol. 20, p. 48.

Remarks.

This species is found in all Swedish Paleocene localities and occurs abundantly in the calcareous facies of Maglehem. Globig. triloculinoides is known from the Midway Formation, lowest Wilcox, or corresponding formations in Alabama, California, Washington, East Borneo and from the lowest Tertiary in the Caucasus. In Sweden it has never been found in the uppermost Maastrichtian, but it occurs frequently in the base of the Danian and becomes abundant in the upper part of this formation. Also Globigerina bulloides Burrows & Holland from the Thanet Beds seems to belong to this species.

### Globigerina compressa Plummer.

For references, see Cushman 1942, C. C. L. Vol. 18, p. 44.

Remarks.

This species occurs very rarely in the Swedish Paleocene. Several specimens have been found in the Paleocene at Ystad and in the clay at Tygelsjö. They are typical and, as the Midway specimens, they show a distinct umbilicus and umbilical apertures, covered by small lips on the base of the last chambers. Therefore this species must belong to the genus Globigerina and not as Cushman (1942) supposed to the genus Globorotalia.

In the Swedish Danian this species is generally rare. It is recorded from the Midway, lowest Wilcox formation or the corresponding formations in New Jersey, Alabama, and from the Caucasus region.

### Globigerina pseudo-bulloides Plummer.

For references, see Cushman 1942, Vol. 18, p. 43.

Besides G. triloculinoides G. pseudo-bulloides is the most common species in the Swedish Paleocene. But all specimens are distinctly smaller than the originals from the Texas Midway. In the Swedish Danian this species has been found abundantly in the upper part and rarely in the lower Bryozoan limestone. Hitherto G. pseudo-bulloides is recorded only from the Midway or corresponding formations and from the lowest Tertiary from the Caucasus region.

### Globigerinella aspera (Ehrenberg).

For references, see Brotzen 1936, S. G. U. Ser. C, No. 396, Årsbok 30, No. 3, p. 170.

Remarks.

The specimens of Globigerinella in the Swedish Paleocene are not distinguished from those occurring in the Danian and Maastrichtian. They are distinguished from the Eocene Glob. micra Cole by the more inflated chambers and the uncurved sutures.

Occurrence.

Globigerinella aspera occurs rarely in the Paleocene at Klagshamn and Ystad, commonly in the clay at Tygelsjö and has not been found in the boulders of Maglehem.

### Globigerinoides sp.

Single specimens of Globigerinoides have been found, characterized by the lack of an umbilicus and with several accessory apertures on the sutures. They are very badly preserved and they are doubtless redeposited from the underlying Danian.

### Globorotalites lobata n.sp.

Pl. 17, fig. 3.

Diagnosis.

Test small, diameter up to 0.3 mm, generally less, proportion of the diameter: height = 3 : 2. Spiral side flat or slightly conical, umbilical side strongly convex or highly conical, peripheral margin sharply carinate, distinctly lobate. On the spiral side the chambers flat, sutures crescent-shaped and transparent, on the umbilical side the chambers strongly inflated and the sutures strongly depressed. 4—5 chambers in the final whorl. Wall smooth.

Remarks.

This species belongs to the genus Globorotalites Brotzen 1942 and not to the genus Globorotalia Cushman. The difference between these two genera is the presence or lack of an umbilicus. This species is characterized by the lack of an umbilicus and is distinguished from the other known species by the strongly lobate peripheral margin.

Occurrence.

Globorotalites lobata has been found only as single specimens in our samples but not in the conglomerate at Klagshamn. The largest specimens were from the greensand at Klagshamn and the best preserved specimens occur in the Paleocene boulders at Maglehem.

Holotype: S. G. U, No. 2572 Ystad, gjuteriet 21 m.

(Original to Pl. 17 fig. 3, disappeared).

### Cymbalopora sp.

Pl. 15, fig. 1.

Remarks.

One single specimen has been found in the greensand at Klagshamn. It is flat convex, irregularly broken on the margins, the largest diameter about 0.55 mm. The upper side is rough and the middle part shows eight indistinct chambers composing a spiral with one and a half whorl. On the lower side irregular tubes run from the periphery into the umbilicus and discharge in it. Seven such tubes are visible.

The taxonomic position of this species is indicated by the shape of the umbilical side and by the spiral arrangement in the young stage. This species resembles Cymbalopora radiata v. Hagenow, which, however, has a conical test and not a flat one as this specimen. The characters of this single specimen do not permit of giving it a specific name.

### The genus Epistomina Terquem and Höglundina n.gen.

The genus Epistomina is characterized by the lateromarginal or lateral aperture and by a partition in the inside of the chambers. This genus, as generally understood by palaeontologists, seems to consist of very different types, distinguished by the shape and position of the apertures.

Terquem and Berthelin (1879, 1883) pronounced the importance of the shape of the aperture for the systematic position of this genus. Uhlig (1883) observed the inner partition in the chambers and described in great detail the variations of the aperture. He distinguished types

1) with lateromarginal and interiomarginal apertures,

2) with lateromarginal apertures and, in the septae in the inside of the test, areal apertures,

3) with lateral apertures and, in the inside of the chambers, as in the preceding type.

Sensu stricto only the last types belong to the genus Epistomina, but the other types have so far not been distinguished from Epistomina. The first types are not observed by the author. Types of the second group occur commonly in the Tertiary and Quaternary. For them a new genus shall be erected: the genus Höglundina. The genus has been named in honour of Fil. dr. H. Höglund, Lysekil. Its genotype is Rotalia elegans D'Orb. An interesting investigation was made by Rzehak (1885, 1888) disclosing that tertiary and recent specimens of »Epistomina» elegans lack an interiomarginal aperture on the last chamber and only have the lateromarginal aperture. Brady's opinion that the lateral and lateromargina laperture of Epistomina are »more or less abnormal» was erroneous and for many years restrained the progress of the taxonomy of the entire group of Epistominidae (Ceratobuliminidae Glässner). But on the other hand Brady made the important discovery that the wall of »Epistomina» = Höglundina is built up of several layers. In the year 1934 Plummer continued Uhlig's half-forgotten studies and described the interior structure of several genera (Epistomina, Epistominoides, and in 1936 Ceratobulimina). Glässner 1937 concluded all these investigations and erected the Family Ceratobuliminidae.

Plummer's and Glässner's studies were the fundamental step towards a natural taxonomy of this branch of Rotaliiformes. But contrary to Glässner's conclusions the author distinguished between forms with lateral or lateromarginal apertures, the Epistominidae, and forms with umbilical apertures and partitions in the inside of the chambers — the Ceratobuliminidae (Brotzen 1942). These two groups are closely related.

The development of the genera and species in these two groups is characterized by a reduction of the inside partition and a simplification of the aperture. The recent Höglundina shows many primitive characters and is a good example of the construction of the partition and the aperture. Only in the last chamber of the recent or Miocene species does a partition occur. (See Plummer 1934, fig. 1). In the previous chambers the partition is reduced and what remains are some small ribs on the interior wall and the preceding septum

(see Pl. 15, fig. 3 b), and in the angle of the spiral and umbilical wall there is a short lamella. In the final chamber the partition continues from the spiral side into the chamber and forms a roof over the lateromarginal apertural slit (tectum = tec.). Downward the partition is fixed on the inner wall (latus inferior = l. inf.); along the entire height it is fixed on the preceding septum (sept. 2) (see Pl. 17,

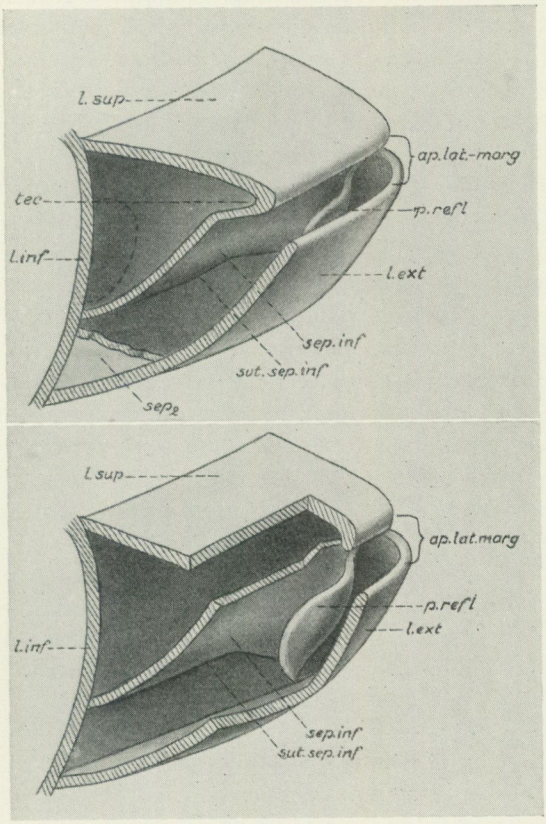


Fig. 23. Schematic figures of the last chamber in Höglundina.
ap. lat. marg. = latero marginal aperture. l. ext. = umbilical wall. l. inf. = wall of the preceding spiral. l. sup. = spiral wall. p. refl. = pars reflecta on the septaum inferius. sep 2. = septum between the last and preceding chamber. sut. sep. inf. = suture between partition and the inner spiral.

figs. 7, 8; text-fig. 23). The opening from the preceding chamber into the last one lies interiomarginal and discharges into the inner part of the last chamber. This opening (foramen septale) is more or less elongate, but never a small slit as in other rotaliiformes. The anterior part of the partition forms a free edge, curving rapidly backwards (pars reflecta = p. refl. see text-fig. 23).

Thus the inner part of the last chamber has an oriform opening to the exterior part. The function of this interior construction is stated by Plummer: »It is likely that the inner wall or chamber partition of Epistomina and Epistominoides is a protective device to prevent too ready exit of the protoplasm through a rather large and exposed aperture. The protoplasm passes readily

from chamber to chamber through large foramina into the larger compartment of the final chamber, but to gain exit from the shell it must pass around the fold of the anterior edge of the partition and out through a comparatively narrow passageway or vestibule between the partition and the ventral wall to the aperture.»

It is of interest to note that »Epistomina» spinulifera Reuss from the Gault of Folkestone has partitions in all chambers except the proloculum. The free edge, the pars reflecta, is very small, but distinct. In the early types the partition seems to be very complete in all chambers and is reduced in younger stages of evolution. Another ancestral character is that in the oldest species studied (from the Upper Jurassic) the septal foramen is areal, not interiomarginal as in Höglundina. During the evolution of the family Epistominidae the partition of the chambers will be reduced, so that more advanced genera only have rudiments of the inner structure or that this structure has disappeared completely. The reduction cannot be followed step by step, but in many cases it is easy to correlate the strongly reduced parts with the primitive Epistomina stage (cf. Parrella, Alabamina, Siphonina, etc., in this paper). In the uppermost Lias occur species of some new genera of Epistominidae, the aperture of which lies areal or lateral. Partly the aperture is rounded but never slit-shaped. Those forms seem to belong an ancestral group, characterized by a very complete partition in all chambers of the specimens. From the phylogenetic point of view they can be regarded as ancestors of the Epistomininae and Ceratobulimininae.

The oldest known species for certain belonging to Epistomina or Höglundina occurs in the Lias. It is possible that such forms are known also from the uppermost Trias (Parker & Jones 1860, Quat. Journ. Geol. Soc.). Uhlig supposed that Pulvinulina broeckiana Brady 1870 from the Namur Carbon might belong to this genus, but that cannot be the case.

### Höglundina scalaris (Franke).

Pl. 15, figs. 2, 3.

1926 Pulvinulina partschiana Plummer, Univers. Texas Bull. No. 2644, p. 153, Pl. 11, fig. 5.
1927 Epistomina scalaris Franke, Danmarks geol. undersög. II Raekke No. 46, p. 30, Pl. IV, fig. 6.

Remarks.

The specimens occurring in the Danish and Swedish Paleocene do not all differ in their main characters from Höglundina elegans (D'Orb). (Epistomina elegans according to Cushman 1927, C. C. L. Vol. 3, p. 182). According to Franke the spiral side is characterized by four whorls, steplike on each other, and the centre is a big tubercle (»Die Spiralseite zeigt 4 Umgänge, die schwach treppenförmig abgesetzt sind. Nähte sehr schief mit Nahtleisten. Die innerste Windung ist knopfartig gewölbt».). Franke's original types in the collection of the Danish Geolog. Survey, Copenhagen, are strongly convex in the centre of the spiral side. They are not common among recent Epistomina elegans specimens, but they do occur. Topotypes from the Danish Paleocene from Sundkrogen and specimens of the Swedish Paleocene include extreme types like those described by Franke together with types like recent ones.

The differences between the young Tertiary and recent Höglundina elegans and the specimens of the Paleocene are the generally small diameter and the indistinct layer structure of the wall of the Paleocene species. The diameter is never as much as 1 mm, mostly it is less than 0.5 mm.

The layers in the wall of recent and young Tertiary Epistomina elegans are very distinct, even young and small specimens display a structure as in Brady's figure. But in the specimens from the Swedish Paleocene and from the Midway Formation the layers of the wall are very indistinct also under strong magnification. The inside wall in the early chambers is not so much reduced as in the recent ones. The Texas forms determined by Plummer as Ep. elegans 1934 do not differ from the Swedish and Danish ones and must therefore belong to the same species.

Occurrence.

Höglundina scalaris occurs rarely in the greensand, in the clay and in the conglomerate in the Klagshamn region, in the boulders of Maglehem; it has not been found in the samples from Ystad.

### The genus Epistominoides Plummer 1934.

The genus Epistominoides was erected by Plummer in 1934 and its species have hitherto been found only in the Texas and Alabama Midway and lowest Wilcox formation. A new find in Sweden and Denmark has enabled us to study this characteristic genus and I shall only make certain comments on the complete description of the structural details as published by Plummer. Epistominoides would seem to be a good example of the reduction of the inner structure and the aperture in the family Epistominidae. In Höglundina the marginal aperture forms a long slit below the peripheral margin and extends the entire length of the chamber. In Epistominoides the aperture is reduced to the anterior part of the peripheral margin, lying as in Höglundina below a tectum of the spiral wall and the turning of the spiral wall which divides the inside of the chamber into two compartments. Judging by the length of the aperture the partition is short and is not fixed to the preceding septum, as in Höglundina, but to the umbilical wall in the posterior part; in the anterior it is united with the last septum (apertural face). The partition reaches the preceding septum in the middle of the height of the chamber and on the anterior side it is detached from the last septum. The free edge of the partition runs more or less parallel to the periphery of the test. This inner free edge of the partition is folded to the umbilical side. Transparent tests show the connection between the partition and the umbilical side and the last septum as a supplementary suture. The principal difference in the inner structure of Höglundina and Epistominoides is the position of the communication between the compartments. In Höglundina (see Pl. 17, figs. 7, 8) the communication is situated in the horizontal plane of the test and in Epistominoides in the vertical plane. The reduction of the interior wall causing a separation of but the anterior end of chamber must be

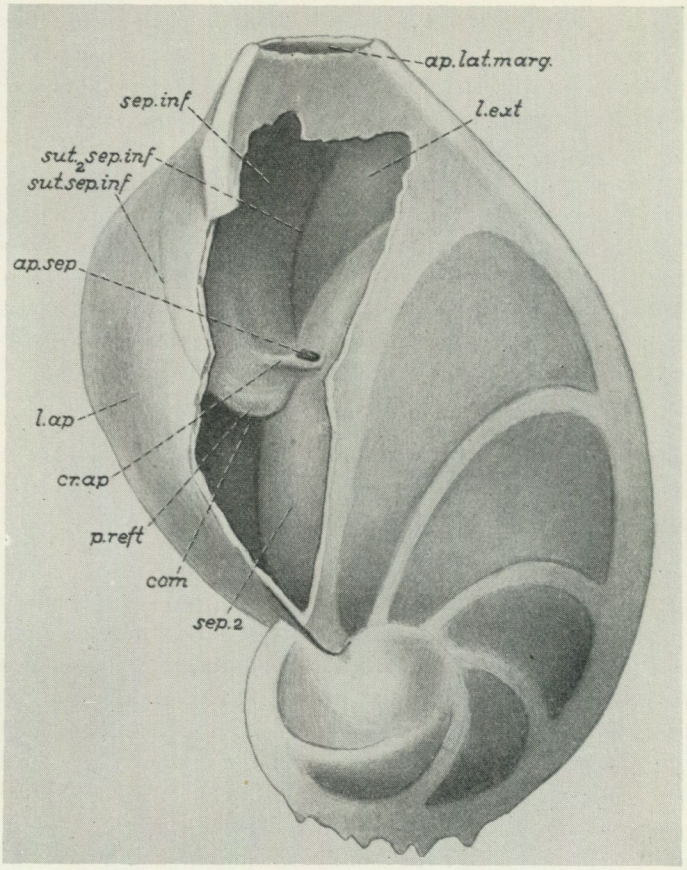


Fig. 24. Epistominoides midwayensis Plummer. Midway formation Texas.
ap. lat. marg. = aperture latero marginal. — ap. sep. = foramen septale. — com. = communication between the compartments. — cr. ap. = wall below the septal foramen. — l. ap. = apertural face. l. ext. = umbilical wall. — p. reft. = pars reflecta. sep 2. = septum. — sut. 2. sep. inf. = suture between the partition and the umbilical wall. — sut. sep. inf. = suture between the partition and the apertural face.

considered a characteristic evolutionary step, which will be more progressive in the genus Alabamina. A primitive character is the presence of the inner wall in all chambers of the test, as in the early species of Epistomina and Höglundina.

**Epistominoides midwayensis Plummer.**

Pl. 17, fig. 4; text-fig. 24.

1934 Plummer, Amer. Midland Nat. Vol. 15, p. 605, Pl. 24, fig. 4.
1942 Cushman & Todd, C. C. L., Vol. 18, p. 42, Pl. 7, figs. 21, 22.
1944 Cushman, C. C. L., Vol. 20, p. 47, P[1]. 8, fig. 1.

Remarks.

Only a few specimens of this species have been found in the region of Tygelsjö, in the clay at Ystad and one single specimen in the clay of Sundkrogen,

Copenhagen. They are distinguished from the American ones only by their small test, the maximum length of which is not more than 0.25 mm. The umbilicus is not so distinct as on the types. The transparent specimen from Sundkrogen shows the sutures and supplement sutures as do the American ones.

The occurrence of this species in the lowest Paleocene in Sweden and Denmark as in the Wills Point and Naheola formations in Texas and Alabama throws valuable light on the paleogeography and stratigraphy of the oldest Tertiary.

### The genus Alabamina Toulmin.

Alabamina Toulmin 1941 Journ. Paleont. Vol. 15, p. 602.
Eponidoides Brotzen 1942 Sv. G. U. Ser. C, Nr 451, p. 38.

In 1941 Toulmin erected the genus Alabamina with the genotype Alabamina wilcoxensis Toulmin; he also described the interesting structure of the interior of the last chamber. But Toulmin does not draw conclusions as to the taxonomic position of this genus. The author, who during the war knew nothing about Toulmin's investigations, erected a new genus for this group in 1942 and ranged it into the family Epistominoidae. This opinion is greatly supported by a structure analysis according to Toulmin's investigations. In 1945 Glaessner (Principles of Micropalaeontology, Melbourn) ranged Alabamina into the subfamily Discorbinae, considering it to be closely related to Eponides, but the inner structure demonstrates that this must be wrong.

According to Toulmin the septal wall of this genus folds towards the spiral side and forms a peripheral edge (Toulmin fig. 4 A c—d). This part must be correlated with the folding of the spiral side with the partition over the apertural slit in Epistomina Höglundina and Epistominoides and must also be named »tectum». Below the tectum the wall folds into the final chamber — Toulmin's area d, e, g. This fold towards the interior forms a shallow hollow, parallel to the tectum and will be named »scrobis septalis». In the direction of the inner margin of the septum the scrobis septalis becomes a deep and narrow funnel, the entire length of which is open downwards. In fig. 25 this funnel is named »infundibulum». A true interiomarginal aperture lies below the infundibulum.

Toulmin affirmed that only the septum of the final chamber has this shape, and that in the early ones the aperture is subtriangular, broad dorsally and narrowing to a point ventrally. On all well preserved specimens from the Cretaceous and Tertiary that could be studied the structure of the septum of the preceding chambers is the same as the structure of the last. The limited thickness of the wall in the folding part promotes destruction in the interior of the chamber and at the site of the scorbis and the infundibulum there is a triangular opening.

The transformation of the inner partition of Höglundina to that of Epistominoides must be the result of a long specialization. The condition for the change of the structure was the shortening of the marginal aperture. If the aperture changes from the margin to the septal face and from there to the in-

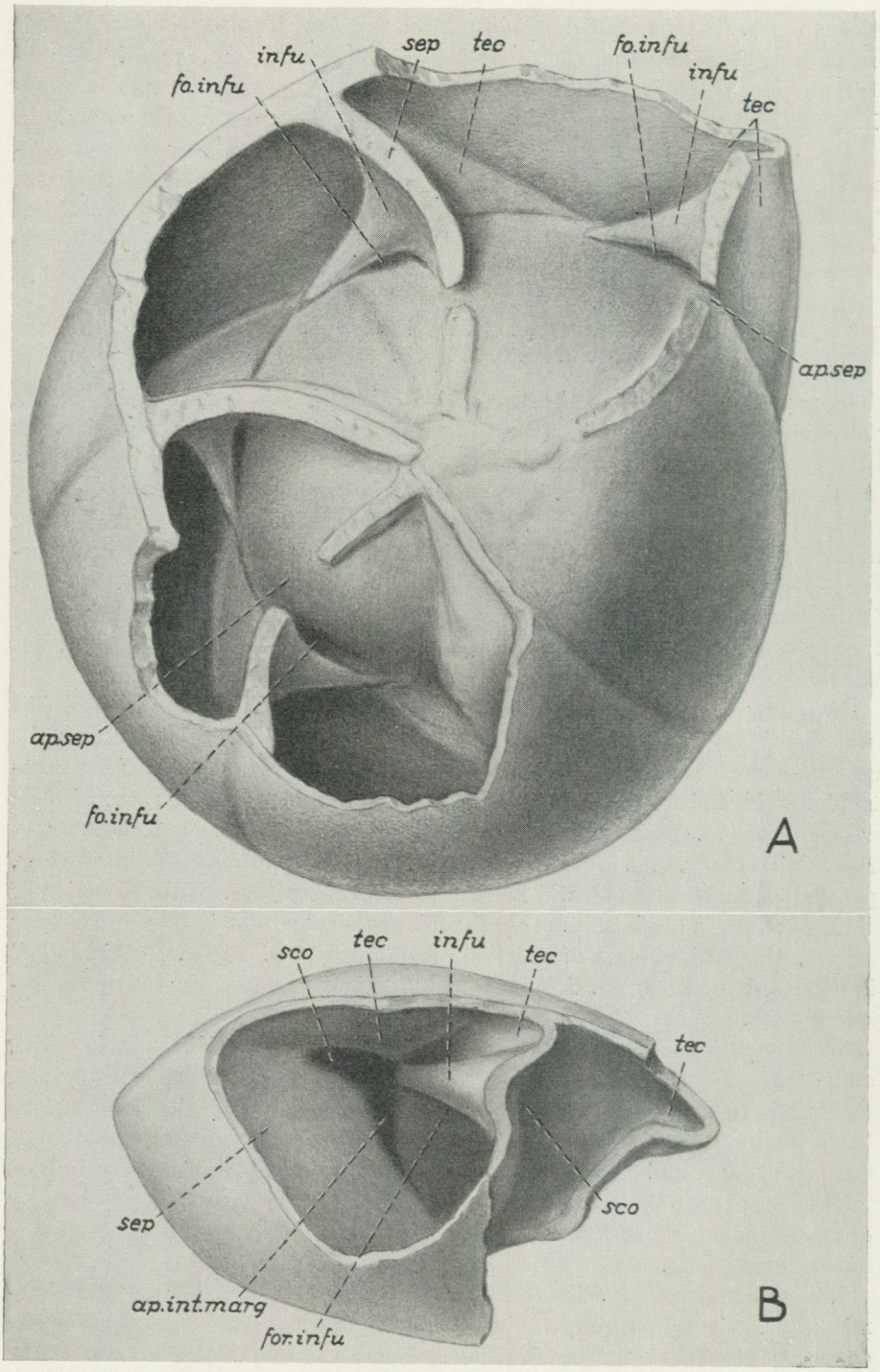


Fig. 25. Alabamina sp. Klagshamn Danian.

A = umbilical view, parts of the umbilical wall destroyed. — B = peripheral view, final chambers opened. — ap. int. marg. = aperture interiomarginal. — ap. sep. = foramen septale. — fo. infu. = foramen infundibulum. — infu. = infundibulum. — sco. = scorbis septalis. sep. = septum. tec. = tectum.

terior margin, the partition must be more or less parallel to the septal face. In this case we might expect a strong reduction of the interior structure. Therefore the author correlates the scorbis septalis with the marginal aperture of Höglundina and Epistominoides, and the infundibulum with the partition, which in the same way as in Epistominoides has a connection with the larger compartment downwards. The narrow and very small vestibule in the infundibulum must also be correlated with the small and narrow compartment or vestibule in Epistomina or Epistominoides. It may be of interest to remember that in the Jurassic species of Epistomina an interiomarginal aperture occurs besides the marginal aperture. This aperture has disappeared in the geologically younger species of Höglundina, but in Alabamina and also in Parrella such an interiomarginal aperture pre-exists. Alabamina seems to derive from the Jurassic Höglundina. The presence of the same apertural structure also in the interior of all chambers must be an ancestral character. The genus Alabamina occurs from the Santonian to recent and has been found in clay, sand- and limestones. The oldest Alabamina has hitherto been described from the Pirpauan stage of New Zealand, which is correlated with Santonian-Campanian in Europe (Alabamina creta = Pulvinulinella creta Finlay 1940 Trans. & Proceed. Roy. Soc. New Zealand, Vol. 69, o. 463, Pl. 66, figs. 187—192).

**Alabamina midwayensis nov.nom.**

Pl. 16, figs. 1, 2; text-figs. 25, 26.

1926 Pulvinulina exigua Plummer, Univ. Texas Bull. 2644, p. 150, Pl. XI, figs. 3 a—b.
1926 Pulvinulina exigua var. obtusa Plummer, l. c., p. 151, Pl. XI, figs. 2 a—c.
1927 Pulvinulina grata Franke, Danmarks geol. unders. II Raekke No. 38, Pl. IV, fig. 2.
1936 Pulvinulinella exigua var. obtusa Jennings, Bull. Amer. Paleont. Vol. 23, p. 34, Pl. IV, figs. 4 a—b.
1940 Pulvinulina grata Staesche & Hiltermann, Abh. Reichsst. Bodenforsch. N. F. H. 201, Pl. 48, fig. 11—12.
1942 Pulvinulinella obtusa Cushman & Renz, C. C. L. Vol. 18, p. 11, Pl. II, fig. 4.
1942 Pulvinulinella obtusa Cushman & Todd, l. c. Vol. 18, p. 42, Pl. 7, figs. 19, 20.
1944. Pulvinulinella obtusa Cushman, l. c. Vol. 20, p. 46, Pl. 7, fig. 29.

Diagnosis.

Test more or less equally biconvex, peripheral margin bluntly acute, very faintly lobate, 5—6 chambers in the last coil, sutures transparent, not depressed, almost straight and tangential to the spiral suture on the spiral side, radial and slightly curved on the umbilical side; a small central filling may be present on the umbilical side. The septal wall low, tectum strongly projected, scrobis narrow and short, aperture narrow; wall smooth, mostly glossy.

Remarks.

Ever since Toulmin in 1941 distinguished between closely related species of the genus Alabamina, it has become necessary to differentiate the Midway species of Alabamina from species of the English Thanet sands. These species are very similar and only their variants and extreme forms distinguish them. In text-figure 26 I have tried to differ between species from the Upper Cre-

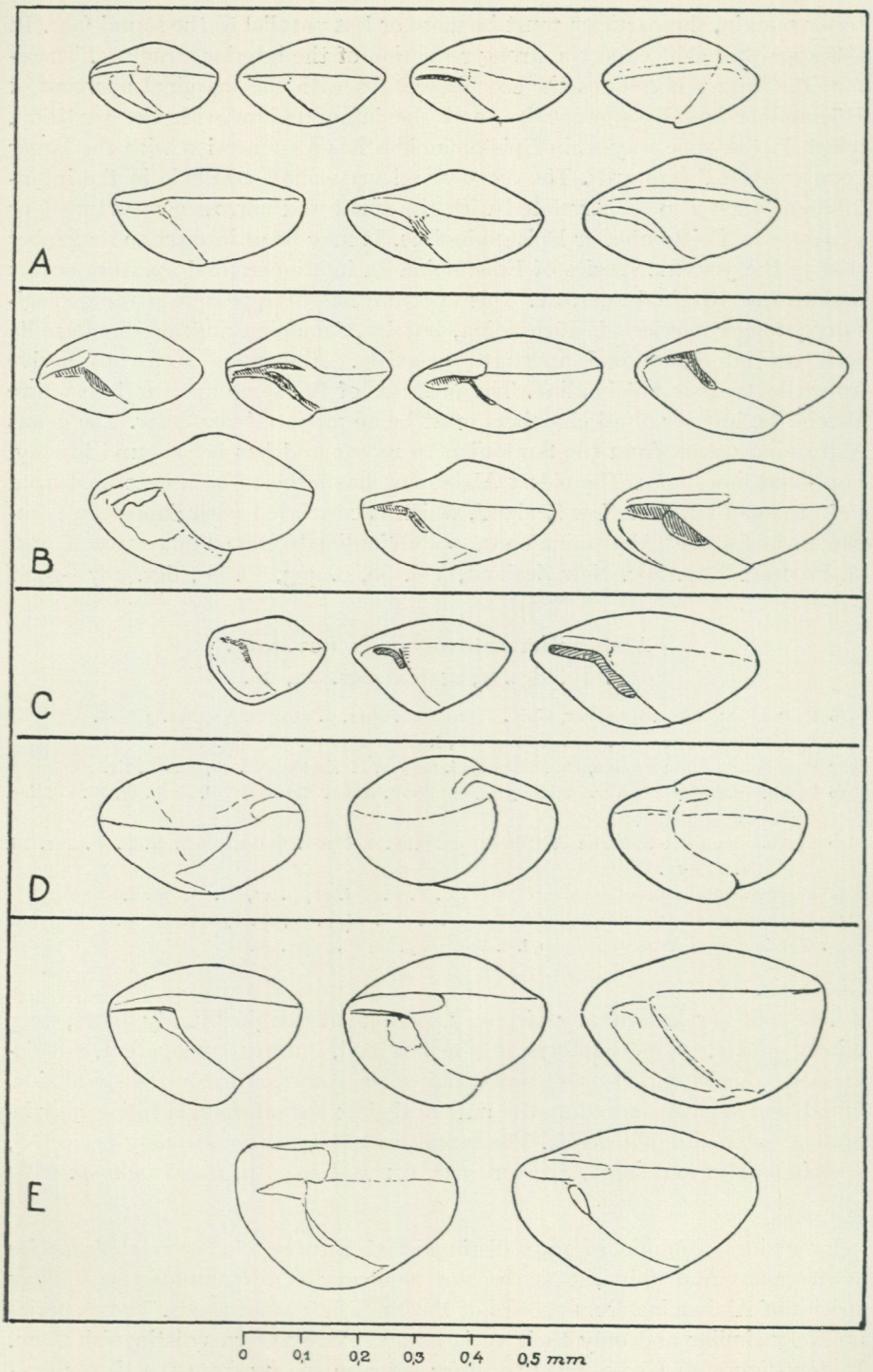


Fig. 26.

A. Alabamina midwayensis, Midway, Texas. — B. Alabamina midwayensis, Ystad gjuteriet 20 m. — C. Alabamina wilcoxensis Toulmin, Wilcox, Alabama. — D. Alabamina obtusa (Burr. & Holland). Thanet beds, Pegwell Bay. England. — E. Alabamina dorsoplana (Brotzen). Upper row, Ystad gjuteriet 20 m. Lower row, Klagshamn Danian.

taceous and Lower Tertiary. The first described species of the group is Alabamina obtusa (Burrows and Holland) (Pulvinulina exigua var. obtusa 1897 Proc. Geol. An. Vol. 15, p. 49, Pl. 2, fig. 25), one of the most common foraminifera of the Thanet sands. »It differs from P. exigua Brady chiefly in its *obtuse periphery*.» Topotypes from the Thanet sands that I have been able to study, were very obtuse and globular; their umbilical side was much higher than the spiral side and consequently the septal wall was also higher than broad.

The typical Alabamina from the Midway Formation — specially from the Upper Midway of Texas — is characterized by the almost uniformly convex test and its bluntly acute periphery. This type has a septal wall which is broader than high and is well distinguished from Alabamina obtusa. The difference between the recent Alabamina exigua Brady and the Alabamina midwayensis — the new name for this species — is very distinct. The recent species is distinctly lobate, the sutures on the umbilical side more depressed than on all Lower Tertiary forms, the test compressed, the spiral side mostly higher than the umbilical side and the septal wall very low.

The variants of Alabamina midwayensis range from low tests with a very acute periphery to higher tests with a more »obtuse» periphery. Such »obtuse» specimens occur in the basal parts of the Texas Midway formation and were described by Plummer as Pulvinulina exigua var. obtusa. All variants of this Midway species are well distinguished from the typical Alabamina obtusa by their low septal face and the flat test. In Sweden all variants of Alabamina midwayensis occur in the basal greensand and lower clay of Ystad and Klagshamn, but in the upper clay of Solnäs and in the Danish localities of the Paloecene clay at Sundkrogen there only occur forms with an acute periphery.

It is typical of this species, and it is also observed on other Alabamina species, that in the young the test is higher in proportion to the diameter than it is in the adult. Especially the young specimens are very like Alabamina obtusa Burrows and Holland.

The compressed type of Alabamina wilcoxensis Toulmin (1941 Journ. Paleont., Vol. 15, p. 603, Pl. 81, fig. 10—14, text-fig. 4 A—C) from the Wilcox of Alabama is more highly convex on the umbilical side and flatly convex on the spiral side. This species is the genotype. Extreme compressed forms in the adult are well distinguished from Alabamina midwayensis, but young specimens are very similar to forms from the Midway and Paleocene in Europe with their quite acute periphery.

Similar to Alabamina obtusa Burrows and Holland is Alabamina dorsoplana Brotzen (Eponides dorsoplana 1940, S. G. U. Årsbok 34, p. 31, fig. 8, 2 a, b, c) from the Maastrichtian and Danian in Sweden. This species is distinguished from Alabamina midwayensis by the high umbilical side, the low spiral side and the high septal wall. This last character also distinguishes Alabam. dorsoplana from Alabam. wilcoxensis. This Cretaceous species is distinctly different from Alabamina obtusa by the flat spiral side and the not so globular shape. On the septal front the scrobis is very broad and deep, the infundibulum long and the aperture relatively large.

Occurrence.

This species is typical in the Midway formation of Texas and the acute types are index fossils in the upper part of that formation, whereas types with a more »obtuse» peripheral margin predominate in the basal Midway. Both types are described from the Midway of Alabama, especially from the Naheola formation, from the Hornerstown Formation in New Jersey, and from the Soldano Rocks in Trinidad. In Sweden this species is abundant at all Paleocene localities and in the uppermost Danian it occurs together with Alabamina dorsoplana. From the Danish Paleocene of Sundkrogen Franke described Pulvinulinella grata, the topotypes of which I could study. These specimens belong to the type of Alabamina midwayensis with an acute peripheral margin. Types described as Pulvinulina grata by Staesche and Hiltermann from the German Paleocene must also belong to Alabamina midwayensis.

Glässner (1937) described Alabamina species as Eponides exigua var. obtusa from the Senonian, Danian and Paleocene in the Caucasus (Problems of Paleontology, Moscow, Vol. II and III, p. 378), but does not figure them. He distinguishes typical forms with acute and forms with »obtuse» peripheral margins. It is possible that Alabamina dorsoplana and Alabamina midwayensis occur in Caucasus and that the former are confined to the Cretaceous and the latter to the Paleocene.

Holotype: S. G. U. No. 2598, Klagshamn, konglomerate.

### Alabamina dorsoplana (Brotzen).

Pl. 16, fig. 3; text-figs. 25, 26, 27.

1940 Eponides dorsoplana Brotzen, S. G. U. Årsbok 34, p. 31, fig. 8; 2 a—c.
1942 Eponidoides dorsoplana Brotzen, 1. l. Nr. 36, p. 38, text-fig. 12: 6.

The difference between this species and closely related types has been discussed above. Specimens from the Swedish Paleocene are confined to its lower part and are absent in the clay from Solnäs. It is therefore possible that all the specimens of this species are redeposited from the Danian, where they occur abundantly. The occurrence of this species begins in the Maastrichtian in Sweden (Brotzen 1945) and it is abundant in the entire Danian. In 1926 Plummer described (Texas Univ. Bull. 2644, p. 151) a type as: »The glauconitic strata of the Ripley formation in Mississippi yield a test of this structure (Pulvinulina exigua Plummer), but its ventral convexity is very high and it must be regarded as a variety.» Alabamina dorsoplana would thus seem to occur also in the American Cretaceous.

### Alabamina solnäsensis n.sp.

Pl. 16, fig. 4.

Diagnosis.

Test small, rarely more than 0.3 mm in diameter, spiral side slightly convex, umbilical side strongly convex; peripheral margin broadly runded, distinctly

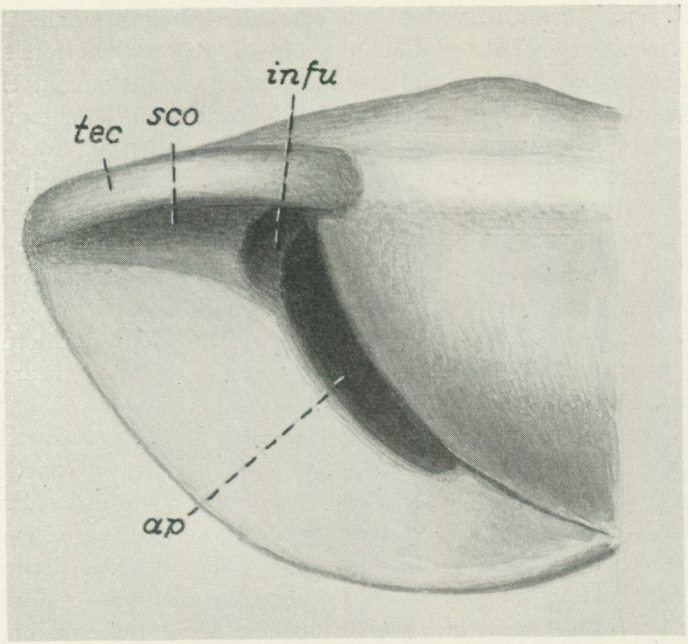


Fig. 27. Alabamina dorsoplana (Brotzen). Apertural face.
ap. = aperture, infu. = infundibulum, sco. = scrobis septalis. tec. = tectum.

lobate; five chambers in the whorl, on the spiral side elongate, low in the radial direction, slightly inflated, sutures on the spiral side distinctly depressed, straight or fairly curved, on the umbilical side radial, slightly curved, thickened into the centre; septal wall high; scorbis septalis short and deep; tectum strongly projected; aperture large; wall smooth, almost glossy.

Remarks.

In shape this pretty species resembles Alabamina obtusa Burrows and Holland (cf. p. 101). It is distinguished by the depressed sutures on the spiral side, the elongate chambers and by the distinctly lobate peripheral margin. The whorls on the spiral side increase slowly in height, a good character of this species.

Occurrence.

Alabamina solnäsensis is confined to the clay of Solnäs, Tygelsjö and to the boulder of Maglehem. In the Danish Paleocene this species is abundant in the clayish layers of Copenhagen and occurs in the localities Sundkrogen and Västra Gasverk.

Holotype: S. G. U. No. 2619. Solnäs—Tygelsjö.

### The Genus Parrella, Finlay 1939.

Specimens of this genus occur abundantly in the Swedish and Danish Danian, but they are very rare in the Swedish Paleocene. They belong to the

species P. lens (Brotzen), which is a characteristic form of the Danian. All these specimens in the Paleocene are undoubtedly redeposited from the Danian.

Referring to the notes on the preceding genera (Epistomina, Höglundina, Epistominoides and Alabamina) there now follow some brief comments on the structure and evolution of this genus. The genus Parrella was erected by Finlay in 1939 (Transact. & Proceed. Roy. Soc. New Zealand, Vol. 69, p. 523) with the genotype Anomalina bengalis Schwager. In 1940 the author erected the genus Osangularia for the same types and in 1942 he established the relationship of this genus to genera from the Family Epistominidae. In 1941 Toulmin redescribed the characters of this genus and placed it close to the genus Alabamina. Finally Glässner in 1945 (Principles of Micropalaeontology) placed the genus Parrella in the subfamily Discorbinae, near the genera Alabamina, Pulvinulinella, and Coleites.

According to Finlay (also Glässner) the aperture is ». . . a narrow slit between the periphery and the closed umbilicus, extending from the basal suture obliquely in peripheral and ventral direction into the apertural face.»

Toulmin has completed the description »aperture consisting of two portions, an elongate opening in the septal face about halfway between the periphery and the umbilical area, at an angle of 45—90° to the peripheral plane and a short slit extending from the elongate opening along the base of the septal face towards the umbilical area.» These were the same observations as made by the author in 1940. »Die Mündung besteht aus einem gewinkelten Loch (os angulare) deren einer Schenkel längs des inneren Randes der letzten Kammer liegt. Der zweite verläuft mehr oder weniger schräge, quer über die Stirnfläche der letzten Kammer. Oft sind beide Schenkel getrennt, so dass zwei Mündungen vorhanden sind.» These details of the aperture are often very indistinct, because »its location is especially likely to be covered by extraneous matter lodged in the crevice at the base of the septal face» (Toulmin).

All well preserved specimens of Parrella from the Upper Cretaceous and the Lower Tertiary show the two different openings and they never reach each other (Parrella withei [Brotz.], Parr. cordieriana [D'Orb.], Parr. lens [Brotz.], Parr. expansa Toulmin). On all these types the septal face has a distinct hollow between the areal aperture (the aperture oblique to the septal face) and the interior margin of the septal face, forming a wide funnel. A generally narrow interiomarginal aperture is situated at the deepest point of this funnel, which may be correlated to the infundibulum of the genus Alabamina. On the Parrella earliest known (Parrella incisa n.sp.)[1], the hollow is elongate, continuing to the umbilical plug, and the aperture is a very narrow and long slit in the bot-

[1] *Parella incisa n.sp.* Text-fig. 28, B.

Diagnosis. Test small, spiral side strongly convex, umbilical side flat or slightly convex. Spiral side with two and a half or three whorls, chambers 8—10 in the final whorl, indistinct, sutures indistinctly transparent; on the umbilical side a narrow, distinctly elevated central plug, the last sutures slightly depressed. Areal aperture elongate, generally angulate in its upper part, interiomarginal aperture very long and narrow, making a deep incision a short distance around the umbilical plug. Wall smooth. Diameter up to 0.32 mm. Occurrence: Arnager greensand, Bornholm Denmark, Cenomanian.

Holotype. S. G. U. No. 2576, Madsegrav Bornholm, Cenomanian.

tom of this hollow. The infundibulum seems to be deeper in younger geological species than in the earlier ones, and the interior marginal aperture becomes short. (It has been impossible for the author to study recent or younger Tertiary specimens and according to the figures the interior marginal opening

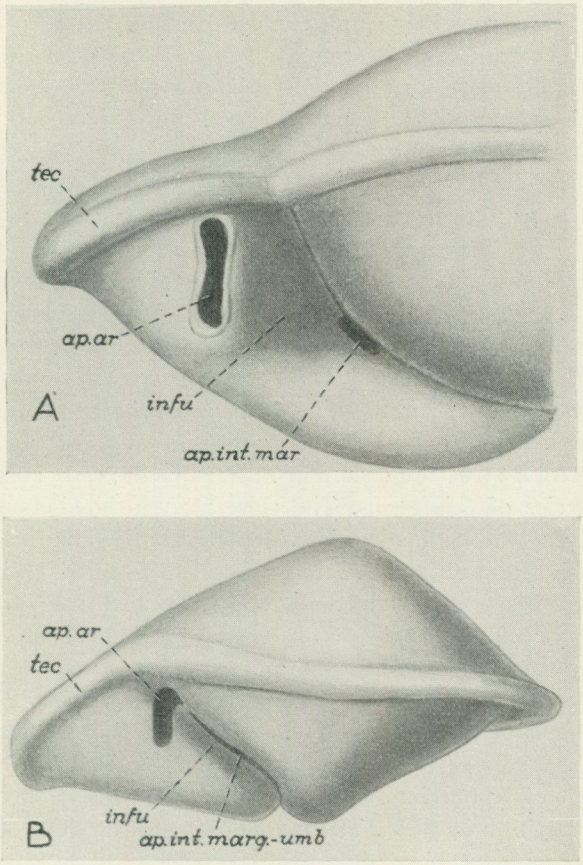


Fig. 28.
A. Parrella lens (Brotzen). Klagshamn Danian.
B. Parrella incisa n.sp. Madsegrav Bornholm, Cenomanian.
ap. ar. = aperture arealis.
ap. int. marg. = aperture interiomarginal.
infu. = infundibulum. tec. = tectum.

disappears completely in these stages of evolution). It was very difficult to observe the interior of the chambers, but generally the interiomarginal aperture was present only in the final septum and lacking in the preceding ones.

The occurrence of two different apertural openings in the genus Parrella is an ancestral character, which proves the relationship to the early forms of Epistomina, and the construction of the septal funnel demonstrates the relationship to the genus Alabamina. The reduction of the interiomarginal aperture

during the evolution indicates the possibility of a third type existing, leading to types with only one areal aperture, as in Pulvinulinella, Siphonina and related groups all known from the Upper Cretaceous.

The principal change in the shape of the tests in this genus was described by the author in 1945; the early species are characterized by the highly elevated spiral side and flat or slightly convex umbilical side. Species from the uppermost part of the Cretaceous and from the Lower Tertiary are almost biconvex, often with a highly convex umbilical side and a flat spiral side. Such forms dominate in the younger Tertiary and recent.

### The genus Siphonina and the subgenus Pulsiphonina n.subg.

The genus Siphonina is characterized by the oval aperture, which is situated on a short neck. Species of this genus occur typically in the lower Eocene. Early species without an apertural neck occur already in the Maastrichtian as »Siphonina» prima Plummer. This species and related forms have an elongate apertural slit below the peripheral margin on the anterior part of the last chamber. The peripheral keel and a lip below the apertural slit form a primitive neck. The same apertural structure occurs in Pulvinulinella, especially in the Upper Cretaceous species of this genus. The close relationship between these early Pulvinulinella and the »Siphonina» is evident and both must have evolved from the same branch of Rotaliiformes. It will be very difficult to derive these genera from Rosalina (Discorbis) or related genera, because the character of the aperture is very different, and no links are known between Rosalina and the genera with an areal or lateromarginal aperture. Such apertural shapes occur only in Epistomina and related forms and it thus seems that Pulvinulina and Siphonina belong to the Epistominidae. Species of Siphonina show only simple chambers and no sign of the partition as in Epistomina. The interior of the chambers of the early Pulvinulinella species has not been studied, but I expect a rest of the partition in them. The taxonomic position of »Siphonina» prima and related forms is problematic. In all these species the apertural neck is lacking or very indistinct. The forms mentioned are distinguished from Pulvinulinella by the pore canals in the peripheral keel, which are also preserved in the early whorls and mark the entire spiral side as in advanced species of the genus Siphonina. For such species I propose the new subgenus Pulsiphonina, with the genotype Siphonina prima Plummer.

This subgenus is known from the Maastrichtian, Danian and Paleocene, possibly also from the lowest Eocene; its geographical distribution is recorded from the Gulf states (N. America), the Caucasus and from Northern Europe. The following species belong to the new subgenus:

P. prima (Plummer) Maastrichtian — Paleocene (Eocene?),
P. eklundi (Brotzen) Maastrichtian — Danian,
P. oblique-camerata (Ten Dam) — Paleocene.

**Pulsiphonina elegans n.sp.**

Pl. 17, fig. 5.

Diagnosis.

Test biconvex, spiral side more elevated than umbilical side, peripheral margin slightly lobate, five to six chambers in the final whorl; sutures strongly curved, on the spiral side transparent, on the umbilical side slightly depressed; umbilical disk distinct, but not elevated; aperture with a lip on the umbilical side.

Remarks.

This species is closely related to Pulsiphonina eklundi from the Swedish Danian. It has more chambers in the final whorl (Pulsiph. eklundi 4—5, Pulsiph. elegans 5—6); the lip on the umbilical side of the aperture is distinct on the Paleocene species and lacking or indistinct on the Danian form. According to the description this lip is also lacking on Pulsiphonina oblique-camerata Ten Dam. The chambers are more elongate on the umbilical side than in Pulsiphonina oblique-camerata and Puls. prima, the last one being generally more delicate than the Swedish one. All species are very closely related and it is possible that the different shapes of the Paleocene Pulsiphonina species are attributable to the characters of the sediment and are only variants of the same form.

This species occurs at all Swedish Paleocene localities and its frequency is generally 10—30 per mille. In the Lower Danish Paleocene it is not rare (Copenhagen and Lellinge).

Holotype: S. G. U. No. 2579, Klagshamn, conglomerate.

**The genus Coleites, Plummer 1934.**

The genus Coleites with the genotype Coleites reticulosus was erected by Plummer in 1934 (The Amer. Midland Nat. Vol. XV, No. 5, p. 605). This species is found in the Upper Midway formation in Texas, in the Alabama Wilcox Eocene and also in the Alabama Midway (Cushman & Garrett 1939, Cushman 1940, Toulmin 1941). The occurrence of this genus outside America was recorded by Glaessner already in 1936 (Probl. of Paleontology). He gave a list of foraminifera from the uppermost Cretaceous at Bruderndorf near Vienna and noted there »Coleites sp.», and in 1937 (Problems of Paleont. Vol. II—III) he recorded Coleites reticulosus Plummer from the Caucasus Paleocene. In 1941 Toulmin erected a new species, Coleites laevigatus (Base of Eocene in Alabama). P. Marie in 1943 (C. R. S. Soc. Géol. France No. 3 p. 19) found that Coleites reticulosus occurs at the base of the Eocene in Egypt, and a new species, »Frondicularia» arborescens Halkyard occurs in the Eocene of Biarritz, Tercis, Northern Marocco, and in the Cuba Eocene. In Sweden and Denmark this genus occurs in the Danian and in the Paleocene. Its taxonomic position is determined principally by the shape of aperture. Plummer stated in the original diagnosis »aperture in early chambers an irregularly elliptical opening above

the base of the septal face and close to the periphery on the ventral side, gradually becoming terminal as chambers become more nearly rectilinear and developing a faint tooth on the ventral side of the elongate and narrow orifice; foramina connected by a tube extending to the aperture of the final chamber». Two characters are interesting, the areal position of the aperture also in the coiled stage, and the interior tube connecting the inner foramina (see figs. 29, 31). In the group Rotaliiformes such an aperture occurs only in the Family Epistominidae. Cushman and Garrett 1939 (C.C.L. vol. 15, pl. 15, fig. 15) figured a young coiled specimen, the aperture of which is a long areal slit, more or less parallel to the spiral plane. The same shape is shown in Toulmin's figure. This type of aperture occurs in the genus Pulvinulinella and therefore P. Marie determined Pulvinulinella cancellata Cushman & Bermudez (C. C. L. 1936, vol. 12, p. 35, pl. 6, figs. 7 a, b) as Coleites.

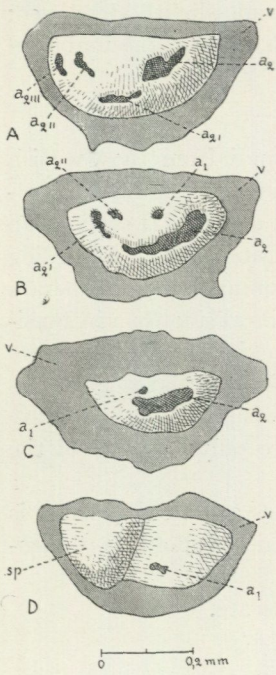


Fig. 29. Coleites reticulosus (Plummer). Danian Klagshamn. Shape of septa with resorptions.

A. = septum between the last and preceding chambers. B—D = septa between the early stages. $a_1$ = the real foramen septale(?). $a_2$—$a_{2'''}$ = resorptions of the septa. $v^2$ = sections of the wall.

On several Swedish specimens it could be observed that the septa in the rectilinear stage are perforated by some irregular foramina, caused by resorption in the interior of the test (Fig. 29). On the other hand, the primary aperture is reduced in the inner septa; it is smaller and the faint tooth has disappeared. In the spiral stage only an areal aperture is present and no remnants of an interiomarginal aperture are observed In well preserved specimens the author could find remnants of the »internal tube». A narrow wall, surrounding the upper part of the aperture, extends from the inner side of the aperture, and runs without adhesions through the chamber to the next septum (fig. 30). There it is fixed as a narrow band near the preceding apertural opening. This internal wall is massive and does not form a closed tube (fig. 30, 31, 32). It resembles the internal partitions in Epistomina and the infundibulum of Alabamina, and demonstrates the relationship between Coleites and the other Epistominidae. The evolution of this genus is not difficult to follow either. In the Upper Cretaceous of the Bavarian Alps and in the Swedish Maastrichtian there occurs a Pulvinulinella with the typical network of raised ridges on the surface of the wall, »Pulvnulina» favosoides Egger (1899 Abh. Bayr. Akad. II Cl. vol. 21, p. 150, pl. 20). This species is similar in all respects to the coiled part of Coleites, and Marie stated that the marocspheric generation of Coleites lacks the rectilinear stage. In the Swedish Danian and Paleocene occurs a Coleites, Coleites danicus n. sp., generally found only as coiled specimens and only a few with a typical rectilinear part. This species is exactly like »Pulvinulina» favosoides

Egger in the coiled stage and the differences between these two species are small. Thus it cannot be doubted but that Coleites must have developed from Pulvinulinella and especially from forms with the »Coleites» ornament, which occur from the Cretaceous to recent (Pulvinulinella cancellata Cushman & Bermudez; Pulvinulinella huneri Howe 1939 from the Eocene of Lousiana;

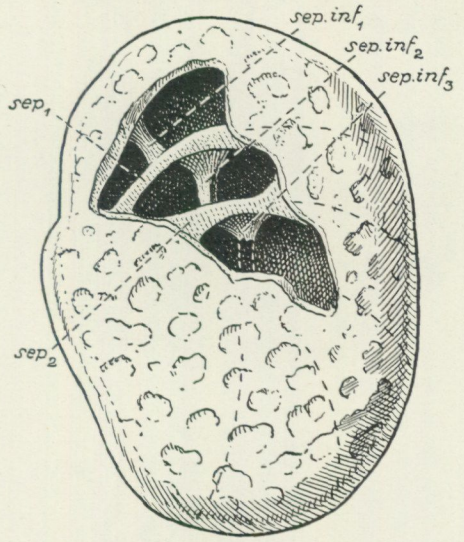


Fig. 30. Coleites reticulosus Plummer. Danian, Klagshamn. Spiral side, spiral wall partly taken away, septa ($sep_1$, $sep_2$) and the reduced partitions (sep. $inf_{1-3}$) visible.

»Pulvinulina» favus Brady 1877 Geol. Mag. Dec. II Vol. IV, p. 294). A similar evolution is evident in the genus Rectoeponides Cushman & Bermudez (1936 C. C. L. vol. 12, p. 31), which resembles the simple coiled and unornamented Pulvinulinella allata Marsson from the Upper Cretaceous. We can thus follow the evolution of an ornamented and an unornamented branch of primitive Pulvinulinella.

Finally it should be stated that reeticular ornamentation is common in Jurassic and Lower Cretaceous Epistomina species and is never observed in other families of the Rotaliiformes.

### Coleites reticulosus Plummer.

Pl. 18, fig. 1; text-figs. 29, 30, 31, 32, 33.

Pulvinulina reticulosa Plummer 1926, Univ. Texas Bull. 2644, p. 152, pl. 12, figs. 5 a, b.

Coleites reticulosus Plummer 1934, Am. Mid. Nat., vol. 15, p. 606, pl. 24, figs. 5—9. — Glaessner 1937, Probl. Paleontology, vol. II—III, p. 354. — 1939 Cushman & Garrett, C. C. L. vol. 15, p. 87, pl. 15, figs. 14—20. — Cushman 1940, C. C. L. vol. 16, pl. 12, fig. 20. — Marie, 1943. C. R. S. Soc. géol. France. p. 20.

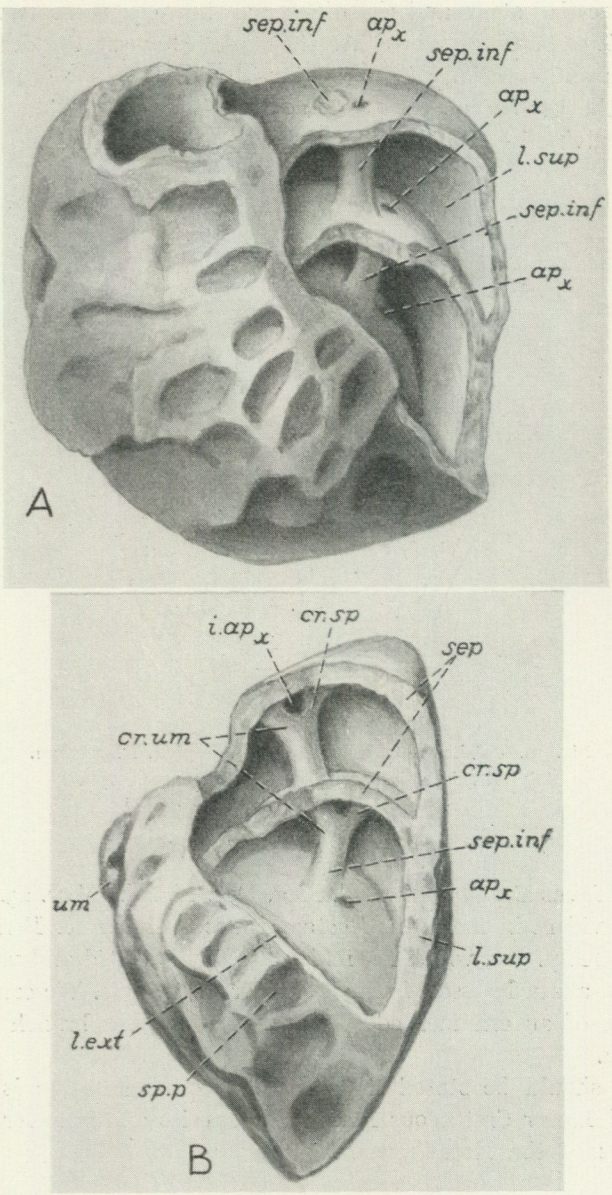


Fig. 31.

Coleites reticulosus Plummer, Danian, Klagshamn, Young specimen without uniserial part; two chambers opened. A = umbilical view, B = peripheral view. ap = foramina, cr. sp = crista above the foramen (direction to the spiral side), cr. um = crista below the foramen (direction to the umbilical side), i. $ap_x$ = entrance of the foramen, l. ext = umbilical wall, l. sup = spiral wall, sep = septum, sep. inf. = reduced partition, um = umbilicus.

Remarks.

The Swedish specimens of the Danian and Paleocene are in all details similar to the topotypes collected by Mrs. Plummer and must belong to the same species. In 1943 Marie stated that the specimens figured by Cushman and Garret in 1939 differ from the types and possibly represent a new species, intermediate between Coleites arborescens and Coleites reticulosus. But the specimens from Wood Bluff, Alabama seem to present only the normal varia-

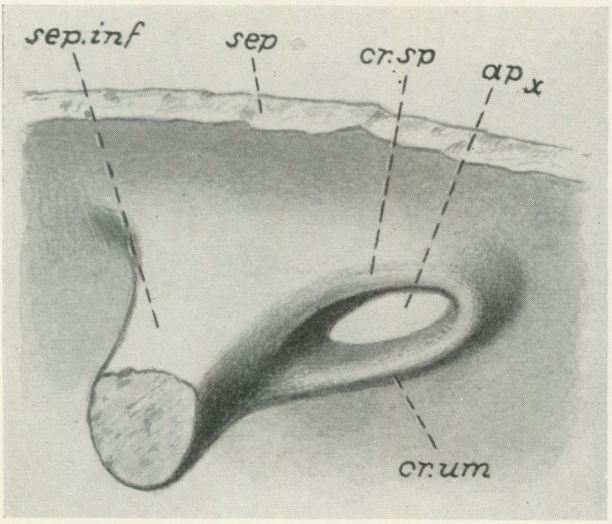


Fig. 32. Coleites reticulosus Plummer. Inside of a septum and its foramen.
$ap_x$ = foramen, cr. sp = crista above the foramen (in the direction to the spiral side), cr. um = crista below the foramen, sep. = septum, sep. inf. = the reduced partition.

tion of Coleites reticulosus. Toulmin's type from the Salt Mountain Limestone of Alabama is a little different from the typical forms, its ornament is finer in the rectilinear part of the test and is lacking on the last chambers. Unfortunately the specimens from the Upper Wilcox formation of Alabama and from the Vincentown Formation of New Jersey are only described and not figured (Toulmin 1941) so their real position is not certain. A figure of the specimens from the Caucasus Paleocene is also lacking. Marie's determination in 1943 must be correct, because he makes a very sharp distinction between the several species of this genus.

The Swedish Paleocene specimens are very badly preserved. They are black at all localities and cannot be redeposited from the Danian. In the Danian this species is generally well preserved and found in all states of evolution. The largest of them has a length of 1.06 mm, breadth 0.60 mm, and 4—5 chambers in the rectilinear part. The apertural character of this species is described in the general review of the genus; it resembles Plummer's description.

Occurrence.

Coleites reticulosus Plummer occurs very rarely in the Swedish Danian and Paleocene. The oldest occurrence is in the Middle Danian of Landskrona (wells Vattenverk I and Weibull I cf. Brotzen 1940). It is more common in the upper-

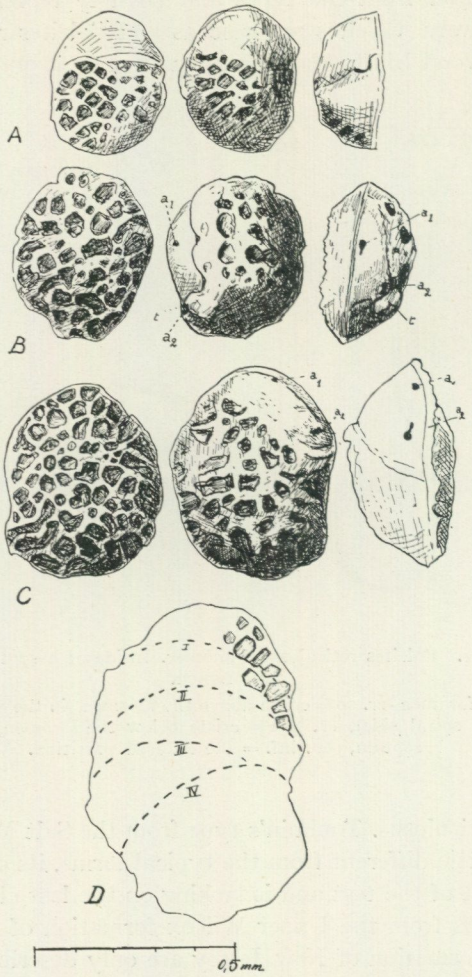


Fig. 33. Coleites reticulosus (Plummer). Danian Klagshamn. Stages of evolution.

most Danian in the quarries of Klagshamn and Limhamn. Single specimens have been found in the quarries of Östratorp, Trelleborg, and in several wells at Malmö. In the Paleocene several specimens have been found in the conglomerate at Klagshamn, in the greensand and in the clay at Ystad. According to the literature this species has a wide distribution in the Danian, Paleocene and lowest Eocene in North America as well as in Europe and Africa.

**Coleites danicus n.sp.**

Pl. 18, fig. 2.

Diagnosis.

Test subcircular to elongate, about equally biconvex, periphery acute or keeled; 5—6 chambers in the last whorl of the coiled stage, in the rectilinear part up to five, sutures on the spiral side transparent, on the umbilical side slightly depressed. Wall in the young with raised suture ridges, mostly elevated near the middle part of the spiral side, and only a few radial costae near the centre of the umbilical side. In the adult ornamented on both sides, reticulate, highest in the middle part of the sides, slightly on the margins and in the rectilinear part, without ornament on the last chamber of the uncoiled part. Aperture Pulvinulinella like in the young ones and terminal in the adult.

Remarks.

Young uncoiled specimens resemble Pulvinulinella, especially Pulvinulinella huneri Howe (Eocene, 1939 State of Lousiana, Geological Bull. No. 14, p. 81, pl. 11, figs. 14—16). The Swedish specimens are distinguished by the more irregular ornament on the spiral side and the slight ornament on the umbilical side. In the adult the ornament becomes similar to that of Coleites reticulosus and is distinguished by the unornamented margins of the last chamber, the distinct keel around the margin and the biconvex test, also in the rectilinear stage. The mature specimens resemble the figure of Coleites reticulosus Toulmin 1941, and possibly the Alabama species and the Swedish ones are the same.

In the uppermost Danian coiled and uncoiled specimens occur together, but in the Paleocene only uncoiled ones have hitherto been found. The specimens from the Danian are more ornamented than those from the Paleocene, but the differences are not important.

Marie in 1933 asserted that Coleites had evolved from planoconvex types with chambers in the rectilinear part of the same breadth as the coiled part in the Paleocene to such types in the Eocene as are biconvex and the chambers of the rectilinear part broader than the diameter of the coiled part. The Swedish material shows that already in the Danian both types occur, planoconvex and biconvex. The breadth of the recticular part varies considerably in both types. The biconvex type with a simple ornament seems to be primitive and resembles the ancestry form of Pulvinulinella.

A study of the apertural character and the interior of the chambers was impossible on the few specimens available.

Occurrence.

Coleites danicus is a very rare form in the uppermost Danian of Limhamn; two specimens have been found in the Ystad Paleocene, one in the upper and one in the lower part.

Holotype: S. G. U. No 2627, Clay, Ystad, Gjuteriet.

**The genus Karreria, Rzehak.**

Genotype: Karreria fallax Rzehak.

Diagnosis.

Test fixed on plants, rounded or elongate, flat or concave on the spiral side, convex on the umbilical side. Chambers in the young forming two or three whorls, in the adult arranged in a rectilinear stage. Aperture in the coiled stage rounded or elongate in the direction of the spiral plane, areal, in the adult terminal, wall smooth, generally thick.

Remarks.

Rzehak in 1891 (Ann. K. K. naturh. Hofmuseum vol. 6) erected the genus Karreria with the genotype Karreria fallax. No figure was given in this short first notice, but in 1895 Rzehak (Ann. K. K. naturh. Hofmuseum vol. 10 p. 226) described the genotype in detail with figures. Franke described this species from the Paleocene in Denmark (1926 Danmark geol. undersøg. II Raekke, no 46, p. 40). Liebus (1931 Statn. Geol. ustav. Ceskoslovenske Repl. Svaz 14 b) and Galloway (1933 A manual of Foraminifera) noted this genus, but in his taxonomic work (1927, 1933, 1940) Cushman was very reluctant to erect a special genus for this »Cibicides» form. Cushman and Bermudez (1936, C. C. L. vol. 12, p. 33) found a new Karreria, which does not differ from the genotype in all genetic characters, but they erected a new genus Stichocibicides with the genotype Stichoc. cubensis. The taxonomic position of Karreria is very uncertain. Rzehak related Karreria with Carpenteria; other authors related it with Cibicides. Cushman and Bermudez derive Stichocibicides from Eponides.

The shape of the test of this genus shows characters typical of certain Cibicides species. Several Cibicides species form their spiral side as the base on which they are fixed, generally parts of algae. In the Upper Maastrichtian such species occur with a thick wall as Cibicides beaumontiana D'Orb, which is very similar to coiled specimens of Karreria fallax. But Cibicides beaumontiana is characterized by an interior marginal and umbilical aperture, which in all stages corresponds to Karreria fallax. Preparations of Cibicides beaumontiana show that in the interior of the test secondary openings occur in the septa, which are areal, rounded and free from the interior margin. It may be possible that Karreria evolved from this Cibicides species and lost the typical aperture. In this case the flat side must be the umbilical and the convex the spiral side.

On the other hand, Karreria has the same shape as Coleites and is only distinguished by the lack of the Coleites ornament. The preparation of the openings of the septa shows the same figures as in Coleites and also the secondary resorptions. The apertures of young Karreria specimens are areal, generally more or less elongate in the direction of the spiral plane (fig. 33). This shape of aperture is characteristic for the Epistominiidae and it may be possible that Karreria is related to Coleites, thus belonging to the family Epistominiidae. One valuable character for the relation to the Epistominiidae is lacking in Karreria — the remnant of interior partitions. All chambers are simple and many young specimens studied hav not such remnants.

Only new finds can help to establish the real taxonomic position of Karreria, but provisionally this genus must be related to the Epistominiidae.

Only three species of Karreria are so far known, one occurring in the Danian(?) at Bruderndorf near Vienna, in the Danish-Swedish Danian and in the Paleocene: Karreria fallax Rzehak, the other in the Upper Eocene at Cuba, Karreria cubensis Cushman & Bermudez, and a new species, which has been found in the Paleocene of Belgium (see p. 32).

In 1928 M. P. White (Journ. Paleontology, vol. II, p. 299) described Karreria fallax, but this foraminifer is a real Cibicides species (possibly C. beaumontiana D'Orb.) with a typical Cibicides aperture.

### Karreria fallax Rzehak.

Pl. 18, fig. 3; text-figs. 34, 35, 36, 37.

Karreria fallax Rzehak 1891 (Ann. K. K. Naturhist. Hofmuseum, vol. 6, p. 6. — Rzehak 1895 ib. vol. 10, p. 40, pl. 7, figs. 7, 8. — Franke 1927, Danmarks geol. unders. II. Raekke No. 46, p. 40, pl. 4, fig. 7.

Remarks.

All specimens from the Swedish Danian and Paleocene are very typical and they do not differ from Rzehak's description and figures. The length of the specimens varies, spiral tests generally dominate, specimens with 2 or 3 chambers in the rectilinear part occur more rarely than spiral tests, and tests with 4 chambers in an elongate arrangement are very rare. The spiral side varies according to the base on which the test was fixed. Many specimens show typical differences between microspheric and megalospheric generations. The microspheric forms have globular prolocula with a diameter of 25 $\mu$ (fig. 37). About 6—7 chambers form the first whorl. The entire coiled part contains two and a half or three whorls before the rectilinear stage begins. The number of whorls on the spiral part of the microspheric forms observed is large and the breadth of the rectilinear part is generally broader than that of the megalospheric ones. The apertures of the rectilinear part are irregular, generally elongate, and one tooth is lacking. The megalospheric forms are characterized by the smaller spiral part with only a few chambers. The diameter of the proloculum varies between 55 $\mu$ and 85 $\mu$ (figs. 37). Two types of the megalospheric form are observed, one with globular proloculum and the other with semiglobular proloculum. The former is generally smaller than the latter. Like the spiral part also the rectilinear stage is smaller and narrower than that stage in the microspheric forms. Teeth on the upper margins of the apertures in the

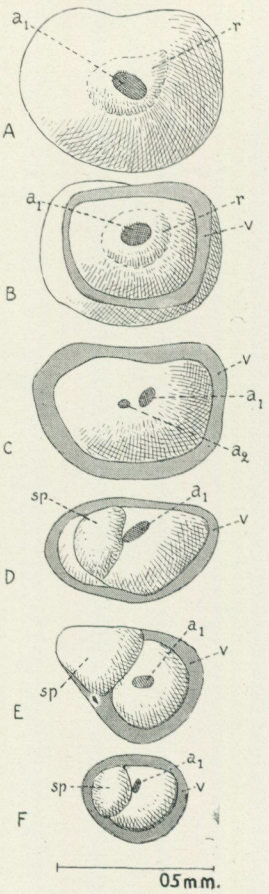


Fig. 34. Karreria fallax Rzehak. Danian Klagshamn. Apertural face and the preceding septa of one and the same specimen. $a_1$ = aperture on foramen septale. $a_2$ = resorption of the septa. r. = apertural neck. sp. = spiral arrangement of chambers. v. = sections of the wall.

rectilinear part are rare in the microspheric forms, but they occur regularly in the megalospheric ones. The teeth are large, directed into the chamber, rarely out from the test. Supplementary openings may occur in the rectilinear stage on the sutures of megalospheric tests.

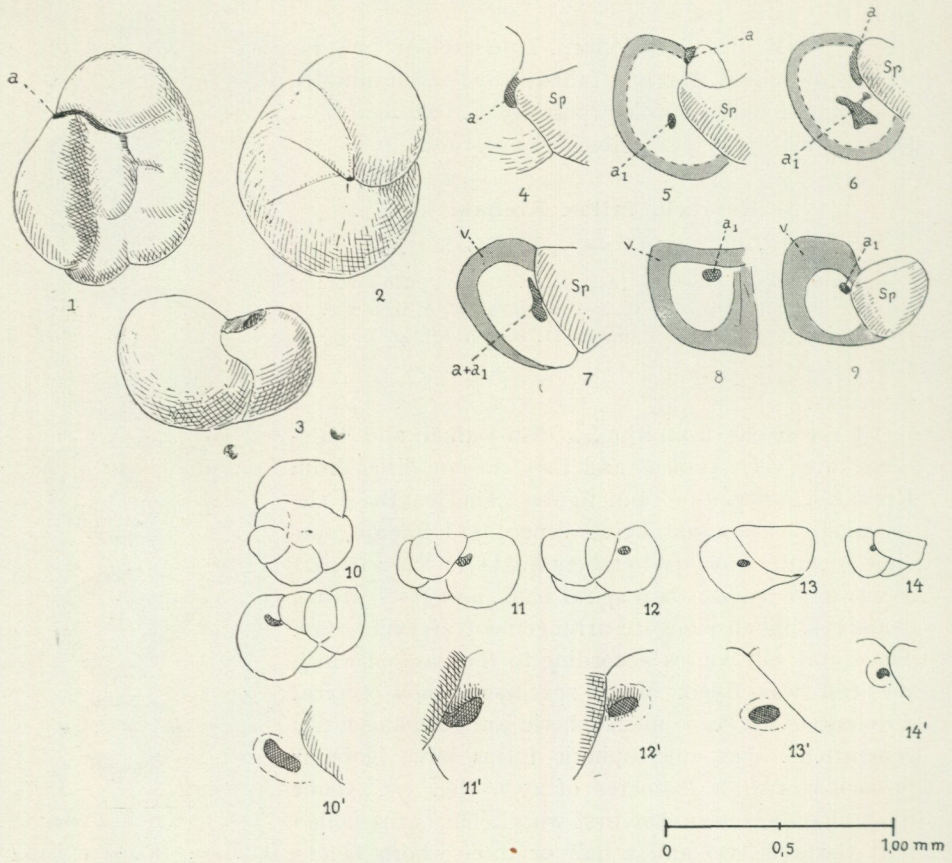


Fig. 35.
1— 9. Cibicides beaumontiana (D'Orb.). Maastrichtian, Rügen, Germany.
4— 9. Apertural faces and septa.
10—14. Karreria fallax Rzehak. Danian Klagshamn.
11—14. Septa of the chambers.
10—14. Foramina septalia enlarged.

Specimens from the Danian and the Paleocene in Sweden show the same variations and generic forms and differ only in size. Generally the specimens from the Danian are larger than those from the Paleocene.

The differences between Karreria fallax and Karreria cubensis (= Stichocibicides cubensis Cushman and Bermudez C. G. L. 1936 vol. 12, p. 33, pl. 5, figs. 19—21) are:

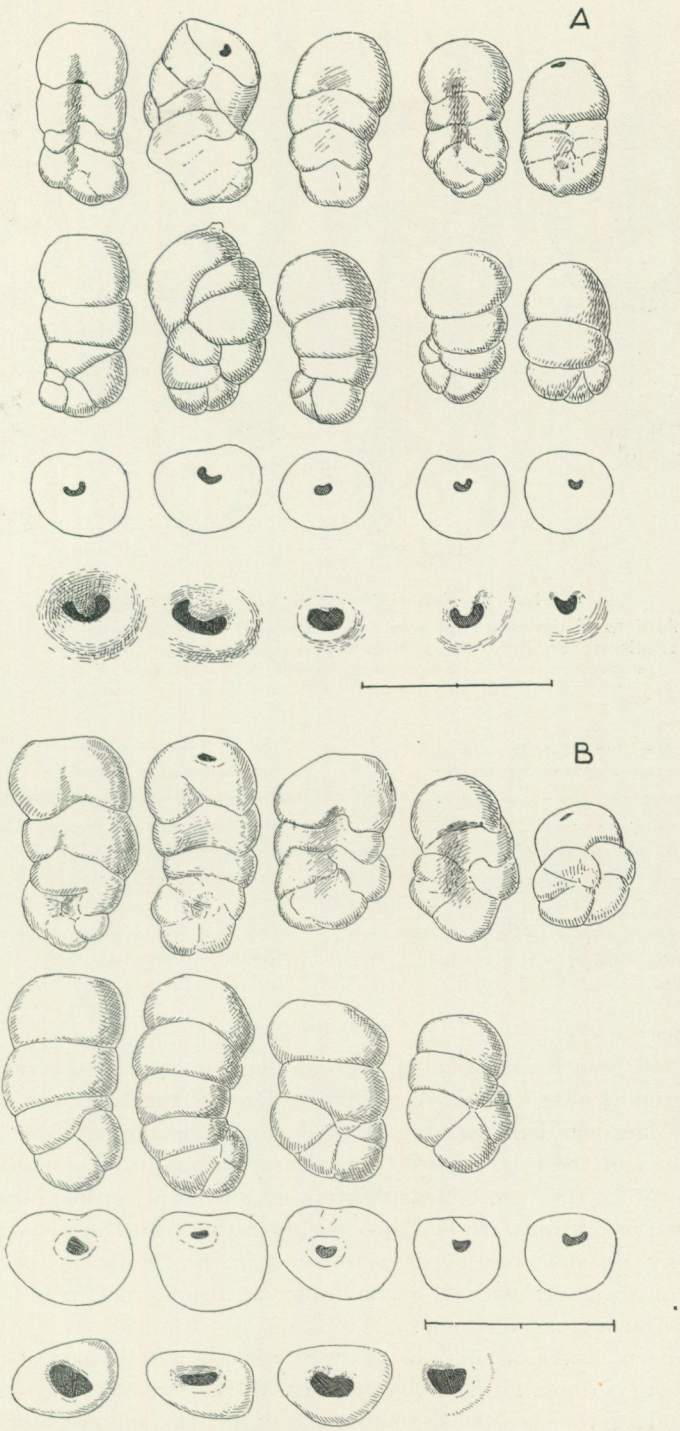


Fig. 36. Karreria fallax Rz. Danian Klagshamn. A. Megalospheric forms. B. Microspheric forms. Apertures especially enlarged.

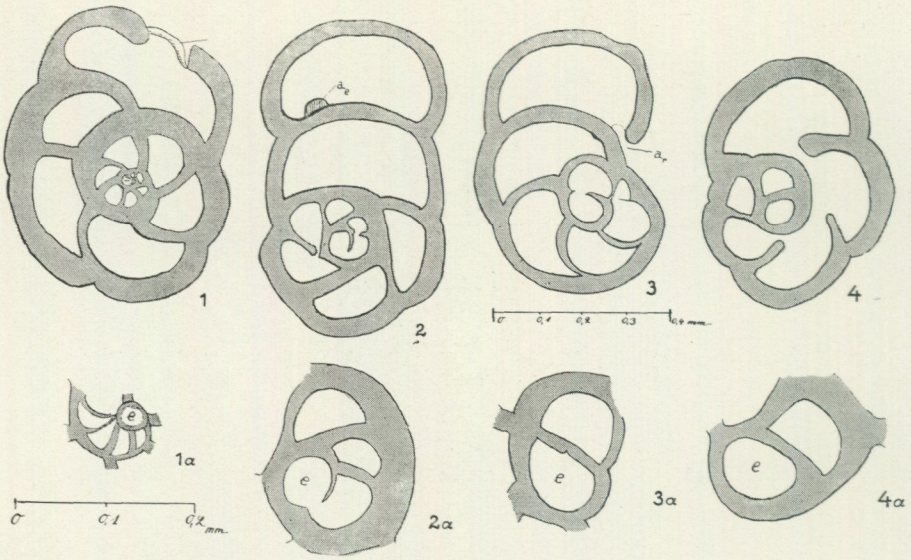


Fig. 37. Karreria fallax Rz. Danian Klagshamn.
Sections of the entire specimens and especially enlarged initial parts.
1. Microspheric form. 2—4. Megalospheric forms.
a. = aperture, ac. = opening in the suture, ar. = aperture of the spiral type.

| Karreria fallax: | Karreria cubensis: |
|---|---|
| peripheral margin acute or rounded | peripheral margin keeled |
| angle between the spiral and umbilical side 90 degrees or more | angle between spiral and umbilical side generally less than 70 degrees |
| diameter of the spiral part larger than the breadth of the chambers in the rectilinear part | generally the spiral diameter is smaller than the breadth of the rectilinear part |
| breadth of the chambers in the rectilinear part slowly increasing or not increasing | breadth of the chambers in the rectilinear part rapidly increasing, rarely not or slowly increasing. |

Occurrence.

The holotype of Karreria fallax has been found in the lowest layer of a quarry at Bruderndorf near Vienna. According to Rzehak this layer was Tertiary, but in 1936 Glaessner demonstrated (Problems of Paleontology vol. I) that the foraminifera of these layers are Cretaceous. The majority of these forms are very typical for the Upper Maastrichtian in Northern Europe, others occur in the Danian or not until in the Paleocene in the Swedish-Danish Syncline. Possibly many Maastrichtian types were living in the Danian of the Tethys and the age of the layer with Karreria fallax at Bruderndorf may be correlated with the Danian or Paleocene.

In Sweden Karreria fallax occurs rarely in the middle part of the Danian, but in the uppermost Danian it is frequent. In the Swedish Paleocene Karreria fallax is rare in the clay at Klagshamn and in the clay and greensand at Ystad. In the conglomerate at Klagshamn it does not seldom occur, and in the clay at

Tygelsjö it is a common form, whose frequency is 15 per mille. It is not found in the boulder of Maglehem. This species was recorded from the Danish Paleocene by Franke. There it occurs commonly in the clay of the lowest Paleocene in the region of Copenhagen; it is also found in the clay and greensand at Lellinge, south of Copenhagen.

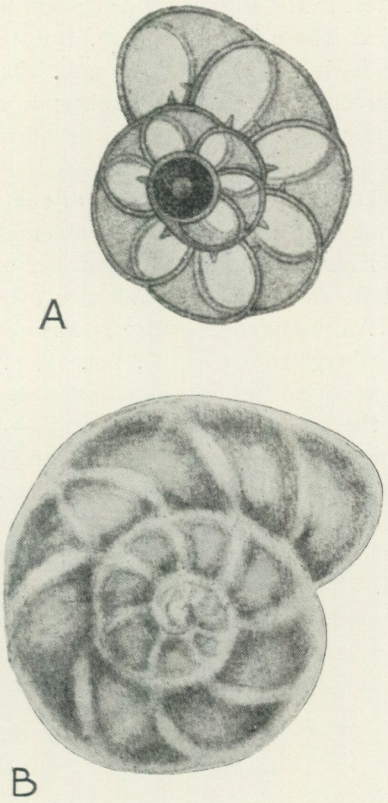


Fig. 38. Pninaella nitidula (Chaster). According Heron Allan & Earland 1913. A. Viewed as transparent object in optical sections. 265 ×. B. Opaque superior view. 300×.

**The genus Pninaella nov.gen.**

Genotype Pninaella scanica n.sp.

Diagnosis.

Test trochoid, biconvex, chambers all visible from the umbilical side, only those of the whorl last formed visible on the umbilical side. Generally without umbo, chambers simple, septa reduced, aperture very large, occupying almost the entire transverse section of the whorl or the larger part of the septa. Wall smooth, fine or medium perforation.

Remarks.

This genus is characterized by the enlarged aperture of the reduction of the septa. In the genotype remnauts of the septa are preserved, but the aperture is

generally larger than the rest of the septae. A recent species, described by Chaster in 1890 (Report of Southport Soc. of Nat. Science) as Pulvinulina nitidula, certainly also belongs to this new genus. This species was described as a Cassidulina by Heron Allan & Earland in 1913 (Proc. Roy, Irish Acad. Vol. 31, p. 70, pl. V, figs. 6—9). This very small species is transparent and its sutures are visible around the test in the spiral view and seem to form an arrangement of pairs of chambers like those in Cassidulina. But the arrangement of the chambers in the whorls is simple and not alternate. The sutures are curved on the spiral side in the direction of the last chamber; on the umbilical side they are curved in the direction of the proloculum. The spiral view is thus like that of Cassidulina. The septa of these species are quite reduced and only the sutures are a little thicker than the other parts of the wall.

The taxonomic position of this new genus is problematical, its shape reminding of Eponides and Epistominoides. Enlargement of the aperture has no so far been observed in the genus Eponides or other related forms of the family Valvulineridae. An enlarged aperture is known from the genus Eponidella Cushman & Hedberg (1935 C. C. L. Vol. 11, p. 13), which belongs to the family Epistominidae or to the Ceratobuliminidae. The shape of the test and the reduction of the septa seem to indicate that the genus Pninaella is related to the Epistominidae. Two species are so far known, P. scanica n.sp. from the Swedish Paleocene, and P. nitidula Chaster, which occurs in the Pliocene of Cornwall and is now distributed from the Mediterranean to Iceland. Specimens of P. nitidula from the Swedish shores have been received from Dr. H. Höglund of Lysekil, who observed the real arrangement of the chambers in this species. The genus has been named in honour of my wife, P. Brotzen, who has worked with me on foraminiferal research during the past ten years.

**Pninaella scanica n.sp.**

Pl. 15, figs. 5, 6.

Diagnosis.

Test large, diameter up to 1.00 mm, almost equally biconvex, peripheral margin acute; three or three and a half whorls on the spiral side, 7—8 chambers in the whorl, the last a little inflated, sutures transparent, slightly curved, the last ones slightly depressed. Umbilical side with a small umbilical disk, sutures curved, aperture large, of the same outline as the transverse section of the whorl, the breadth of the septa approx. 1/3 of the diameter of the breadth of the whorl. Wall with medial perforation.

Remarks.

The shape of the test resembles that of Höglundina elegans (D'Orb) and related forms. It is distinguished by the apertural character and the lack of the interior partition in the chambers. All the specimens available were badly preserved on the apertural face, but all the sections of the test disclose reduced septa and the septal foramen in all chambers is very large. The correlation with the recent »Pulvinulina» nitidula Chaster shows that the fossil and the

recent species belong to the same new genus, characterized by reduced septa. This reduction has progressed farther in the recent species. The recent and fossil species are distinguished by the size, the reduction of the septa and shape of the sutures. The sutures on the umbilical side of the recent species are curved backwards in the direction of the proloculum, those of the Paleocene species are curved in the direction of the last chamber.

Occurrence.

Pninaella scanica occurs very rarely in the greensand at Ystad.

Holotype: S. G. U. No. 2639, Greensand at Ystad.

### The genera Lamarckina and Ceratobulimina.

The two genera Lamarckina (Berthelin) and Ceratobulimina Toula are distinguished from the preceding genera by the position of the aperture. Their aperture is umbilical or derives from an umbilical one. Cushman described the genus Lamarckina and its American species in 1926 and could demonstrate the stratigraphic value of this genus. In the next year Cushman and Harris published valuable notes on the genus Ceratobulimina, which in 1934 were completed by Plummer's excellent paper on the structure of Ceratobulimina (American Midland Nat. Vol. 17, p. 460). In 1937 Glaessner erected the new family Ceratobuliminidae, containing Lamarckina, Epistominina, Epistominoides, Missisippina, Eponidella, Ceratobulimina, Pseudobulimina and Robertina (Studies in Micropaleontology Vol. I, p. 19). In this paper the construction of the inner partition of the named genera is described and their relations demonstrated. In 1942 the author (Sveriges geologiska undersökning, Årsbok 36, No 8, p. 35) erected the family Epistominidae, which partly agrees with the Family Ceratobulimina Glaessner, but contains more forms. The author supposed two different lines of evolution in the family Epistominoidae to occur, one derived from the genus Epistomina and the other from Lamarckina. The new researches prove that these two evolutionary lines represent the two subfamilies Epistomininae and Ceratobulimininae.

In 1946 Ten Dam published a short paper on the development of the genera Ceratobulimina and Lamarckina. This paper contains only a description of some species and establishes the occurrence of Lamarckina and Ceratobulimina in the Lower Cretaceous.

Lamarckina and Ceratobulimina are typical genera of the subfamily Ceratobulimininae. Both genera generally have an umbo; its aperture is situated on the umbilical wall and the interior partition is distinct in all chambers. This partition is formed as in Epistomina, dividing the chambers in two sections. The difference between Epistomina and Ceratobulimininae is that in Epistomina the junction between the foramen septale and the aperture runs between the umbilical wall and the inner partition, i. e. downwards in the normal position of the test, and in Ceratobulimininae the junction is situated between the spiral wall and the interior part, i. e. upwards in the normal position.

In Lamarckina the division of the final chamber is more complete than in Ceratobulimina: its partition is fixed on the umbilical, frontal and spiral walls and only a relatively small foramen makes possible the junction between the two separate parts. The apertural room is smaller than the other part. In Ceratobuliminae the two divisions of the final chamber are more or less equal, the partition being fixed on the umbilical, frontal and septal wall, but only reaching three fourths of the height of the last chamber. Consequently it is never fixed on the spiral side walls.

A typical trait of the test of Ceratobulimina is the closing of the umbilical apertural foramen after the building of a new chamber. Over the apertural foramen lies a vaulted shutting. In types with an umbilicus this shutting is visible in the umbilicus and often it contains a separate room of the chamber. In Ceratobulimina tuberculata n.sp. this shutting is strongly tuberculate on the umbilical side.

Lamarckina seems to derive from the Lower Jurassic species, whose taxonomic position is between the Epistomininae and Ceratobuliminae. The types of the Lower Cretaceous were not attached to the bottom or to plants; in the Upper Cretaceous, however, both free and attached species occur. Types without umbilicus cannot belong to this genus, and those occurring in the Upper Jurassic are generally more closely related to the Epistomininae than to the Lamarckininae.

The genus Ceratobulimina is so far known from the uppermost Cretaceous to recent. The oldest species known remind in many details of Lamarckina. Ten Dam in 1946 described a Ceratobulimina from the Gault. It will be interesting to see a more detailed description and figure of these old forms. It does not seem difficult to derive Ceratobulimina from Lamarckina. In the Tertiary Ceratobulimina rapidly developed new forms, characterized by a reduction of the umbilicus. Simultaneously with the reduction of the umbilicus the primitive rounded aperture becomes a comma-shaped and elongate slit, extending from the interior margin into the frontal face, similar to the aperture of the Bulimina. The recent studies of H. Höglund (1947) on the inner structure of the Buliminidae promt the conclusion that the Ceratobuliminae and Buliminidae posse the same ancestry.

### Lamarckina naheolensis Cushman & Todd.

Pl. 17, fig. 6.

L. naheolensis Cushman & Todd 1942 C. C. L. vol. 18, p. 39, pl. 7, figs. 5—7. — Cushman 1944, C. C. L. vol. 20, p. 45, pl. 7, fig. 23.

Remarks.

Prof. J. A. Cushman has kindly sent me topotypes of Lamarckina naheolensis for comparison. The American and Swedish Paleocene specimens resemble each other in all details as to shape and inner structure. Also their varieties are of the same character. Some types are more rounded than the figures of Cushman and Todd and others more elongate than the figure of the Swedish ones.

The inner structure of the final chamber is principally as in Ceratobulimina. The partition bent with a small lip into the larger room with the foramen septale. The margin of the partition in the junction between the two apartments is dented like those of Ceratobulimina perplexa and Ceratobulimina exima figured by Plummer in 1936.

Occurrence.

In 1914 Cushman stated: »This species, recently described from the Paleocene, Naheola formation of Alabama occurs commonly and in a typical form in this material. It should prove to be a good index fossil.» In the Swedish Paleocene this species is very rare, but very typical specimens were found in the greensand and clay at Ystad, and in the clay at Tygelsjö; in a small sample from the boulder of Maglehem very well preserved specimens were found, so in that locality the species is not rare. Lamarckina naheolensis also occurs in the lowest Paleocene of Copenhagen and at Lellinge. The American index fossil for the uppermost Midway formation in Alabama is also a good index fossil for the Scandinavian lowest Paleocene.

### Ceratobulimina perplexa (Plummer).

Pl. 19, fig. 1.

Rotalia perplexa Plummer, Univ. Texas Bull. 2644, 1926, p. 156, pl. 12, fig. 2.

Ceratobulimina perplexa Cushman & Harris, C. C. L., vol. 3, 1927, p. 173, pl. 29, fig. 2. — Plummer, Amer. Midl. Nat. Vol. 17, 1936, p. 460. text-figs. 1—4. — Glaessner, Studies in Micropaleontology, vol. 1, 1937, pp. 20, 23, pl. 1, figs. 2, 3, pl. 2, fig. 25. — Cushman & Todd, C. C. L. vol. 18, 1942, p. 41, pl. 7, figs. 23, 24.

Remarks.

The Swedish specimens do not differ from the topotypes available collected by Mrs. Plummer from the Midway Formation. The height of the Texas types is generally less than that of the Swedish ones, but in the Texas Midway there also occur many specimens with a broad rounded peripheral margin like the majority of the specimens in the Swedish Paleocene samples. The typical ornament, consisting of slightly raised sutures on the spiral side, is the same on the Swedish and American types.

The last chamber is rarely well preserved in the Swedish specimens: it is generally open and shows remnants of the inner partition, resembling in all details the American ones.

Ceratobulimina perplexa occurs in the Swedish Paleocene together with a closely related species, described in the following as Ceratobulimina tuberculata. The differences between the species are constant and each of them must belong to a special form. They are distinguished in the following list:

| *Cerat. perplexa* | *Cerat. tuberculata* |
|---|---|
| chambers in the last whorl 7—8 | 6—7 |
| spiral side | |
| ornament distinct | indistinct |
| sutures not depressed or indistinctly depressed | last sutures distinctly depressed |

| *Cerat. perplexa* | *Cerat. tuberculata* |
|---|---|
| umbilical side | |
| chambers form knots near the umbilicus | chambers equally inflated |
| sutures deeply depressed lines near the umbilicus | sutures distinctly depressed, not forming lines |
| inside and margins of the umbilicus smooth | inside and margins of the umbilicus tuberculate. |

Occurrence.

Ceratobulimina perplexa occurs rarely in the Paleocene at Klagshamn; it is more common in the Paleocene at Ystad. Some single specimens have been found in the boulder at Maglehem. It is lacking in the clay at Tygelsjö. This species seems to be limited to the base of the Swedish Paleocene. So far this species is only known from the Midway formation in Alabama and Texas. In Alabama this species only occurs on the top of the Midway formation (as in the Naheola formation). In the Midway group of Texas it is common only in the Wills Point formation; in the Kincaid it occurs very rarely. In the Danian formation in Sweden all Ceratobulimina species are lacking and in the upper zones of the Paleocene only Ceratobulimina tuberculata occurs. Ceratobulimina perplexa is also in Sweden and Denmark one of the best guide fossils for the base of the Paleocene.

**Ceratobulimina tuberculata n.sp.**

Pl. 19, figs. 2, 3.

Diagnosis.

Test almost equally biconvex, outline rounded or rounded oval, peripheral margin broadly rounded, slightly lobate on the last chambers. 6—7 chambers in the final whorl on the spiral side; on the umbilical side only five visible, rapidly increasing in the adult, fairly inflated on both sides. Sutures in the adult distinctly depressed, slightly curved. Apertural front broad, the bulge around the aperture with a dentate margin. Aperture umbilical, covered by the bulging area. Umbilicus large and deep, its margin and inner side covered with distinct tubercles. Except for these tubercles the wall of the test is smooth and glossy.

Remarks.

This species is closely related to the preceding species. The difference between the two are shown in a list above. The shape of the aperture and the construction of the inner partition are the same in both. The large umbilicus and the umbilical aperture seem to be common in all species in the Paleocene and Eocene; in the younger species the umbilicus disappears and the slit-shaped aperture develops slowly.

The tuberculation of the inside of the umbilicus is not so prominent in the geologically oldest specimens and it becomes more distinct in the upper layer of the Paleocene.

Occurrence.

This species has been found in the Paleocene at Klagshamn, Ystad and Tygelsjö. At the two first localities it occurs rarely and together with Ceratobulimina perplexa Plummer. In the clay at Tygelsjö Ceratobulimina tuberculata becomes more common and occurs without the other species. This species is also very abundant in the Lower Paleocene at Copenhagen (Sundkrogen and Västra gasverk); the specimens from the Sundkrogen Paleocene are especially well preserved. The youngest geological occurrence of Ceratobulimina tuberculata seems to be in the Lellinge Greensand from the Lellinge River (Denmark). The specimens from that locality are characterized by the strong tuberculation in the umbilical area. One very characteristic specimen was found in the Thanet sand of Pegwell Bay, England.

Holotype: S. G. U. No 2654. Lower Paleocene clay at Sundkrogen (Copenhagen).

### The genus Asterigerina.

The taxonomy of the genus Asterigerina has hitherto been very doubtful and a special family was erected. This family — the Amphisteginidae — contains, as is evident from the name, also the genus Amphistegina. The common character of these two genera is the occurrence of so-called »supplementary chambers». All other characters, the shape of the chambers, the position of the aperture, and the structure of the wall, are so different that there cannot exist any relationship between these genera.

The chambers of Asterigerina are arranged in a simple spiral, distinctly visible on the spiral side. On the umbilical side each chamber is divided into two parts by an internal partition, which is visible on the umbilical side and there forms the characteristic starlike arrangement of the sutures. One of the parts is situated along the periphery and the other near the centre. The peripheral crescent-shaped part has the real aperture. All specimens of Asterigerina must increase by the building of the two parts of the final chamber at the same time, because only specimens with the final apertural part have been found. The communication of the plasma from the second last chamber to the outside was as follows: through the second last aperture into the centre part of the last chamber, from the interior or centre part of the final chamber through a slit in the partition into the peripheral or apertural part of the same chamber and then out from the test through the real aperture. The aperture of all Asterigerina species lies in a crescent lobe, more or less parallel to the peripheral margin of the test; it is elongate, generally broad. The umbilical wall of the last chamber extends a tooth into the aperture, which tooth may be dentate as in many Lamarckina and Ceratobulimina species. Around the aperture of several Asterigerina species the inner whorl is tuberculate, like such tuberculations in Ceratobulimina.

The general arrangement of the chambers with their partitions, the junction for the plasma in the interior of the chambers, the position and shape of the

aperture are quite comparable to the features in Ceratobuliminidae, especially in certain Lamarckina species. The author therefore concludes, that Asterigerina must belong to the Family Ceratobuliminidae.

The publication of an Asterigerina from the lowest Oolitic (Jurrassic) by Ten Dam and Reinhold in 1941 was of very great value for the phylogeny of Asterigerina (Some foraminifera from the Lower Liassic and Lower Oolitic of the Eastern Netherlands). They described an Asterigerina from the lowest Oolitic, earlier described as Discorbis from the same layers in Germany, Asterigerina dreheri Bartenstein. Thanks to the kindness of Director Reinhold and Dr. Voorthuysen, I could study the originals and topotypes in the Geologische Stichting in Haarlem. Asterigerina dreheri was not a real Asterigerina, but a very closely related new genus, which may be the ancestor of the Asterigerina species in younger geological stages. This new genus Reinholdella (Genotype Asterigerina dreheri, collection Geologische Stichting Haarlem nr. F. 410, original of Ten Dam and Reinhold's figure 1, 1941) is characterized by an umbilical and interiomarginal aperture and an inner partition in the chambers as in Lamarckina. This new genus is distinguished from Asterigerina by the shape of the aperture and the situation of the inner partition, from Lamarckina by the lack of an umbilicus and the occurrence of an interiomarginal part of the aperture, from Epistomina by the lack of a lateral aperture. Reinholdella closely approaches an ideal type of the primitive Ceratobulimininae and possibly it is an ancestral genus of Lamarckina, Ceratobulimina and Asterigerina. This genus shows the relations between Lamarckina and Asterigerina and is valuable as a demonstration of the taxonomic position of Asterigerina.

In 1937 Glaessner assumed a relation to exist between the Asterigerina and the Ceratobuliminidae, but he is of opinion that Amphistegina and Asterigerina must be closely related (»Supplementary chambers and internal partitions are found in Asterigerina and Amphistegina. It would be most important to study carefully the morphology of these genera and to compare it with the particular features of our new group = the family Ceratobuliminidae»).

The oldest known Asterigerina was described by Schijfsma in 1946 from the Campanian of the Netherlands, but this genus must be expected to occur already in the middle or upper Jurassic.

**Asterigerina nörvangi n.sp.**

Pl. 18, fig. 4, 5.

Diagnosis.

Test small, diameter up to 0.35 mm, almost equally biconvex, 6—7 chambers in the final whorl, sutures transparent, not depressed, on the umbilical side central parts of chambers large, umbilical plug not elevated, only transparent. Wall generally smooth, rarely tuberculate near the centre of the umbilical side.

Remarks.

All the topotypes of Asterigerina primaria Plummer are flat or concave on the umbilical side, as Plummer originally described the shape. This character

sharply distinguishes the Swedish specimens from the Texas ones; the plug on the umbilical side is also more distinct in the Texas species than in the Asterigerina nörvangi. The tuberculation on the umbilical side has been observed only once, but it occurs in all Texas forms. Apart from these differences the Swedish and Texas species are closely related and are possibly only two geographical variations. Asterigerina primaria is recorded also from Alabama, but the side views are not figured.

The new species has been named in honour of Mr. A. Nörvang, micropaleontologist of the Danish-American-Prospecting Co, to whom I am indebted for the Asterigerina species from the Danish Tertiary.

Occurrence.

This species occurs very rarely in the Paleocene of Ystad. It is more frequent in the lower than in the upper part.

Holotype: S. G. U. No. 2666, Ystad, Gjuteriet, 21 m.

### Allomorphina halli Jennings.

Pl 19, figs. 4, text-figs. 39, 40, 41.

Allomorphina halli Jennings 1936, Bull. Americ. Paleontol. Vol. 23, no. 78, p. 34, pl. IV, fig. 5.
Allomorphina trigona (non Reuss) Franke 1927, Danmarks Geolog. Unders., II Raekke, no. 46, p. 12, pl. I, fig. 11.

Remarks.

Franke and Jennings figure the surfaces of this very typical species, but do not describe the interior of the test. The outside greatly resembles Reuss's figure from the Miocene of the Basin of Vienna, but in all the variants observed the Paleocene species is distinguished by its final chamber, which is never so high as in the Miocene species. The aperture, below a distinct lip, is not

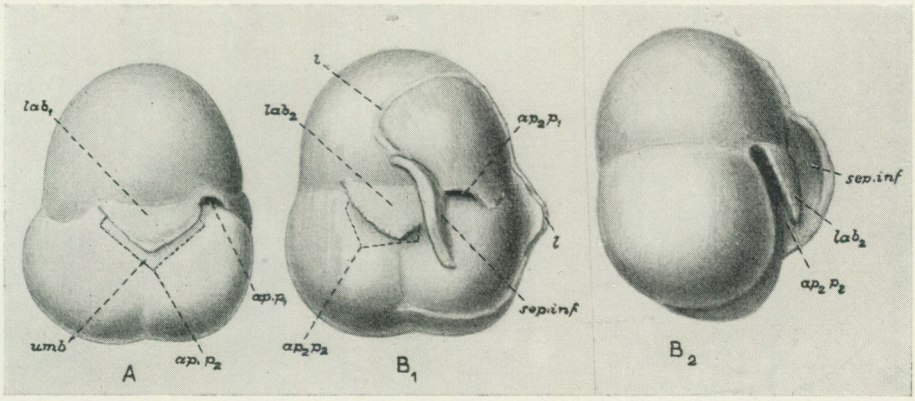


Fig. 39. Allomorphina halli, Jenn. Sundkrogen. A = specimen with complete final chamber. $B_1$ = specimen with destroyed external wall of the final chamber, umbilical side. $B_2$ = the same specimen, peripheral side. ap. $p_1$, $ap_2$ $p_1$ = apertural part beside the umbilical lip (of the last and of the preceding chamber, resp.) ap. $p_2$, $ap_2$ $p_2$ = apertural part below the umbilical lip, l = remnant of the external wall of the final chamber, $lab_1$, $lab_2$ = umbilical lip of the final, resp. preceding chamber, sep. inf. = internal wall.

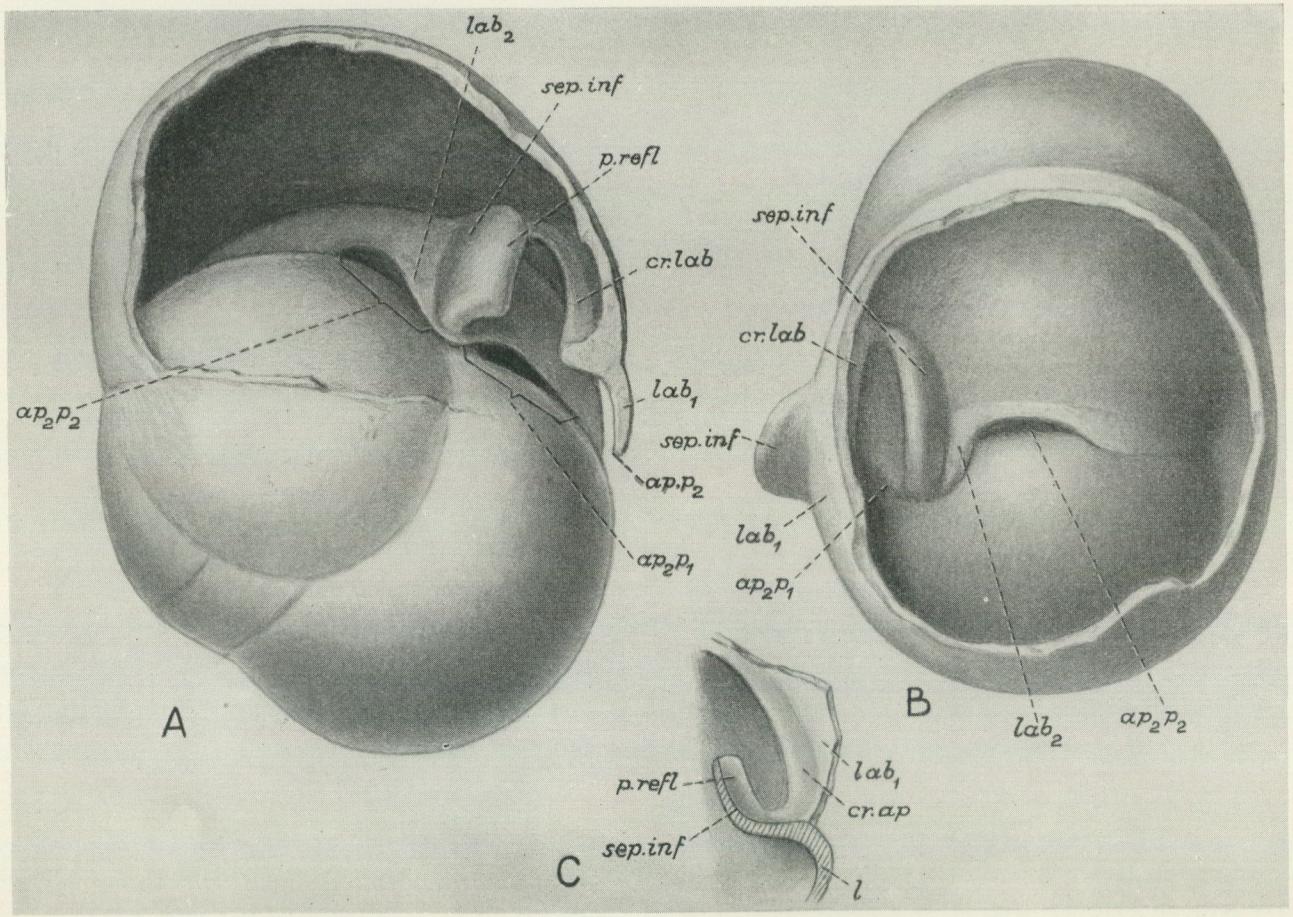


Fig. 40. Allomorphina halli Jenn. Specimens with opened final chamber, A chamber opened across the umbilical region, B chamber opened tangential, C the internal wall, apertural lip and apertural crista seen from the under-side. ap. $p_1$, $ap_2 p_1$ apertural part below the umbilical lip, ap. $p_2$ $ap_2$ $p_2$ apertural part beside the umbilical lip, cr. lab crista on the inside of the umbilical lip, $lab_1$, $lab_2$ umbilical lip of the final and preceding chamber, 1 external wall, p. refl pars reflecta of the internal wall, sep. inf. internal wall.

the same as on Reuss's type. Types from Sundkrogen (Copenhagen) are in all details the same as the specimens from the Swedish Paleocene. The types from the Hornerstown formation in New Jersey are not different to the Swedish ones, judging by Jennings's figures. All Swedish and Danish specimens show a structure in the inside between the last and the preceding aperture. On the umbilical side of the test three chambers are visible and in the centre a small umbilicus is marked by a depression. The aperture is a slit from the

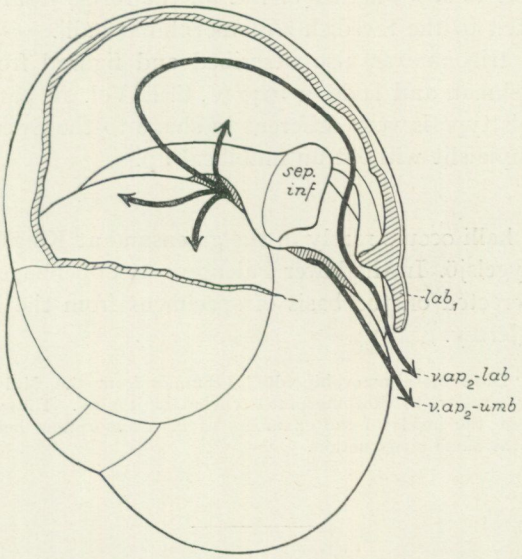


Fig. 41. Allomorphina halli, Jenn. Sketch of the connection between the inside and the outside of the test. v. $ap_2$ — lab connection between the foramen below the lip and the aperture, v. $ap_2$ — umb connection between the foramen beside the lip and the aperture.

umbilicus to the periphery along the interior margin of the last chamber. A distinct lip of the umbilical wall covered the aperture in the neighbourhood of the umbilical region. The same type of aperture is preserved in the inside of the test of the preceding chambers, but each foramen — aperture in younger stages of the specimen — is divided by a small pillar into two openings, one of which opened from one chamber to the next and the other connected the preceding chamber directly with the umbilical depression. In the interior of the last chamber is a small wall, running from the apertural lip of the second last chamber more or less parallel to the final aperture, and then at right angles to the preceding aperture. The aperture was enclosed by this small wall in the inside, and the wall continued on the inside of the apertural lip as a fine border. This structure is observed also in all the other chambers of each specimen. The inside wall of the chambers resembles the structure of the walls of the chambers of the Epistominidae, especially of the Ceratobuliminidae. The genotype of the Allomorphina is Reuss's Miocene species. The interior of the genotype is not known and possibly it is not the same as in »Allomorphina» halli.

The relationship to Cretaceous Valvulineria or Quadrimorphina allomorphinoides (Reuss) and to Rotomorphina cushmani (Finlay Transact. & Proceedings Roy. Soc. New Zealand, Vol. 69, part 3, 1939) must also be studied in this connection.[1] Thanks to the kindness of Mrs. H. J. Plummer it has been possible for me to study one specimen of Allomorphina trigona from the Texas Midway formation. This specimen lacks all structures in the inside. Its shape is not similar to that of the specimen figured by Plummer in 1927. Therefore it is very difficult to say whether or not all the forms from the Midway formation are related to the Swedish »Allomorphina» halli.

Allomorphina trigona was also described and figured from the Arkansas Paleocene by Cushman and Todd in 1946 (C. C. L. Vol. 22, part. 2, p. 63, pl. 11, figs. 11, 15). This type is very different in shape to the Swedish ones and its aperture is a simple slit without an umbilical lip.

Occurrence.

Allomorphina halli occurs rarely in the greensand at Klagshamn, commonly in the clay at Tygelsjö. In the lower Paleocene at Copenhagen it is abundant. The type was erected on the basis of specimens from the Hornerstown formation of New Jersey.

[1] Specimens of "Discorbis allomorphinoides" Plummer from the Midway Formation (coll. Plummer) are very similar to Rotomorphina cushmani Finlay. These specimens show the same construction in the inside of the chambers as in Allomorphina halli. Cretaceous forms of this group have the same construction.

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G. F. F. = Geologiska föreningens i Stockholm förhandlingar.
M. D. G. F. = Meddelelser fra Dansk Geologisk Forening.
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## Explanation of Plate V.

Figs. 1, 2. Pseudoclavulina anglica Cushman. Solnäs 9m. S. G. U. Fig. 1. No. 2204; Fig. 2. No. 2205. 100 x p. 37
Fig. 3. Bermudezina danica (Franke); Solnäs 9m. S. G. U. No. 2202. 100 x p. 36
Fig. 4. Citharina plummoides (Plummer); Klagshamn greensand. S. G. U. No. 2245. 25 x p. 45
Fig. 5. Citharina plummoides (Plummer); initial part from figure 4. 50 x p. 45
Fig. 6. Ataxophragmoides frankein. sp. Ystad gjuteriet 21 m. S. G. U. No. 21. 50 x p. 36

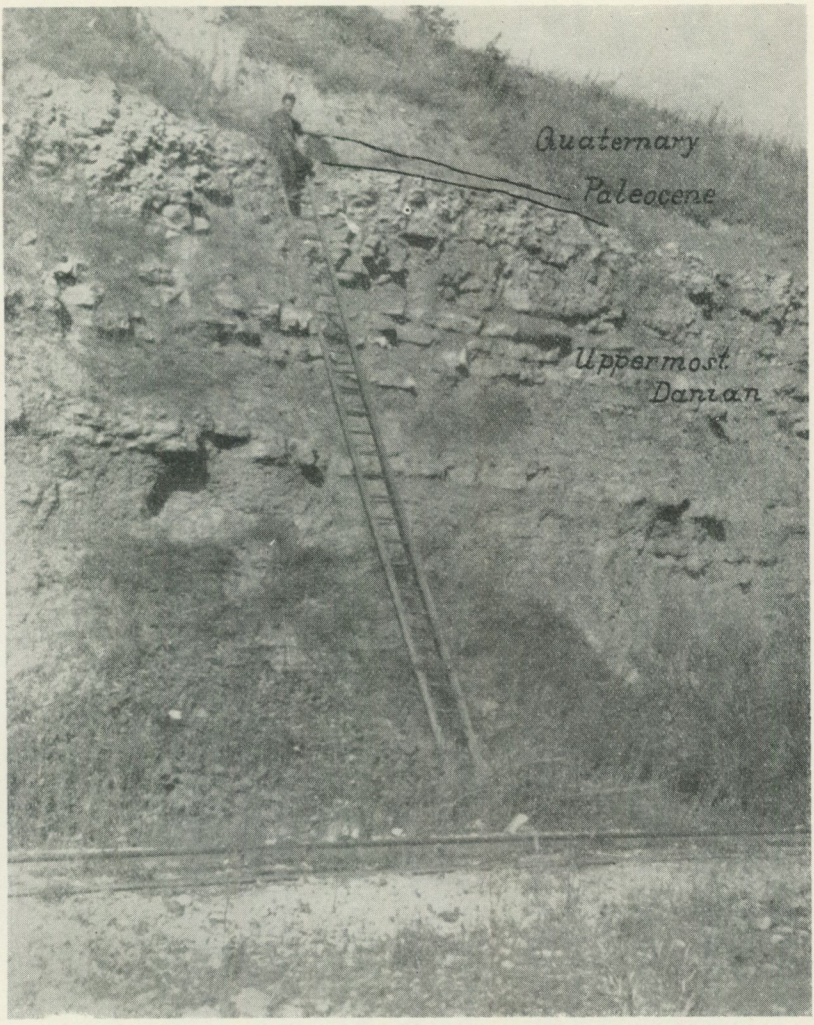



Fig. 1. The Paleocene in the southern wall of the quarry at Klagshamn.

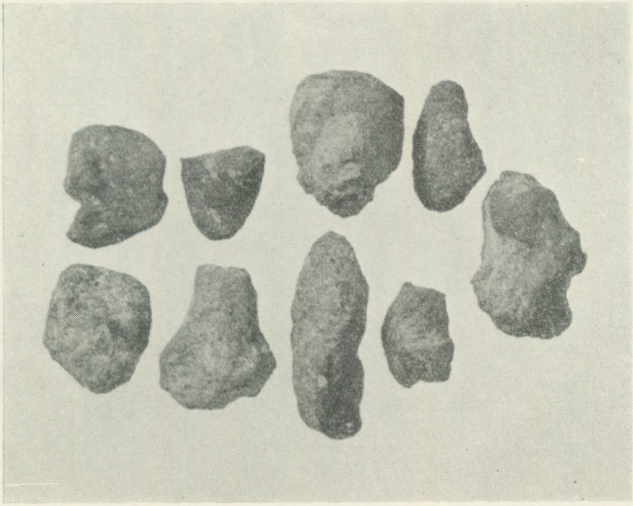


Fig. 2. Phosphatic nodules from the Paleocene bottom conglomerate.

Fig. 1. Corrugated surface of the Danian limestone; discontinuities filled with Paleocene glauconitic matter. $^3/_4$ nat. size.

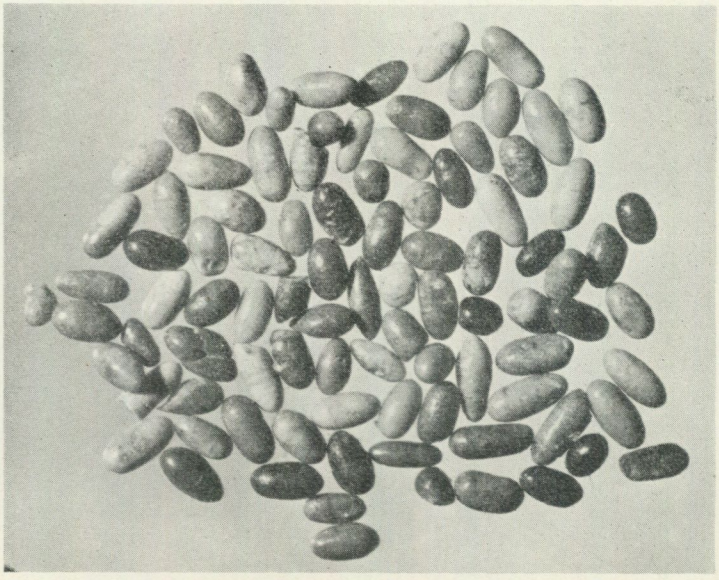


Fig. 2. Coprolites (Echinoidea?) from the well »Ystad gjuteriet», level 21 m. 10 ×. p. 12.

Fig. 1. Paleocene boulder from Ystad port. Coll. R. Hägg. State Museum of Nat. History. Among the fossils abundantly: Sphenotrochus latus v. Koenen, Cucullaea dewalquei v. Koenen, Pectunculus corneti v. Koenen, Corbula koeneni Cossm., Ostrea sp., Dentalium undiferum v. Koenen, Dentalium rugiferum v. Koenen, Siphodentalium intumescens v. Koenen, Solarium koeneni Ravn, Turritella nana v. Koenen, Eulima solidula v. Koenen. About $^{3}/_{5}$.

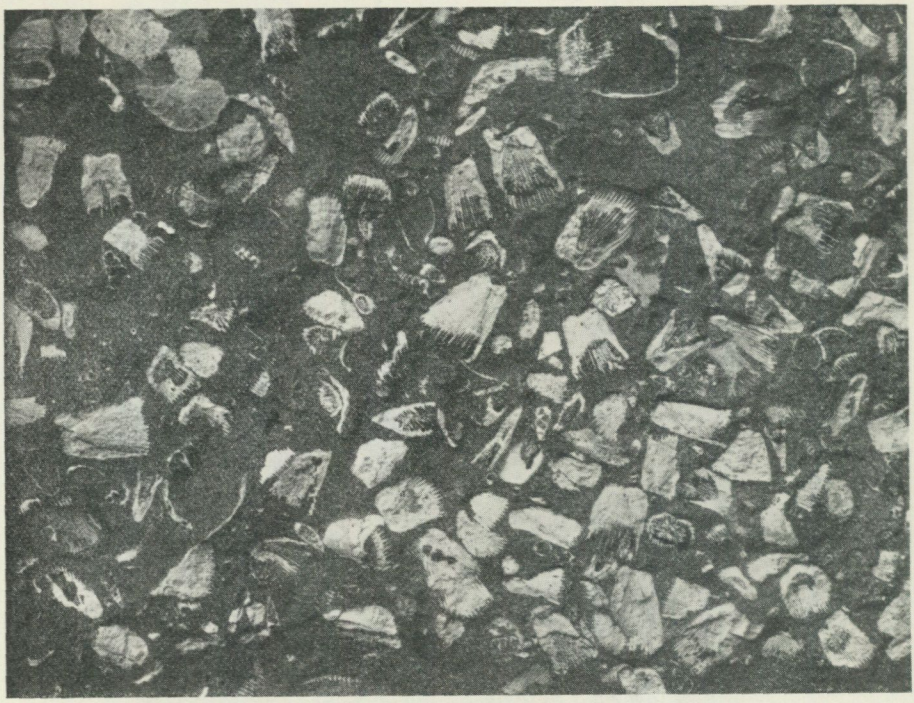


Fig. 1. Erratic Paleocene boulder from Ystad port; concentration of Sphenotrochus latus v. Koenen. Coll. R. Hägg. State Museum of Nat. History. Nat. size.

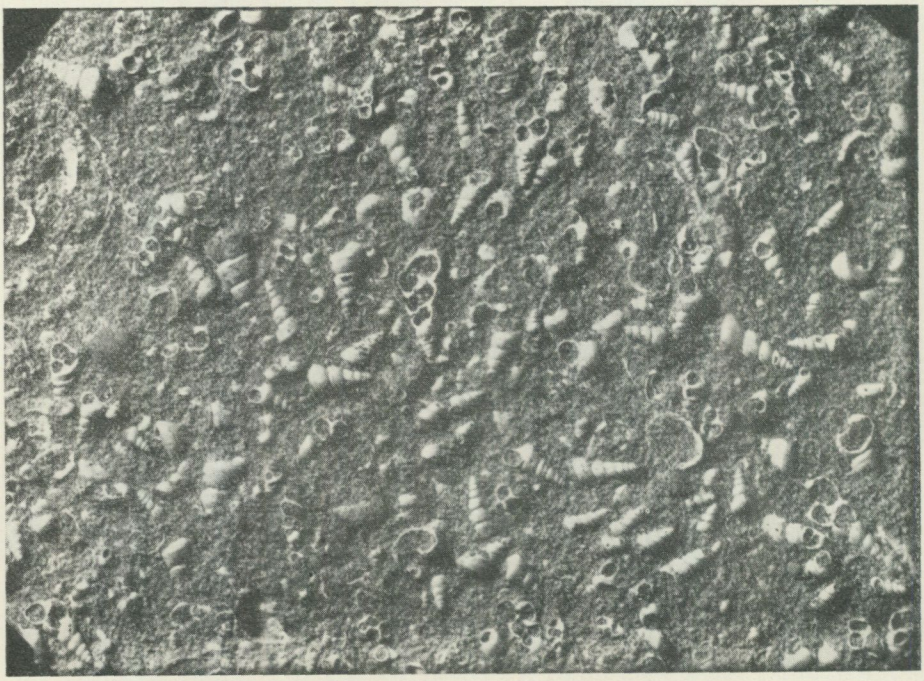
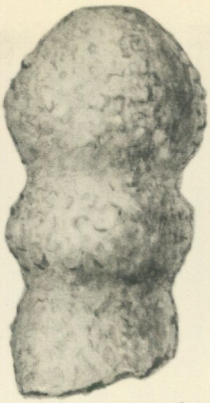
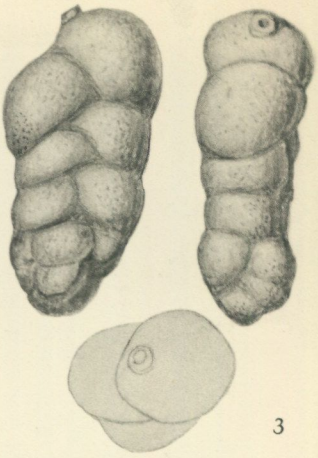


Fig. 2. Erratic Paleocene boulder from Ystad port; concentration of Turritella nana v. Koenen. in brownish sandstone. Coll. R. Hägg. State Museum of Nat. History. 3 ×.

1a



2a



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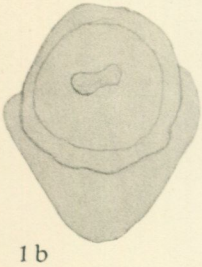
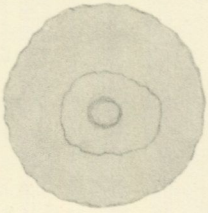
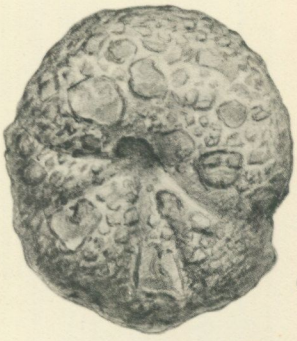


1b



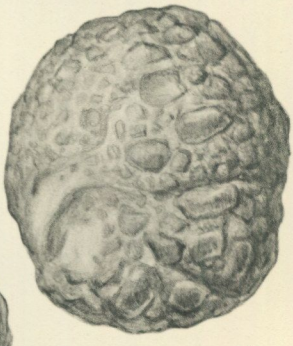
2b



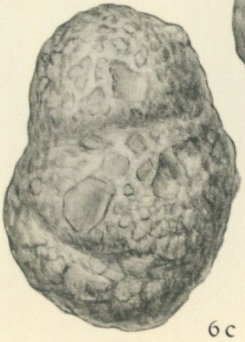
6a

5

4



6b



6c

Explanation of This plate see p. 140

## Plate 6

Fig. 1. Arenobulimina mohreni n. sp. Ystad gjuteriet 21m. S. G. U. No. 13. 62 x p. 35

Fig. 2. Arenobulimina cuskleyae Jennings. Ystad gjuteriet 21m. S. G. U. No. 9. 100 x p. 34

Fig. 3. Bolivinopsis scanica n. sp. Ystad gjuteriet 20 m. S. G. U. No. 129. 100 x p. 54

Fig. 4. Bulimina aspero-aculeata n. sp. Ystad gjuteriet 21m. S. G. U. No. 136. 100 x p. 60

Figs. 5, 6. Bulimina paleocenica n. sp. Ystad gjuteriet 21m. S. G. U. No. 139. Ystad gjuteriet 20m. S. G. U. No. 138. 100 x p. 61

Fig. 7. Angulogerina wilcoxensis Cushman & Ponton. Ystad gjuteriet 21m. S. G. U. No. 147. 100 x p. 63

Fig. 8. Pyramidina crassa n. sp. Ystad gjuteriet 20m. S. G. U. No. 143. 100 x p. 63

Fig. 9. Angulogerina europaea Cushman & Edward. Ystad gjuteriet 20m. S. G. U. No. 154. 100 x p. 64

Fig. 10. Angulogerina cuneata n. sp. Ystad gjuteriet 21m. S. G. U. No. 151. 100 x p. 64

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## Plate 7

Fig. 1. Robulus klagshamnensis n. sp. Klagshamn conglomerate. S. G. U. No. 2234. 16 x p. 41

Fig. 2. Robulus klagshamnensis, Klagshamn conglomerate. S. G. U. No. 2233. 16 x p. 41

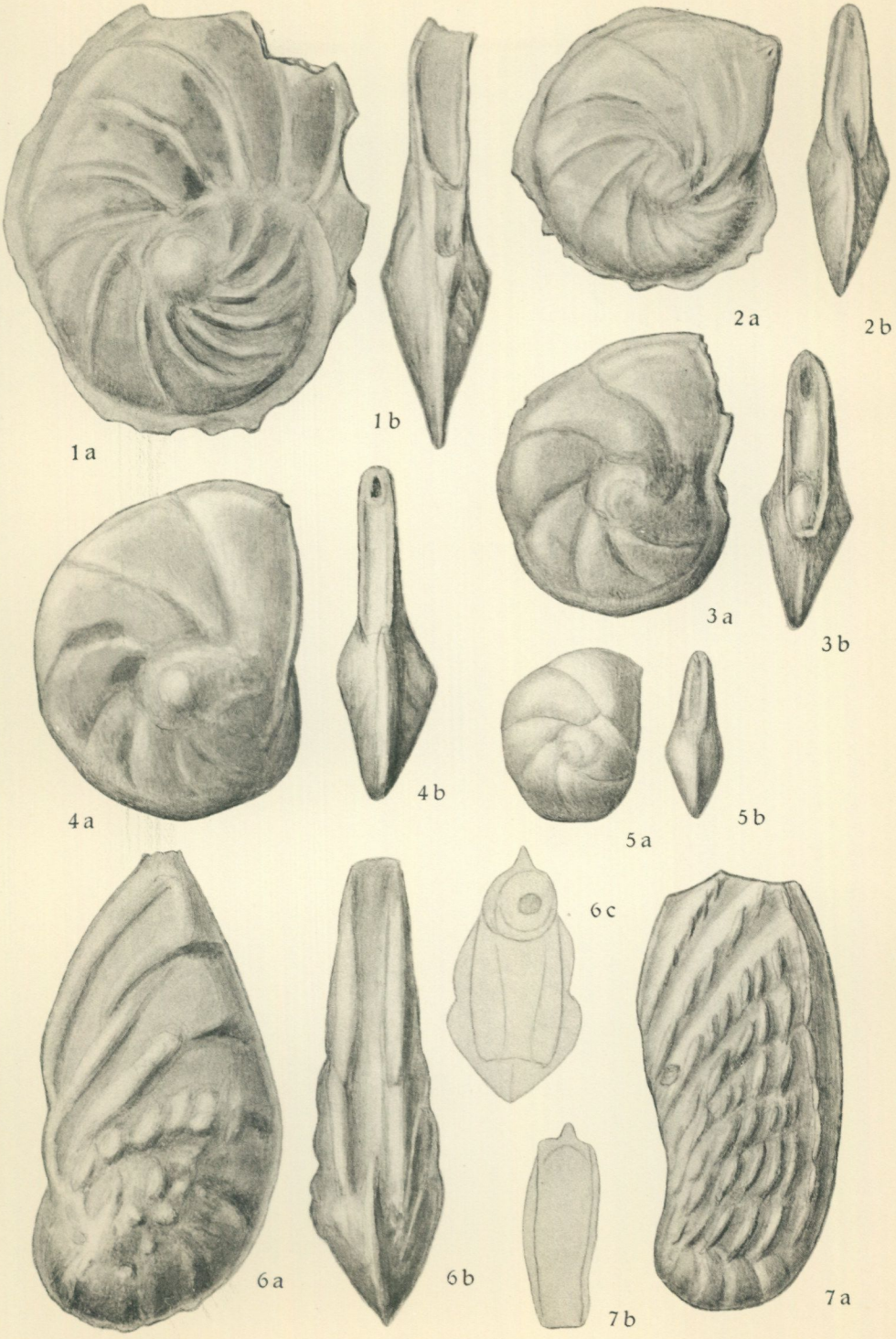
Fig. 3. Robulus discus n. sp. Klagshamn conglomerate. S. G. U. No. 2227. 16 x p. 42

Fig. 4. Robulus discus n. sp. Klagshamn conglomerate. S. G. U. No. 2226. 16 x p. 42

Fig. 5. Robulus discus n. sp. Klagshamn conglomerate. S. G. U. No. 2228. 16 x p. 42

Fig. 6. Astacolus gryi n. sp. Klagshamn conglomerate. S. G. U. No. 2239. 50 x p. 44

Fig. 7. Astacolus paleocenicus n. sp. Ystad gjuteriet 21m. S. G. U. No. 37. 25 x p. 43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## Plate 8

Fig. 1. Nonion cf. graniferum (Terquem); Ystad gjuteriet 20m. S. G. U. No. 2386. 50 x p. 69

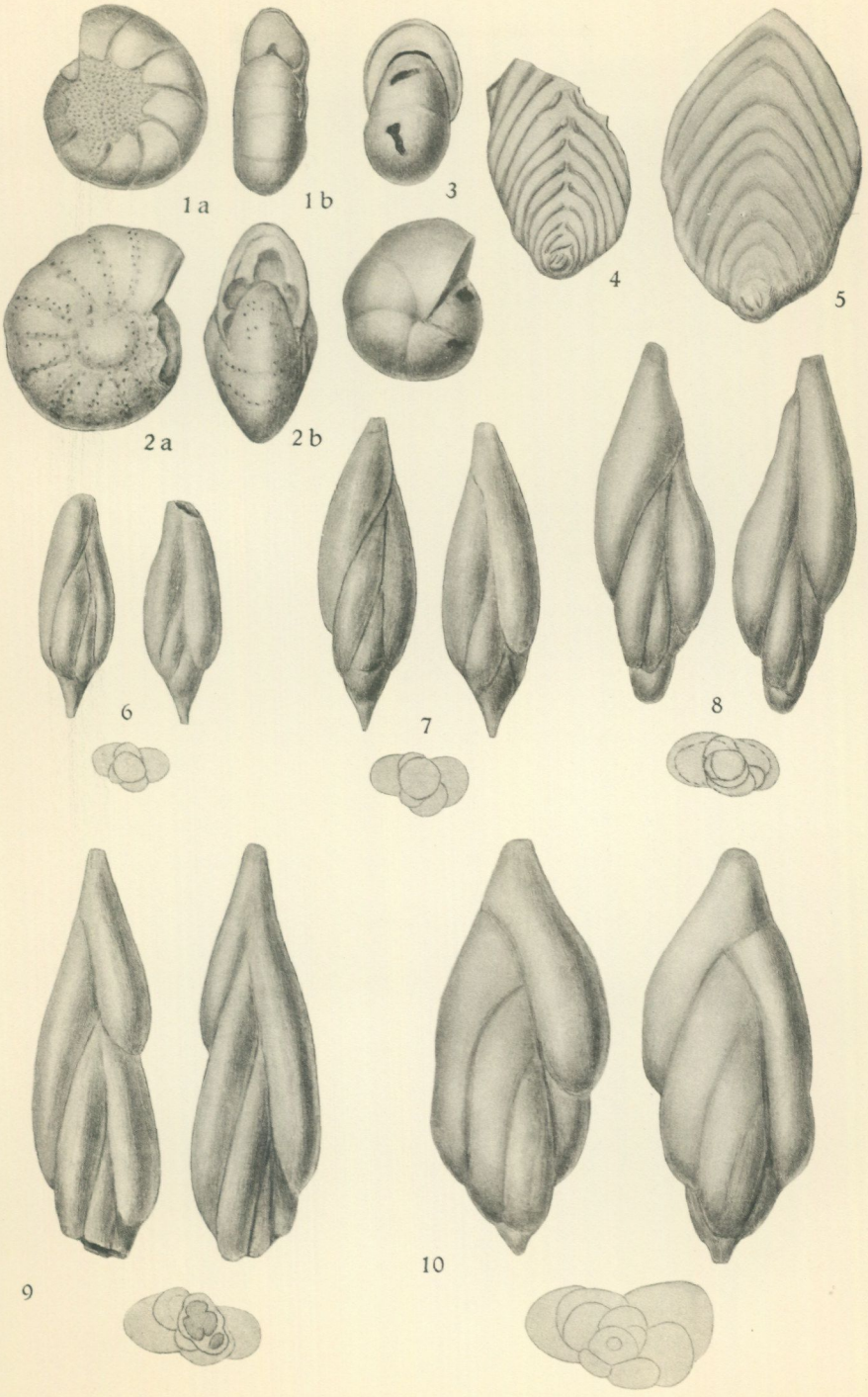
Fig. 2. Elphidiella prima (ten Dam); Ystad gjuteriet 20m. S. G. U. No. 2394. 50 x p. 70

Fig. 3. Pullenia aff. americana Cushman. Klagshamn conglomerate. S. G. U. No. 2377. 50 x p. 68

Fig. 4. Palmula robusta n. sp. Klagshamn conglomerate. S. G. U. No. 2252. 7,5 x p. 45

Fig. 5. Palmula robusta n. sp. Klagshamn conglomerate. S. G. U. No. 2249. 7,5 x p. 45

Figs. 6—10. Sigmomorphina soluta n. sp. Klagshamn conglomerate. S. G. U. No. 2300, 2301, 2302, 2303, 2306. 50 x p. 53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## Plate 9

Fig. 1. Bulimina rosenkrantzi n. sp. Ystad gjuteriet 20m. S. G. U. No. 157. 100 x p. 61

Fig. 2. Virgulina sandegreni n. sp. Ystad gjuteriet 20m. S. G. U. No. 163. 100 x p. 65

Figs. 3, 4. Bolivina ödumi n. sp. Klagshamn greensand. S. G. U. Fig. 3. No. 2357. Fig. 4. No. 2358. 100 x p. 65

Fig. 5. Bolivina paleocenica n. sp. Ystad gjuteriet 20m. S. G. U. No. 2361. 100 x p. 66

Fig. 6. Patellina sp. Ystad gjuteriet 21m. S. G. U. No. 2402. 100 x p. 71

Fig. 7. Bolivinita selmensis Cushman. Ystad gjuteriet 20m. S. G. U. No. 165. 100 x p. 56

Fig. 8. Conorbina sp. Ystad gjuteriet 21m. S. G. U. No. 2403. 100 x p. 71

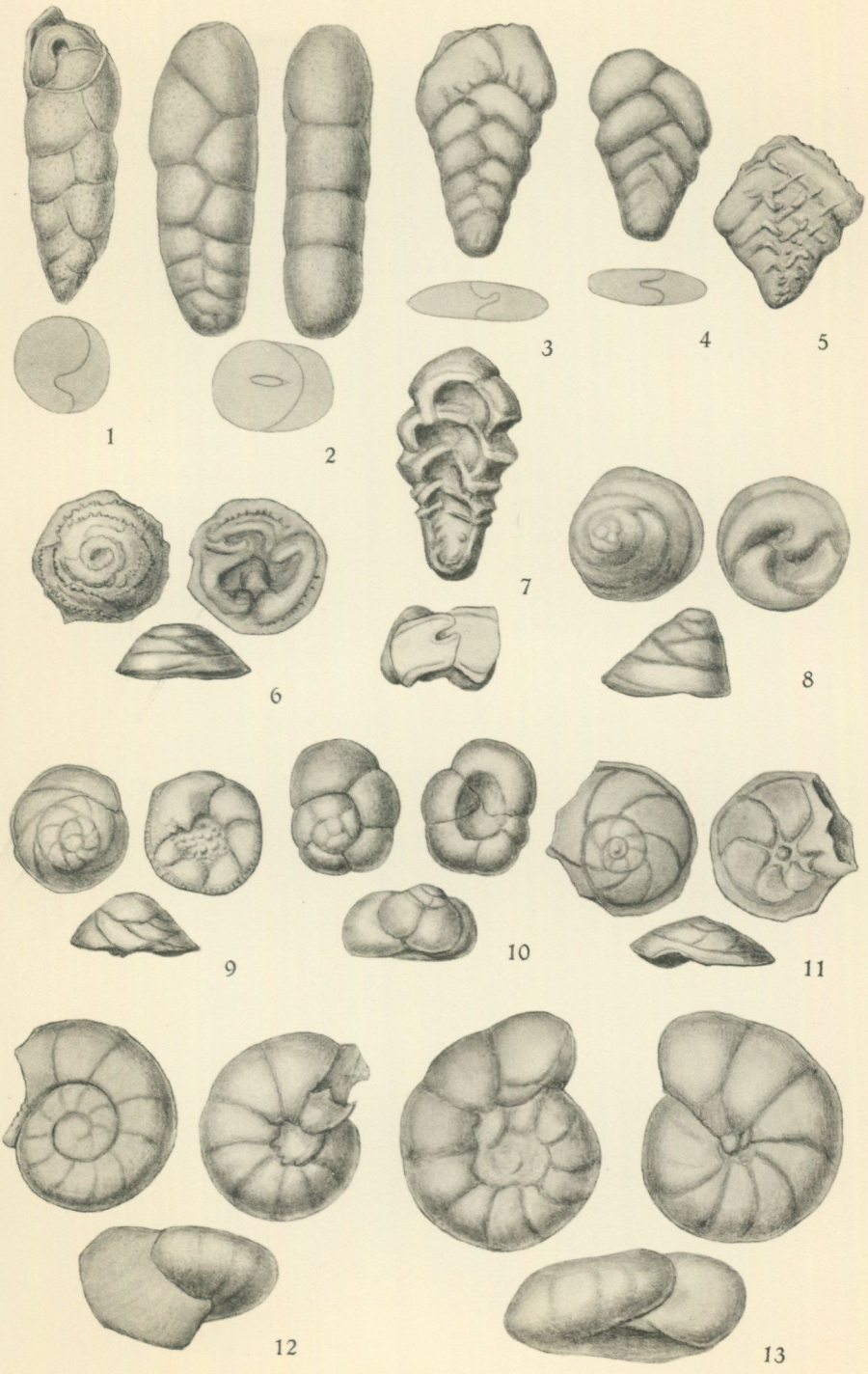
Fig. 9. Rosalina ystadiensis n. sp. Solnäs. S. G. U. No. 2410. 100 x p. 72

Fig. 10. Gavelinella (?) sp. Ystad gjuteriet 21m. S. G. U. No. 2442. 100 x p. 76

Fig. 11. Rosalina koeneni n. sp. Ystad gjuteriet 21m. S. G. U. No. 2414 100 x p. 73

Fig. 12. Valvulineria laevis Brotzen. Ystad gjuteriet 21m. S. G. U. No. 2423. 100 x p. 73

Fig. 13. Valvulineria ravni n. sp. Ystad gjuteriet 21m. S. G. U. No. 2426. 100 x p. 74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## Plate 10

Figs. 1, 2. Buliminella constrictula n. sp. Ystad gjuteriet 20m. S. G. U. Fig. 1. No. 2324. Fig. 2. No. 2325. 100 x p. 58

Figs. 3, 4. Buliminella parvula n. sp. Solnäs 9m. S. G. U. Fig. 3. No. 2318. Fig. 4. No. 2319. 100 x p. 57

Fig. 5. Bulimina rosenkrantzi n. sp. Klagshamn greensand. S. G. U. No. 2338. 100 x p. 61

Figs 6, 7. Bulimina aspero-aculeata n. sp. Solnäs. 9m. S. G. U. Fig. 6. No. 2332. Fig. 7. No. 2333. 100 x p. 60

Fig. 8. Bulimina midwayensis Cushman & Parker. Solnäs 9m. S. G. U. No. 2326. 100 xp. 58

Figs. 9, 10. Bulimina aff. ovata D'Orbigny; macro-and microspheric specimen. Solnäs 9m. S. G. U. Fig. 9. No. 2328. Fig. 10. No. 2329. 100 x p. 59

Fig. 11. Loxostoma applinae (Plummer); Solnäs 9m. S. G. U. No. 2366. 100 x p. 66

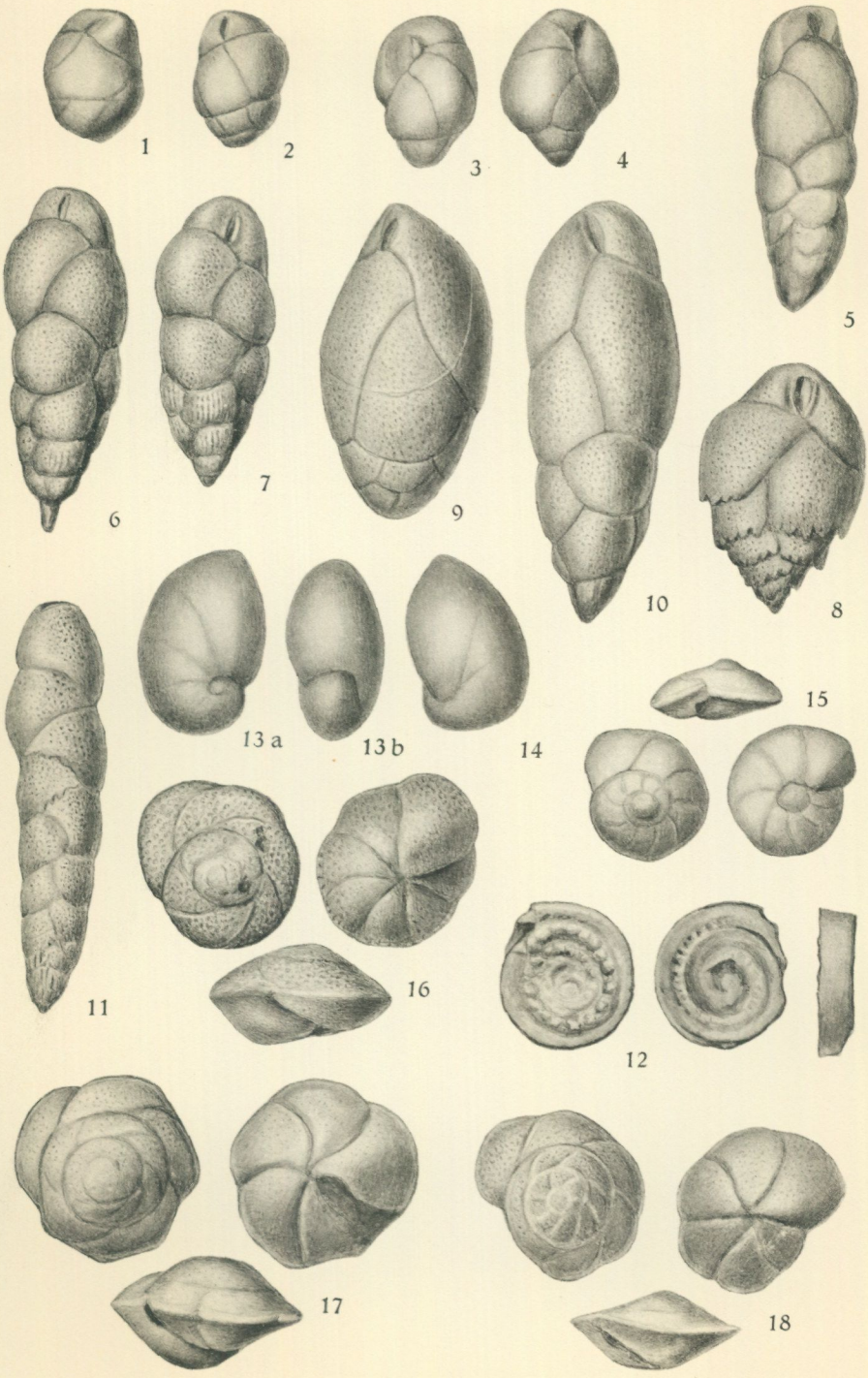
Fig. 12. Spirillina nodifera Terquem; Solnäs 9m. S. G. U. No. 2370. 100 x p. 67

Figs. 13, 14. Nonionella ovata n. sp. Klagshamn greensand. S. G. U. Fig. 13. No. 2382. Fig. 14. No. 2383. Klagshamn conglomerate. 100 x p. 68

Fig. 15. Cibicides mammillatus n. sp. Ystad gjuteriet 21m. S. G. U. No. 2505. 100 x p. 81

Fig. 16. Eponides toulmini n. sp. Klagshamn conglomerate. S. G. U. No. 2462. 100 x p. 78

Figs. 17, 18. Eponides lunata n. sp. Klagshamn greensand. S. G. U. No. 2455. Klagshamn conglomerate. S. G. U. No. 2456. 100 x p. 77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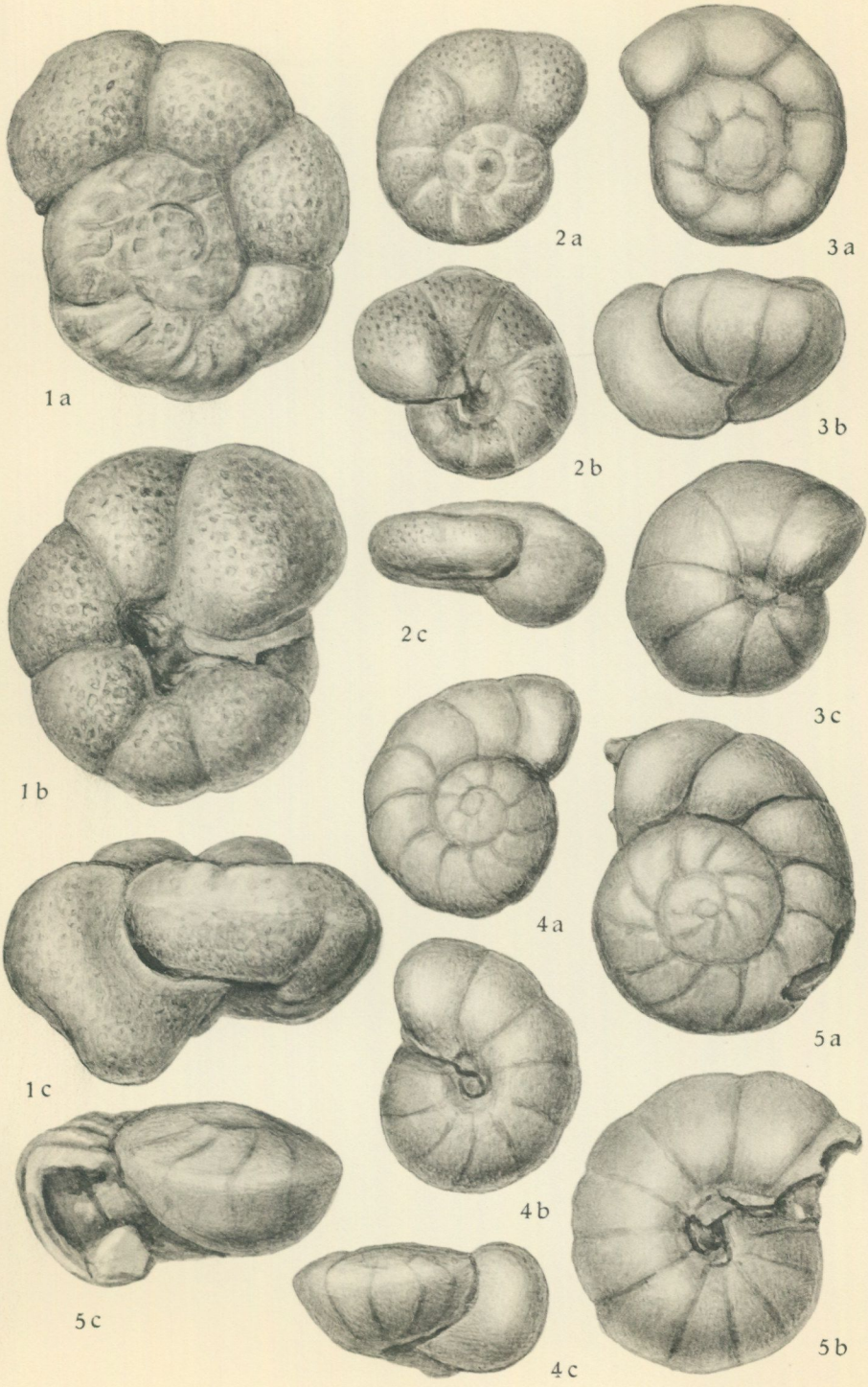
## Plate 11

Fig. 1. Gavelinella lellingensis n. sp. Lellinge Denmark, Black clay. S. G. U. No. 2435. 100 x p. 75

Fig. 2. Gavelinella lellingensis n. sp. Solnäs 9m. S. G. U. No. 2436. 100 x p. 75

Fig. 3. Gyroidinoides soldanii (D'Orbigny) var. octocamerata. Ystad gjuteriet 20m. S. G. U. No. 2443. 100 x p. 76

Figs. 4, 5. Gyroidinoides pontoni n. sp. Klagshamn conglomerate. S. G. U. Fig. 4. No. 2448. Fig. 5. No. 2449. 100 x p. 76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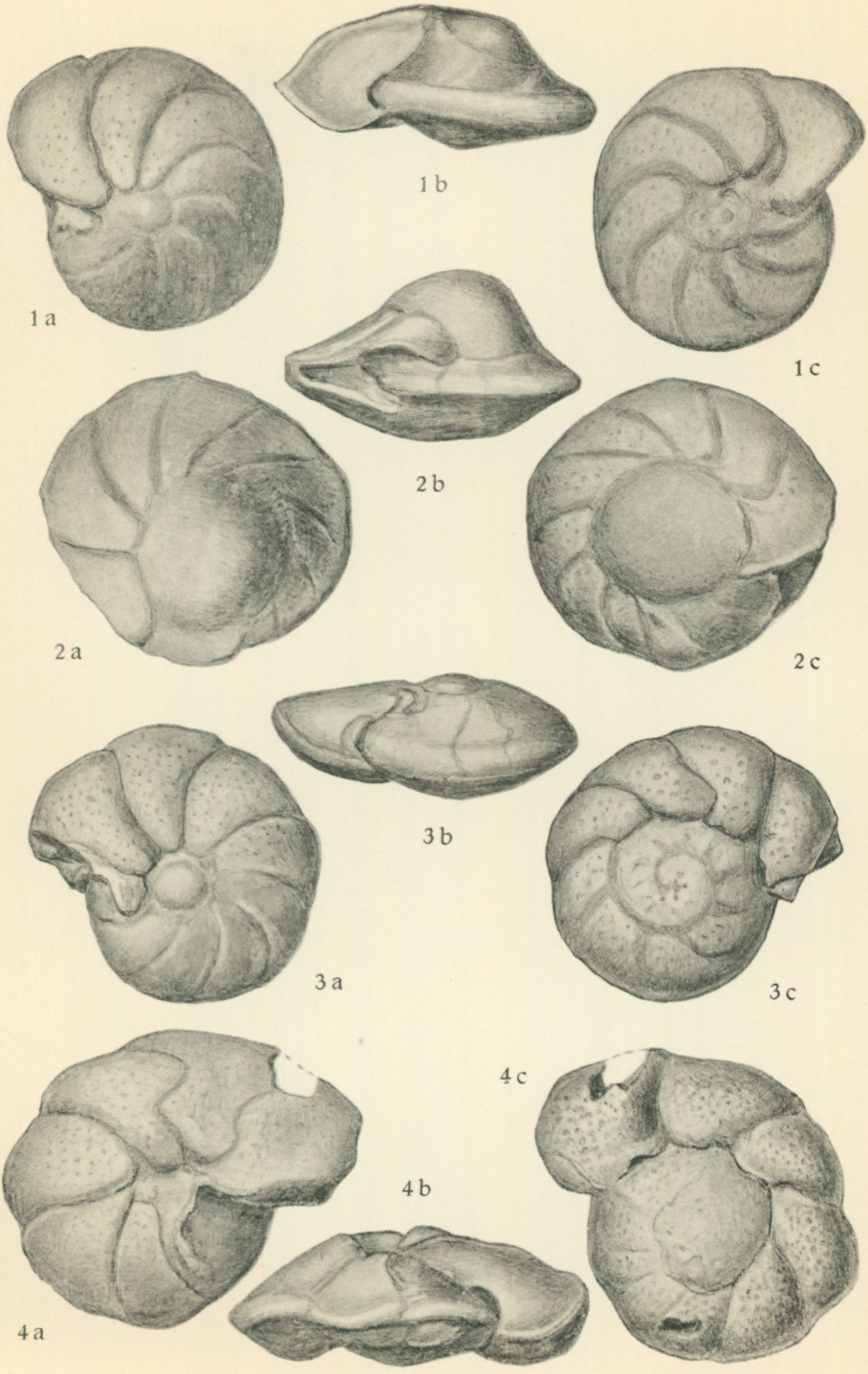
## Plate 12

Figs. 1, 2. Cibicides succedens n. sp. Ystad gjuteriet 20m. S. G. U. Fig. 1. No. 2475. Fig. 2. No. 2476. 100 x p. 80

Figs. 3, 4. Cibicidoides proprius n. sp. Ystad gjuteriet 20m. S. G. U. Fig. 3. No. 2467. Ystad gjuteriet 21m. S. G. U. Fig. 4. No. 2468. 100 x p. 78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## Plate 13

Fig. 1. Cibicides reinholdi ten Dam; Solnäs 9m. S. G. U. No. 2509. 100 x p. 82

Fig. 2. Cibicides ekblomi n. sp. Solnäs 9m. S. G. U. No. 2510. 100 x p. 82

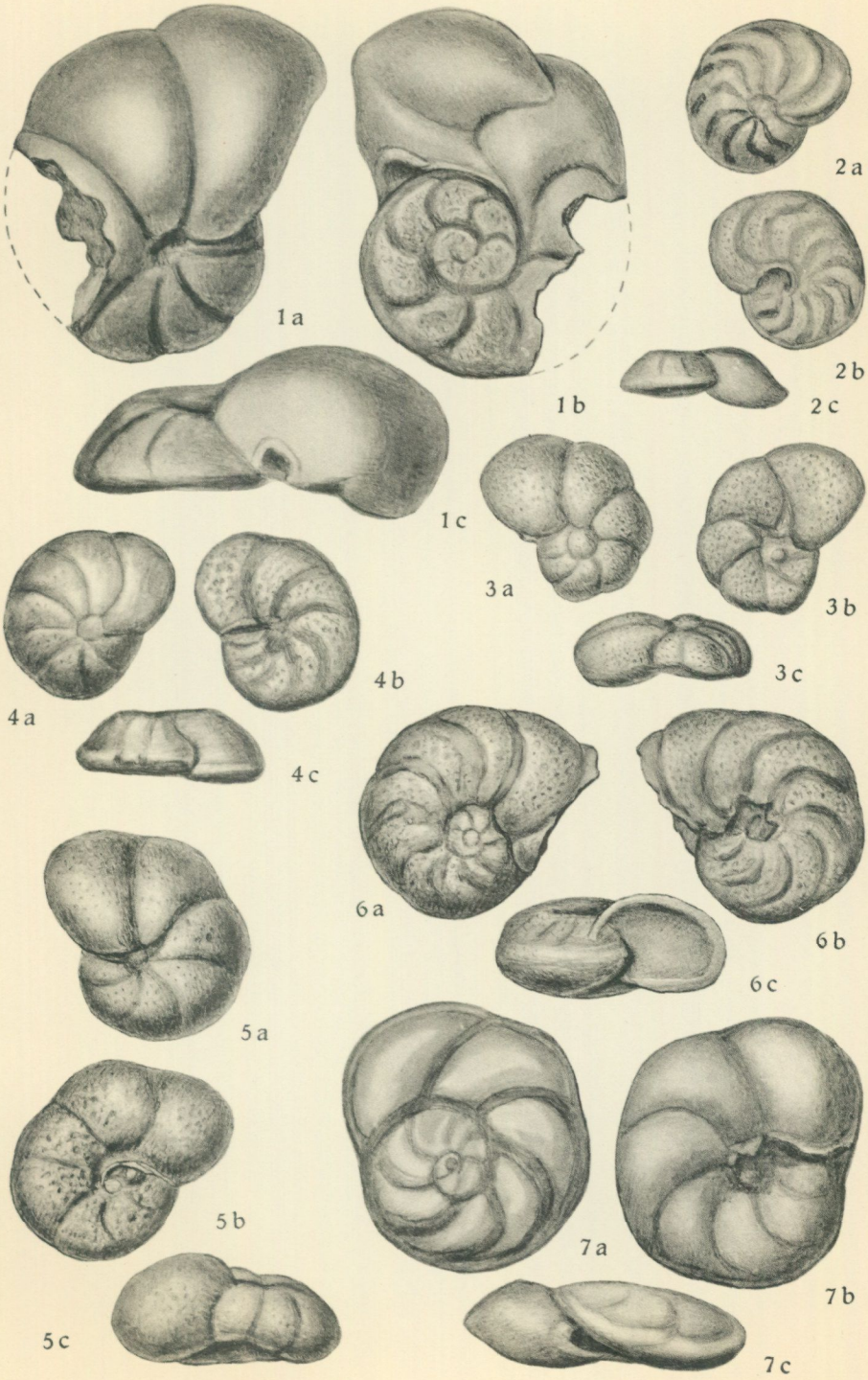
Fig. 3. Cibicides burlingtonensis Jennings Solnäs 9m. S. G. U. No. 2496. 100 x p. 84

Fig. 4. Cibicides simplex n. sp. Ystad gjuteriet 21m. 100 x p. 83

Fig. 5. Cibicides simplex n. sp. Solnäs 9m. S. G. U. No. 2488. 100 x p. 83

Fig. 6. Cibicides umbilicata n. sp. Ystad gjuteriet 21m. S. G. U. No. 2515. 100 x p. 84

Fig. 7. Planulina limbata n. sp. Ystad gjuteriet 20m. S. G. U. No. 2518. 100 x p. 85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## Plate 14

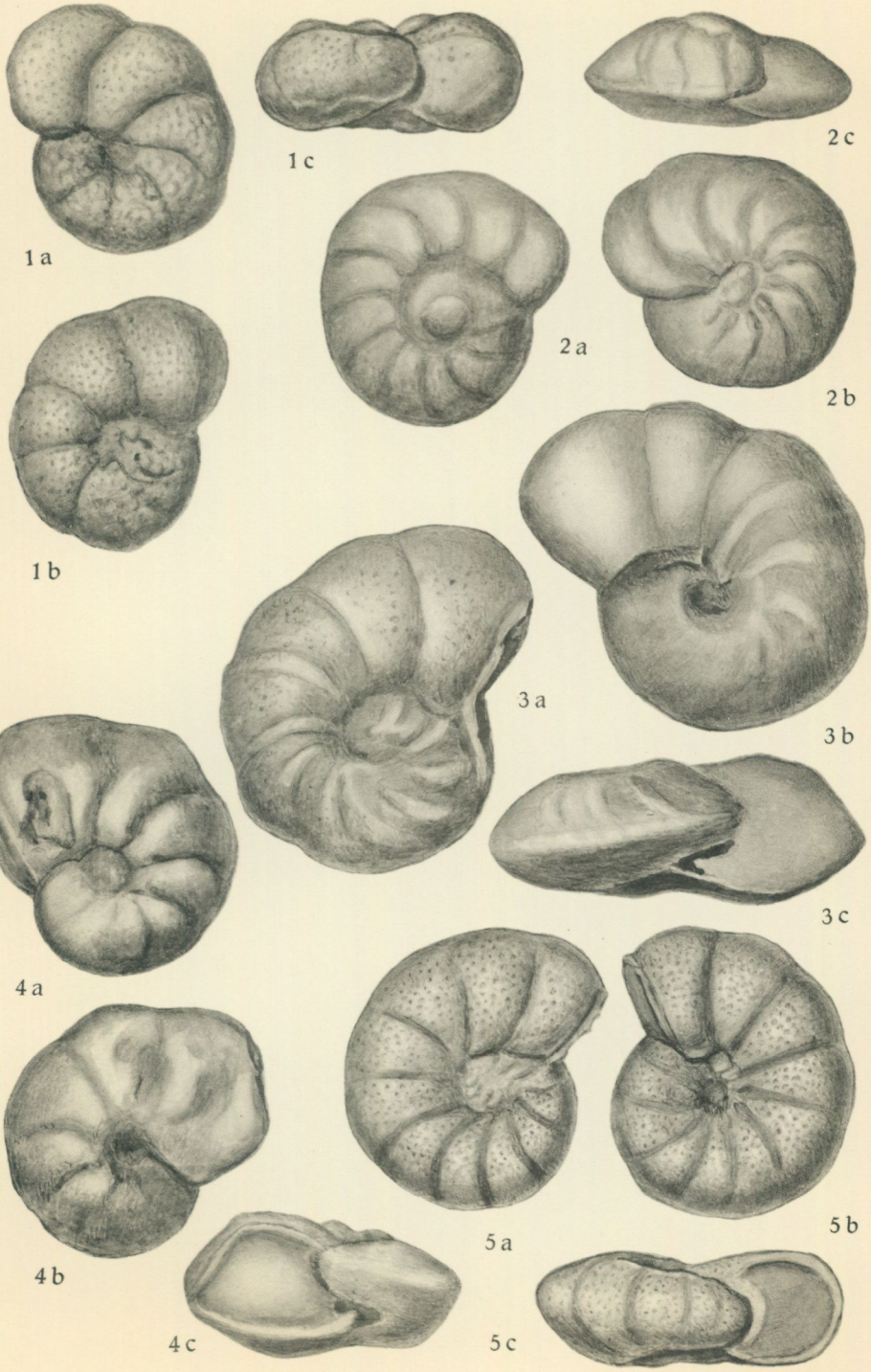
Fig. 1. Anomalinoides danica (Brotzen); Ystad gjuteriet 21m. S. G. U. No. 2522. 50 x p. 87

Fig. 2. Anomalinoides acuta (Plummer); Ystad gjuteriet 20m. S. G. U. No. 100 x p. 87

Fig. 3. Anomalinoides midwayensis (Plummer); Ystad gjuteriet 20m. S. G. U. No. 2544. 100 x p. 88

Fig. 4. Anomalinoides midwayensis. Klagshamn conglomerate. S. G. U. No. 2545. 100 x p. 88

Fig. 5. Anomalinoides nobilis n. sp. Solnäs 9m. S. G. U. No. 2546. 100 x p. 89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## Plate 15

Fig. 1. Cymbalopora sp. Klagshamn greensand. S. G. U. No. 2574. 75 x p. 91

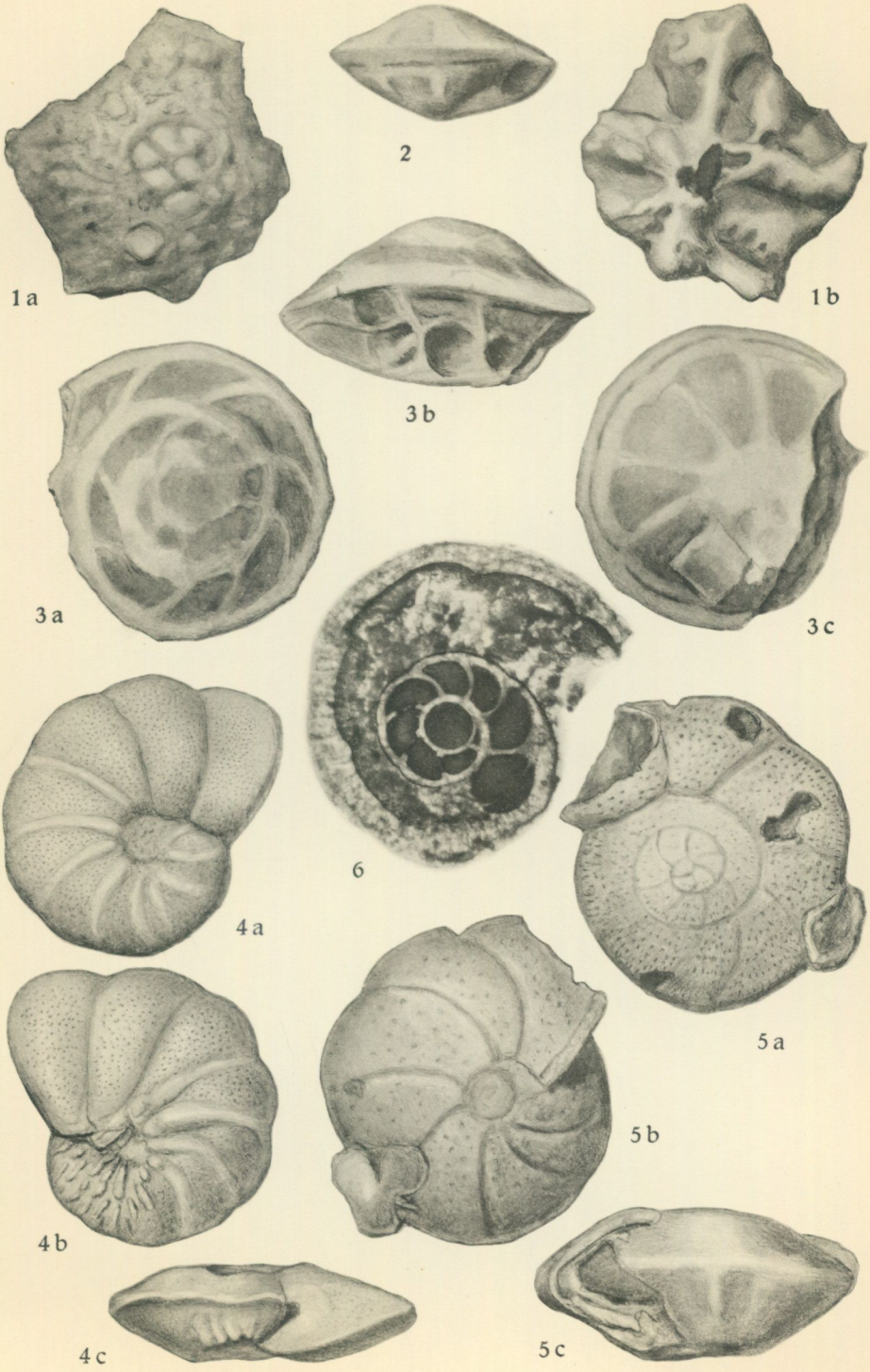
Fig. 2. Höglundina scalaris (Franke). Klagshamn greensand. S. G. U. No. 2585. 75 x p. 94

Fig. 3. Höglundina scalaris (Franke). Klagshamn greensand. S. G. U. No. 2588. 75 x p. 94

Fig. 4. Anomalinoides aspera n. sp. Ystad gjuteriet 21m. S. G. U. No. 2539. 50 x p. 88

Fig. 5. Pninaella scanica n. sp. Ystad gjuteriet 21m. S. G. U. No. 2639. 75 x p. 120

Fig. 6. Pninaella scanica n. sp. Ystad gjuteriet 21 m. Thin section. 75 x p. 120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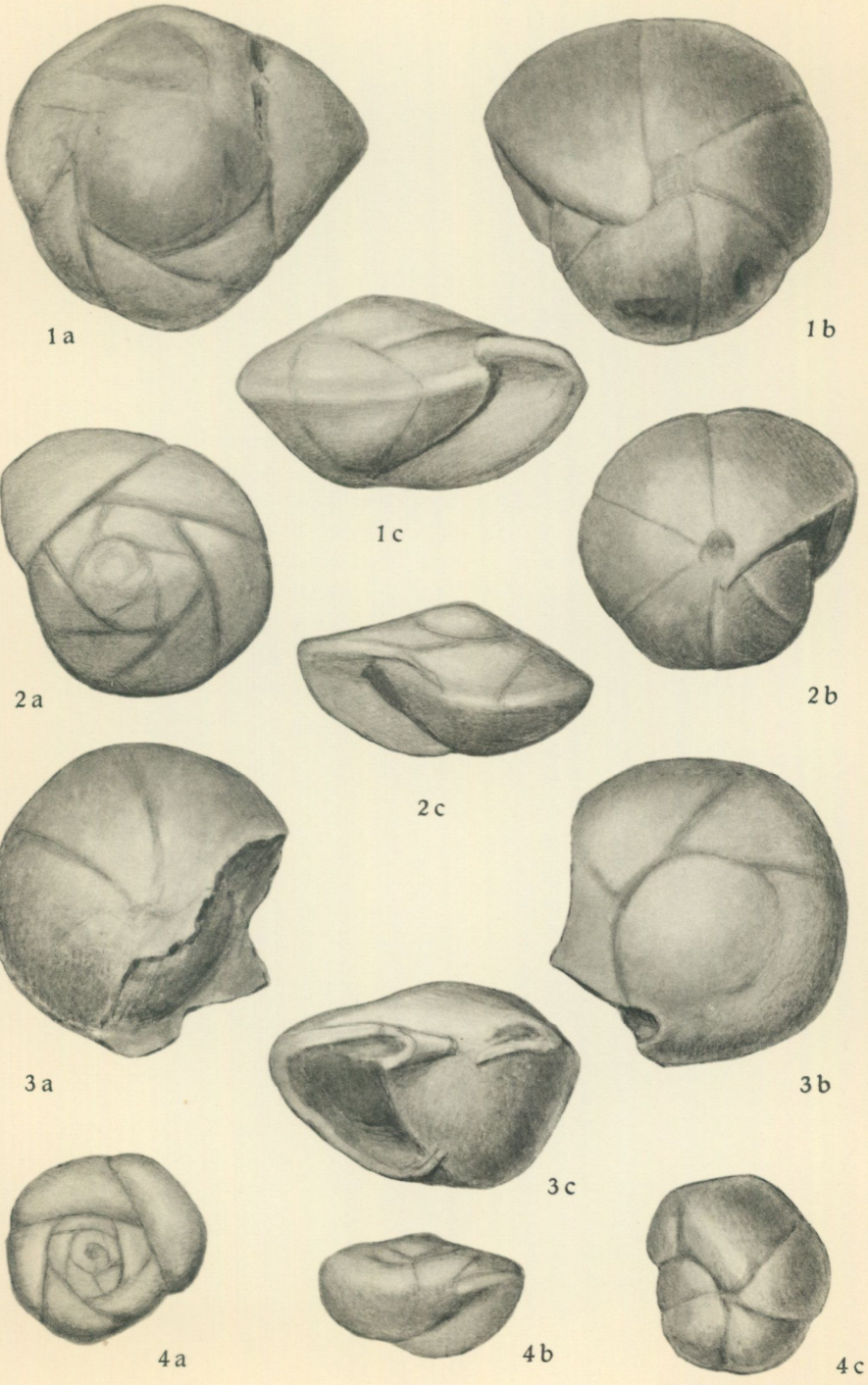
## Plate 16

Fig. 1. Alabamina midwayensis n. sp. Klagshamn conglomerate. S. G. U. No. 2598. 100 x p. 99

Fig. 2. Alabamina midwayensis n. sp. Ystadgjuteriet 20m. S. G. U. No. 2597. 100 x p. 99

Fig. 3. Alabamina dorsoplana (Brotzen). Ystad gjuteriet 20m. S. G. U. No. 2612. 100 x p. 102

Fig. 4. Alabamina solnäsensis n. sp. Solnäs 9m. S. G. U. No 2619. 100 x p. 102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## Plate 17

Fig. 1. Cibicides sahlströmi n. sp. Ystad gjuteriet 21m. S. G. U. No. 2500. 100 x p. 85

Fig. 2. Globigerina triloculinoides Plummer. Ystad gjuteriet 21m. S. G. U. No. 2555. 100 x p. 89

Fig. 3. Globorotalites lobata n. sp. Klagshamn greensand. 100 x p. 91

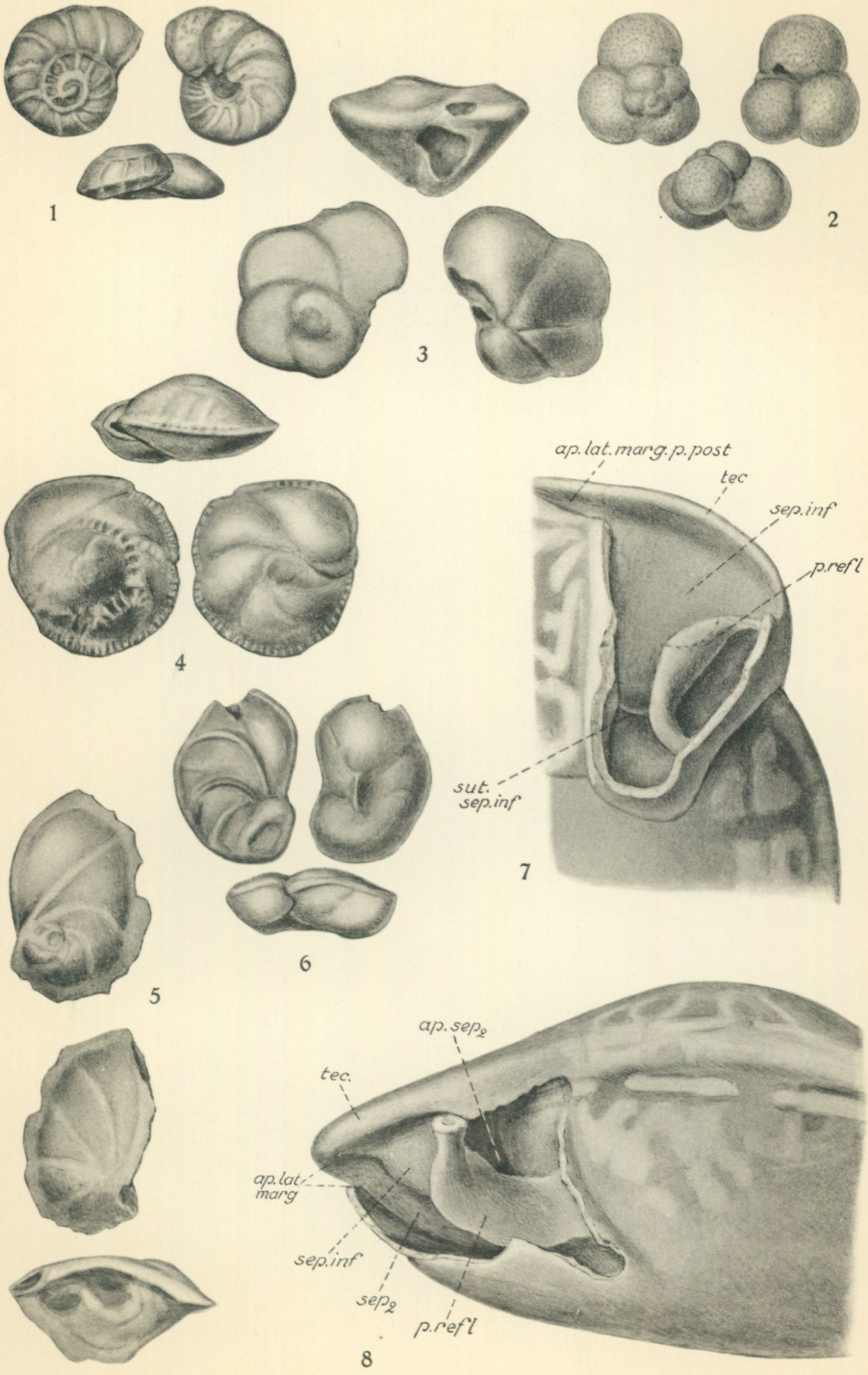
Fig. 4. Pulsiphonina elegans n. sp. Klagshamn conglomerate. S. G. U. No. 2579. 100 x p. 107

Fig. 5. Epistominoides midwayensis Plummer. Solnäs 9m. S. G. U. No. 2593. 100 x p. 96

Fig. 6. Lamarkina naheolensis Cushman & Todd. Ystad gjuteriet 20m. S. G. U. No. 2641 x p. 122

Fig. 7. Höglundina elegans Gulf of Mexico, Albatross expedition 1885. 60 x p. 92

Fig. 8. Höglundina elegans Gulf of Mexico, Albatross expedition 1885. 60 x p. 92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## Plate 18

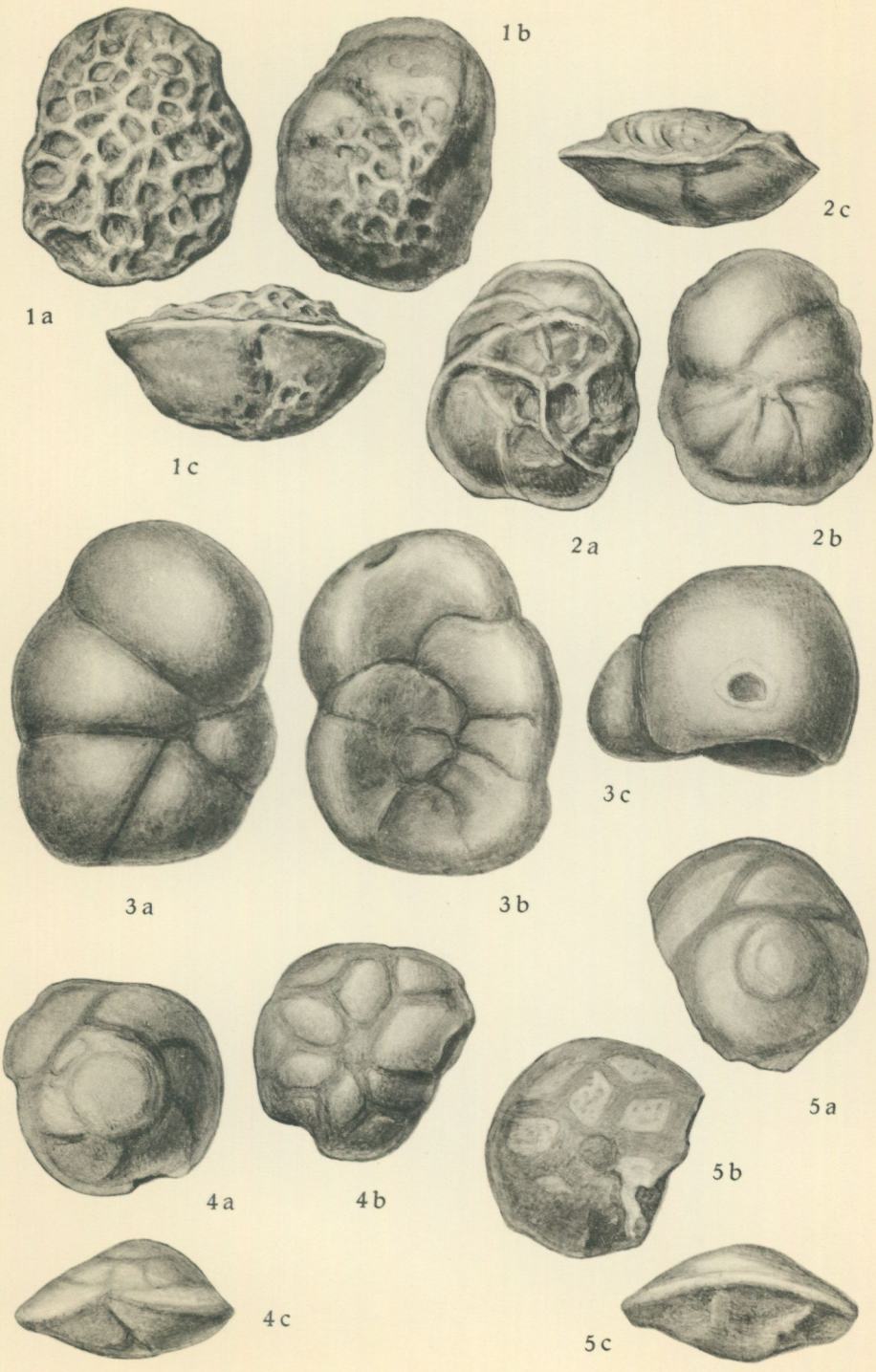
Fig. 1. Coleites reticulosus Plummer. Klagshamn conglomerate. S. G. U. No. 2622. 100 x p. 109

Fig. 2. Coleites danicus n. sp. Ystad gjuteriet 20m. S. G. U. No. 2627. 100 x p. 113

Fig. 3. Karreria fallax Rzehak; Klagshamn conglomerate. S. G. U. No. 2630. 100 x p. 114

Fig. 4. Asterigerina nörvangi n. sp. Ystad gjuteriet 21m. S. G. U. No. 2656. 100 x p. 126

Fig. 5. Asterigerina nörvangi n. sp. Ystad gjuteriet 20m. S. G. U. No. 2666. 100 x p. 126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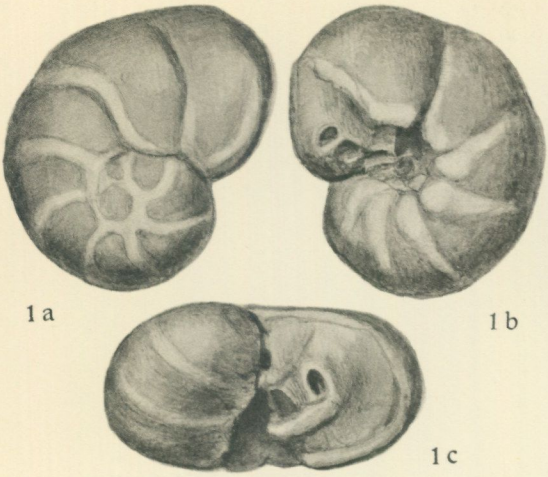
## Plate 19

Fig. 1. Ceratobulimina perplexa Plummer; Ystad gjuteriet 20m. S. G. U. No. 2647. 100 x p. 123

Fig. 2. Ceratobulimina tuberculata n. sp. Sundkrogen. S. G. U. No. 2654. 100 x p. 124

Fig. 3. Ceratobulimina tuberculata n. sp. Sundkrogen. S. G. U. No. 2655. 100 x p. 124

Fig. 4. Allomorphina halli Jennings; Solnäs 9m. S. G. U. No. 2669. 100 x p. 127



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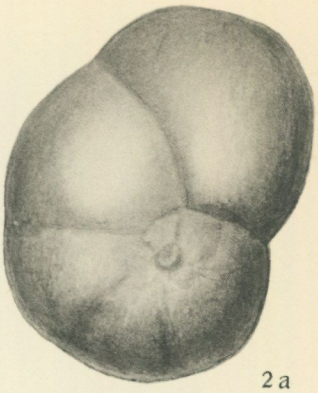

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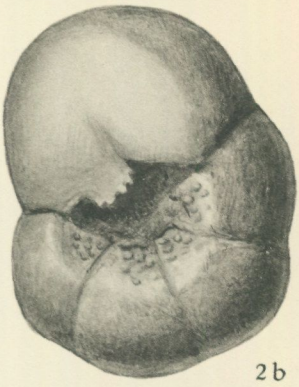

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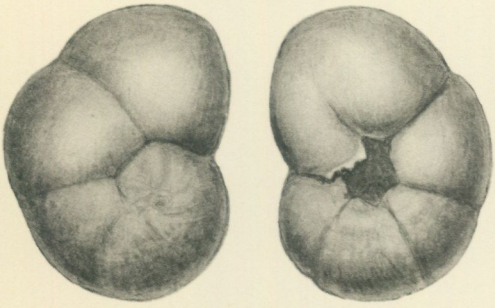

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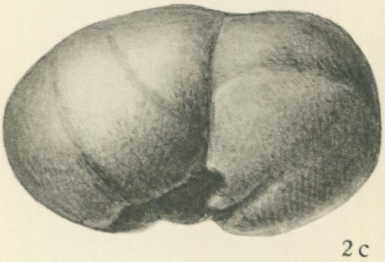

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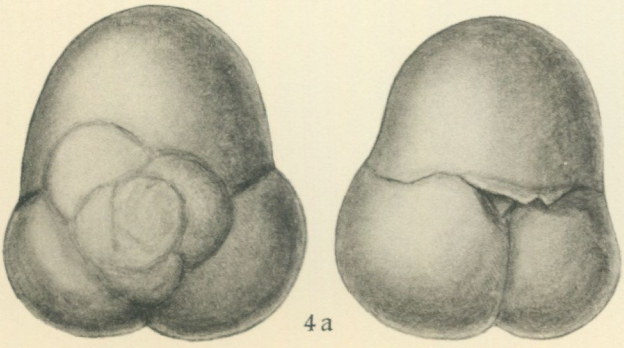

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| | Klagshamn | | Naffentorp | | Tygelsjö | | | Ystad Gjuteriet | | Maglehem | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conglomerate | Greensand | № 220 | № 187 | Solnäs 246 | Vadst 374 | G. Svensson 375 | 21 m | 20 m | № 543 | № 736 |
| *Spiroplectammina cf. laevis* | | | | | | | | | | | |
| —"— *wilcoxensis* | | | | | | | | | | | |
| *Arenobulimina cushleyae* | | | | | | | | | | | |
| —"— *mohréni* | | | | | | | | | | | |
| *Ataxophragmoides frankei* | | | | | | | | | | | |
| *Bermudeziana danica* | | | | | | | | | | | |
| *Pseudoclavulina anglica* | | | | | | | | | | | |
| *Arenaceous species* | | | | | | | | | | | |
| *Spiroloculina inflata* | | | | | | | | | | | |
| —"— *tricarinata* | | | | | | | | | | | |
| *Quinqueloculina cf. plana* | | | | | | | | | | | |
| *Triloculina inflata* | | | | | | | | | | | |
| *Lagena sp. sp.* | | | | | | | | | | | |
| *Nodosaria Dentalina* | | | | | | | | | | | |
| *Lenticulina* | | | | | | | | | | | |
| *Robulus klagshamnensis* | | | | | | | | | | | |
| —"— *discus* | | | | | | | | | | | |
| *Astacolus paleocenicus* | | | | | | | | | | | |
| —"— *greyi* | | | | | | | | | | | |
| *Citharina plummoides* | | | | | | | | | | | |
| *Palmula robusta* | | | | | | | | | | | |
| *Globulina gibba* | | | | | | | | | | | |
| —"— *inaequalis* | | | | | | | | | | | |
| —"— *ampulla* | | | | | | | | | | | |
| —"— *rotundata* | | | | | | | | | | | |
| —"— *lacrima* | | | | | | | | | | | |
| —"— *arenacea* | | | | | | | | | | | |
| *Pyrulina thouini* | | | | | | | | | | | |
| —"— *fusiformis* | | | | | | | | | | | |
| *Guttulina communis* | | | | | | | | | | | |
| —"— *problema* | | | | | | | | | | | |
| —"— *costata* | | | | | | | | | | | |
| —"— *hantkeni* | | | | | | | | | | | |
| —"— *lactea* | | | | | | | | | | | |
| —"— *roemeri* | | | | | | | | | | | |
| —"— *spicaeformis* | | | | | | | | | | | |
| —"— *sp.* | | | | | | | | | | | |
| *Pseudopolymorphina paleocenica* | | | | | | | | | | | |
| —"— *geijeri* | | | | | | | | | | | |
| *Sigmomorphina soluta* | | | | | | | | | | | |
| —"— *pseudoregularis* | | | | | | | | | | | |
| *Bolivinopsis scanica* | | | | | | | | | | | |
| *Gümbelina cf. globulosa* | | | | | | | | | | | |
| *Bolivinita selmensis* | | | | | | | | | | | |
| *Buliminella parvula* | | | | | | | | | | | |
| —"— *constrictula* | | | | | | | | | | | |
| *Bulimina midwayensis* | | | | | | | | | | | |
| —"— *ovata* | | | | | | | | | | | |
| *aspero-aculeata* | | | | | | | | | | | |
| —"— *rosenkrantzi* | | | | | | | | | | | |
| —"— *paleocenica* | | | | | | | | | | | |
| *Pyramidina crassa* | | | | | | | | | | | |
| *Angulogerina wilcoxensis* | | | | | | | | | | | |
| —"— *cuneata* | | | | | | | | | | | |
| —"— *europaea* | | | | | | | | | | | |
| *Virgulina sandegreni* | | | | | | | | | | | |
| *Bolivina ödumi* | | | | | | | | | | | |
| —"— *paleocenica* | | | | | | | | | | | |
| *Loxostoma applinae* | | | | | | | | | | | |
| *Spirillina nodifera* | | | | | | | | | | | |
| —"— *vivipara* | | | | | | | | | | | |
| —"— *recta* | | | | | | | | | | | |
| *Pullenia aff. americana* | | | | | | | | | | | |
| *Nonionella ovata* | | | | | | | | | | | |
| *Nonion cf. graniferum* | | | | | | | | | | | |
| *Elphidiella prima* | | | | | | | | | | | |
| *Patellina sp.* | | | | | | | | | | | |
| *Conorbina sp.* | | | | | | | | | | | |
| *Rosalina ystadiensis* | | | | | | | | | | | |
| —"— *koeneni* | | | | | | | | | | | |
| *Valvulineria laevis* | | | | | | | | | | | |
| *ravni* | | | | | | | | | | | |
| *Gavelinella bullata* | | | | | | | | | | | |
| —"— *lellingensis* | | | | | | | | | | | |
| —"— *sp.* | | | | | | | | | | | |
| *Gyroidinoides soldani v. octocamerata* | | | | | | | | | | | |
| —"— *pontoni* | | | | | | | | | | | |
| *Eponides lunata* | | | | | | | | | | | |
| —"— *toulmini* | | | | | | | | | | | |
| *Cibicidoides proprius* | | | | | | | | | | | |
| *Cibicides succedens* | | | | | | | | | | | |
| —"— *mammillatus* | | | | | | | | | | | |
| —"— *reinholdi* | | | | | | | | | | | |
| —"— *eklömi* | | | | | | | | | | | |
| —"— *simplex* | | | | | | | | | | | |
| —"— *burlingtonensis* | | | | | | | | | | | |
| —"— *umbilicata* | | | | | | | | | | | |
| *Cibicides sahlströmi* | | | | | | | | | | | |
| —"— *sp.* | | | | | | | | | | | |
| *Planulina limbata* | | | | | | | | | | | |
| *Anomalinoides danica* | | | | | | | | | | | |
| —"— *acuta* | | | | | | | | | | | |
| —"— *aspera* | | | | | | | | | | | |
| —"— *midwayensis* | | | | | | | | | | | |
| —"— *nobilis* | | | | | | | | | | | |
| *Globigerina triloculinoides* | | | | | | | | | | | |
| —"— *compressa* | | | | | | | | | | | |
| —"— *pseudo-bulloides* | | | | | | | | | | | |
| *Globigerinella aspera* | | | | | | | | | | | |
| *Globigerinoides sp.* | | | | | | | | | | | |
| *Globorotalites lobata* | | | | | | | | | | | |
| *Höglundina scalaris* | | | | | | | | | | | |
| *Epistominoides midwayensis* | | | | | | | | | | | |
| *Alabamina* —"— | | | | | | | | | | | |
| —"— *dorsoplana* | | | | | | | | | | | |
| —"— *solnäsensis* | | | | | | | | | | | |
| *Parrella incisa* | | | | | | | | | | | |
| *Pulsiphonina elegans* | | | | | | | | | | | |
| *Coleites reticulosus* | | | | | | | | | | | |
| —"— *danica* | | | | | | | | | | | |
| *Karreria fallax* | | | | | | | | | | | |
| *Pninaella scanicus* | | | | | | | | | | | |
| *Lamarckina naheolensis* | | | | | | | | | | | |
| *Caratobulimina perplexa* | | | | | | | | | | | |
| —"— *tuberculata* | | | | | | | | | | | |
| *Asterigerina nörvangi* | | | | | | | | | | | |
| *Allomorphina halli* | | | | | | | | | | | |

per mille
> 300
> 200
> 100
> 50
> 25
> 10
> 5
> 1

+ Single specimens in the entire sample

**Table I**

*Frequency of Foraminiferal Species in the Swedish Paleocene*

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