MONOGRAPH ON THE FORAMINIFERA OF THE TYPE-LOCALITY OF THE MAESTRICHTIAN

(SOUTH-LIMBURG, NETHERLANDS)

BY

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(With plate 1—16).

CONTENTS.

CHAPTER III.

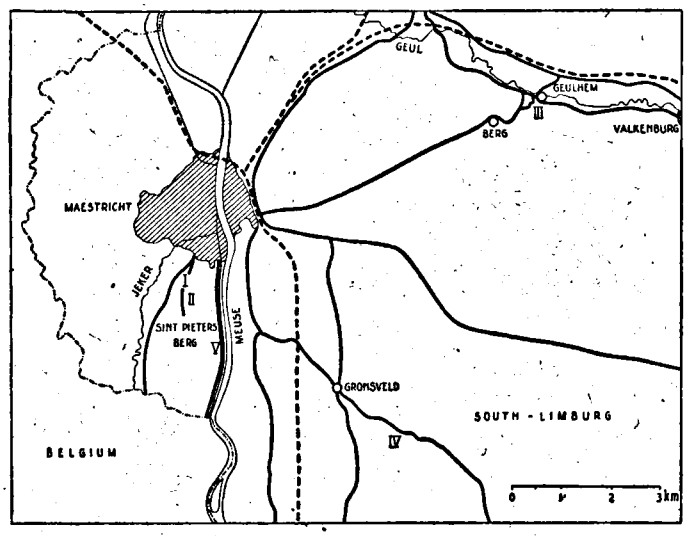
INTRODUCTION.

The description of the Foraminifera of the type-locality of the Maestrichtian and its stratigraphical value is the object of this thesis.

This type-locality is found in the Southern part of the Dutch province of Limburg.

South of Maestricht from which the name Maestrichtian is derived, lies the Sint Pietersberg where the finest outcrops of the zone examined are to be found (see the adjacent map). Thirty-five samples in all were taken out of two outcrops of the Sint Pietersberg (I and II).

For comparison I took 18 samples out of a quarry near Geulhem (III),



Map of the South West part of the Dutch province of Limburg.

because on the other bank of the Meuse many outcrops of the Maestrichtian are to be found as well.

During the research on the samples mentioned above it appeared that only the younger part of the Maestrichtian occurred in these samples. Of the older part another 17 samples were examined out of an outcrop near Gronsveld (IV) and 3 samples out of a third outcrop of the Sint Pietersberg (V).

The Dutch Maestrichtian appeared to possess a foraminiferal-fauna which was both rich in species and in specimens. The entire fauna consists of 137 species, 10 of which are new ones. The descriptions of these species are found in Chapter II.

For the stratigraphical research a range-chart was composed (plate 12 as far and including plate 15) of each section. Of a number of characteristic forms of each section the percentage-numbers were calculated, which were combined in a diagram (plate 16). For this purpose I counted about 30 000 specimens. The conclusion I arrived at as a result of this statistical research will be found in Chapter III.

The fact that this research could be published in the present form, I owe to several people. I thereby wish to acknowledge my great debt of gratitude to them all.

The Managing Board of the "Eerste Nederlandse Cement Industrie" at Maestricht supplied the necessary financial support.

Mrs. Dr. W. A. E. MINIS—VAN DE GEYN, keeper of the "Natuurhistorisch Museum" at Maestricht pointed out to me the outcrops where I might collect the best samples. During my research she always assisted me by word and deed.

Dr. J. H. VAN VOORTHUYZEN, geologist at the "Geologische Stichting" at Haarlem, placed material at my disposal and always offered me hospitality at the laboratory of the Stichting, whenever I wanted to compare my finds with the species there.

Dr. J. HOFKER, teacher at the Hague, very kindly put his manuscript at my disposal in which he treated a number of Cretaceous Foraminifera from Holland.

Mrs. W. H. VAN DAM—NEDERHOED kindly helped me with the translation of this publication into English. She corrected the part translated by myself and translated the remaining part. I shall not easily forget the many hours spent in her hospitable house.

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Miss COR ROEST attended to the drawings with a patience and application which evoked my sincerest admiration.

Mr. W. F. TEGELAAR took all the photographs with the greatest care, so that even of the badly-preserved material the scientifically necessary features remained visible.

But for Mr. L. P. BIENFAIT, my husband-to-be, this thesis would never have been written. Whether he rendered a service to science or not, time will show. I am indebted to him for three years happy student-life, for which I wish to give him every credit.

CHAPTER I.

WORKING-METHOD.

§ 1. The material.

The material examined originates from five sections.

Section I: Ten samples taken out of the pit under the fortress of Sint Pieter on the St. Pietersberg. These samples were taken by Mr. C. KRUIT out of every layer differing from the soft marl which is generally found on the St. Pietersberg, as shown in the following table:

No:	Depth:	Short description:
K 1	5,00 m.	light-yellow fossil waste-bed
K 2	6,55 m.	the same
K 3	7,55 m.	the same
K 4	8,15 m.	light-yellow *Bryozoa*-bed
K 5	9,05 m.	somewhat darker yellow *Bryozoa*-bed
K 6	10,65 m.	light-yellow *Bryozoa*-bed
K 7	11,90 m.	very hard white *Bryozoa*-bed
K 8	12,65 m.	hard dark-yellow *Bryozoa*-bed
K 9	13,20 m.	the same
K 10	17,50 m.	yellow *Echinida*-breccia-bed.

Section II: twenty-five samples, taken out of the so-called Burgerwacht-quarry. These, taken by myself, were in each case at about the same distance (80 cm) from each other, and I paid special attention to the peculiarities of the layers from which the samples were taken, as shown in the following table:

No:	Depth:	Short description:
B 25	1,00 m.	light-yellow soft marl
B 24	1,80 m.	rather hard light-yellow marl
B 23	2,60 m.	nearly white hard *Bryozoa*-bed
B 22	3,40 m.	light-yellow rather soft marl
B 21	4,20 m.	the same
B 20	5,00 m.	yellow rather soft marl
B 19	5,80 m.	the same
B 18	6,60 m.	yellow harder marl
B 17	7,40 m.	yellow rather soft marl
B 16	8,20 m.	somewhat darker yellow fossil-waste-bed
B 15	9,00 m.	the same
B 14	9,80 m.	yellow rather soft marl
B 13	10,60 m.	very light-yellow hard *Bryozoa*-bed
B 12	11,40 m.	the same

No:	Depth:	Short description:
B 11	12,20 m.	light-yellow fossil-waste-bed
B 10	13,00 m.	light-yellow soft marl
B 9	13,80 m.	the same
B 8	14,60 m.	the same
B 7	15,40 m.	the same
B 6	16,20 m.	the same
B 5	17,00 m.	light-yellow fossil-waste-bed
B 4	17,80 m.	the same
B 3	18,60 m.	very light-yellow fossil-waste-bed
B 2	19,40 m.	the same
B 1	20,20 m.	the same.

Section III: eighteen samples from the outcrop in the Geulvalley near Geulhem on the south-side of the path Valkenburg—Geulhem on the turning to Berg. These samples were taken by myself in the same way as described in section II as shown in the following table:

No:	Depth:	Short description:
G 18	1,00 m.	yellow soft marl
G 17	1,80 m.	the same
G 16	2,60 m.	the same
G 15	3,40 m.	the same
G 14	4,20 m.	the same
G 13	5,00 m.	light-yellow soft marl
G 12	5,80 m.	yellow soft marl
G 11	6,60 m.	yellow hard *Bryozoa*-bed
G 10	7,40 m.	yellow hard marl
G 9	8,20 m.	yellow soft marl
G 8	9,00 m.	yellow very soft marl
G 7	9,80 m.	the same
G 6	10,60 m.	yellow hard *Bryozoa*-bed
G 5	11,40 m.	yellow very soft marl
G 4	12,20 m.	the same
G 3	13,00 m.	the same
G 2	13,80 m.	yellow harder marl
G 1	14,60 m.	yellow soft marl.

Section IV: seventeen samples from the outcrop in the Savelsbos in the parish of Gronsveld. These samples were taken by Mr. H. J. JONKER and Mr. K. L. DE VRIES. They were handed over to me by the "Geologische Stichting" at Haarlem. Twenty-nine samples in all were taken from this section; so that the distances between the different samples should agree with those mentioned previously, I made a choice from these twenty-nine as shown in the following table:

No:	Depth:	Short description:
S 29	0,25 m.	hard light-yellow *Bryozoa*-bed
S 28	0,50 m.	light-yellow soft marl
S 27	1,00 m.	the same
S 25	1,50 m.	the same
S 22	2,50 m.	yellow hard fossil-bed

No:	Depth:	Short description:
S 20	3,25 m.	light-yellow fine marl with flints
S 18	4,25 m.	the same with many flints
S 16	5,25 m.	the same with flints
S 14	6,25 m.	the same with flints
S 12	7,00 m.	the same with flints
S 10	7,75 m.	the same with a great many flints
S 9	8,25 m.	the same with many flints
S 7	9,00 m.	light-yellow fine marl
S 5	10,00 m.	light-yellow fine marl with flints
S 4	10,25 m.	the same with flints
S 2	10,50 m.	the same with flints
S 1	11,10 m.	light-yellow fine marl.

Section V: three samples out of the coprolite-bed of Slavante (St. Pietersberg). These samples were in the "Rijksmuseum van Geologie en Mineralogie" at Leiden. The *Foraminifera* had already been extracted. FRANCKEN (1947) has given the following description of the layer in which the *Foraminifera* were found: "a thin, discontinuous, soft, greenish-brown fossiliferous bed, never more than 0,20 m thick. Locally it divides, and then the intercalation of granular limestone brings the total thickness of the "Coprolite horizon" to 3,5 m. Besides the characteristic Coprolites it contains a fairly large number of glauconite grains and numerous specimens of a small *Brachiopod, Thecideum pappilatum.* The glauconite and these *Brachiopods* may be more conspicuous than the Coprolites."

Of these three samples 17433 is out of the layer just under the coprolite-bed, 17434 and 17435 are both out of the layer just above this bed.

§ 2. Preparing material.

Of every sample a handful was taken. When the sample came from a hard layer of marl it was first crushed in a mortar. It was boiled with a saturated solution of Na_2SO_4 (this method is minutely described by WICHER (1942)). After pouring off the water and after cooling off, part of the rock alway disintegrated further. This process generally had to be repeated a few times before the rock had fallen apart sufficiently to be washed.

A method of disintegrating the rock by means of H_2O_2 (described by HILTERMANN (1947)) gave too little result to be successfully applied.

When the sample came from a softer layer an hour's soft boiling was sufficient. Samples from soft marls such as those from Gronsveld (section IV) had sufficiently disintegrated to be washed after 24 hours' staying in water.

For the washing four nested sieves were used with diameters of 2,0 mm, 0,5 mm, 0,24 mm and 0,075 mm. After prolonged washing with plenty of cold water the residue was dried on the sieves in an oven of about 60° for about four hours.

The coarsest residue contained only a few large *Lepidorbitoides* or *Siderolites.*

The three other residues were examined in the following way: three spreadings of each put on a metal plate of 7½ to 5½ cm were completely extracted. This means that of each sample the same quantity of rock was

examined, so that the number of *Foraminifera* can be taken as a norm of the percentage.

The method to separate the *Foraminifera* from the rock by means of heavy liquids (bromoform or carbontetrachloride) had no effect on this material as most specimens were filled up.

The samples from Slavante which were already extracted formed an exception. I always took about 300 specimens because this number corresponded with the average number of *Foraminifera* in the other samples.

The numbers of all species were counted and finally tabulated (plate 12—15).

§ 3. Drawing.

A drawing was made of each species, if necessary from various views. Photographs were made of the horizontal and vertical sections of the *Orbitoididae* and some other forms. In order to get an idea of the differences in size between the forms all species, magnified 50 times with the help of a drawing-prism, were put on paper in outline only. Miss COR ROEST afterwards finished the figures under my personal supervision.

As the material was badly preserved different specimens had often to be taken for the different views.

To get a good figure of the new species some paratypes have often been necessary besides the topotype.

§ 4. Literature.

a. On the Limburg area.

The *Foraminifera* of the Maestricht Chalk have been mentioned and described by various writers.

FAUJAS ST. FOND (1799) is the first to mention *Foraminifera* out of the Limburg Cretaceous, namely *Lepidorbitoides minor, Orbitoides apiculata* and *Siderolites calcitrapoides.* He does not yet recognize them as *Foraminifera* and classes them with the *Polyps,* as LAMARCK points out. The first two forms are called *numismale,* the last has retained its name.

In 1851 VON HAGENOW mentions two *Bryozoa* in the appendix of his work on the South-Limburg Cretaceous *Bryozoa,* of which he does not at that time know the exact place in the phylum of the *Bryozoa.* These are *Orbitolites macropora* (later *Omphalocyclus macropora*) and *Cymbalopora radiata.* Both afterwards prove to be *Foraminifera.*

REUSS (1862) describes 43 species of *Foraminifera* out of the Maestricht Chalk, 16 of which he found in Limburg alone up to that time. I myself found 23 of these species described by REUSS. The great difference in number may in my opinion be partly explained by the fact that REUSS gave different names to one and the same species. Moreover he did not give a figure of every species described, which hampers a correct determination. Besides the description and one or two figures REUSS stated of every species whether it was rare, common or abundant. No localities are given, so that his publication from a stratigraphical point of view is of little value.

UBAGHS (1887) only gives a list of *Foraminifera* found by him in the Limburg Cretaceous. He gives no figures, but does say out of which zones the species originated. He met with a hundred species out of the Maestricht

Chalk, 32 of which I found myself, but here again I must mention that in the list of UBAGHS numerous synonyms have been given as different species.

HOFKER in the years 1926—1932 gives an elaborate description of 23 Cretaceous *Foraminifera* of Limburg. Three of which I did not come across in my material.

Neither did I find *Rhabdammina cretacea* sp. n. described by RIJSINGE (1928).

My brother W. A. VISSER (1937) gives descriptions of the forms found by himself in the Limburg Cretaceous. As his collection has been kept in the "Rijksmuseum van Geologie en Mineralogie" at Leiden I had the opportunity to compare his finds with mine. I then came to the conclusion that several determinations were not correct. In Chapter III, § 2 I shall discuss this matter more closely when dealing with the species in question. His conclusions about depth of the sea and climate must therefore be taken with slight reserve.

VAN RAADSHOVEN (1940) gives a list of *Foraminifera* which he and other authors came across in the Limburg Cretaceous up to that point of time. I had the opportunity to inspect his collection at Utrecht and agreed with most of his views.

COSIJN (1942) describes two species of the Burgerwacht-quarry out of which one of my sections were taken. These are *Lepidorbitoides minor* and *Siderolites calcitrapoides*. The author traces the phylogeny of both forms and finds that in the younger layers the protoconch becomes larger. According to him this is a proof that we are dealing with forms recently originated. Forms on the way to becoming extinct have a gradually diminishing protoconch in the younger layers.

SCHIJFSMA (1946) in an extensive article treats the *Foraminifera* out of the Hervian (Middle-Campanian) of South-Limburg. I found 23 from the 91 forms described by him, among which in large quantities his new species *Discorbis supracretacea*.

In 1949 HOFKER again describes 19 species out of the Upper Cretaceous of South-Limburg giving some additions and corrections of his articles of the years 1926—1932. Five of this forms I did not come across.

HOFKER handed me his last manuscript, which besides a new classification describes a number of Dutch Cretaceous *Foraminifera*[1]). As we, however, start from different points of view I could not always agree with his opinions displayed in this manuscript.

b. On areas outside Limburg.,

REUSS (1860 and 1862), BEISSEL (1891), EGGER (1899) and FRANKE (1925 and 1928) supplied me with the necessary data on the Upper Cretaceous of Germany. The age of the species described agree for the greater part with my material. A rather great number turned out to occur in both areas.

For France I consulted the papers written by MARIE (1937, 1938, 1941 and 1942), I am of opinion that the Craie Blanche of the Basin of Paris is older than the Limburg Maestrichtian and that also the facies is different. The similarity with the Limburg Maestrichtian is not very great.

[1]) This article will shortly be published in "Het Natuurhistorisch Maandblad".

From England I am only acquainted with the publication of CHAPMAN (1891—1896) about the Gault of Folkestone which as a matter of fact is of little importance for this research.

The Swedish Cretaceous has been accurately examined by BROTZEN (1935, 1936, 1940, 1945, 1948). The complete descriptions and the excellent figures were of great value to me.

As far as I know, nothing on the subject of *Foraminifera* of the Belgian Cretaceous has been published and I could not obtain the publications on Russian Cretaceous.

I also used the publication of CUSHMAN (1946) on the *Foraminifera* of the Upper Cretaceous of the Gulf Coast Region. Besides I consulted numerous shorter publications on the *Foraminifera* of the Upper Cretaceous of North- and South-America.

Every species found I compared with the original description. When the original description was not available I looked up the species in the Catalogue of *Foraminifera* of ELLIS & MESSINA.

CHAPTER II.

PALEONTOLOGY.

§ 1. General survey.

I found in the Limburg Maestrichtian a foraminiferal fauna, consisting of 137 species. These belong to 69 genera and 23 families, ten of them being new species. Ten new forms only occur once, therefore I have only determined the genus of these forms.

Surveying the fauna of the sections examined we notice the following facts:

a. The fauna of the sections I, II and III (Sint Pietersberg and Geulhem) is approximately the same.
b. The fauna of section IV (Savelsbos, Gronsveld) has a great number of species in common with the fauna of section I, II and III, but differs especially in the appearance of very small forms: *Reussella cushmani, Gavelinella stelligera* and *Leptodermella maestrichtiensis*, which abundantly occur together with *Rotalia tuberculifera*, which is much smaller here than in sections I, II and III. Therefore this fauna makes the impression of a dwarf fauna.
c. The fauna of section V (Slavante) is quite divergent, owing to the abundant appearance of agglutinants. The forms often are of a red-brown colour and make the impression of being eroded.

On surveying the species found in the various sections it appears that:

1. the *Lagenidae* infrequently occur both in number of species and in number of specimens;
2. the agglutinants continually diminish in number in the younger layers;
3. the *Rotaliidae* both in number of species as in number of specimens is the best represented family;
4. the well-known Upper Cretaceous *Foraminifera Globigerina cretacea* D'ORBIGNY, *Palmula reticulata* (REUSS) and *Globotruncana stuarti* (LAPPARENT) are entirely missing.

§ 2. Description of the species.

The determination of the material is based on CUSHMAN'S Classification (1948). To elucidate this every genus is preceded by the genus-description of CUSHMAN (1948), so that I should not have to repeat the genus-characteristics of each species.

The sequence of the descriptions is the same as used by CUSHMAN (1948).

FAMILY SACCAMMINIDAE.

Subfamily *Saccammininae.*

LEPTODERMELLA RHUMBLER 1935.

Test single-chambered, plano-convex, rounded in dorsal view, semi-elliptical in side view, dorsal side convex, ventral side flattened or concave; wall thin, of chitin with a layer of fine, arenaceous material on the surface; aperture in the middle of the ventral side.

Leptodermella maestrichtiensis sp. n. pl. 7, fig. 13.

Test subglobar, apertural face slightly flattened, other side slightly conic. Aperture slightly dented in the apertural face.
Wall very finely agglutinant.

Diameter: 0,14—0,2 mm.

Holotype: No 18860 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: St. Pietersberg, B 5.

Occurrence: Holland: Maestrichtian, (Mb, Mc), South-Limburg.

Remarks: DE WIT (1943) and VAN RUMMELEN (1949) describe micro-organisms of the Limburg Cretaceous.
DE WIT finds them in the flints and classifies them in the *Flagellata*-family *Hystrichosphaeridae* of WETZEL.
VAN RUMMELEN (1949) finds them in the marl of Ransdaal and describes them as one of the genera, described by DE WIT (1943), namely *Membranilarnax.*
Neither describe an aperture.
The VAN RUMMELEN specimens, however, are soluble in HCl, those of DE WIT not, so presumably they are concerned with different organisms.
The specimens, found by myself in great abundance, are very similar to those of VAN RUMMELEN. They are partly soluble in HCl, because they are built up from small pieces of chalk. In my opinion the specimens, mentioned by VAN RUMMELEN belong to the *Leptodermella* described above.

FAMILY LITUOLIDAE.

Subfamily *Lituolinae.*

LITUOLA LAMARCK 1804.

Test in the early stages planispiral, later portion typically uncoiled; interior labyrinthic; wall arenaceous with much cement; aperture in early stages at the base of the apertural face, single, later becoming multiple and in the terminal face.

? Lituola nautiloidea LAMARCK, pl. 8, fig. 1.

Lituolites nautiloidea LAMARCK 1804 (ELLIS & MESSINA Catalogue).
Lituola nautiloidea LAMARCK CUSHMAN 1927, (CCLF), p. 142, pl. 28, fig. 8, 9.
MARIE 1937, p. 261.
MARIE 1941, p. 27, pl. 2, fig. 13, 14.
Haplophragmium grande (not REUSS) BEISSEL 1891, p. 18, pl. 4, fig. 31—40.
EGGER 1899, p. 144, pl. 3, fig. 14—16.
FRANKE 1928, p. 169, pl. 15, fig. 19.

Test round, biconvex, involute, provided with a wide umbilicus on both sides. No uncoiled part present, probably broken.

Periphery broadly rounded.
Chambers indistinct, about 11 number, very gradually increasing in size as added.
Sutures indistinct, slightly curved, depressed.
Wall rather rough, mostly of a red-brown colour.

Only one specimen (17433).
Diameter: 0,6 mm.
Thickness: 0,31 mm.

Occurrence: Germany: Lower Mucronaten-Senonian, Aachen, Preussberg.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian, (Ma), South-Limburg.

Remarks: As I found only one specimen, I could not examine its interior. So I cannot demonstrate that the walls are labyrinthic. As the uncoiled part is probably broken off, it is difficult to distinguish this form from *Haplophragium grande* (REUSS).
As MARIE (1941) argues, that *Haplophragmium grande* only occurs in the Middle Cretaceous and not in the Maestrichtian and as *Lituola nautiloidea* LAMARCK does occur in the Maestrichtian I assume that this form is *Lituola nautiloidea* LAMARCK.

FAMILY TEXTULARIIDAE.

Subfamily *Spiroplectammininae*.

SPIROPLECTAMMINA CUSHMAN 1927.

Test free, early chambers planispiral in both microspheric and megalospheric forms, and forming a considerable portion of the test; later chambers biserial; wall agglutinant, amount of cement variable; aperture a low opening at the base of the inner margin.

Spiroplectammina baudouiana (D'ORBIGNY) CUSHMAN, pl. 1, fig. 1.

Textularia baudouiana D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
REUSS 1860, p. 233.
EGGER 1899, p. 24, pl. 2, fig. 10—11.
FRANKE 1925, p. 12, pl. 1, fig. 15.
FRANKE 1928, p. 135, pl. 12, fig. 12.
MARIE 1941, p. 63, pl. 2, fig. 21.
SCHIJFSMA 1946, p. 30, pl. 1, fig. 2.
Spiroplectammina baudouiana (D'ORBIGNY) CUSHMAN 1932 (CCLF), p. 87, pl. 11, fig. 1.
CUSHMAN 1946, p. 27, pl. 5, fig. 12.

Test tapering, oval in transverse section, initial end blunted, apertural face flattened.
Periphery rounded, flattened.
Chambers hardly visible, in the first part rapidly increasing in size as added, in the last part more gradually increasing in size as added, about 16 in number.
Sutures only distinct in the last part.
Wall finely perforate.

Length: 0,82—0,6 mm.
Breadth: 0,67—0,41 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Holland: Hervian and Maestrichtian (Mb—Md), South-Limburg.
Trinidad: Upper Cretaceous.

Subfamily *Textulariinae.*

TEXTULARIA DEFRANCE 1824.

Test free, elongate, tapering, typically compressed with the zigzagline between the chambers on the middle of the flattened side; early chambers in the microspheric form usually planispiral coiled, later biserial, chambers simple, not labyrinthic; wall agglutinant, cement of various sorts, the relative amount variable; aperture typically an arched slit at the inner margin of the chamber, occasionally in the apertural face.

Textularia agglutinans D'OBIRGNY, pl. 1, fig. 2.

Textularia agglutinans D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
FRANKE 1928, p. 132, pl. 12, fig. 7, 8.
MARIE 1941, p. 62, pl. 2, fig. 19.
Textularia concinna REUSS 1860, p. 89, pl. 13, fig. 1.
EGGER 1899, p. 27, pl. 2, fig. 25, 26.

Test tapering, more long than broad, initial end compressed, apertural end slightly inflated.
Periphery of the first part acute, of the last part rounded.
Chambers about 16 in number, increasing in breadth as added, more in the first part than in the last part.
Sutures sometimes distinct and slightly depressed.
Last chamber flattened or inflated.
Wall roughly agglutinant.

Length: 1,1—0,52 mm.
Breadth: 0,67—0,52 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Mc, Md), South-Limburg.

Remarks: FRANKE (1928) distinguishes two varities: concinna and paralella. CUSHMAN (1932, CCLF) supposes that the so-called variety concinna is no *Textularia,* but a *Gaudryina.*

Textularia conulus REUSS, pl. 1, fig. 4.

Textularia conulus REUSS 1845 (ELLIS & MESSINA Catalogue).
REUSS 1860, p. 87, pl. 13, fig. 3.
REUSS 1862, p. 320.
EGGER 1899, p. 28, pl. 2, fig. 8.
FRANKE 1928, p. 132, pl. 12, fig. 4, 5.
HOFKER 1931, p. 74, 8 fig.
EICHENBERG, 1934/1935, p. 152, pl. 15, fig. 5.
W. A. VISSER 1937, p. 73.
Textularia sp. BEISSEL 1891, p. 68, pl. 13, fig. 20—22.

Test tapering more long than broad, oval in transverse section, initial end blunted.

Chambers about 12 in number, increasing in size as added.

Sutures indistinct, not depressed.

Apertural face flattened.

Length: 0,9—0,44 mm.

Breadth: 0,68—0,4 mm.

Occurrence: Germany: Upper Cretaceous N.W. part, Aachen, Oberbayerische Alpen.
Holland: Maestrichtian, (Mc and Md), South-Limburg.

Remarks: According to HOFKER (1931) the three species of *Textularia* described by REUSS (1862) out of the Limburg Cretaceous, are the 3 generations of one species: *Textularia conulus*. These three species are: *Textularia conulus* REUSS, *Textularia globifera* REUSS (= *Textularia globosa*) and *Textularia faujasi*. In a later publication of HOFKER (1949), however, he describes another form as *Textularia faujasi* (see remarks *Textularia foeda)*.

CUSHMAN (1932, CCLF, p. 89) argues, that *Textularia conulus* is a *Dorothia*. *Dorothia*, however, has a trochoid initial part, totally missing in the specimens found. As REUSS (1862) also describes *Textularia conulus* out of the Limburg Cretaceous, in my opinion this form is a *Textularia*.

? Textularia cf. foeda REUSS, pl. 8, fig. 4.

Textularia foeda REUSS 1846 (ELLIS & MESSINA Catalogue).
REUSS 1860, p. 89.
FRANKE 1928, p. 133, pl. 12, fig. 6.
CUSHMAN 1932, (CCLF) p. 90.
Gaudryina spec. HOFKER 1931, p. 78, fig. 6—8.
Textularia faujasi (not REUSS) HOFKER 1949, p. 10, fig. 5.

Test very large, elongate, elliptical in cross section, hardly tapering.

Chambers rather distinct, about 20 in number, broader than high, very gradually increasing in size as added.

Sutures rather distinct, slightly depressed, nearly horizontal.

Wall very rough, built up from rather large sand- and chalk-grains.

Only 3 broken specimens (S 7, S 9, S 12).

Length of the largest one: 2,7 mm.

Breadth: 0,82—0,9 mm.

Occurrence: Germany: Turonian-Senonian, N.W. part.
Holland: Maestrichtian (Mb), South-Limburg.

Remarks: In the remarks of *Textularia conulus* I already notice, that HOFKER in 1931 describes *Textularia faujasi* as one of the three generations of *Textularia*.

In the same publication HOFKER mentions a large form, with he preliminary calls *Gaudryina spec.* In 1949 he has more material at his disposal and he again describes this form, now under the name of *Textularia faujasi* REUSS, thus under the name of the form which in 1931 he takes as a generation of *Textularia conulus*.

Textularia faujasi REUSS (1862) is a rather strongly tapering form with an elliptical cross section. This description does not agree with the form, described above, which does agree with the description and the figure given

by HOFKER (1931 and 1949). So I cannot agree with HOFKER's opinion, that this form is a *Textularia faujasi.*

CUSHMAN (1932, CCLF) remarks, that the *Textularia foeda* described by REUSS (1845) is a *Gaudryina,* but in his publication of the Family *Valvulinidae* (1937 and 1947) he does not mention this form.

As I have only broken specimens and the initial part is deficient in each case I cannot be sure about the genusname.

As the form most agrees with *Textularia foeda* REUSS (1845) I have given it this name. The only difference is in the size. The form described above is much larger than the form described by REUSS.

Textularia subconica FRANKE, pl. 1, fig. 3.

Textularia trochus D'ORBIGNY var. *subconica* FRANKE 1928, p. 131, pl. 12, fig. 1.
Textularia subconica FRANKE: CUSHMAN 1932 (CCLF) p. 95, pl. 11, fig. 11.
CUSHMAN 1946, p. 30, pl. 6, fig. 21, 22.

Test compressed, especially the early portion.

Periphery angled, sometimes lobate.

Chambers about 12 in number, rapidly increasing in size to the apertural end.

Sutures mostly distinct, slightly depressed.

Apertural end flattened.

Length: 0,4—1,0 mm.
Breadth: 0,36—0,64 mm.
Thickness: 0,28—0,48 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Remarks: FRANKE (1928) describes this species as *Textularia trochus* var. *subconica.* According to CUSHMAN (1932, CCLF) *Textularia trochus* is not a *Textularia,* but a *Gaudryina.* The variety of FRANKE (1928) is a real *Textularia,* and now has got the name *subconica.*

Textularia sp., pl. 1, fig. 5.

Test tapering, initial end acuminate, slightly compressed and curved. Apertural end round to broadly oval in cross section.

Chambers distinct, about 10 in number, very rapidly increasing in size as added. Last four chambers subglobular and round. The earlier more broad than high.

Sutures distinct, depressed in the last part, nearly horizontal.

Apertural face convex.

Wall finely agglutinant.

Only one specimen.
Length: 0,5 mm.
Breadth: 0,28 mm.
Thickness: 0,2 mm.

Holotype: No. 18853 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Geulhem, G 4.

FAMILY VERNEUILINIDAE.

TRITAXIA REUSS 1860.

Test triserial, triangular in transverse section, the angles acute or somewhat rounded; chambers usually distinct, but not inflated, three making up each whorl but the last, one or more chambers in the adult terminal, usually somewhat contracted; sutures usually distinct and slightly depressed; wall agglutinant, usually of fine particles with much cement and usually the exterior smoothly finished; aperture in the early stages textularian, a low opening at the inner margin of the last-formed chamber, in the adult terminal and usually rounded.

Tritaxia dubia (REUSS) EGGER, pl. 1, fig. 7.

Verneuilina dubia REUSS 1851 (ELLIS & MESSINA Catalogue).
Tritaxia tricarinata REUSS 1860 (part), p. 228, pl. 12, fig. 1.
Tritaxia dubia (REUSS) EGGER 1899, p. 41, pl. 4, fig. 7, 8.

Test elongate, tapering to both ends, triangular with rounded angles in cross section, sides flattened, slightly twisted.

Chambers indistinct, numerous, the one last formed nearly terminal.

Sutures indistinct, not depressed, oblique.

Wall finely agglutinant.

Length: 0,36—0,44 mm.
Breadth: 0,16—0,2 mm.

Occurrence: Germany: Upper Senonian, Aachen, Hannover, Westphalia, Pommeriana.
Holland: Maestrichtian (Mb—Md), South-Limburg.

GAUDRYINA D'ORBIGNY 1839.

Test with the chambers triserial, the adult biserial, the early portion typically triangular with distinct angles, but in some species the chambers rounded, and the angles obtuse or broadly rounded, adult portion with the biserial chambers of various shapes, chambers usually distinct, the early ones sometimes obscure; sutures usually distinct except in the early portion, typically depressed, very rarely limbate; wall agglutinant throughout; aperture in the early stages at the inner margin of the last-formed chamber, in some species tending to become terminal in the final chamber.

Gaudryina laevigata FRANKE, pl. 1, fig. 8.

Gaudryina laevigata FRANKE 1914, p. 431, pl. 27, fig. 1, 2.
FRANKE 1928, p. 142, pl. 13, fig. 3.
WHITE 1928, p. 312, pl. 42, fig. 6.
BROTZEN 1936, p. 34.
CUSHMAN 1937 (*Verneuilinidae*), p. 41, pl. 6, fig. 10—17.
CUSHMAN & HEDBERG 1941, p. 84, pl. 21, fig. 8.
CUSHMAN 1946, p. 33, pl. 8, fig. 4.
CUSHMAN 1947 (CCLF), p. 6, pl. 2, fig. 3—6.

Test tapering, more long than broad, early part sharply triangular in transverse section with subacute angles, later part rectangular in transverse section with subacute to rounded angles. The triangular (and triserial) part is mostly smaller than the rectangular (and biserial) part.

Chambers indistinct in the former part, distinct in the last part, gradually increasing in size as added. About 8 in number. Last chamber slightly inflated.

Sutures only distinct in the last part, slightly depressed.
Apertural face flattened.
Wall finely agglutinant.

Length: 0,74—0,3 mm.
Breadth: 0,52—0,3 mm.

Occurrence: Germany: Upper Cretaceous, Basin of Munster.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mc—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.
Mexico: Upper Cretaceous.
Columbia: Upper Cretaceous, Santander del Norte.
Venezuela: Santa Anita formation.

Gaudryina rugosa D'ORBIGNY, pl. 1, fig. 6.

Gaudryina rugosa D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
KARRER 1870, p. 166.
BEISSEL 1891, p. 69, pl. 13, fig. 30—37.
FRANKE 1914, p. 432, pl. 17, fig. 3.
FRANKE 1925, p. 14, pl. 1, fig. 19.
FRANKE 1928, p. 141, pl. 13, fig. 2.
PLUMMER 1931, p. 135, pl. 8, fig. 11.
APPLIN 1936, p. 219.
BROTZEN 1936, p. 35.
ALBRITTON & PHLEGER 1937, p. 350.
MARIE 1937, p. 261.
CUSHMAN 1937 (*Verneuilinidae*), p. 36, pl. 4, fig. 14—19, pl. 5, fig. 1, 2.
CRESPIN 1938, p. 393, 394.
WEDEKIND 1938, p. 186.
HENSON 1938, p. 228.
VAN RAADSHOVEN 1940, p. 12.
MARIE 1941, p. 65, pl. 2, fig. 22, 23.
CUSHMAN 1946, p. 32.
SCHIJFSMA 1946, p. 32, pl. 1, fig. 6.

Test tapering, more long than broad, the early part in transverse section triangular with acute angles and flat sides, the latter part in transverse section rounded to quadrangular with rounded angles, never distinct ribs as *Gaudryina laevigata*.

Chambers not always distinct, gradually increasing in size as added. The size of the biserial and triserial part is very variable, sometimes the triserial part is the largest, sometimes the biserial.

Sutures, when distinct, slightly depressed.
Apertural face flattened.

Length: 0,92—0,3 mm.
Breadth: 0,4—0,26 mm.

Occurrence: Germany: Turonian—Senonian, N.W. part.
France: Craie Blanche, Basin of Paris.
Holland: Hervian and Maestrichtian (Mc—Md), South-Limburg.

U.S.A.: Navarro, Texas; Upper Cretaceous, N. Dakota.
Palestine, Syria, Iraq and Egypt: Upper Cretaceous.
Australia: Upper Cretaceous.

FAMILY VALVULINIDAE.

Subfamily *Eggerellinae*.

ARENOBULIMINA CUSHMAN 1927.

Test with the earlier chambers triserial, later chambers spirally arranged, more than three to a whorl, close coiled; wall arenaceous, with much cement, typically with a broad rounded tooth.

Arenobulimina ovoidea MARIE, pl. 8, fig. 2.

Arenobulimina puschi (not REUSS) MARIE 1937, p. 261.
Arenobulimina ovoidea MARIE 1941, p. 51, pl. 4, fig. 39.
CUSHMAN 1947 (*Valvulinidae*) p. 13, pl. 3, fig. 5.
Bulimina affinis (not D'ORBIGNY) (pars) W. A. VISSER 1937, p. 88.

Test elongate, nearly round in cross section, initial part tapering, latter part somewhat cylindrical.

Chambers rather indistinct, 4—5 whorls, of 3 chambers each, gradually increasing in size as added. Last whorl occupies about $^3/_5$ of the test.

The spiral suture is somewhat depressed and mostly distinct, the sutures between the chambers are indistinct, slightly curved in the last part.

Apertural face slightly flattened, oblique to the plane of coiling, mostly of a red-brown colour.

Length: 0,55—1,00 mm.
Breadth: 0,3—0,51 mm.

Occurrence: France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma), South-Limburg.

Remarks: The *Bulimina affinis* described by W. A. VISSER (1937) out of the Kunrade and the Maestricht Chalk Ma and Mb is an *Arenobulimina ovoidea* MARIE. The forms out of the Gulpen Chalk, described by the same author are genuine *Bulimina affinis* D'ORBIGNY.

MARSSONELLA CUSHMAN 1933.

Test trochoid, rounded in section, in early stages conical with four or five chambers to a whorl, later reduced to three, and in the adult to two in a whorl; chambers simple, undivided, apertural end flat or concave; wall arenaceous, calcareous with a chitinous lining; aperture, a low elongate opening at the inner margin of the chamber or extending into the chamber wall.

Marssonella oxycona (REUSS) CUSHMAN, pl. 8, fig. 3.

Gaudryina oxycona REUSS 1860, p. 229, pl. 12, fig. 3.
REUSS 1863, p. 33.
KARRER 1870, p. 166.
EGGER 1899, p. 38, pl. 4, fig. 1—3..
FRANKE 1925, p. 15, pl. 1, fig. 20.
FRANKE 1928, p. 143, pl. 13, fig. 8.
CUSHMAN & CHURCH 1929, p. 501, pl. 36, fig. 3, 4,
CUSHMAN 1931, p. 300, pl. 34, fig. 6.

WICKENDEN 1932, p. 205, pl. 29, fig. 3.
SANDIGDE 1932, p. 268, pl. 41, fig. 213.
CUSHMAN 1932, p. 332.
CUSHMAN & JARVIS 1932, p. 18, pl. 5, fig. 1, 2.

Marssonella oxycona (REUSS) CUSHMAN 1933 (CCLF), p. 36, pl. 4, fig. 13.
CUSHMAN 1937 (*Valvulinidae*) p. 56, pl. 5, fig. 27—29, pl. 6, fig. 1—17.
FRIZZELL 1943, p. 340, pl. 55, fig. 15.
CUSHMAN 1946, p. 43, pl. 12, fig. 3—5.
CUSHMAN 1947, (Suppl. *Valv.*) p. 21.
HOFKER 1949, p. 12, fig. 6.

Textularia turris (not D'ORBIGNY) SCHIJFSMA 1946, p. 31, pl. 1, fig. 3.

Test conical, with a flattened apertural face and a subacute initial part.
Chambers rather distinct, many in number, gradually increasing in size as added.
Sutures rather distinct, straight, slightly depressed.
Wall smooth.

Only three broken specimens (2 in 17434, 1 in S 22).
The length could not be measured.
Diameter of the apertural face: 0,52—0,63 mm.

Occurrence: Germany: Turonian—Senonian, N.W. part.
Holland: Hervian and Maestrichtian (Ma and Mb), South-Limburg.
U.S.A.: Navarro, Taylor and Austin, Gulf Coast Region; Upper Cretaceous, California.
Trinidad: Upper Cretaceous.
Peru: Upper Cretaceous.

DOROTHIA PLUMMER 1931.

Test a trochoid spire, in the earlier stage in the microspheric form with five or six chambers in a whorl, rapidly reducing the number to four, then three and in the adult with two in each whorl; wall agglutinant, becoming largely calcareous in some living forms; aperture narrow, at the base of the inner margin.

Dorothia pupoides (D'ORBIGNY) CUSHMAN, pl. 1, fig. 10.

Gaudryina pupoides D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
REUSS 1862, p. 318.
MARIE 1937, p. 261.
FAHRION 1937, p. 192.
MARIE 1941, p. 65, pl. 3, fig. 24—27.

Dorothia pupoides (D'ORBIGNY) CUSHMAN 1937 (*Valvulinidae*), p. 77, pl. 8, fig. 18, 19.

Test elongate, initial part triangular with rounded angles in cross section. The latter part oval in cross section. Both parts are equally large.
Chambers distinct, only in the biserial part, slightly inflated there, 4—5 in number, rapidly increasing in size as added.
Sutures distinct in the biserial part, depressed there, nearly horizontal.
Wall finely agglutinant.

Only three specimens, one adult.
Length: 0,42 mm.
Breadth: 0,24 mm.

Occurrence: Germany: Upper Cretaceous, Aachen.
France: Craie Blanche, Basin of Paris.
England: Chalk of Claring.
Holland: Maestrichtian (Mc—Md), South-Limburg.
U.S.A.: Saratoga Chalk.
Africa: Upper Cretaceous, Tanganjika Territorium.

Remarks: BROTZEN (1936, p. 36—38) mentions a new species *Dorothia plummerae*, allied to this species and wrongly called by many authors: *Dorothia pupoides*.

BROTZEN describes the following differences between these species:

Dorothia pupoides has an initial part, small and well separated from the last part. The chambers of the last part increase very rapidly in size as added and are inflated.

Dorothia plummerae has a trochoid initial part, gradually changing into the biserial part, the chambers of the last part are slightly inflated and have distinct, but not depressed sutures.

My specimens agree *D. pupoides* as described by BROTZEN (1936) and are aberrant from the description and figures, given by FRANKE (1925 and 1928).

PLECTINA MARSSON 1878.

Test in earlier stages rounded, with as many as five chambers to a whorl, rapidly reducing to two in the adult; chambers simple, undivided; wall agglutinant, often with much cement; aperture in early stages textularian, in the adult rounded, in the terminal face, but without a neck.

Plectina ruthenica (REUSS) MARSSON, pl. 1, fig. 9.

Gaudryina ruthenica REUSS 1851 (ELLIS & MESSINA Catalogue).
Plectina ruthenica (REUSS) MARSSON: FRANKE 1925, p. 16, pl. 1, fig. 25.
FRANKE 1928, p. 145, pl. 13, fig. 11.
CUSHMAN & CHURCH 1929, p. 50, pl. 36, fig. 5, 6.
CUSHMAN 1937 (*Valvulinidae*), p. 105, pl. 11, fig. 10—14.

Test elongate, earlier part triangular in cross section, latter part oval in cross section. The last part the largest of the test.

Chambers numerous, indistinct in the earlier part, the last distinct and slightly inflated.

Sutures only distinct, oblique and depressed between the last five chambers.

Wall roughly agglutinant.

Length: 0,4—1,08 mm.
Breadth: 0,2—0,34 mm.
Thickness: 0,16—0,24 mm.

Occurrence: Germany: Upper Senonian, Rügen, Aachen and Weissen Schnesberg.
Holland: Maestrichtian (Ma, less abundant in Mb—Md), South-Limburg.

ORBIGNYNA HAGENOW 1842.

Test in the early stages irregularly trochoid with several chambers to a whorl, later in the adult becoming planispiral and involute; chambers with the periphery subdivided by radiating partitions running in from the outer wall; wall arenaceous, with calcareous

sand and fragments of mollusc prisms; aperture at the base of the apertural face in the young stage, with a definite tooth, in the adult rounded or elliptical, in the middle of the apertural face.

Orbignyna aquisgranensis (BEISSEL), pl. 8, fig. 5.

Lituola aquisgranensis BEISSEL 1891, p. 12, pl. 3, fig. 1—54, pl. 16, fig. 33—35.
FRANKE 1925, p. 82, pl. 7, fig. 6.
FRANKE 1928, p. 172, pl. 15, fig. 22, 23.
Haplophragmium grande not REUSS HOFKER 1949, p. 6, fig. 2.
Pseudoglandulina paralella not MARSSON W. A. VISSER 1937, p. 87.
Nodosaria monile not VON HAGENOW (pars) W. A. VISSER 1937, p. 87.
Orbignyna aquisgranensis (BEISSEL) CUSHMAN 1937 (*Valvulinidae*) p. 89, pl. 21, fig. 31—33.

Test elongate, nearly round in transverse section.

Chambers of the coiled part indistinct, chambers of the uncoiled part more distinct, 4—6 in number.

Sutures only distinct in the uncoiled part, straight, slightly depressed.

Wall rather smooth.

Two forms are distinguishable:

var. *typica*: chambers of the uncoiled part keep the same breadth, outside form short and thick.

var. *conica*: chambers of the uncoiled part increase in breadth, last chamber slightly inflated, outside form long and slender with a knob-shaped coiled part.

Length: 0,8—1,2 mm (*conica*); 0,81—1,33 m (*typica*).
Breadth: 0,33—0,5 mm (*conica*); 0,41—0,5 mm (*typica*).

Occurrence: Germany: Upper Cretaceous, Aachen.
Holland: Maestrichtian (Ma and Mb), South-Limburg.

Remarks: A section of both forms shows that the wall is not labyrinthic. We therefore are dealing with an *Orbignyna* and not with a *Lituola*.

W. A. VISSER (1937) describes the var. *conica* as *Nodosaria monile*, together with real *N. monile*. His *Pseudoglandulina parallela* is partly the var. *typica*.

HOFKER (1949) describes a *Haplophragmium grande* from the Upper Senonian of South-Limburg. The figures and description do not agree with those of this species, which is a coiled thick form with a distinct umbilicus on both sides. The description and the figures, however, do agree with *Orbignyna aquisgranensis*, described above. HOFKER also distinguishes two forms, a short and blunt one and a slender one, according to him the A_1 and A_2 generation of this species.

FAMILY MILIOLIDAE.

QUINQUELOCULINA D'ORBIGNY 1826.

Test with the coiling in five planes, the chambers a half coil in length and added successively in planes 144° apart, five chambers completing a cycle of two turns about the axis in section, but two and a half coils lengthwise, each chamber 72° from its next adjacent one, but 144° from immediate predecessor; wall with an interior chitinous layer outside of which is a calcareous imperforate layer, in some species with an outer layer of sand grains; aperture at the end of the chamber, rounded, typically with a simple tooth.

Quinqueloculina antiqua (FRANKE), pl. 2, fig. 19.

Miliolina antiqua FRANKE 1928, p. 126, pl. 11, fig. 26.

Test oval with subacute ends, somewhat longer than broad, nearly triangular in section with subacute angles and slightly concave lateral faces.

Chambers distinct, long and rather broad, with flattened faces, covering for a great part the inner chambers.

Sutures distinct, slightly depressed between the coils.

Wall smooth, calcareous, thin. Because of this thin wall nearly all specimens are broken.

Aperture not produced, no tooth visible.

Length: 0,26—0,7 mm.
Breadth: 0,19—0,41 mm.
Thickness: 0,13—0,26 mm.
These dimensions are nor sure as most of the specimens are broken.

Occurrence: Germany: Emscherian, Westphalia,
Cenomanian, Mecklenburg.
Turonian, Pommeriana.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Quinqueloculina stolleyi BROTZEN, pl. 2, fig. 18.

Miliolina antiqua f. angusta FRANKE 1928, p. 127, pl. 11, fig. 25.
Quinqueloculina stolleyi BROTZEN 1936, p. 46, pl. 2, fig. 6.

Test oval with rounded ends, slightly triangular in section with rounded angles.

Chambers distinct, slightly inflated, long and narrow, 3 visible at one side, 4 at the other.

Sutures distinct, depressed between the coils.

Wall smooth, imperforate.

Aperture slightly produced, no tooth visible.

Length: 0,37—0,5 mm.
Breadth: 0,2—0,28 mm.
Thickness: 0,15—0,18 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mc—Md), South-Limburg.

FAMILY LAGENIDAE.

Subfamily *Nodosariinae*.

LENTICULINA LAMARCK 1804.

Test planispiral, bilaterally symmetrical, typically close coiled and involute, tending to become uncoiled in some species; chambers numerous, triangular in side view; wall finely perforate, glassy; the aperture radiate, at the peripheral angle, the slits equal.

Lenticulina acuta (REUSS), pl. 2, fig. 5.

Cristellaria acuta REUSS 1860, p. 69, pl. 10, fig. 3.
Cristellaria gibba D'ORBIGNY f. *acuta* (REUSS) FRANKE 1928, p. 106, pl. 10, fig. 12.

Test oval, biconvex, the apertural face is somewhat higher than the spiral initial end. Indistinct central plug on both sides.

Periphery acute.

Chambers indistinct, triangular, rapidly increasing in size as added, about 9 in number.

Sutures indistinct, slightly curved, not depressed or limbate.

Wall smooth.

Height: 1,3 mm.
Breadth: 0,82 mm.
Thickness: 0,22 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (one specimen in Md), South-Limburg.

Remarks: *Lenticulina acuta* resembles *Lenticulina rotulata*, differs in the height and the form: *L. rotulata* is round, *L. acuta* oval.

Lenticulina sp., pl. 7, fig. 6.

Test oval, initial part broadly rounded, apertural end slightly acuminate, compressed. All chambers reach the initial spire.

Apertural face is about three times higher than the height of the initial spire.

Periphery subacute.

Chambers, 11 visible, rapidly increasing in height as added, much narrower than high.

Sutures distinct, not depressed, slightly curved.

Wall smooth.

Only one specimen.
Length: 0,68 mm.
Breadth: 0,44 mm.
Thickness: 0,28 mm.

Holotype: No 18788 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Sint Pietersberg, B 9.

Remarks: This species resembles *Cristellaria ovalis* REUSS and *Cristellaria obvoleata* REUSS. *Cristellaria ovalis*, however, has a keeled periphery and is more inflated than this form; *Cristellaria obvoleata* has 5 chambers and a rounded periphery.

Lenticulina rotulata LAMARCK, pl. 2, fig. 6.

Lenticulites rotulata LAMARCK 1804 (ELLIS & MESSINA Catalogue).
Cristellaria rotulata (LAMARCK) REUSS 1862, p. 326.
KARRER 1870, p. 179.
BEISSEL 1891, p. 55, pl. 10, fig. 20—43.
EGGER 1899, p. 122, pl. 11, fig. 3, 4.
EICHENBERG 1936, p. 8, pl. 4, fig. 2.
FAHRION 1937, p. 192.
HENSOLDT 1937, p. 358, 359, 365.

Lenticulina rotulata LAMARCK: MARIE 1937, p. 262.
VAN RAADSHOVEN 1940, p. 12.
MARIE 1941, p. 104, pl. 10, fig. 111—112.
FRIZZELL 1943, p. 341, pl. 56, fig. 2.
THALMANN 1946.
Robulus rotula HOFKER 1949, p. 16, fig. 9.
Robulus orbicularis (not) D'ORBIGNY
Robulus inornatus (not) D'ORBIGNY
Robulus rotulatus LAMARCK
Robulus münsteri (not) REUSS
W. A. VISSER 1937, p. 74.

Test round, biconvex, the height of the apertural face is the same as the height of the spiral initial end.

Periphery acute.

Chambers triangular, gradually increasing in size as added, 9 in number.

Sutures strongly curved, limbate, in the centre indistinct owing to a plug of clear shell material.

Wall smooth.

Diameter: 0,77 mm.
Thickness: 0,48 mm.

Occurrence: Germany: Upper Cretaceous, Aachen, N.W. part, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma and one specimen in Md), South-Limburg.
Africa: Upper Cretaceous, Tanganjika Territorium.
Peru: Upper Cretaceous.

Remarks: HOFKER (1949) described *Robulus rotula* (LAMARCK). According to the ELLIS & MESSINA Catalogue STACHE described in 1865 a *Cristellaria rotula* from the New Zealand Tertiary. The species of LAMARCK is called *rotulata*. Figures and description of HOFKER (1949) agree with *L. rotulata* and not with *Cristellaria rotula*. Therefore I assume that HOFKER means *Lenticulina rotulata* and not *Lenticulina rotula*.

I cannot prove the trimorphism, found by HOFKER (1949) in this species, as I found only a few specimens.

Looking at the *Robulus* species of W. A. VISSER (1937) I found, that all belong to one species, namely *Lenticulina rotulata*.

According to BROTZEN (1936) D'ORBIGNY combines *Cristellaria comptoni* and *Cristellaria rotulata*, though there is a distinct difference between them in the central knob of *Lenticulina comptoni*.

After D'ORBIGNY many authors confound the two species. BROTZEN separates them in a satisfactory way. As the Limburg species lacks the distinct knob it is *Lenticulina rotulata*.

PLANULARIA DEFRANCE 1824.

Test planispral, bilaterally symmetrical, very much compressed, the sides nearly parallel, microspheric form more coiled in the young; aperture at the peripheral angle, radiate, sometimes with the ventral slit expanded.

Planularia osnabrugensis (VON MUNSTER) FRANKE, pl. 2, fig. 8.

Cristellaria osnabrugensis VON MUNSTER 1838 (ELLIS & MESSINA Catalogue).
FRANKE 1925, p. 73, pl. 6, fig. 7.
FRANKE 1928, p. 109, pl. 10, fig. 6.

Test oval to round, compressed on both sides, spiral initial end has about the same height or is a little bit smaller than the apertural face.

Periphery acute, not keeled.

Chambers distinct, triangular, small, gradually increasing in size as added, about 12 in number.

Sutures distinct, curved, raised.

Wall ornamented with the ribs of the raised sutures.

Length: 0,3—0,74 mm.
Breadth: 0,23—0,52 mm.
Thickness (of the apertural face): 0,07—0,22 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Remarks: FRANKE in 1925 and 1928 describes *Cristellaria osnabrugensis* as "flach", but draws this species as a rather inflated one. The original figure of VON MUNSTER, although rather bad, shows a small, very compressed species, just as my specimens are.

Planularia sp., pl. 7, fig 4.

Test slightly uncoiled, last four chambers do not reach the initial spire.

Periphery broadly rounded.

Chambers distinct, about 11 in number, more broad than long.

Sutures distinct, not depressed, oblique.

Wall ornamented with many (about 20) low longitudinal ribs, curved, parallel with the coiling of the test.

Length: 0,6 mm.
Breadth: 0,24 mm.
Thickness: 0,12 mm.

Only one specimen.

Holotype: No 18791 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Sint Pietersberg, B 5.

Remarks: By its many low ribs and the compressed test this species differs from other ribbed species: *Cristellaria (Marginulina) tenuissima* REUSS (with few high ribs) and *Marginulina striatifera* TAPPAN (with many high ribs, but round in cross setion).

Planularia truncata (REUSS), pl. 2, fig. 7.

Cristellaria truncata REUSS 1851 (ELLIS & MESSINA Catalogue).
? FRANKE 1928, p. 106, pl. 9, fig. 24.

Test oval, planispiral, compressed on both sides. The apertural face is 1—2 times higher than the initial spiral end.

Periphery subacute.

Chambers distinct, small, triangular, 1—12 in number, gradually increasing in size as added. The last chamber does not reach the initial spiral end.

Sutures slightly curved, indistinct.

Wall smooth, but mostly much recristallized.

Length: 0,26—0,63 mm.
Breadth: 0,19—0,44 mm.
Thickness: 0,08—0,15 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Remarks: The name given by REUSS (1851) is preoccupied by D'ORBIGNY in 1843 (ELLIS & MESSINA Catalogue).

REUSS describes several *Planularia*-like species from the German Upper Cretaceous: *Cristellaria harpa* (1860, Westphalia), *Cristellaria intermedia* (1845, Bohemia), *Cristellaria multisepta* and *Cristellaria truncata* (1851, Lemberg), *Cristellaria nuda* (1862, Rügen) and *Cristellaria grata* (1863, N. Germany). The differences between them are very small:

The last chamber of *Cr. multisepta* always reaches the spiral initial end.

The last chamber of *Cr. nuda* sometimes reaches the spiral initial end, sometimes not.

The last chamber of *Pl. truncata* does not reach the spiral initial end while *Cr. intermedia* is the most coiled one, *Cr. harpa* the most uncoiled one and *Cr. grata* is the thickest.

FRANKE (1928) considers *Cr. multisepta, Cr. nuda* and *Cr. truncata* as varieties of *Cristellaria gibba* D'ORBIGNY. But from his figures I am not certain that his species *Cr. truncata* is really a *Cr. truncata,* because it has not the compressed form described by REUSS. It has a more inflated form. Yet FRANKE (1928) describes *Cristellaria gibba* and his varieties as compressed forms.

Though I agree with FRANKE (1928) on the relation between *Cr. truncata, Cr. nuda* and *Cr. multisepta,* I should like to add *Cr. harpa, Cr. grata* and *Cr. intermedia* as related forms.

I doubt whether the only difference between these six species, viz. the more coiled or less coiled form is a real specific difference, especially, when I see that *Cr. nuda* has sometimes coiled tests, sometimes uncoiled tests. Moreover the most uncoiled form, *Cr. harpa,* is geologically the youngest (Mucronata-Senonian), a symptom known about other coiled animals too.

If after research it is evident that these four species belong to one species, the name, first given, *Cr. intermedia,* has priority.

The *Robulus multiseptus,* described by W. A. VISSER (1937) is partly a *Nonion,* viz. *Nonion troostae* sp. n., partly not *R. multiseptus* owing to its inflated and non compressed form.

As the specimens of my material most resemble *Cristellaria truncata* REUSS I call this species *truncata,* according to CUSHMAN's Classification: *Planularia truncata.*

MARGINULINA D'ORBIGNY 1826.

Test subcylindrical or somewhat compressed, earliest portion close coiled, later uncoiled, final chambers often inflated; aperture radiate, in the early coiled portion as in Lenticulina, later becoming central and terminal.

Marginulina paralella (REUSS), pl. 7, fig. 3.

Cristellaria paralella REUSS 1863, p. 67, pl. 7, fig. 1—2.
Cristellaria linearis REUSS 1863, p. 66, pl. 12, fig. 1.
Vaginulina paralella (REUSS) FRANKE 1928, p. 79, pl. 7, fig. 15.

Test elongate, slightly curved at the initial end, compressed oval in section. Apertural end acuminate.

Chambers distinct, about 7 in number, more broad than high. Last chamber slightly inflated.

Sutures distinct, depressed, oblique.
Wall smooth.

Only two specimens from one sample.
Length: 0,66, 0,66 mm.
Breadth: 0,24, 0,26 mm.
Thickness: 0,16, 0,18 mm.

Occurrence: Germany: Hils and Gault, N. part.
Holland: Maestrichtian (Md); South-Limburg.

Marginulina trilobata D'ORBIGNY, pl. 8, fig, 7.

Marginulina trilobata D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue)
CUSHMAN & JARVIS 1932, p. 28, pl. 9, fig. 3, 4.
MARIE 1937, p. 263.
MARIE 1941, p. 108, pl. 13, fig. 158, 159.
CUSHMAN 1946, p. 64, pl. 22, fig. 22.
Marginulina ensis REUSS BEISSEL 1891, p. 51, pl. 9, fig. 40—64.
Cristellaria trilobata (D'ORBIGNY) FRANKE 1925, p. 68, pl. 5, fig. 18.
FRANKE 1928, p. 98, pl. 9, fig. 4.
Vaginulina trilobata (D'ORBIGNY) WHITE 1928, p. 206, pl. 29, fig. 4.
Hemicristellaria ensis (REUSS) PLUMMER 1932, p. 146, pl. 10, fig. 4.
Saracenaria trilobata (D'ORBIGNY) BROTZEN 1936, p. 91, fig. 1, textfig. 28, 29.
Vaginulinopsis trilobata (D'ORBIGNY) SCHIJFSMA 1946, p. 69, pl. 2, fig. 18, 19.

Test elongate, egg-formed in cross section, first part slightly curved.
Periphery at the side of the aperture subacute, at the other side rounded.
Chambers indistinct, broader than high, about 12 in number, very gradually increasing in size as added.
Sutures indistinct, in the uncoiled part oblique, provided with a drawn-out thickening, not reaching the periphery.
Wall rather rough owing to poor preservation.

Only two specimens (17434 and 17435).
Length: 1,1, 1,4 mm.
Breadth: 0,3 mm.

Occurrence: Germany: Senonian, N.W. part, Aachen.
France: Craie Blanche, Basin of Paris.
Sweden: Lower Senonian, Eriksdal.
Holland: Hervian and Maestrichtian (Ma), South-Limburg.
Trinidad: Upper Cretaceous.

Remarks: This form is extensively described by BROTZEN (1936) and MARIE (1941).
BROTZEN (1936) describes the form under the name *Saracenaria* and distinguishes 3 generations. Only the two megalospheric generations are provided with a thickening of the sutures. BROTZEN assumed *Marginulina ensis* REUSS as the microspheric generation, a smooth form, without decoration. According to him, BEISSEL (1891) made the same assumption when describing *Marginulina ensis*, but BEISSEL only notices the resemblance between *Vaginulina costulata* D'ORBIGNY and some of his forms *Marginulina ensis*. FRANKE (1927) on the other hand, calls some *Marginulina ensis* described by BEISSEL's *Cristellaria trilobata*; others maintain the name *ensis*.

MARIE (1941) indicates the resemblance between this form *Marginulina trilobata* and the American *Marginulinae silicula* (PLUMMER), *austiana* CUSHMAN and *plummerae* CUSHMAN.

SCHLIJFSMA (1946) separates the two forms figured by MARIE (1941). Figure 158 is said to be SCHLIJFSMA's new species *Vaginulina daini*, figure 159 the genuine *trilobata*. Moreover SCHLIJFSMA transfers the genus name into *Vaginulinopsis*.

As I have only two specimens, both macrospheric, it is impossible for me to discuss the remarks of BROTZEN (1936), MARIE (1941) and SCHLIJFSMA (1946).

On account of the subcylindrical test, which is certainly not compressed, this form is not a *Vaginulina*, but a *Marginulina*. The genus name *Vaginulinopsis* erected by SILVESTRI in 1904 is doubtful according to CUSHMAN's Classification (1948).

DENTALINA D'ORBIGNY 1826.

Test arcuate elongate; chambers numerous in a linear series; sutures usually oblique, at least in early portion; aperture radiate, peripheral in early stages, later nearly central and terminal.

Dentalina cf. incrassata BEISSEL, pl. 3, fig. 9.

Dentalina incrassata BEISSEL 1891, p. 35, pl. 7, fig. 10—13.
FRANKE 1927, p. 671.
FRANKE 1928, p. 36, pl. 3, fig. 13.

Test elongate, slightly curved, compressed in cross section, initial chamber slightly inflated, apertural end acuminate.

Chambers distinct, more broad than high, especially in the first part, gradually increasing in size as added.

Sutures distinct, depressed, slightly oblique.

Wall ornamented with many (20—24) thin and low longitudinal ribs, not parallel to the longitudinal axis of the test.

Only broken specimens. Therefore the length could not be measured, nor could the number of the chambers be fixed.

Thickness: about 0,41 m.

Occurrence: Germany: Upper Senonian, Aachen.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Remarks: This species is clearly distinguished from *Dentalina marcki* REUSS by the thin and low ribs. I am not sure, however, about the species-name. There are only broken specimens, so there is no initial chamber with a spine, a characteristic of *Dentalina incrassata*.

Another possibility is the *Dentalina confluens* REUSS of the Senonian "Grünsand" of New Jersey.

Dentalina legumen REUSS, pl. 8, fig. 6.

Nodosaria (Dentalina) legumen REUSS 1845 (ELLIS & MESSINA Catalogue).
Dentalina legumen REUSS 1860, p. 43, pl. 3, fig. 5.
FRANKE 1928, p. 27, pl. 2, fig. 23.
Nodosaria legumen REUSS: EGGER 1899, p. 54, pl. 5, fig. 36—39, pl. 6, fig. 1—3.

Test elongate, slightly curved, oval in cross section.

Chambers 9 in number, gradually increasing especially in length. First chamber provided with a spine, the last three chambers slightly inflated.

Sutures distinct, oblique, depressed in the last part.

Wall smooth.

Aperture at the end of a rather long and slender outgrowth of the last chamber.

Only one specimen (S 22).
Length (without spine): 2,2 mm.
Breadth: 0,33 mm.

Occurrence: Germany: Turonian-Senonian, N.W. part.
Holland: Maestrichtian (Mb), South-Limburg.

Dentalina marcki REUSS, pl. 3, fig. 10.

Dentalina marcki REUSS 1860, p. 188, pl. 2, fig. 7.
FRANKE 1925, p. 36, pl. 3, fig. 22.
FRANKE 1928, p. 37, pl. 3, fig. 16, 17.
BROTZEN 1936, p. 80, pl. 5, fig. 27.
SCHIJFSMA 1946, p. 44, pl. 2, fig. 27.
Nodosaria cf. marcki REUSS: CUSHMAN 1946, p. 74, pl. 27, fig. 7.
Nodosaria vertebralis (not BATSCH) HOFKER 1932, p. 141—145, 3 textfig.

Test elongate, round in cross section, very slightly curved, initial chamber provided with a distinct spine, apertural end slightly acuminate.

Chambers distinct, 10 in number, gradually increasing in size as added. The initial chamber inflated. The 3 or 4 first chambers more broad than high. The latter as broad as high.

Sutures distinct, depressed, especially in the last part, straight.

Wall ornamented with longitudinal high ribs, 8—10 in number. The first part has more ribs than the last part. The ribs do not reach the last chamber or the two latter chambers.

Length: 2,4—3,1 mm.
Breadth: 0,33—0,48 mm.

Occurrence: Germany: Pläner—Upper Senonian, N.W. part.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: When following the Classification of CUSHMAN (1948), we are unable to say whether we are dealing with a *Nodosaria* or a *Dentalina*: the sutures are at right angles to the axis, a characteristic of *Nodosaria*, the aperture is excentric, a characteristic of *Dentalina*. As the whole test is slightly curved, like most *Dentalina*-tests are I prefer the genus-name *Dentalina*.

There are many species of ribbed Cretaceous *Dentalines* and *Nodosarias*.

FRANKE (1925 and 1928) describes 32 of them out of the German Cretaceous.

BROTZEN (1936) mentions 7 of them out of the Lower Senonian of Eriksdal (Sweden).

HOFKER (1932) combines 7 recent *Nodosaria's*, 4 Cretaceous *Nodosaria's*, 7 Cretaceous *Dentalines* and one *Marginulina* to one species, and calls this *Nodosaria vertebralis* BATSCH, a recent form, which according to him occurs in the Dutch Cretaceous.

When looking at the Cretaceous forms, mentioned by HOFKER (1932)

there is indeed little difference between *Dentalina steenstrupi* REUSS, *Dentalina marcki* REUSS, *Nodosaria bacillum* DEFRANCE, *Dentalina affinis* REUSS, *Dentalina majuscula* MARSSON, *Nodosaria zippei* REUSS and *Nodosaria intercostata* REUSS. The ribs vary somewhat in number and height, cover sometimes the last chamber, sometimes not. *N. bacillum, N. zippei* and *N. intercostata* are real *Nodosaria,* the other real *Dentalina. Dentalina lilli,* also mentioned as a synonym by HOFKER, does not belong here owing to the absence of ribs. I disagree with HOFKER, who only sees the difference between *Dentalina* and *Nodosaria* as a generation-difference in his trimorphism-theory.

BROTZEN (1936) sees and mentions differences between the following species: *Dentalina marcki, Nodosaria steenstrupi* and *Nodosaria zippei.* From the original description of REUSS it is apparent, that *Dentalina marcki* has no ribs, and *Dentalina steenstrupi* does have ribs on the last chamber. This is a characteristic of which FRANKE (1928) has said, that the absence of ribs on the last chamber only occurs in single specimens and that there are transitions from smooth last chambers to wholly ribbed last chambers.

BROTZEN states the same so that the main difference between *D. marcki* and *D. steenstrupi* disappear.

In my material there are too few specimens to prove with certainty that there are transitions. So I cannot show that *D. marcki* and *D. steenstrupi* are the same species. As my specimens have no ribs on the last chamber I have given this species the name *D. marcki.* Neither can I prove that HOFKER is right to consider *Dentalina affinis* and *Dentalina majuscula* synonyms. I think HOFKER is going too far to combine also *Nodosaria bacillum, N. zippei* and *N. intercostata* and the recent forms with the Cretaceous *Dentalina marcki, D. steenstrupi, D. affinis* and *D. majuscula.*

Dentalina monile (VON HAGENOW), pl. 3, fig. 11.

Nodosaria monile VON HAGENOW 1892 (ELLIS & MESSINA Catalogue).
HOFKER 1932, p. 145—147, 2 textfig.
W. A. VISSER 1937, p. 87.
HENSOLDT 1938, p. 366.
VAN RAADSHOVEN 1940, p. 12.
CUSHMAN 1947 (CCLF), p. 12, pl. 3, fig. 18—21.

Dentalina monile (VON HAGENOW) BEISSEL 1891, p. 31, pl. 16, fig. 30, 32—40.
FRANKE 1925, p. 34, pl. 3, fig. 11.
FRANKE 1928, p. 31, pl. 2, fig. 27.
MARIE 1937, p. 264.
MARIE 1941, p. 89, pl. 11, fig. 127—130.

Test elongate, circular in cross section, apertural face slightly acuminate.

Chambers distinct, slightly inflated, equally broad as high, hardly increasing in size as added, more than six in number.

Sutures distinct, at right angles to the axis, depressed.

Wall smooth.

The length could not be measured, because there are only broken specimens.

Breadth: 0,3—0,44 mm.

Occurrence: Germany: Upper Senonian, N.W. part.
France: Craie Blanche, Basin of Paris.

Holland: Maestrichtian (Mc—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.
Venezuela: Santa Anita formation.

Remarks: One of the specimens has the peculiarity, that the chambers do not increase in size as added, but some of these are smaller than the earlier chambers. The following chambers increase in size normally.

Again HOFKER (1932) combines 4 species into one, because of his trimorphism-theory. He calls *Marginulina ensis* REUSS the B-form, *Dentalina tenuicaudata* REUSS and *Dentalina acuminata* REUSS the A_1-form, and *Dentalina monile* (VON HAGENOW) the A_2-form of the species *Nodosaria monile*. There is indeed no difference between *D. tenuicaudata* and *D. acuminata*. The specimens described here are too few in number to admit of a fruitful discussion of this statement.

Dentalina proteus REUSS, pl. 3, fig. 8.

Dentalina proteus REUSS 1862, p. 306, pl. 1, fig. 6—9.
HOFKER 1932, p. 142.
Nodosaria proteus (REUSS) EGGER 1899 (pars), p. 70, pl. 7, fig. 22 and 25.

Test elongate, circular in cross section, initial end rounded, apertural end acuminate.

Chambers distinct, in the earlier part more broad than high, in the latter part more high than broad, hardly increasing in size as added.

Sutures distinct, not depressed, nearly at right angles to the axis.

Wall smooth, but round the sutures and the earlier chambers ornamented with many low ribs, not parallel to the longitudinal axis of the text.

Length: 2,7 mm.
Thickness: 0,6 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen.
Holland: Maestrichtian (Mb, Md), South-Limburg.

Remarks: This species is one of the synonyms, given by HOFKER (1932) for *Nodosaria vertebralis* BATSCH. The specimens from South-Limburg, described here, are clearly characterized by the partial ornamentation of low ribs. This is quite different from the ornamentation with high ribs as seen in *Nodosaria vertebralis*.

EGGER (1899) gives 4 figures of *Nodosaria proteus*, of which two are provided with an initial spine (pl. 4, fig. 23 and 24). As REUSS describes *Dentalina proteus* positively with a rounded initial end and without an initial spine I cannot agree with EGGER on the species-name of these two spined specimens.

NODOSARIA LAMARCK 1812.

Test typically with chambers in a straight linear series, curved in the early stages of the microspheric form in many species, not strongly embracing; sutures in the adult at right angles to the axis; aperture terminal, radiate.

Nodosaria prismatica REUSS, pl. 7, fig. 14.

Nodosaria prismatica REUSS 1860, p. 180, pl. 2, fg. 2.
REUSS 1863, p. 36, pl. 2, fig. 7.
EGGER 1899, p. 77, pl. 8, fig. 5, 8.

FRANKE 1925, p. 41, pl. 3, fig. 41.
FRANKE 1928, p. 48, pl. 4, fig. 11, 12.
BROTZEN 1936, p. 88, pl. 5, fig. 17, 18.

Test elongate, round in cross section, initial chamber provided with a spine, apertural end acuminate.

Chambers distinct, 5 in number, gradually increasing in height as added, keeping the same breadth.

Sutures distinct, slightly depressed.

Wall ornamented with six distinct, low and narrow longitudinal ribs.

Length without spine: 0,8 mm.
Breadth: 0,2 mm.

Occurrence: Germany: Upper Cretaceous, Westphalia, Oberbayerische Alpen.
England: Hils and Gault.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mb, Md), South-Limburg.

TRISTIX MACFADYEN 1941.

Test free, hyaline, consisting of a number of chambers, generally triangular in section, joined in a straight series; aperture terminal, simple, according to VAN VOORTHUYZEN (1947) with an internal tube.

Tristix globuliferum (REUSS), pl. 3, fig. 12.

Rhabdogonium globuliferum REUSS 1860, p. 57, pl. 7, fig. 6.
FRANKE 1928, p. 73, pl. 6, fig. 21.
Dentalinopsis globuliferum (REUSS) BROTZEN 1936, p. 139, pl. 5, fig. 49.

Test globular, with acuminate apertural end.

Two chambers, the first is globular, the second has three offsets on this globe and is triangular in cross section, acuminate to the apertural end, with a round aperture.

Only one specimen.
Length: 0,35 mm.
Breadth: 0,28 mm.

Occurrence: Germany: Upper Senonian, Westphalia, Hannover.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Md), South-Limburg.

Remarks: The preservation of this one specimen is too poor to distinguish the internal tube.

PSEUDOGLANDULINA CUSHMAN 1929.

Test with chambers in a straight linear series, embracing the last-formed one making up a large proportion of the test; chambers uniserial throughout; aperture radiate, terminal.

Pseudoglandulina paralella (MARSSON), pl. 2, fig. 9.

Glandulina paralella MARSSON 1878 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 83, pl. 5, fig. 25.
Pseudoglandulina paralella (MARSSON), W. A. VISSER, p. 87.
CUSHMAN 1946, p. 77, pl. 27, fig. 35.

Test elongate, cylindrical with rounded initial end and acuminate apertural end.

Chambers indistinct, two in number, nearly equally large.

Sutures indistinct, oblique, slightly depressed.

Wall smooth.

Only one specimen.

Length: 0,85 mm.

Breadth: 0,44 mm.

Occurrence: Germany: Upper Cretaceous, Rügen and Oberbayerische Alpen.
Holland: Maestrichtian (Md), South-Limburg.
Trinidad: Upper Cretaceous, Lizard Springs.

FRONDICULARIA DEFRANCE 1824.

Test more compressed, in the early stage in the microspheric form sometimes partially coiled, megalospheric form not coiled, later chambers extending back on the two sides of the test forming inverted V-shaped (chevron-shaped) chambers; aperture terminal, radiate.

Frondicularia archiaciana D'ORBIGNY, pl. 7, fig. 2.

Frondicularia archiaciana D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
BRADY 1884, p. 520, pl. 114, fig. 12.
BEISSEL 1891 (pars), p. 39, pl. 8, fig. 1—12.
EGGER 1899, p. 87, pl. 10, fig. 19, 20.
FRANKE 1925, p. 52, pl. 2, fig. 18.
FRANKE 1928, p. 71, pl. 6, fig. 14, 15.
CUSHMAN 1930 (CCLF), p. 37, pl. 5, fig. 9—12.
SANDIGDE 1932, p. 278, pl. 42, fig. 15, 26.
CUSHMAN 1936 (CCLF), p. 19, pl. 4, fig. 8—10.
CRESPIN 1938, p. 394.
CUSHMAN & TODD 1943 (CCLF), p. 60, pl. 10, fig. 24.

Test oval, compressed on both sides, initial end obtuse, apertural end broken.

Periphery slightly lobate, angular with two right angles, nearly two keels, running as ribs along the inflated first chamber.

Chambers distinct, narrow, gradually increasing in size as added, initial chamber strongly inflated, the diameter is larger than the thickness of the test.

Sutures distinct, straight, strongly depressed.

Wall smooth, except on the initial chamber, which is provided with ribs, roughly perforate.

Only one broken specimen.

Breadth: 0,4 mm.

Thickness: 0,15 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
Holland: Maestrichtian (Md), South-Limburg.
U.S.A.: Ripley formation, Annona Chalk, Navarro in Texas and Arkansas.
Australia: Upper Cretaceous, N.W. basin.

Frondicularia biformis MARSSON, pl. 7, fig. 1.

Frondicularia biformis MARSSON 1878 (ELLIS & MESSINA Catalogue).
FRANKE 1925, p. 53, pl. 4, fig. 19.
FRANKE 1928, p. 72, pl. 6, fig. 19, 20.
MARIE 1941, p. 118, pl. 14, fig. 167.

Test oval, rounded initial end, acuminate apertural end.
Periphery broadly rounded, slightly lobate.
Chambers 6 in number, narrow, very gradually increasing in size as added.
Sutures straight, curved to the periphery, depressed.
Wall smooth, roughly perforate.

Only one specimen:
Length: 0,77 mm.
Breadth: 0,41 mm.
Thickness: 0,15 mm.

Occurrence: Germany: Upper Senonian, Pommeriana, Rügen.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Md), South-Limburg.

Subfamily *Lageninae.*

LAGENA WALKER & JACOB 1798.

Test consisting of a single chamber; wall calcareous, finely to coarsely perforate, often highly ornamented, with or without a neck, aperture radiate (rarely), rounded, elliptical or slitlike, terminal.
When provided with an internal tube we have to deal with Entosolenia (Family Buliminidae).

Lagena acuticostata REUSS, pl. 2, fig. 1.

Lagena acuticostata REUSS 1862, p. 305, pl. 1, fig. 4.
REUSS 1863, p. 331, pl. 5, fig. 63.
EGGER 1899, p. 106, pl. 5, fig. 12.
CUSHMAN 1931, p. 308, pl. 35, fig. 12.
CUSHMAN 1932, p. 357, pl. 35, fig. 13.
BROTZEN 1936, p. 112, textfig. 37.
CUSHMAN 1946, p. 94, pl. 39, fig. 14, 15.
Globulina myristiformis (not) WILLIAMSON: W. A. VISSER 1937, p. 87.

Test globular, aperture slightly produced.
Wall ornamented with 9 high longitudinal costae.

Only one specimen:
Diameter: 0,31 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mc), South-Limburg.
U.S.A.: Annona Chalk, Saratoga Chalk.

Remarks: BROTZEN (1936) gives a number of forms, which agree with the description of *Lagena isabella* D'ORBIGNY, *Lagena acuticostata* REUSS, *Lagena costata* WILLIAMSON and *Lagena sulcata* WALKER & JONES. These species are indeed very similar. BROTZEN calls them all *Lagena isabella.* For the only specimen, found in the Geulhem Maestrichtian I prefer the name *Lagena*

acuticostata, because REUSS describes the type-specimen from the same locality. I am sure therefore we are here concerned with the same species.

When we compare W. A. VISSER's (1937) *Globulina myristiformis* with my one specimen it turns out to be *Lagena acuticostata*.

Lagena aspera REUSS, pl. 2, fig. 3.

Lagena aspera REUSS 1863, p. 305, pl. 1, fig. 5.
FRANKE 1928, p. 88, pl. 8, fig. 7.
CRESPIN 1938, p. 394.
MARIE 1941, p. 77, pl. 9, fig. 92.

Test globular, apertural end slightly produced.
Wall ornamented with small spines, spread over the whole surface.

Diameter: 0,22—0,74 mm.

Occurrence: Germany: Upper Senonian, N.W. part.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Mc—Md), South-Limburg.
Australia: Upper Cretaceous, N.W. basin.

? Lagena globosa (MONTAGU) REUSS, pl. 2, fig. 4.

Vermiculum globosum MONTAGU 1803 (ELLIS & MESSINA Catalogue).
Lagena globosum (MONTAGU) REUSS 1863, p. 318, pl. 1, fig. 1—3.
EGGER 1899, p. 102, pl. 5, fig. 3.
FRANKE 1925, p. 59, pl. 4, fig. 36.
FRANKE 1928, p. 85, pl. 8, fig. 30.
BROTZEN 1936, p. 109, pl. 7, fig. 3.
W. A. VISSER 1937, p. 87.
VAN RAADSHOVEN 1940, p. 12.
CUSHMAN & HEDBERG 1941 (CCLF), p. 91, pl. 22, fig. 11—13.
CUSHMAN & TODD (CCLF), p. 61, pl. 10, fig. 27.
SCHLIFSMA 1946, p. 54, pl. 2, fig. 16.
Oolina globosa (MONTAGU) PARR 1947, p. 119, pl. 6, fig. 4.

Test globular to clavate, with produced radiate aperture.
Wall smooth, not ornamented, finely perforate.

Length (with produced aperture): 0,3—1,01 mm.
Breadth: 0,22—0,85 mm.

Occurrence: Germany: Hils and Gault, N. part; Emscherian and Senonian, N.W. part.
Sweden: Lower Senonian, Eriksdal.
Holland: Campanian and Maestrichtian (Mc—Md), South-Limburg.
Texas: Navarro, Corsicana Marl.
Colombia: Upper Cretaceous.

Remarks: CUSHMAN (1946) observes concerning the Cretaceous forms belonging to the genus *Lagena* and *Entosolenia* that these are too poorly preserved to be sure about the genus-name. Therefore he gives all these forms the genus-name *Lagena*, also when they are earlier described as *Entosolenia*. Concerning the species described above and the following I have

the same difficulty; therefore I give these two forms the genus-name *Lagena*.

The internal tube, the characteristic of *Entosolenia* is not visible, as most specimens are filled up with secondary chalk.

? Lagena lineata WILLIAMSON, pl. 2, fig. 2.

Entosolenia lineata WILLIAMSON 1848 (ELLIS & MESSINA Catalogue).
PARR 1947, p. 120.
Lagena lineata WILLIAMSON: CUSHMAN 1946, p. 95, pl. 39, fig. 25.

Test egg-shaped, slightly produced.
Wall ornamented with many low longitudinal ribs, hardly visible.

Height: 0,55 mm.
Thickness: 0,3 mm.
Breadth: 0,22 mm.

Occurrence: Holland: Maestrichtian (Mb—Mc), South-Limburg.
U.S.A.: Ripley formation, Tennessee.

Remarks: See the remarks of *Lagena globosa*. An internal tube is not visible in the two only specimens found.

FAMILY POLYMORPHINIDAE.

Subfamily *Polymorphininae*.

QUADRULINA CUSHMAN & OZAWA 1930.

Test with the chambers added in planes 90° apart from one another, that is arranged in a tetraloculine series, at least in the later stages; aperture terminal, radiate.

Quadrulina cf. rhabdogonoides (CHAPMAN), pl. 3, fig. 7.

For a synonymy vide CUSHMAN & OZAWA, 1930, p. 18.

Test oval, with acuminate initial end, obtuse apertural end. Last part slightly compressed, first part more or less quadrangular in cross section.

Chambers distinct, broad and short, first part tetraserial, last part biserial, about 7 chambers visible on one side.

Wall smooth.

Only one specimen.
Length: 0,96 mm.
Breadth: 0,6 mm.
Thickness: 0,48 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 18.
Add: Holland: Maestrichtian (Md), South-Limburg.

GUTTULINA D'ORBIGNY 1839.

Test with the chambers more or less elongated, added in planes 144° apart from one another, that is in a quinqueloculine series, each chamber as added removed farther from the base; aperture terminal, radiate.

Guttulina adhaerens (OLSZEWSKI) CUSHMAN & OZAWA, pl. 4, fig. 3.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 36.
Add to this list:

Guttulina adhaerens (OLSZEWSKI) CUSHMAN & JARVIS 1932, p. 40, pl. 40. fig. 8.
CRESPIN 1938, p. 393.
CUSHMAN & TODD 1943 (CCLF), p. 61, pl. 11, fig. 1.
CUSHMAN & DEADERICK 1944, p. 336, pl. 52, fig. 18.
CUSHMAN 1946, p. 96, pl. 40, fig. 8—10.
CUSHMAN & RENZ (CCLF), p. 43.

Test more or less flattened at one side, more or less inflated at the other, the cross section is indistinctly triangular.

The initial end very obtuse, the apertural end acuminate. The largest breadth is just above the initial end.

On the inflated side 1 or 2 chambers inflated between the last. On the flattened side 3 chambers visible. Chambers long and narrow.

Sutures distinct, depressed.

Wall smooth.

Length: 0,97—0,41 mm.
Breadth: 1—0,26 mm.
Thickness: 0,48—0,22 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 36.
Add: Holland: Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.
Trinidad: Upper Cretaceous.
Australia: Upper Cretaceous.

Remarks: This species resembles *Guttulina problema*, but *G. adhaerens* has always longer and narrower chambers, is less inflated and much more slightly built. It is possible, that the three species *G. problema, G. trigonula* and *G. adhaerens* are only three generations of one species.

Guttulina caudata (D'ORBIGNY), pl. 4, fig. 6.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 36.
Add: *Guttulina caudata* (D'ORBIGNY) VAN RAADSHOVEN 1940, p. 12.

Test slightly triangular in form, also in cross section, initial end rounded and provided with a spine, apertural end acuminate.

Periphery rounded.

Chambers elongate, each successive nearly reaching the base. Four chambers on the somewhat inflated side of the test, three chambers visible on the flattened one.

Sutures distinct, slightly depressed.

Wall smooth.

Length (except spine): 0,83—0,44 mm.
Breadth: 0,7—0,33 mm.
Thickness: 0,44—0,22 mm.

Occurrence: vide CUSHMAN & OZAWA 1930, p. 36.
Add: Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: CUSHMAN & OZAWA (1930) mention two *Guttulina's* with a spine: *Guttulina caudata* D'ORBIGNY from the Eocene and *Guttulina adhaerens* (OLSZEWSKI) var. *cuspidata* CUSHMAN & OZAWA from the Cretaceous. These two forms are very much alike: *G. caudata* is more compressed than *G. adhaerens* var. *cuspidata*.

The features of the species described above agree in most respects with the Eocene one. It differs in its dimensions, as it is larger than the *G. caudata* described by CUSHMAN & OZAWA. The triangular compressed form and the elongate chambers are like *G. caudata*. On comparing the specimens, mentioned by VAN RAADSHOVEN (1940) with my own I am convinced that they are of the same species. So I consider it correct to call this species *Guttulina caudata* as VAN RAADSHOVEN did.

The figure XXXIII of HOFKER (1930) also seems to me a *Guttulina caudata* and not a *Polymorphina fusiformis* (ROEMER).

Guttulina paalzowi CUSHMAN & OZAWA, pl. 4, fig. 4.

Guttulina paalzowi CUSHMAN & OZAWA 1930, p. 46, pl. 11, fig. 4.

Test long and narrow, obtuse at both ends, more or less round in cross section.

Chambers distinct, broad, 5 or 6 in number, each successive chamber not reaching to the base.

Sutures not distinct, slightly depressed.

Wall smooth and thick.

Length: 1,33—1,19 mm.
Breadth: 0,55—0,48 mm.
Thickness: 0,44—0,37 mm.

Occurrence: Holland: Maestrichtian (Mb—Md), South-Limburg.

Guttulina problema D'ORBIGNY, pl. 4, fig. 1.

For an extensive synonymy vide CUSHMAN & OZAWA 1930, p. 19.
Add to this list:

Polymorphina communis D'ORBIGNY: HOFKER 1930, p. 4, fig. III—V, p. 15, fig. XXIX—XXXI.
HENSOLDT 1938, p. 363.
Guttulina communis D'ORBIGNY: W. A. VISSER 1937, p. 87.
BROTZEN 1948, p. 49.
Guttulina problema D'ORBIGNY: CRESPIN 1938, p. 395.
SCHIJFSMA 1946, p. 67.
BROTZEN 1948, p. 49.

Test very remarkable for its always rounded triangular cross section. Initial end rounded (shape more or less diamond-shaped) or forming a straight line with the following chambers (shape more or less triangular). Between these extremes there are many intermediate forms.

Four or three chambers visible at the more or less inflated side. 1 or 2 inflated and produced between the two other chambers.

Three chambers visible at the more or less flattened side.

Sutures always distinct, sometimes depressed.

Wall smooth.

Length: 1,5—0,26 mm.
Breadth: 1,2—0,25 mm.
Thickness: 0,85—0,2 mm.

Occurrence: Germany: Upper Cretaceous, East Prussia.
Sweden: Upper Cretaceous, Palaeocene, South-Sweden.
Holland: Hervian, Maestrichtian (Ma—Md), South-Limburg.
Australia: Upper Cretaceous, N.W. basin.

Vide for further references CUSHMAN & OZAWA 1936, p. 19.

Remarks: This species resembles *Guttulina trigonula* (REUSS). The difference is that *G. trigonula* has always the form of an isosceles triangle and the greatest breadth is always larger than its length. *Guttulina problema* has never these characteristics. Yet it is sometimes difficult to decide whether the specimen is a *Guttulina problema* or a *Guttulina trigonula*.

BROTZEN (1948) distinguishes *Guttulina problema* and *Guttulina communis* D'ORBIGNY. *G. problema* is said to be elongate and more developed, *G. communis* is short and broad. In my opinion CUSHMAN & OZAWA (1930) have conclusively proved that these two forms are the same.

Guttulina problema D'ORBIGNY var. I, pl. 1, fig. 13.

This variety differs from *G. problema* in the acute periphery and the rib running along the inflated part of the test. The cross section is in consequence triangular with acute angles.

Only one specimen.
Length: 0,84 mm.
Breadth: 0,6 mm.
Thickness: 0,44 mm.

Holotype: No. 18774 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, K 1 (Md).

Guttulina trigonula (REUSS), pl. 4, fig. 5.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 28.
Add: *Guttulina trigonula* (REUSS) BROTZEN 1936, p. 113, pl. 7, fig. 13.
VAN RAADSHOVEN 1940, p. 12.
CUSHMAN 1946, p. 95, pl. 40, fig. 6, 7.

Test rounded triangular in cross section and in outside form. Initial part forms with the following chambers the right line of the base of an isosceles triangle, the outside form of the test.

Four chambers visible on the inflated side, two inflated and produced between the two last chambers. Three chambers visible on the flattened side (the base of the triangle of the cross section).

Sutures distinct, depressed.
The greatest breadth is just above the base.
Wall smooth.

Length: 1,1—0,3 mm.
Breadth: 1,26—0,43 mm.
Thickness: 0,78—0,26 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 28.
Add: Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Remarks: See for the differences with *Guttulina problema* there.

Guttulina uviformis (REUSS), pl. 1, fig. 14.

Guttulina spicaeformis (ROEMER) CUSHMAN & OZAWA 1930 (pars), p. 31.

Test elongate, obtuse on both ends, slightly compressed, more or less oval in cross section.

Chambers distinct, slightly inflated, short and broad, the last two larger than the earlier chambers.

Sutures distinct, depressed.

Wall smooth.

Only one specimen.

Length: 0,82 mm.

Breadth: 0,37 mm.

Thickness: 0,33 mm.

Occurrence: Vide CUSHMAN and OZAWA 1930, p. 31.

Add: Holland: Maestrichtian (Me), South-Limburg.

Remarks: CUSHMAN & OZAWA (1930) put this species under the synonymy of the species *Guttulina spicaeformis* (ROEMER) from the Tertiary. They call *Guttulina uviformis* a Cretaceous representative of this species and an intermediate form between *Guttulina hantkeni* CUSHMAN & OZAWA and *Guttulina spicaeformis*. REUSS' figure agrees with my specimens and not with the figures of *Guttulina spicaeformis* and *Guttulina hantkeni*, given by CUSHMAN & OZAWA. So I would like to give my species the name of *Guttulina uviformis*.

GLOBULINA D'ORBIGNY 1839.

Test globular or somewhat elongate, rounded or somewhat compressed in section: chambers somewhat quinqueloculine, but due to overlapping, appearing triserial; sutures usually not depressed, aperture terminal, radiate.

Globulina exserta (BERTHELIN), pl. 4, fig. 9.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 80.

Test oval, slightly compressed, oval in cross section, both ends more or less produced.

Chambers distinct, the first small, the latter much larger, forming nearly the whole test, 5 in number.

Sutures distinct, depressed.

Wall smooth, thick.

Length: 0,92—0,74 mm.

Breadth: 0,66—0,48 mm.

Thickness: 0,66—0,41 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 80.

Add: Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: The dimensions are in every case larger than those given by CUSHMAN & OZAWA (1930).

On comparing the figures, given by BERTHELIN my species agree partly with *Polymorphina bucculenta* BERTHELIN, partly with *Polymorphina exserta* BERTHELIN. CUSHMAN & OZAWA consider both species only as varieties of one species. *P. exserta* has a distinct acute initial end, according to BERTHELIN. My specimens lack this characteristic.

Globulina gravis (KARRER), pl. 4, fig. 11.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 84.

Add: *Globulina gravis* (KARRER) HOFKER 1926, p. 10.
VAN RAADSHOVEN 1940, p. 12.
MARIE 1941, p. 168, pl. 23, fig. 240—242.

Test egg-shaped, slightly triangular in cross section, initial end rounded, apertural end acuminate.

Chambers distinct, about 4 visible on both sides, more of less triserially arranged.

Sutures distinct, depressed.

Wall smooth.

Length: 1,91—0,63 mm.
Breadth: 0,55—0,41 mm.
Thickness: 0,48—0,33 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 84.
Add: France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Globulina lacrima REUSS, pl. 4, fig. 7.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 77.
Add to this list: *Polymorphina gibba* D'ORBIGNY: HOFKER 1930, p. 5, fig. VII—XI.
Globulina gibba D'ORBIGNY: W. A. VISSER 1937, p. 87.
Globulina lacrima REUSS: VAN RAADSHOVEN 1940, p. 12.
VIEAUX 1941, p. 624.
GOUDKOFF 1945, p. 967.
GLAESSNER 1945, p. 157.
SCHIJFSMA 1946, p. 66, pl. 7, fig. 2.
BROTZEN 1948, p. 48.

Test globular, apertural end usually produced, initial end rounded.
Chambers few, about 3 visible.
Sutures distinct, not depressed.
Wall smooth.

Diameter: 0,92—0,22 mm.
Thickness: 0,74—0,16 mm.

Occurrence: Vide CUSHMAN & OZAWA, p. 77.
Add: Sweden: Danian, Oresund.
Holland: Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Denton formation, Texas .
New Guinea: Upper Cretaceous, Highlands.

Globulina lacrima REUSS **cf. var. horrida** REUSS, pl. 7, fig. 17.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 79.

This variety differs from *Globulina lacrima* by the wall, which is provided with very small spines.

Only one specimen (S 14).
Diameter: 0,37 mm.

Occurrence: see CUSHMAN & OZAWA 1930, p. 79.
Add: Holland: Maestrichtian (Mb), South-Limburg.

Remarks: CUSHMAN & OZAWA (1930) notice that this form has mostly a fistulose apertural end. The Limburg specimen lacks this characteristic.

Globulina lacrima REUSS **var. subsphaerica** (BERTHELIN), pl. 4, fig. 8.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 78.
Add: *Globulina lacrima* REUSS var. *subsphaerica* (BERTHELIN) TAPPAN 1940, p. 111, pl. 17, fig. 24.
CUSHMAN & GOUDKOFF 1944 (CCLF), p. 57, pl. 9, fig. 14.
CUSHMAN 1946, p. 96, pl. 40, fig. 13.

Test slightly compressed, egg-formed, with rounded initial end and produced apertural end.
Other characteristics like *Guttulina lacrima* REUSS.

Length: 1,26—0,26 mm.
Breadth: 0,93—0,22 mm.
Thickness: 0,73—0,18 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 78.
Add: Holland: Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region, California, Texas.
Trinidad: Upper Cretaceous.

Globulina lacrima REUSS **var. I**, pl. 1, fig. 12.

This variety differs only in the ornamented wall, provided with small knobs, giving a rough exterior.

Only one specimen:
Length: 0,6 mm.
Breadth: 0,6 mm.

Holotype: No. 18776 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, K 1 (Md).

Globulina lacrima REUSS **var. II**, pl. 1, fig. 11.

This variety differs only in the ornamentation of the wall. The initial part is ornamented with high short ribs, irregularly spread over the surface of the wall. The last part is smooth.

Only one specimen.
Length: 0,66 mm.
Breadth: 0,52 mm.

Holotype: No. 18775 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, K 1 (Md).

Globulina prisca (REUSS), pl. 4, fig. 2.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 73.
Add: *Globulina prisca* (REUSS) BROTZEN 1936, p. 114, pl. 7, fig. 11.
VAN RAADSHOVEN 1940, p. 12.
MARIE 1941, p. 168, pl. 22, fig. 238, 239.
CUSHMAN 1946, p. 97, pl. 40, fig. 15—17.
TEN DAM 1948, p. 175.

Test small and slender, oval in cross section. The apertural end more acute than the initial end, being rounded-subacute.

The greatest breadth is at the middle of the test.

Three chambers visible on both sides, the two last nearly extending to the initial end.

Sutures indistinct.

Wall smooth.

Length: 1,2—0,26 mm.
Breadth: 0,55—0,18 mm.
Thickness: 0,48—0,18 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 73.
Add: France: Craie Blanche, Basin of Paris.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Globulina rotundata (BORNEMANN), pl. 4, fig. 10.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 86.
Add: *Globulina rotundata* (BORNEMANN) HOFKER 1930 (pars), p. 8, fig. XIII.
W. A. VISSER 1937, p. 87.
VAN RAADSHOVEN 1940, p. 12.

Test more or less clavate, initial end always rounded, apertural end more or less produced. Cross section round .

Chambers few in number, not always distinct, elongate.

Sutures indistinct, not depressed.

Wall smooth, usually thick.

Length: 0,81—0,55 mm.
Breadth: 0,52—0,37 mm.
Two aberrant specimens with a length: 1,33 and 1,2 mm, and a breadth: 0,9 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 86.
Add: Holland: Maestrichtian (Ma, Mc—Md),South-Limburg.

Remarks: According to CUSHMAN & OZAWA (1930) *Globulina rotundata* is a Tertiary species. They mention *Globulina ampla* as the corresponding form in the Cretaceous. But on account of the produced apertural end, it being the only difference between *G. rotundata* and *G. ampla* I call this species *G. rotundata*, just as HOFKER (1930), W. A. VISSER (1937) and VAN RAADSHOVEN (1940) do.

On comparing my specimens with the original figure of BORNEMANN and the figures given by CUSHMAN & OZAWA there is more resemblance between my specimens and BORNEMANN's figure, because the last misses the more or less produced apertural end.

The resemblance to *Globulina exserta* and *Globulina gravis* is also great. *Globulina gravis* is always distinguishable from *Globulina rotundata* by its more or less depressed sutures, especially the suture between the last chamber and the last but one chamber. Moreover *G. gravis* has a slightly triangular cross section.

Globulina exserta has always two remarkable large last chambers, is oval in cross section.

The outside form of all three are the same: clavate to oval.

SCHLIFSMA (1946) describes a *Globulina spec.*, showing much resemblance to *Globulina rotundata.* He does not call this species *rotundata,* because *G. rotundata* is a Tertiary species.

SCHLIFSMA's figures do not agree with my specimens, so I think his species is different.

PYRULINA D'ORBIGNY 1839.

Test elongate or fusiform, with the early chambers triloculine, later biserial, in the early stages of microspheric form quinqueloculine; aperture terminal, radiate.

Pyrulina acuminata D'ORBIGNY, pl. 3, fig. 4.

For a synonymy vide CUSHMAN & OZAWA, p. 58.
Add: *Pyrulina acuminata* D'ORBIGNY: MARIE 1937, p. 264.
MARIE 1941, p. 170, pl. 24, fig. 243, 246.

Test on both sides acuminate, nearly circular in cross section.

The first chambers small, the last much larger, forming about two-third of the test, arranged in a biserial series, except the very first part perhaps.

Sutures indistinct, not depressed.

Wall smooth.

Length: 0,66—0,55 mm.
Breadth: 0,4—0,33 mm.
Thickness: 0,37—0,3 mm.

Occurrence: Vide CUSHMAN & OZAWA, p. 58.
Add: France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: The dimensions of these specimens are smaller than those given by CUSHMAN & OZAWA (1930).

Pyrulina cylindroides (ROEMER), pl. 3, fig. 5.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 56.
Add: *Pyrulinella cylindroides* (ROEMER) HOFKER 1930, p. 13, fig. XXVI—XXVIII.
Pyrulina cylindroides (ROEMER) TAPPAN 1940, p. 114, pl. 8, fig. 1.
VAN RAADSHOVEN 1940, p. 12.
CUSHMAN & TODD 1943 (CCLF), p. 62, pl. 11, fig. 2.
CUSHMAN 1946, p. 97, pl. 40, fig. 18, 19.
CUSHMAN & RENZ 1947, p. 43.

Test elongate, oval to circular in cross section.

Apertural end and initial end acuminate, apertural end more than the initial one.

Chambers elongate, each farther removed from the initial end, varying in number.

Sutures depressed.

Length: 1—0,50 mm.
Breadth: 0,41—0,22 mm.
Thickness: 0,5—0,22 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 56.
Add: Holland: Maestrichtian (Ma, Mc—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region; Corsicana Marl and Grayson formation, Texas.
Trinidad: Upper Cretaceous.

PSEUDOPOLYMORPHINA CUSHMAN & OZAWA 1930.

Test elongate, usually somewhat compressed, early chambers quinqueloculine, later ones becoming biserial, slightly overlapping; aperture terminal, radiate.

Pseudopolymorphina digitata (D'ORBIGNY), pl. 4, fig. 14.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 108.
Add: *Globulina rotundata* (not BORNEMANN) HOFKER 1930 (pars), fig. XIV, XV, XVIa, XVII, XVIII.
Pseudopolymorphina digitata (D'ORBIGNY) CUSHMAN 1936, p. 418.
VAN RAADSHOVEN 1940, p. 12.
SCHIJFSMA 1946, p. 67, pl. 7, fig. 6.
CUSHMAN 1946, p. 98, pl. 40, fig. 21.

Test elongate, like a cylinder, usually round in cross section, sometimes slightly depressed. Initial end rounded, apertural end more produced.
Chambers slightly biserial with oblique sutures, broad and short, varying in number.
Sutures distinct, not depressed.
Wall smooth.

Length: 1,77—0,92 mm.
Breadth: 0,63—0,33 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 108.
Add: Holland: Hervian, Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Pseudopolymorphina incerta (EGGER), pl. 4, fig. 15.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 110.
Add: *Pseudopolymorphina incerta* (EGGER) CUSHMAN 1946, pl. 4, fig. 1.

Test oval, compressed on both sides, rounded periphery, initial and apertural end.
Chambers: three or four visible on both sides, broad. First sometimes produced between the latter.
Sutures distinct, not depressed.
Wall smooth.

Length: 1,07—0,52 mm.
Breadth: 0,6—0,4 mm.
Thickness: 0,41—0,26 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 110.
Add: Holland: Maestrichtian (Ma, Mc—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Pseudopolymorphina leopolitana (REUSS), pl. 4, fig. 12.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 108.
Add: *Polymorphina rudis* not REUSS: HOFKER 1930, p. 11, fig. XXI—XXV.

Test elongate, oval, slightly compressed, rounded initial and apertural end. Periphery rounded.

Chambers of the initial part biserial, to the apertural end inclining to be uniserial, 5—6 visible on both sides, shorter and broader than the chambers of *Pseudopolymorphina soldanii.*

Sutures distinct, slightly depressed.

Wall smooth.

Length: 1,28—0,7 mm.
Breadth: 0,74—0,3 mm.
Thickness: 0,66—0,22 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 108.
Add: Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: This species differs from *Pseudopolymorphina soldanii* in the form and the arrangement of the chambers: *P. soldanii*: triserial to biserial, *P. leopolitana*: biserial to uniserial. Besides *P. leopolitana* is always more inflated than *P. soldanii.*

Pseudopolymorphina soldanii D'ORBIGNY, pl. 4, fig. 13.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 92.
Add: *Globulina rotundata* (not BORNEMANN) HOFKER 1930 (pars), fig. XVI.
Polymorphina soldanii D'ORBIGNY: HOFKER 1930, p. 11, fig. XX.
Pseudopolymorphina soldanii D'ORBIGNY: VAN RAADSHOVEN 1940, p. 12.
SCHIJFSMA 1946, p. 8, pl. 7, fig. 7.

Test oval, compressed on both sides, initial end rounded, apertural end more produced.

Periphery rounded.

Chambers 5—6 visible on both sides, triserial in the initial part, inclining to be biserial to the apertural end, more narrow than the chambers of *Pseudopolymorphina incerta.*

Sutures more or less depressed.

Wall smooth.

Length: 1,63—0,74 mm.
Breadth: 0,81—0,44 mm.
Thickness: 0,63—0,26 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 92.
Add: Holland: Hervian, Maestrichtian (Ma—Md), South-Limburg.

Remarks: This species differs from *Pseudopolymorphina incerta* in its narrow chambers and the depressed sutures. Moreover the specimens are always larger than those of *Pseudopolymorphina incerta.*

SIGMOMORPHINA CUSHMAN & OZAWA 1930.

Test compressed, in the adult at least, with chambers added in planes, slightly less than 180° and more than 144° from one another, each proceeding chamber farther removed from the base; aperture terminal, radiate.

Sigmomorphina kronenburgae sp. n., pl. 3, fig. 3.

Test oval with acuminate ends, slightly compressed, in cross section oval.

Chambers distinct, elongate, broader than the chambers of *Sigmomorphina soluta,* each successive chamber farther removed from the base.

Sutures distinct, not depressed.
Wall smooth.

Length: 0,85—0,41 mm.
Breadth: 0,44—0,3 mm.
Thickness: 0,33—0,18 mm.

Holotype: No. 18766 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, B 1 (Mc).

Remarks: I have given the name *Sigmomorphina kronenburgae* in honour of Miss G. KRONENBURG, librarian of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Sigmomorphina semitecta (REUSS) **var. terquemiana** (FORNASINI), pl. 4, fig. 16.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 129.
Add: *Sigmomorphina semitecta* (REUSS) var. *terquemiana* (FORNASINI) CUSHMAN 1946, p. 98, pl. 41, fig. 13.
CUSHMAN & RENZ 1947 (CCLF), p. 44.

Test oval with obtuse ends, slightly compressed.
Periphery rounded.
Chambers distinct, elongate, each successive chamber farther removed from the base, about 6 visible on both sides.
Wall smooth.

Length: 0,55—1,04 mm.
Breadth: 0,26—0,48 mm.
Thickness: 0,22—0,3 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 129.
Add: Holland: Maestrichtian (Ma, Mc—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.
Trinidad: Upper Cretaceous.

Remarks: These specimens are narrower and larger than the specimens, measured by CUSHMAN & OZAWA (1930).

Sigmomorphina soluta BROTZEN, pl. 3, fig. 1.

Polymorphina fusiformis (not ROEMER) HOFKER 1930 (pars), fig. XXXII.
Sigmomorphina sp. VAN RAADSHOVEN 1940, p. 12.
Sigmomorphina soluta BROTZEN 1948, p. 53, pl. 8, fig. 6—10, textfig. 10: 16.

Test elongate, compressed on both sides, broadly oval in form. Initial end usually provided with a spine, apertural end acuminate.
Periphery rounded.
Chambers distinct, clavate, each successive chamber farther removed from the base, varying in number, usually five.
Sutures distinct, depressed.
Wall smooth.

Length (except spine): 1,4—0,55 mm.
Breadth: 0,33—0,26 mm.
Thickness: 0,33—0,26 mm.

Occurrence: Sweden, Danian, Paleocene, South-Sweden.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: HOFKER (1930) calls this species *Polymorphina fusiformis*. He makes comparisons with *Guttulina elliptica* and *Polymorphina leopolitana* (both described by REUSS). Both lack the elongate chambers, the spine of the initial end and the compressed form of the test, all features of *P. fusiformis*, according to HOFKER.

According to CUSHMAN & OZAWA (1930) *Pyrulina fusiformis* (ROEMER) is a species with a fusiform to cylindrical test, acute at both ends, almost circular in end view, chambers rather short, first arranged in a nearly triserial series, later becoming biserial, sutures not depressed. This description and the figure given agree with the bad description and the figure of ROEMER himself, so HOFKER's *Polymorphina fusiformis* is not a *fusiformis*, but a species unknown in 1930.

BROTZEN (1948) describes *Sigmomorphina soluta* as a new species which perfectly agrees with the figure of HOFKER (1930), the specimens of *Sigmomorphina sp.* of VAN RAADSHOVEN and my specimens.

Sigmomorphina sp., pl. 3, fig. 2.

Test elongate, compressed, acuminate at the initial end, obtuse at the apertural end, keeping the same breadth from the initial end to the apertural end.

Chambers distinct, very narrow and elongate, each successive chamber only a little bit farther removed from the base, about 7 in number.

Sutures distinct, depressed.

Wall smooth.

Only one whole and five damaged specimens
Length: 1,33 mm.
Breadth: 0,41 mm.
Thickness: 0,22 mm.

Holotype: No. 18765 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Geulhem, G 15 (Md).

SIGMOIDELLA CUSHMAN & OZAWA 1930.

Test compressed, with the chambers in sigmoid series, but each reaching to the base and embracing the preceding ones of the same series at one side; aperture terminal, radiate.

Sigmoidella cf. elegantissima (PARKER & JONES), pl. 3, fig. 6.

For a synonymy vide CUSHMAN & OZAWA 1930, p. 140.
Add: *Polymorphina elegantissima* (PARKER & JONES) HOFKER 1930, pl. 19, fig. XXXV.

Only one broken specimen, in form more like HOFKER's figure than like CUSHMAN & OZAWA's.

Test broadly ovate, compressed, more or less acute apertural end, a very broadly rounded initial end.

Periphery slightly angulate.

Chambers distinct, elongate, about 5 visible on both sides.

Sutures distinct, not depressed.

Wall smooth.

Length: about 0,9 mm.
Breadth: 0,55 mm.
Thickness: 0,33 mm.

Occurrence: Vide CUSHMAN & OZAWA 1930, p. 140.
Add: Holland: Maestrichtian (Md), South-Limburg.

Remarks: HOFKER (1930) mentions one specimen from Houthem. My specimen from Geulhem near Houthem, has a more angulate periphery than HOFKER's specimen, lacks the angulate margin of the chambers, mentioned by CUSHMAN & OZAWA (1930) and visible in the figure of BRADY (1884).

The specimens of HOFKER and myself are probably of the same species, only differing from *Sigmoidella elegantissima* by the non-angulate margin of the chambers, a result of poor preservation.

Subfamily *Ramulininae*.

ENANTIOMARGINULINA MARIE 1941.

Test close coiled, composed of alternating chambers; wall calcareous, finely perforate; aperture radiate, at the peripheral angle of the last-formed chamber.

This genus recently erected by MARIE (1941) is placed in this family with some restriction until the early stages can be studied further.

Enantiomarginulina elongata (D'ORBIGNY) MARIE, pl. 7, fig. 5.

Marginulina elongata D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 95, pl. 9, fig. 22.
FRANKE 1925, p. 55, pl. 4, fig. 26.
FRANKE 1928, p. 76, pl. 7, fig. 6, 7.
EICHENBERG 1933, p. 9, pl. 2, fig. 19.
CUSHMAN 1937 (CCLF), pl. 14, fig. 8.
MARIE 1937, p. 263.
Enantiomarginulina elongata (D'ORBIGNY) MARIE 1941, p. 164, pl. 20, fig. 232; pl. 21, fig. 233.

Test elongate, initial part curved, following part cylindrical, initial end obtuse, apertural end acuminate.

Chambers indistinct in the curved part, the following part numbers in my young specimen two chambers, as broad as high.

Sutures indistinct, not depressed, oblique.

Wall smooth.

Only one specimen.
Length: 0,56 mm.
Breadth: 0,24 mm.

Occurrence: Germany: Turonian—Senonian, N.W. part; Upper Cretaceous, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Belgique: Craie Blanche, Ciply.
Holland: Maestrichtian (Md), South-Limburg.

FAMILY NONIONIDAE.

NONION MONTFORT 1808.

Test free, planispiral, more or less involute, bilaterally symmetrical, periphery broadly rounded to acute; chambers numerous; wall finely of coarsely perforate, calcareous; aperture median, an arched, usually low opening between the base of the apertural face and the preceding coil.

Nonion troostae sp. n., pl. 6, fig. 13.

Test oval, triangular in transverse section, on both sides a small umbilicus. The apertural face is triangular and cut in by the initial end. The initial end is about half the apertural face.

Periphery acute to subacute, especially the periphery of the initial end.

Chambers distinct, triangular, narrow and long, rapidly increasing in height as added, 8—10 visible in the last whorl.

Sutures distinct, slightly depressed, especially in the last part.

Wall very smooth.

Length: 0,26—0,82 mm.
Breadth: 0,15—0,52 mm.
Thickness (= breadth of the apertural face): 0,15—0,37 mm.

Holotype: No. 18818 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Sint Pietersberg, K 1.

Occurrence: Ma—Md.

Remarks: At first sight this species seems to be a *Cristellaria*. The aperture at the margin of the last chamber is not always distinct. So it is understandable that W. A. VISSER (1937) describes this species partly as *Robulus multiseptus*. The Gulpen specimens are indeed *Robulus multiseptus*. The Maestricht specimens, however, are *Nonion troostae*.

In his manuscript[1]) HOFKER describes this species as *Nonionella cretacea* CUSHMAN. But on comparing his specimens in the collection of the "Geologische Stichting" at Haarlem with CUSHMAN's figures and description there is no likeness whatever. I can agree with the alliance to *Nonionella extensa* BROTZEN, also mentioned by HOFKER, but the test of this new species is quite symmetric and not provided with an overlapping chamber on one side, visible at *Nonionella extensa*.

I have called this species *Nonion troostae* in honour of Miss G. TROOST, assistant at the micropaleontological laboratory of the "Rijksmuseum voor Geologie en Mineralogie" at Leiden.

NONIONELLA CUSHMAN 1926.

Test free, subtrochoid, dorsal side only partially involute, ventral side completely so, close coiled; chambers in the adult inequilateral developing a distinct, elongate lobe at the umbilical end, covering the umbilicus, wall calcareous, finely perforate; aperture at the base of the apertural face, low and elongate, extending from the periphery toward the ventral side.

Nonionella cf. ansata CUSHMAN, pl. 6, fig. 12.

Nonionella ansata CUSHMAN 1938 (CCLF), p. 44, pl. 7, fig. 7.
CUSHMAN 1946, p. 101, pl. 44, fig. 1.

Test oval, compressed on both sides.

Periphery rounded.

Chambers distinct, 10 in number, triangular. The height increases very rapidly as added. The last chamber is about 3 times higher than the initial coiled part.

[1]) See note, page 208.

Sutures distinct, slightly curved to the periphery.

Wall smooth.

The lobe, covering the umbilicus at the umbilical side is not distinct. The last two chambers cover the umbilicus on the one side more than on the other.

Only one specimen.

Length: 0,8 mm.

Breadth: 0,63 mm.

Thickness: 0,41 mm.

Occurrence: Holland: Maestrichtian (Mc), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Remarks: This species resembles to a great extent *Nonionella ansata* CUSHMAN, but is larger. The latter moreover occurs in America only.

As I only found one specimen, I cannot be certain, that this is a real *Nonionella ansata* and not a related new species.

FAMILY CAMERINIDAE.

Subfamily *Camerininae*.

OPERCULINA D'ORBIGNY 1826.

Test bilaterally symmetrical, planispiral, complanate, usually all coils visible from the exterior, earlier coils sometimes involute, chambers undivided; periphery with a thickened "marginal chord"; wall calcareous, perforate, smooth or ornamented with bosses; aperture single, at the base of the apertural face, median.

Operculina fleuriausi (D'ORBIGNY), pl. 1, fig. 17, pl. 10, fig. 1 and 6.

Amphistegina fleuriausi D'ORBIGNY 1826 (ELLIS & MESSINA Catalogue).
REUSS 1862, p. 308, pl. 1, fig. 10—12.
HOFKER 1926, p. 29 and p. 79, 2 textfig.
? BROTZEN 1935, p. 372.
VAN RAADSHOVEN 1940, p. 12.
Operculina complanata (not DEFRANCE) W. A. VISSER 1937, p. 87.
Operculina complanata (DEFRANCE) var. *granulosa* (LEYMERIE) BRADY 1884, p. 743, pl. 62, fig. 6, 7, 9, 10.
BANNINK 1948, p. 80.

Test round, biconvex, adult specimens have a strongly flattened last whorl round the biconvex inner part.

Periphery subacute, in the adult thickened and more thick than the flattened last whorl.

Chambers indistinct, great in number, inner whorls covered by the pustules of the ornamentation.

Sutures sometimes distinct, strongly curved backward.

Wall ornamented with sometimes more, sometimes fewer pustules, large in the centre, smaller to the periphery, placed along the sutures, sometimes wholly missing. There are many transitions between very ornamented walls to smooth walls.

Thin-section:

Horizontal: 29—39 high and narrow chambers in 3 to 4 evolute (except the last, which can be involute) whorls, rather rapidly increasing in height

as added. The last whorl is therefore about 7 times broader than the first. One stolon at the margin of the earlier whorl.

A canal-system is present, simple in the septal wall, complicate in the spiral wall.

The initial chamber is round and has a diameter of 0,04—0,05 mm.

Vertical: planispiral. Pillars extend from the centre into the pustules on the surface. Sometimes a noose is formed at the periphery, caused by the marginal bending.

I do not find microspheric forms.

Diameter: 0,41—1,63 mm.
Thickness: 0,19—0,52 mm.

Occurrence: ? Sweden: Mucronaten Senonian, Harvik.
Holland: Maestrichtian (Md), South-Limburg.

Remarks: This very remarkable species was first mentioned by D'ORBIGNY in his Tableau méthodique de la classe des Cephalopodes (1826, Ann. Sc. Nat. vol. 7, p. 304).

REUSS (1862) describes it accurately from the Maestricht Cretaceous. He mentions also the canal-system noticed by me.

BRADY (1884) enters this species in the synonymy of *Operculina complanata* (DEFRANCE). He points out the transitions which occur between the smooth forms (real *Operculina complanata*) and the ornamented forms which according to him are equal to the form *Operculina granulosa,* described by LEYMERIE. As there is no distinction between these forms he describes the last form (*O. granulosa*) as a variation of *O. complanata.* Apart from the fact that I doubt that this Tertiary form is the same as the Cretaceous *Operculina fleuriausi* it is contradictory to the rules of nomenclature to substitute the species-name *granulosa* for the species-name *fleuriausi,* as D'ORBIGNY gives the name first.

HOFKER (1926) supposes that the form is no *Operculina,* because he does not find a canal-system. He insists upon the old species-name *fleuriausi* and adds *Operculina cretacea* REUSS (1862) to this species as the microspheric form. A third form, which occurs less, without backward curved sutures is supposed to be the A_1-generation. These two latter forms are smooth, the A_1-form, however, has a rough wall.

W. A. VISSER (1937) follows BRADY (1884) without comment and calls this species *Operculina complanata* without pointing out the difference with the real *O. complanata,* which is smooth.

BANNINK (1948) shares the opinion of BRADY (1884) that *Operculina complanata* var. *granulosa* occurs in the Maestrichtian of Holland, but he does not speak of the form *Amphistegina fleuriausi.*

As, according to my researches, this form has a canal-system, simple in the septal wall, complicated in the spiral wall and as moreover the whorls increase very rapidly in height as added, the genus-name *Operculina* seems right to me.

But, according to the rules of nomenclature the species-name *granulosa* of LEYMERIE must be abandoned, for the species-name of *fleuriausi* of D'ORBIGNY has priority, unless further researches show, that *Operculina granulosa* is a form different from *Operculina fleuriausi.*

As *Operculina complanata* exclusively occurs in the Tertiary, it seems desirable to take this form not as a variety of *O. complanata,* but as an independent species, which must be called *Operculina fleuriausi.*

HOFKER (manuscript[1]) also finds a canal-system in this species, but only septal. On account of this he changes the genus-name into *Camerina*. As *Camerina* never has such whorls, rapidly increasing in height as this forms shows, the genus-name *Operculina* is the correct one.

Operculina labanae sp. n., pl. 1, fig. 18, pl. 10, fig. 2, 3.

Amphistegina fleuriausi (D'ORBIGNY) form A_1 HOFKER 1926, p. 80, fig. 5—10, 13.

Test round, compressed, slightly conic on both sides, sometimes one side more conic than the other.

Periphery subacute, slightly lobate.

Chambers involutely arranged, 12—16 in the last whorl, rapidly increasing in height as added.

Sutures distinct, limbate, sometimes raised, radial, sometimes slightly curved backward at the periphery.

Wall smooth, not ornamented, rough.

Thin-section:

Horizontal: 20—40 chambers in 3—4 whorls; all whorls involute, rapidly increasing in breadth as added, the last whorl is about 7 times broader than the first. A septal and a spiral canal-system is distinct. The septae are hardly curved, except the very last end near the periphery. Initial chamber has a diameter of 0,04 mm.

Vertical: involute, distinct pillars extend from the centre to the periphery. A canal-system and pores are visible in the wall. No microspheric forms have been found.

Diameter: 0,33—1,2 mm.

Thickness: 0,18—0,35 mm.

Holotype: No. 18846 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Sint Pietersberg, B 1 (Mc).

Occurrence: Upper part of Mb, Mc.

Remarks: HOFKER (1926) describes this form as the form A_1 of his *Amphistegina fleuriausi*, one of the two macrospheric generations. But the quite involute test, the sutures hardly curved and the missing ornamentation are too many differences to unite this form with *Operculina fleuriausi*. On account of the quite involute test the genus-name should be *Operculinella*, according to CUSHMAN's Classification (1948). In the same year BANNINK, however, argues that there are too many transitions between involute and evolute tests among the *Operculinae* to distinguish *Operculinella* from *Operculina*.

HOFKER again describes in his manuscript[1]) this form, but he gives a diameter up to 0,50 mm, whereas the diameter, found by me is larger (0,33—1,2 mm). The large specimens of my material are not the microspheric form mentioned by HOFKER. For more remarks see the remarks on *Operculina fleuriausi*.

I have given this species the name *Operculina labanae* in honour of my mother MRS. M. VISSER—LABAN.

[1]) See note, page 208.

FAMILY PENEROPLIDAE.

Subfamily *Spirolininae.*

SPIROLINA LAMARCK 1804.

Test free, planispiral, thick, earlier chambers close coiled, usually not completely involute, later ones uncoiled; aperture rounded or irregular.

Spirolina senoniensis (HOFKER), pl. 6, fig. 14, pl. 10, fig. 7, 8.

Operculina spec. indet. W. A. VISSER 1937, p. 88.
Peneroplis senoniensis HOFKER 1949, p. 41—43, fig. 19.

Test round, nearly planispiral, compressed, provided with an open and wide umbilicus on both sides.

Periphery subacute.

Chambers numerous (about 15 in the last whorl), long and narrow, 3—4 whorls, earlier coils exposed on both sides in the centre, increasing very gradually in size as added.

Sutures very distinct, curved, limbate, depressed between the last chambers.

Wall smooth, finely perforate.

Aperture very indistinct.

Thin-section:

Horizontal: an evolute coil of many chambers (30—50 dependent on the diameter), 3—4 whorls. Walls relatively thick, no canal-system. Only one stolon between the chambers. Initial chamber relatively large, 0,05 mm in diameter, provided with a short neck.

Vertical: whorls distinctly evolute, showing on both sides a wide umbilicus.

Diameter: 0,26—0,74 mm.
Thickness: 0,09—0,22 mm.

Occurrence: Holland: Maestrichtian (Mc—Md), South-Limburg.

Remarks: According to HENSON (1950a) this species belongs to the genus *Spirolina*, having a simple aperture, without neck. The aperture, described by HOFKER (1949), seems to be a gap in the wall of the apertural face. After seeing many specimens I cannot find any aperture similar to these of HOFKER. Usually an aperture is invisible at the outside of the test, but from the thin-section it is apparent that there is one stolon between the chambers, at the margin of the chamber and the earlier whorl.

FAMILY HETEROHELICIDAE.

Subfamily *Gümbelinidae.*

GÜMBELINA EGGER 1899.

Test with the early chambers planispiral, at least in the microspheric form, later chambers biserial; wall calcareous, perforate; aperture large and open, arched, at the base of the inner margin of last formed chamber.

Gümbelina globulosa (EHRENBERG) EGGER, pl. 8, fig. 8.

Textularia globulosa EHRENBERG 1840 (ELLIS & MESSINA Catalogue).
EGGER 1910, p. 96, pl. 5, fig. 10.
FRANKE 1928, p. 134, pl. 12, fig. 11.

Textularia (Gümbelina) globulosa EHRENBERG: OLBERTZ 1942, p. 112, pl. 12, fig. 11.
Gümbelina globulosa (EHRENBERG) EGGER 1899, p. 32, pl. 14, fig. 43.
CARMAN 1929, p. 312, pl. 34, fig. 10—20.
WHITE 1929, p. 38, pl. 4, fig. 10.
CUSHMAN 1931 (CCLF), p. 39, pl. 5, fig. 7.
CUSHMAN 1932, p. 338.
CUSHMAN 1936, p. 418, pl. 1, fig. 8.
MORROW 1934, p. 194, pl. 29, fig. 18.
VOORWIJK 1937, p. 5.
CUSHMAN 1938, (CCLF) p. 6, pl. 1, fig. 28—33.
CRESPIN 1938, p. 393, 394.
CUSHMAN & HEDBERG 1941 (CCLF), p. 92, pl. 22, fig. 15.
CUSHMAN & TODD 1943 (CCLF), p. 64, pl. 11, fig. 12.
CUSHMAN & DEADERICK 1944, p. 336, pl. 53, fig. 2, 3.
CUSHMAN 1946, p. 105, pl. 45, fig. 9—15.
Textularia globifera REUSS 1860, p. 232, pl. 13, fig. 7, 8.
REUSS 1862, p. 320.
EGGER 1910, p. 97, pl. 5, fig. 11.
FRANKE 1925, p. 11, pl. 1, fig. 13.
Gümbelina globifera (REUSS) EGGER 1899, p. 33, pl. 14, fig. 35, 36, 53—55.
WHITE 1929, p. 35, pl. 4, fig. 9.
Gümbelina pupa (not REUSS) WHITE 1929, p. 38, pl. 4, fig. 11.

Test small, tapering, first part slightly curved, last part globular owing to the inflated chambers.

Chambers distinct, 11—13 in number, rapidly increasing in size as added, last 5—6 chambers inflated.

Sutures distinct, strongly depressed, especially in the last part.

Wall rather rough, distinctly perforate.

Length: 0,22—0,31 mm.
Breadth: 0,15—0,19 mm.
Thickness: 0,09—0,15 mm.

Occurrence: Germany: Turonian and Senonian, N.W. part, Oberbayerische Alpen.
England: Upper Cretaceous, Gravesend.
Holland: Maestrichtian (Mb), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region; Annona, Georges Bank, Kansas, Wyoming, Texas.
Mexico: Tampico Embayment.
Cuba: Upper Cretaceous.
Colombia: Upper Cretaceous, Santander del Norte.
Australia: Upper Cretaceous, N.W. basin.

Subfamily *Eouvigerininae*.

PSEUDOUVIGERINA CUSHMAN 1927.

Test in early stages of microspheric form biserial, later triserial; adult chambers triangular in section, with the outer angle usually truncated; wall calcareous, usually coarsely perforate; aperture terminal, usually with a tubular neck and phialine lip.

Pseudouvigerina sp., pl. 1, fig. 15.

Uvigerina westfalica (not FRANKE) HOFKER 1930, p. 17, fig. XXXVI.

Test oval, initial end rounded and oval in cross section, last part acuminate and nearly triangular in cross section.

Chambers: the last three distinct, elongate, slightly inflated, the rest indistinct, about 4 in number.

Sutures only distinct in the last part, depressed.

Wall smooth, coarsely perforate.

Length: 0,46 mm.

Thickness: 0,24 mm.

Only one specimen.

Holotype: No. 18772 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Geulhem G 12 (Md).

Remarks: HOFKER (1930) found one similar specimen in Houthem, near Geulhem. He describes this as *Uvigerina westfalica* FRANKE (1928, p. 122, pl. 11, fig. 14). But on comparing the figures and the description given by him, his specimens have more and shorter chambers than the specimens from Houthem and Geulhem have. The structure of FRANKE's species is biserial and the one of the Limburg specimens is indistinctly biserial in the initial part and triserial in the last part.

Therefore FRANKE's species is not the same as the Limburg one.

FAMILY BULIMINIDAE.

Subfamily *Turrilininae*.

BULIMINELLA CUSHMAN 1911.

Test an elongate close spiral, the spiral suture distinct; chambers three or more in a whorl; wall calcareous, perforate; aperture elongate, loop-shaped, very slightly twisted.

Buliminella imbricata (REUSS) CUSHMAN & PARKER, pl. 2, fig. 12.

Bulimina imbricata REUSS 1851 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 52, pl. 15, fig. 48.
FRANKE 1928, p. 159, pl. 14, fig. 20.
CUSHMAN 1931 (CCLF), p. 42, pl. 5, fig. 10.
VAN RAADSHOVEN 1940, p. 12.

Buliminella imbricata (REUSS) CUSHMAN & PARKER 1936 (CCLF), p. 6, pl. 2, fig. 2.
CUSHMAN & PARKER 1947, p. 57, pl. 15, fig. 5.

Test elongate, slightly tapering, round in cross section, initial end rounded, apertural face flattened.

Chambers distinct, rapidly increasing in size as added, numerous, long and narrow, about 5 in a whorl, about 3 whorls, the last chambers occupy the half test, but are not inflated as in *Bulimina intermedia* REUSS.

Sutures distinct, depressed.

Wall smooth.

Length: 0,41—0,26 mm.

Breadth: 0,26—0,17 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Buliminella obtusa (D'ORBIGNY) CUSHMAN & PARKER, pl. 2, fig. 13.

Bulimina obtusa D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
BROTZEN 1936, p. 131, pl. 8, fig. 2.
GOUDKOFF 1945, p. 968.
Buliminella obtusa (D'ORBIGNY) CUSHMAN & PARKER 1934 (CCLF), p. 28, pl. 5, fig. 1.
CUSHMAN & PARKER 1947, p. 6, pl. 2, fig. 1.

Test elongate, tapering, obtuse on both ends, apertural face flattened, round in cross section.

Chambers distinct, numerous, about 4 whorls of each 4 chambers, very gradually increasing in size as added.

Sutures usually distinct, not depressed, except the spiral suture of the last whorl.

Wall rough.

Length: 0,3—0,6 mm.
Breadth: 0,17—0,3 mm.

Occurrence: France: Craie Blanche, Basin of Paris.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Upper Cretaceous, California.

Subfamily *Buliminae.*

BULIMINA D'ORBIGNY 1826.

Test an elongate spiral, generally triserial; chambers inflated, spiral sutures more or less obsolete; wall calcareous, perforate; aperture loop-shaped, with a tooth or plate at one side and an internal tube connecting through the chambers between the apertures.

Bulimina intermedia REUSS, pl. 2, fig. 14.

Bulimina intermedia REUSS 1845 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 5, pl. 15, fig. 3, 4.
FRANKE 1925, p. 27, pl. 2, fig. 23.
FRANKE 1928, p. 160, pl. 14, fig. 23.
CUSMAN & PARKER 1947, p. 80, pl. 19, fig. 12—15.

Test tapering, circular in cross section, initial part, apertural face broadly rounded.

Chambers distinct, very rapidly increasing in size as added, 4—5 chambers in one whorl, the last whorl of the three to four occupies the half test. The last chambers are slightly inflated.

Sutures distinct, oblique, depressed.

In the aperture no distinct tooth of plate visible.

Wall smooth.

Length: 0,3—0,77 mm.
Breadth: 0,24—0,6 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Bohemia, Oberbayerische Alpen.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Bulimina parva FRANKE, pl. 2, fig. 16.

Bulimina parva FRANKE 1928, p. 157, pl. 14, fig. 13.
CUSHMAN & PARKER 1947, p. 80, pl. 19, fig. 17.

Test elongate, tapering, round to triangular with rounded angles in cross section, apertural end obtuse, initial end more acuminate.
Chambers indistinct, gradually increasing in size as added, 3 whorls each with 3 chambers, the last whorl occupies nearly the half test.
Sutures indistinct, slightly depressed.
Wall smooth.

Length: 0,33—0,37 mm.
Breadth: 0,18—0,22 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Bulimina reussi MORROW, pl. 2, fig. 15.

For a synonymy vide CUSHMAN & PARKER 1947, p. 84.
Add to this list:
Bulimina ovulum FRANKE 1925, pl. 2, fig. 17.
FRANKE 1928, p. 157, pl. 14, fig. 14.
Bulimina laevis BEISSEL 1891, p. 66, pl. 12, fig. 39—43.

Test ovate, initial end conic with rounded point, last part subglobular, in cross section oval to round.
Chambers distinct, very rapidly increasing in size as added, about 3 whorls each of 3 chambers, the last whorl with inflated chambers occupies the half test.
Sutures distinct, slightly depressed.
Wall smooth.

Length: 0,22—0,4 mm.
Breadth: 0,17—0,26 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Aachen, Mecklenburg.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.

Bulimina stokesi CUSHMAN & RENZ, pl. 2, fig. 17.

Bulimina stokesi CUSHMAN & RENZ 1946 (CCLF), p. 37, pl. 6, fig. 14.
CUSHMAN & PARKER 1947, p. 137.

Test tapering, triangular in cross section, with rounded angles, initial end provided with a spine, apertural face somewhat flattened.
Chambers distinct, inflated, rapidly increasing in size as added, 3 whorls of about 3 chambers.
Sutures distinct, depressed.

Wall of the last whorl smooth, wall of the rest of the test from the base of the last whorl ornamented with several ribs, ending in spines.

Length: 0,41—0,28 mm.
Breadth: 0,22—0,19 mm.

Occurrence: Holland: Maestrichtian (Md), South-Limburg.
Trinidad: Upper Cretaceous.

Subfamily *Virgulininae*.

VIRGULINA D'ORBIGNY 1826.

Test elongate, more or less compressed, fusiform; early chambers spiral about the elongate axis, especially in the microspheric form, triserial, later becoming irregularly biserial, whole test usually twisted; wall calcareous, finely perforate; aperture elongate, loop-shaped, with an apertural tooth or plate and an internal tube.

Virgulina tegulata REUSS, pl. 2, fig. 11.

Virgulina tegulata REUSS 1845 (ELLIS & MESSINA Catalogue).
CUSHMAN 1937 (*Virgulininae*), p. 4, pl. 1, fig. 8—12.
CUSHMAN 1946, p. 126, pl. 53, fig.1—4.
Bolivina tegulata (REUSS) EGGER 1899, p. 45, pl. 16, fig. 10—11.
FRANKE 1925, p. 21, pl. 2, fig. 7.
FRANKE 1928, p. 153, pl. 14, fig. 5.
MORROW 1934, p. 196, pl. 30, fig. 21.
BROTZEN 1936, p. 131, pl. 11, fig. 7.
MARIE 1937, p. 265.
FAHRION 1937, p. 198, 206.
HENSOLDT 1938, p. 364.
THALMANN 1946, p. 342.
Bolivina incrassata REUSS var. *limonensis* MARIE 1941, p. 205, pl. 42, fig. 303—306.

Test elongate, slightly tapering, compressed, slightly twisted at the first part, both ends acuminate.
Periphery rounded.
Chambers distinct, more high than broad, very gradually increasing in size as added, about 20 in number.
Sutures distinct, depressed, especially in the last part, slightly oblique.
Wall smooth, coarsely perforate.

Length: 0,85—1 mm.
Breadth: 0,26—0,3 mm.
Thickness: 0,18 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma—Md), South-Limburg.
Ecuador: Upper Cretaceous, West part.
Africa: Upper Cretaceous, Tanganjika Territorium.

Remarks: The initial part of these specimens are too poorly preserved to be certain that the genus-name is *Virgulina*.

BOLIVINA D'ORBIGNY 1839.

Test elongate, usually compressed, tapering, initial end and often the whole test twisted; chambers typically biserial; wall calcareous, finely or coarsely perforate; aperture elongate, usually oblique, somewhat loop-shaped, often with a plate-like tooth connecting with an internal tube.

Bolivina incrassata REUSS, pl. 2, fig. 10.

For an extensive synonymy vide CUSHMAN 1937 (*Virgulininae*), p. 38.
Add: *Bolivina incrassata* REUSS: W. A. VISSER 1937, p. 96.
ALBRITTON & PHLEGER 1937, p. 352.
FAHRION 1937, p. 199.
CRESPIN 1938, p. 393, 394.
HENSON 1938, p. 228.
BROTZEN 1945, p. 49.
SCHLIFSMA 1946, p. 77, pl. 6, fig. 9.
CUSHMAN 1946, p. 127, pl. 53, fig. 8—11.
CUSHMAN 1947 (CCLF), p. 15, pl. 4, fig. 20.
Virgulina tegulata not REUSS: BEISSEL 1891, p. 65, pl. 13, fig. 1—7.

Test elongate, slightly tapering, slightly twisted, compressed, both ends broadly rounded.
Periphery rounded.
Chambers distinct, more broad than high, very gradually increasing in size as added, about 16 in number.
Sutures distinct, not depressed.
Wall smooth, coarsely perforate.

Length: 0,37—0,74 mm.
Breadth: 0,17—0,28 mm.
Thickness: 0,08—0,17 mm.

Occurrence: Germany: Upper Senonian, N.W. part.
France: Craie Blanche, Basin of Paris.
Sweden: Maestrichtian, Höllviken.
Holland: Hervian, Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Navarro and Taylor, Gulf Coast Region.
Mexico: Mendez-shale.
Venezuela: Santa Anita-formation.
Palestine, Syria, Iraq and Egypt: Upper Cretaceous.
Africa: Upper Cretaceous, Tanganjika Territorium.

Remarks: Two forms are distinguishable. The first is long and rather narrow (gretaest breadth: 0,22 mm), the second is short and rather broad (greatest breadth: 0,28 mm). The initial chamber of the latter is larger and therefore the initial part is more blunted than that of the first mentioned form. A further investigation of more material may demonstrate the presence of two generations.

Subfamily *Reussellinae*.

REUSSELLA GALLOWAY 1933.

Test distinctly triserial, triangular in transverse section, broadest at the apertural end; wall calcareous, finely or coarsely perforate; aperture elongate, oblique, from the base of the chamber in the apertural face.

Reussella cushmani BROTZEN, pl. 8, fig. 9.

Reussella cushmani BROTZEN 1936, p. 135, pl. 8, fig. 7.
CUSHMAN 1945 (CCLF), p. 24, pl. 5, fig. 1.
Pseudouvigerina sp. CUSHMAN 1931 (CCLF), p. 40, pl. 6, fig. 1.

Test elongate, slightly tapering, in cross section triangular with acute angles and concave sides, initial end subacute, apertural face rounded.
Periphery acute, slightly lobulate, first part sometimes spined.
Chambers distinct, 6—8 visible at each side, gradually increasing in size as added.
Sutures distinct, slightly depressed.
Wall smooth.
Aperture becoming terminal in the adult.

Length: 0,19—0,3 mm.
Breadth: 0,11—0,15 mm.

Occurrence: Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mb), South-Limburg.

FAMILY ROTALIIDAE.

Subfamily *Discorbinae*

CONORBINA BROTZEN 1936.

Test free or attached, trochoid, conical, with an elevated spire, ventral side flattened or concave, umbilicate; wall calcareous, perforate; aperture a narrow opening at the middle of the base of the apertural face.

Conorbina squamiformis (REUSS) BROTZEN, pl. 5, fig. 1.

Rosalina squamiformis REUSS 1854 (ELLIS & MESSINA Catalogue).
Conorbina squamiformis (REUSS) BROTZEN 1936, p. 141.

Test round, dorsal side strongly convex, ventral side concave, provided with a shallow umbilicus.
Periphery acute, lobate.
Chambers distinct, numerous, 3—5 whorls. The first of these with 4—5 chambers, the latter with only two to three chambers, narrow and long, increasing especially in length as added. On the ventral side 3 chambers visible, the last forming nearly half this side.
Sutures distinct, on the dorsal side slightly limbate and oblique, on the ventral side depressed and curved.
Wall smooth, perforate.

Diameter: 0,6—0,22 mm.
Height: 0,18—0,07 mm.

Occurrence: Germany: Turonian, Gosauthale.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Conorbina sulcata (ROEMER), pl. 5, fig. 13.

Rotalia sulcata ROEMER 1841 (ELLIS & MESSINA Catalogue).
REUSS 1863, p. 85, pl. 11, fig. 1.

Test round, very compressed, dorsal side slightly convex, ventral side slightly concave, provided with an open shallow umbilicus.

Periphery acute.

Chambers distinct, curved, 14 in number, in 2½ coil, all visible on the dorsal side, rapidly increasing in length as added, 5 visible on the ventral side.

Sutures distinct, slightly limbate, strongly curved on both sides.

Wall smooth, distinctly perforate.

Diameter: 0,16—0,4 mm.
Height: 0,06—0,08 mm.

Occurrence: Germany: Hils, North part.
Holland: Maestrichtian (Mb), South-Limburg.

DISCORBIS LAMARCK 1881.

Test typically plano-convex, the ventral side flattened, microspheric form sometimes showing a long Spirillina-like second chamber of several coils before division; chambers often produced to partially cover the umbilical area; wall calcarous, perforate; aperture at the base of the umbilical margin on the ventral side of the chamber.

Discorbis cretacea FRANKE, pl. 5, fig. 2.

Discorbis cretacea FRANKE 1925, p. 91, pl. 8, fig. 12.
FRANKE 1928, p. 190, pl. 18, fig. 4.

Test oval, dorsal side convex, ventral side flattened or concave, provided with a distinct shallow umbilicus.

Periphery subacute, lobate.

Chambers 5—8 in number in the last whorl, rapidly increasing in size as added. Last chamber on the ventral side visible as a triangle, forming nearly half this side.

Sutures distinct, depressed, usually curved on both sides.

Wall smooth, coarsely perforate.

Diameter: 0,41—0,85 mm.
Height: 0,15—0,3 mm.

Occurrence: Germany: Upper Cretaceous, Pommeriana.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Remarks: The first chamber usually does not form a distinct knob on the dorsal side, as FRANKE (1925, 1928) argues. Yet all coils on the dorsal side are visible, more visible than the inner coils of the recent *Discorbis obtusa* D'ORBIGNY, a species strongly allied to *Discorbis cretacea*, according to FRANKE. This species also much resembles *Discorbis sigmoidalis* SCHIJFSMA (1946), but differs in the concave ventral side. SCHIJFSMA (1946) describes *Discorbis sigmoidalis* with a flattened ventral side.

Discorbis stelligera (REUSS), pl. 7, fig. 12.

Rosalina stelligera REUSS 1854 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 158, pl. 20, fig. 13—15.

Test round, the dorsal side more convex than the ventral side, the ventral side is provided with a wide shallow umbilicus.

Periphery acute.

Chambers distinct, on both sides in the last whorl, there 6 in number. Inner whorls on the dorsal side covered by a low plug of shell material.

Sutures distinct, limbate, radiate and slightly curved on both sides.
Wall smooth.

Diameter: 0,32 mm.
Thickness: 0,16 mm.

Occurrence: Germany: Turonian and Lower Senonian, Gosauthale; Upper Cretaceous, Oberbayerische Alpen.
Holland: Maestrichtian (Mb, and a very few specimens in Mc and Md), South-Limburg.

Discorbis supracretacea SCHIJFSMA, pl. 5, fig. 3.

Discorbis supracretacea SCHIJFSMA 1946, p. 83, pl. 4, fig. 10.

Test round, ventral side flattened or slightly convex, provided with a small umbilicus, dorsal side strongly convex, remarkable for the plug clear shell material at the top, covering the inner whorls.
Periphery acute to keeled, lobate.
Chambers distinct, 2—3 whorls, in the last whorl 5—8 chambers, equally broad as long, gradually increasing in size as added.
Sutures distinct, limbate, radiate on the ventral side, slightly oblique on the dorsal side.
Wall smooth and very clear, if well preserved.

Diameter: 0,19—0,41 mm.
Height: 0,07—0,15 mm.

Occurrence: Holland: Hervian and Maestrichtian (Mb—Mc), South-Limburg.

LAMARCKINA BERTHELIN 1881.

Test trochoid, evidently attached, dorsal side convex, usually ornamented, ventral side usually flattened or concave, very smooth and highly polished; chambers dorsally distinct, ventrally less so, but often with an umbilical projection; wall calcareous, finely perforate; aperture at the umbilical end of the chamber, often enlarged by resorption.

Lamarckina bienfaiti sp. n., pl. 5, fig. 4.

Test round, dorsal side convex, ventral side flattened, provided with a wide umbilicus.
Periphery subacute.
Chambers distinct on the dorsal side, about two spires, the last with 10 chambers, gradually increasing in size as added.
Sutures curved on the dorsal side, raised as costae, on the ventral side slightly depressed, usually indistinct.
Wall smooth on the ventral side, ornamented with above mentioned costae on the dorsal side.

Diameter: 0,26—0,41 mm.
Thickness: 0,11—0,22 mm.

Holotype: No. 18834 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, B 16 (Md).
Occurrence: Mb—Md.

Remarks: This species shows great likeness with *Lamarckina stormi* BROTZEN (1936), but differs from it by the subacute periphery, the shape of

the test (not conic) and the high costae of the ornamentation. It differs from the Cretaceous *Lamarckina ripleyensis* CUSHMAN (1946) of America by the shape of the test (not oval). I have called it *Lamarckina bienfaiti* in honour of my husband-to-be Mr. L. P. BIENFAIT.

VALVULINERIA CUSHMAN 1926.

Test usually trochoid, close coiled, ventrally umbilicate; chambers numerous, wall calcareous, finely perforate, aperture ventral large, extending from the umbilicus toward the periphery, often with a thin plate filling the umbilical area, sometimes extending into the face of the chambers becoming tripartite.

Valvulineria sp. pl. 7, fig. 11.

Test round, thick, nearly involute, umbilicate on both sides.
Periphery broadly rounded.
Chambers inflated, indistinct, only the chambers of the last whorl visible, about 7 in number, gradually increasing in size as added.
Sutures indistinct, slightly depressed between the two last chambers.
Wall smooth.

Diameter: 0,48 mm.
Thickness: 0,32 mm.

Only one specimen.
Holotype: No. 18867 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, B 5 (Mc).

GAVELINELLA BROTZEN 1942.

Test trochoid in the early stages, nearly planispiral in the adult, biconvex, periphery rounded, umbilicus open; wall calcareous, perforate; aperture a narrow opening along the ventral face of the last-formed chamber extending from the periphery to the umbilicus, with a secondary opening into the umbilical area.

Gavelinella ammonoides (REUSS) BROTZEN, pl. 5, fig. 5.

Rosalina ammonoides REUSS 1844 (ELLIS & MESSINA Catalogue).
Anomalina ammonoides (REUSS) VAN RAADSHOVEN 1940, p. 12.
Gavelinella ammonoides (REUSS) BROTZEN 1942, p. 48, textfig. 16.

Test round, slightly compressed, dorsal side convex, provided with a wide shallow umbilicus, exposing the inner whorls, ventral side less convex or sometimes slightly flattened, provided with a small umbilicus.
Periphery subacute to rounded.
Chambers distinct, high and narrow, 7—9 in the last whorl, visible on both sides, gradually increasing in size as added, 2—3 whorls.
Sutures distinct, slightly depressed between the last two chambers, strongly curved on the dorsal side, less curved on the ventral side.
Wall smooth, finely perforate.

Diameter: 0,22—0,37 mm.
Thickness: 0,09—0,18 mm.

Occurrence: Germany: Plänermergel, Bohemia.
Holland: Maestrichtian (Mb, and a few specimens in Mc), South-Limburg.

Remarks: These specimens are smaller than those, originally described by REUSS.

Gavelinella binkhorsti (REUSS), pl. 5, fig. 6, pl. 10, fig. 12.

Rosalina binkhorsti REUSS 1862, p. 317, pl. 2, fig. 3.
Discorbina binkhorsti (REUSS) EGGER 1899, p. 164, pl. 18, fig. 28—30.
Pulvinulina binkhorsti (REUSS) HOFKER 1927, p. 126, 1 textfig.
Conorbina binkhorsti (REUSS) BROTZEN 1936, p. 145.
Discorbis binkhorsti (REUSS) W. A. VISSER 1937, p. 96.
VAN RAADSHOVEN 1940, p. 12.
BROTZEN 1940, p. 32.
SCHIJFSMA 1946, p. 82, textfig. 4.

Test round, convex on the spiral side, flattened on the umbilical side, sometimes concave owing to the wide umbilicus, especially in the large specimens.

Periphery subacute, provided with a border of clear shell material on the spiral side.

Chambers distinct on both sides, oblique on the spiral side, about 3 whorls, in the last whorl 6 chambers. The chambers on the umbilical side extend with a short of lip in the umbilicus.

Sutures distinct on both sides. Oblique, limbate like bonds on the test on the spiral side, both the suture between the chambers as the spiral sutures. Radial and slightly curved, sometimes slightly depressed on the umbilical side. Sometimes the test has been eroded and the limbate sutures have vanished.

Wall smooth, except the bonds of the limbate sutures and the border along the periphery.

Aperture: the last 3 or 4 chambers have each an aperture, opening into the umbilicus, a sort of lip covering the entrance of each chamber.

Diameter: 0,3—1,2 mm.
Thickness: 0,11—0,4 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen.
Sweden: Maestrichtian and Danian, Oresund.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Remarks: BROTZEN (1942) describes the genus *Gavelinella* as having a nearly biconvex test. In the same publication he describes *Gavelinella bullata* BROTZEN as having a flattened spiral side and a convex umbilical side. Therefore the biconvex test seems not to be an important genus-characteristic. This species seems to be concave on the umbilical side owing to the wide and open umbilicus. The vertical section (pl. 10, fig. 12), however, shows the biconvex test.

HOFKER (1927) minutely describes the aperture in the umbilicus covered by the lips of each chamber. These lips have not grown together. In his manuscript [1]) HOFKER gives this species a new genus-name: *Discopulvinulina* because of the double aperture: a septal and an umbilical one. This new genus is based on his new Classification, explained in this manuscript.

HOFKER's species *Cibicides laevigata* (REUSS) described in the same manuscript [1]) is in my opinion the young specimen of *Gavelinella binkhorsti*,

[1]) See note, page 208.

because the chambers of these small specimens also have apertures debouching in the umbilicus, covered by a small lip, and the ornamentation of bond-like sutures.

Gavelinella bosqueti (REUSS), pl. 5, fig. 8.

Rosalina bosqueti REUSS 1862, p. 316, pl. 3, fig. 1.
Discorbina bosqueti (REUSS) FRANKE 1925, p. 92, pl. 8, fig. 13.
FRANKE 1928, p. 190, pl. 18, fig. 5.
Discorbis bosqueti (REUSS) VAN RAADSHOVEN 1940, p. 12.

Test oval, nearly planispiral. Dorsal side convex, ventral side flattened with a distinct and open umbilicus.

Periphery subacute, lobate.

Chambers only distinct in the last whorl, having 7—8 chambers, rapidly increasing in size as added. The last chamber always, the last but one sometimes inflated.

Sutures only distinct in the last whorl, curved, depressed, also at the periphery.

Wall smooth, coarsely perforate.

Diameter: 0,26—0,81 mm.
Thickness: 0,15—0,33 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: According to BROTZEN (1942) the biconvex test of *Gavelinella* is not a genus-characteristic (see the remarks of *Gavelinella binkhorsti*). As this form has the very remarkable aperture of *Gavelinella* with distinct lips in the umbilicus, I come to the conclusion that the correct genus-name is *Gavelinella*, in spite of the planoconvex test.

Gavelinella pertusa (MARSSON) BROTZEN, pl. 5, fig. 7.

Discorbina pertusa MARSSON 1878 (ELLIS & MESSINA Catalogue).
Rosalina sp. BEISSEL 1891, p. 75, pl. 16, fig. 17—22.
Anomalina pertusa (MARSSON) FRANKE 1925, p. 86, pl. 7, fig. 16.
FRANKE 1927, p. 690.
FRANKE 1928, p. 182, pl. 17, fig. 4.
CRESPIN 1938, p. 394.
HENSOLDT 1938, p. 359.
BROTZEN 1940, p. 29.
Discorbina lorneiana (D'ORBIGNY) var. *pertusa* (MARSSON) MARIE 1941, p. 34, pl. 34, fig. 316.
Gavelinella pertusa (MARSSON) BROTZEN 1942, p. 41, pl. 1 fig. 1, 2.

Test round, biconvex, ventral side provided with a distinct and open umbilicus.

Periphery subacute or rounded, especially the last part.

Chambers only distinct in the last whorl, having 12—14 chambers, gradually increasing in size as added.

Sutures slightly depressed, curved.

Wall smooth, finely perforate.

Diameter: 0,19—0,6 mm.
Thickness: 0,07—0,33 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, (Aachen, Rügen, Pommeriana).
France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: Because of poor preservation *Gavelinella pertusa* resembles sometimes *Gavelinella bosqueti* and *Anomalina complanata.*

The two latter, however, have always a flattened ventral side and besides *Gavelinella bosqueti* has an inflated last chamber. These characteristics are wanting in *Gavelinella pertusa.*

After seeing the collection of VAN RAADSHOVEN (1940) I can state that his *Gyroidina depressa* (ALTH), *Anomalina beaumontiana* D'ORBIGNY and *Anomalina clementina* D'ORBIGNY are all three of the same species: *Gavelinella pertusa.*

Gavelinella stelligera (MARIE), pl. 8, fig. 10.

Planulina stelligera MARIE 1941, p. 245, pl. 37, fig. 247.

Test round, very small and very compressed, dorsal side somewhat convex, ventral side somewhat concave, provided with a small umbilicus.

Periphery subacute.

Chambers distinct on both sides, 11—12 in number in the last whorl gradually increasing in size as added, 2½ whorls.

Sutures distinct, curved on both sides, slightly limbate, sometimes depressed.

Wall smooth, clear, the wall of the first coil is mostly of a brown colour.

Diameter: 0,11—0,22 mm.
Thickness: 0,04—0,07 mm.

Occurrence: France: Craie Blanche, Basin of Paris.
Holland: Maestrichtian (Mb), South-Limburg.

Remarks: The species is much smaller than the form described by MARIE (1941), who gives a diameter of 0,425 mm.

Because of the aperture, opening with distinct lips into the umbilicus, which MARIE also mentions, I give this form the genus-name *Gavelinella.*

Gavelinella tumida BROTZEN, pl. 5, fig. 9.

Anomalia lorneiana (not D'ORBIGNY) BROTZEN 1936, p. 178, pl. 12, fig. 1, 2.
Gavelinella tumida BROTZEN 1942, p. 47, textfig. 15.

Test round, dorsal side convex, ventral side concave, provided with a wide umbilicus.

Periphery rounded or subacute, lobate by the sutures of the last chambers.

Chambers inflated, 7—8 in the last whorl, rapidly increasing in size as added. Especially the last chamber and the last whorl are inflated, therefore the inner whorls seem to be lower than the last whorl.

Sutures distinct, depressed, particularly between the last chambers.

Wall smooth, distinctly perforate.

Diameter: 0,31—0,52 mm.
Height: 0,18—0,22 mm.

Occurrence: Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Ma—Md), South-Limburg.

Remarks: The great variation of the test-shape is characteristic, thanks to the more or less inflated chambers.

HOFKER in his manuscript[1]) describes this species as *Cibicides excavata* BROTZEN, neglecting the fact, that *C. excavata* has a distinct umbilicus on the spiral side. HOFKER's specimens of *Cibicides excavata*, seen by me at Haarlem, are partly *Gavelinella tumida*, partly *Gavelinella bosqueti*.

GYROIDINOIDES BROTZEN 1942.

Test trochoid, ventral side usually convex, umbilicus distinct and open, spiral suture with a depressed channel; wall calcareous, finely perforate; aperture an elongate slit-like opening along the margin of the last-formed chamber.

Gyroidinoides nitida (REUSS) BROTZEN, pl. 5, fig. 10.

Rotalina nitida REUSS 1845 (ELLIS & MESSINA Catalogue).
Rotalia nitida (REUSS) BEISSEL 1891, p. 71, pl. 14, fig. 14—19.
Rotalina soldanii D'ORBIGNY f. *nitida* (REUSS).
FRANKE 1925, p. 89, pl. 8, fig. 3.
FRANKE 1928, p. 187, pl. 18, fig. 1.
OLBERTZ 1942, p. 131.
Gyroidina nitida (REUSS) WHITE 1928, p. 296, pl. 40, fig. 6.
BROTZEN 1936, p. 157, pl. 11, fig. 3.
not W. A. VISSER 1937, p. 96.
CRESPIN 1938, p. 393, 394, 395.
BROTZEN 1940, p. 32.
VAN RAADSHOVEN 1940, p. 12.
MARIE 1941, p. 220, pl. 34, fig. 319.
SCHIJFSMA 1946, p. 85, pl. 5, fig. 1.
CUSHMAN 1946, p. 140, pl. 58, fig. 5.
Gyroidinoides nitida (REUSS) BROTZEN 1942, p. 19, fig. 6: 3.
Gyroidinoides nitidus (REUSS) THALMANN 1946, p. 342.
Gyroidina soldanii (D'ORBIGNY) SANDIGDE 1932, p. 282, pl. 43, fig. 10—12.

Test round, dorsal side flattened to slightly convex, ventral side strongly convex, provided with a small umbilicus.

Periphery subacute to rounded, lobate.

Chambers: 7—10 visible on the ventral side, 2½ coil visible on the dorsal side, gradually increasing in size as added.

Sutures distinct, depressed and radial on the ventral side, less depressed and strongly oblique on the dorsal side.

Wall smooth, perforate.

Diameter: 0,41—0,6 mm.
Thickness: 0,22—0,33 mm.

Occurrence: Germany: Lower and Upper Cretaceous, N.W. part.
France: Craie Blanche, Basin of Paris.
Sweden: Danian, Oresund.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Upper Cretaceous, Texas, Gulf Coast Region.
Australia: Upper Cretaceous, N.W. basin.

[1]) See note, page 208.

Remarks: The forms out of Mb have the same number of chambers, mentioned by other authors. The few specimens, found in Mc and Md, however, have no more than 5 chambers in the last whorl.

The *Gyroidina nitida*, recorded by W. A. VISSER (1937) is no *Gyroidina nitida* at all. Mostly the specimens are of the species *Cibicides involuta*, a few are *Eponides hemisphaerica*.

PSEUDOVALVULINERIA BROTZEN 1842.

Test differing from Valvulineria in not having the ventral lobe over the umbilicus and in having the aperture in the middle of the ventral margin and connecting by a narrow opening with the umbilicus.

Pseudovalvulineria lorneiana (D'ORBIGNY) BROTZEN, pl. 8, fig. 11.

Rosalina lorneiana D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
Anomalina lorneiana (D'ORBIGNY) CUSHMAN 1931 (CCLF) p. 45, pl. 6, fig. 9.
Anomalina clementina (not D'ORBIGNY) CUSHMAN 1931 (CCLF) p. 46, pl. 6, fig. 10.
Discorbis lorneiana (D'ORBIGNY) MARIE 1937, p. 165.
pars MARIE 1941, p. 214, pl. 23, fig. 314, pl. 34, fig. 315.
Pseudovalvulineria lorneiana (D'ORBIGNY) BROTZEN 1943, p. 20, fig. 6: 7.

Test round, dorsal side flattened, or slightly convex, ventral side strongly convex, provided with a shallow wide umbilicus.

Periphery subacute, lobate in the last part.

Chambers in the last whorl distinct on both sides, the inner whorls on the dorsal side obstructed by a sort of knob. In the last whorl 11 chambers, gradually increasing in size as added.

Sutures distinct, depressed and curved between the chambers on the ventral side and between the last chambers on the dorsal side. Spiral suture on the dorsal side also depressed.

Wall distinctly perforate on the ventral side and on the last chambers on the dorsal side, generally decorated with curved ribs between the sutures on the ventral side.

Diameter: 0,44—0,74 mm.
Height: 0,2—0,4 mm.

Occurrence: France: Craie Blanche, Basin of Parts.
Holland: Maestrichtian (Ma, Mb), South-Limburg.

Remarks: MARIE (1941) also treats *Gavelinella pertusa* (MARSSON) BROTZEN as a variation of this species (pl. 34, fig. 316).

BROTZEN (1942) bases the genus *Gavelinella* on this form *pertusa* of MARSSON. I can agree with BROTZEN on account of the much deeper umbilicus and the lack of ornamentation on the walls of *Gavelinella pertusa*. I, therefore do not admit MARIE's figure 316 (pl. 34) to the list of synonyms.

GYROIDINA D'ORBIGNY 1826.

Test trochoid, ventral side usually convex, umbilicus small and deep, spiral sutures with a depressed channel; wall calcareous, finely perforate; aperture, a low arched opening on the ventral side toward the umbilical area.

Gyroidina depressa (ALTH) CUSHMAN & CHURCH, pl. 8, fig. 12.

Rotalina depressa ALTH 1850 (ELLIS & MESSINA Catalogue).
Gyroidina depressa (ALTH) CUSHMAN & CHURCH 1929, p. 51, pl. 41, fig. 4—6.
PLUMMER 1931, p. 190, pl. 13, fig. 3.
CUSHMAN & JARVIS 1932, p. 46, pl. 14, fig. 1.
SANDIGDE 1932, p. 283 ,pl. 43, fig. 16—18.
WICKENDEN 1932, p. 206, pl. 29, fig. 9.
CUSHMAN & HEDBERG (CCLF) 1941, p. 96, pl. 23, fig. 11, 12.
CUSHMAN & DEADERICK 1942 (CCLF), p. 55, pl. 15, fig. 14—16.
CUSHMAN & TODD 1943 (CCLF), p. 68, pl. 12, fig. 4.
CUSHMAN 1944 (CCLF), p. 13, pl. 3, fig. 2.
CUSHMAN 1944 (CCLF), p. 95, pl. 14, fig. 23.
CUSHMAN & DEADERICK 1944, p. 339, pl. 53, fig. 19, 20.
CUSHMAN 1946, p. 139, pl. 58, fig. 1—4.

Test round, dorsal side flattened or slightly convex, ventral side strongly convex, provided with a very small umbilicus, hardly distinct, sometimes missing.

Periphery rounded to subacute.

Chambers distinct, gradually increasing in size as added, 10—11 in the last whorl, 2 whorls.

Sutures distinct, slightly limbate, curved on both sides.

Wall smooth.

Diameter: 0,18—0,41 mm.
Height: 0,12—0,2 mm.

Occurrence: Poland: Upper Cretaceous, Lemberg.
Holland: Maestrichtian (Mb), South-Limburg.
U.S.A.: Austin, Taylor and Navarro age, Gulf Coast Region, California; Corsicana Marl, Texas; Pecan Gap Chalk, Colorado.
Trinidad: Upper Cretaceous.
Colombia: Upper Cretaceous, Santander del Norte.

Gyroidina globosa (VON HAGENOW) CUSMHAN, pl. 5, fig. 11.

Nonionina globosa VON HAGENOW 1842 (ELLIS & MESSINA Catalogue).
Rotalia globosa (VON HAGENOW) REUSS 1862, p. 330, pl. 7, fig. 2.
FRANKE 1925, p. 89, pl. 8, fig. 3.
FRANKE 1928, p. 187, pl. 17, fig. 12.
W. A. VISSER, 1937, p. 96.
Gyroidina globosa (VON HAGENOW) CUSHMAN 1931, p. 310 ,fig. 19.
CUSHMAN 1932, p. 47, pl. 14, fig. 3, 4.
CUSHMAN & HEDBERG 1941 (CCLF), p. 97, pl. 23 ,fig. 14.
CUSHMAN & GOUDKOFF 1944 (CCLF), p. 61, pl. 10, fig. 6.
CUSHMAN & DEADERICK 1944, p. 339, pl. 53, fig. 21, 22.
CUSHMAN 1946, p. 140, pl. 58, fig. 6—8.

Test round, subglobular, nearly involute, spiral side slightly flattened, umbilical side strongly convex, provided with a distinct, narrow umbilicus. The last whorl covers nearly all earlier whorls on the spiral side.

Apertural face encloses that last whorl on the umbilical side more than on the spiral side.

Periphery broadly rounded.

Chambers distinct, inflated, especially the chambers of the last whorl, six to seven in number in the last whorl, gradually increasing in size as added.

Sutures radial, slightly curved and depressed.

Wall smooth.

Diameter: 0,3—0,77 mm.

Thickness: 0,11—0,48 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Rügen, Aachen.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Saratoga Chalk; Upper Cretaceous, California, Arkansas.
Colombia: Upper Cretaceous, Santander del Norte.

Remarks: My specimens agree with the original description of VON HAGENOW: a nearly involute form, like a *Nonion*, but distinguished from this genus by the asymmetrical apertural face and the flattened spiral side.

BROTZEN (1936) describes also *Gyroidina globosa* in his extreme and youngest form as nearly involute. *Gyroidina globosa* out of the older Cretaceous layers is said to be more evolute and to show the earlier whorls on the spiral side. W. A. VISSER (1937) describes the same characteristic of his *Gyroidina globosa* out of the Gulpen Chalk (Upper-Campanian) of South-Limburg. The figures, given by CUSHMAN and other American authors give a less globular and more evolute form than mine.

This species may be mistaken for *Alabamina dorsoplana* BROTZEN. These two forms differ in the periphery and the aperture. *Alabamina dorsoplana* has a bluntly acute and *Gyroidina globosa* has a rounded periphery. *Alabamina dorsoplana* has an aperture in two parts and *Gyroidina globosa* has an aperture slit-shaped, but often the last chamber is broken so that this characteristic is lacking.

Subfamily *Rotaliinae*.

EPONIDES MONTFORT 1808.

Test trochoid, usually biconvex, umbilical area closed, but not typically with a plug; wall calcareous, perforate; aperture a low opening between the periphery and umbilical area, usually well away from the peripheral margin.

Eponides beisseli SCHIJFSMA, pl. 8, fig. 14.

Rotalia sp. BEISSEL 1891, p. 73, pl. 14, fig. 20—24.
Epistomina partschiana not D'ORBIGNY (pars) W. A. VISSER 1937, p. 88.
Eponides beisseli SCHIJFSMA 1946, p. 84, pl. 4, fig. 13.

Test round, biconvex, the dorsal side generally more flattened than the ventral side, no umbilicus.

Periphery subacute, lobate.

Chambers distinct on the ventral side, 6—7 in number, triangular; on the dorsal side: only those of the last whorl visible, 6—7 in number, longer than high. Inner whorls invisible owing to a sort of knob.

Sutures slightly depressed and straight on the ventral side, oblique and slightly curved, not depressed on the dorsal side.

Wall very smooth, mostly of a red-brown colour.

Diameter: 0,48—0,74 mm.
Height: 0,33—0,44 mm.

Occurrence: Germany: Upper Cretaceous, Aachen.
Holland: Hervian and Maestrichtian (Ma), South-Limburg.

Remarks: The *Epistomina partschiana* described by W. A. VISSER (1937) is not this species because these forms lack the distinct umbilical knob and the secundary apertures along the periphery, which are characteristic of *Epistomina partschiana.*

The forms of this species, mentioned by him out of the Ma and Mb, are *Eponides beisseli.*

The forms of this species, mentioned by him out of the Mc and Md, are for the greater part *Pseudoparrella minisae,* but I have also seen *Eponides hemisphaerica, Operculina labanae* and *Planulina tenuissima.*

Eponides carpenteri (REUSS), pl. 5, fig. 12.

Rotalia carpenteri REUSS 1863, p. 94, pl. 13, fig. 6.

Test round, ventral side more convex than dorsal side, umbilical area covered with a distinct plug.

Periphery acute, sometimes keeled.

Chambers, when well preserved, distinct on both sides, about two coils, about 12 chambers in the last coil.

Sutures, when well preserved, distinct, radial on both sides, slightly curved on the dorsal side. Both sides remarkably alike at first sight, only by thorough investigation does the difference become evident. This is the most characteristic quality of this species, but often concealed by poor preservation.

Wall smooth.

Diameter: 0,26—0,91 mm.
Thickness: 0,13—0,44 mm.

Occurrence: England: Gault.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Remarks: REUSS (1863) describes this species from the Gault of England. Description and figures agree very well with my specimens, but the preservation is usually a very poor one, so mistakes in determination are not out of question.

Eponides hemisphaerica (REUSS), pl. 6, fig. 1.

Rotalia hemisphaerica REUSS 1862, p. 314, pl. 2, fig. 5.
Cibicides involuta (not REUSS) HOFKER 1949 (pars), p. 21—25, fig. 21 H, J, K, M, N, O, P, R.
Cibicides hemisphaerica (REUSS) BROTZEN 1940, p. 26.

Test round, biconvex, sometimes the ventral side more or less flattened to concave, umbilical area covered by a distinct plug.

Periphery subacute.

Chambers distinct on both sides, sometimes the last four only distinct

on both sides. On the spiral side the last whorl visible, the earlier whorls indistinct. The umbilical side covered by small knobs of secondary shell material, not always in the same quantity.

Sutures, when distinct, curved on the spiral side, depressed and curved on the umbilical side.

Wall smooth on the spiral side, coarsely perforate and ornamented with sometimes many, sometimes few knobs of secondary shell material on the umbilical side.

Diameter: 0,6—1,3 mm.
Thickness: 0,37—0,52 mm.

Occurrence: Sweden, Danian, Öresund.
Holland: Maestrichtian (Md), South-Limburg.

Remarks: HOFKER (1949) collects the following 3 species
Rotalia polyraphes REUSS
Rotalia involuta REUSS
Rotalia hemisphaerica REUSS.

He calls them *Cibicides involuta*. According to him *R. involuta* is smaller than *R. hemisphaerica* and is therefore the young specimen. *R. polyraphes* has about the same dimensions as *R. involuta*, but lacks the development of secondary chalk on the ventral side through the influence of shallow water.

According to my measurements *Cibicides involuta* and *Eponides hemisphaerica* have the same dimensions, *C. involuta* is somewhat smaller. Therefore *E. hemisphaerica* cannot be the young of *C. involuta*.

Moreover *C. involuta* has a flattened dorsal side (*E. hemisphaerica* convex) and a convex ventral side (*E. hemisphaerica* a flattened to concave one). The periphery of *C. involuta* is more rounded and the aperture of *C. involuta* is placed at the periphery, whereas *E. hemisphaerica* has an aperture between the periphery and the umbilicus.

Cibicides polyraphes is a very small species, much smaller than *C. involuta* and *E. hemisphaerica*, with many more chambers in the last whorl and without the subacute periphery of *E. hemisphaerica* and *C. involuta*. Both sides are nearly equally convex. Therefore the third form, combined by HOFKER with *C. involuta* and *E. hemisphaerica*, cannot be *C. polyraphes*. He means the species *Gavelinella pertusa*, found in the Maestrichtian of South-Limburg, perhaps.

For all these reasons I cannot agree with HOFKER's argumentation about these species. I am fortified in this opinion by the last manuscript [1]) of HOFKER, where he describes a new species *Alabamina cretacea* from the Maestrichtian of South-Limburg. On comparing the figures in this manuscript no. 26a, 26b and 26c with his figure 12, K, J, and R of *Cibicides involuta* in his publication of 1949, it is clear that these species are the same viz. *Eponides hemisphaerica*.

ROTALIA LAMARCK 1804.

Test trochoid, usually biconvex, umbilical area closed, usually with a conical plug of clear shell material; sutures usually limbate dorsally, ventrally deeply depressed, often ornamented along the sides; wall calcareous, perforate, often double, with a canal system; aperture on the ventral side between the periphery and umbilical area.

[1]) See note, page 208.

The genotype of *Rotalia* is *Rotalia trochoidiformis* LAMARCK, quite different from "*Rotalia beccarii*", the form, after which, according to MACFADYEN (1940), all other "*Rotalia*" have been called *Rotalia*. The original genus-name of "*Rotalia*" *beccarii* is "*Streblus*" *beccarii*. Therefore MACFADYEN (1940) maintains that we should abandon the genus-name *Rotalia* for all such forms agreeing with *Rotalia beccarii* and call them *Streblus*.

Though agreeing wholly with these views I adhere to CUSHMAN's Classification (1948) as stated on page 210, in order not to increase the prevailing confusion.

Rotalia tuberculifera REUSS, pl. 5, fig. 14, pl. 10, fig. 9, 10.

Rotalia tuberculifera REUSS 1862, p. 313, pl. 2, fig. 2.
EGGER 1899, p. 162, pl. 19, fig. 19—21.
VAN RAADSHOVEN 1940, p. 12.
Nonion tuberculifera (REUSS) HOFKER 1949, p. 26, fig. 14.

Test round, both sides slightly convex, the ventral side more than the dorsal side, ventral side provided with a central plug.

Periphery acute, lobate, sometimes provided with broken spines.

Chambers only distinct on the ventral side, about 9 visible.

Sutures depressed on the ventral side, radial, indistinct and curved on the dorsal side.

Wall ornamented with many knobs on both sides, large in the centre, smaller to the periphery, arranged in remarkable rows.

Thin-section:

Horizontal: 3—4 whorls, 24—27 chambers. The initial chamber is larger than the second. After this second chamber the chambers increase gradually in size as added.

Diameter of the initial chamber: about 0,03 mm, of the second chamber: 0,02 mm.

Between the septa there is a narrow distinct canal, one stolon at the margin of the earlier whorl.

Vertical: trochoid structure of the coils, pillars, ending in the knobs of the surface on both sides, many pores in the wall, a canal-system is not distinct, but the thin-sections are poor because the specimens are difficult to grind owing to their fragility.

Diameter: 0,22—0,82 mm.
Thickness: 0,11—0,37 mm.

Occurrence: Germany: Upper Senonian, Oberbayerische Alpen.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Remarks: The aperture of this form is very near the periphery, but never at the periphery as HOFKER (1949) describes. Neither is this species symmetrically biconvex and planispiral as HOFKER describes. The dorsal side is always more flattened than the ventral side. The inner whorls on the dorsal side are covered by the knobs of the ornamentation, but in vertical section the trochoid structure is distinct. The chambers of the last whorl are only distinct on the ventral side.

These characteristics point to *Rotalia* and not to *Nonion*.

It is apparent from his manuscript[1]) that HOFKER does not agree with

[1]) See note, page 208.

himself later on, because he changes the genus-name of this form in *Parrella* for several, according to him, typical *Parrella* characteristics:

"It is not a *Streblus* (formerly *Rotalia*) because the pores are less densely placed than they are there, because there is an irregular canal-system on the ventral side, because the chambers are provided with a spine at the periphery and because the aperture is not a ventral split, but, a ventral and hook-shaped opening."

"Several of these characteristics" (which HOFKER does not say) point to *Parrella*. According to CUSHMAN's Classification (1948) the only *Parrella*-characteristic is the aperture, mentioned by HOFKER, but never found by me.

I found an interseptal canal-system only and the aperture is a ventral split, which sometimes approaches the periphery. The pore-density and the spine at each chamber are species-, not genus-characteristics, so that in my opinion there is no objection to the genus-name *Rotalia*.

FAMILY CALCARINIDAE.

SIDEROLITES LAMARCK 1801.

Test with the earliest stages trochoid especially in the microspheric form, not planispiral, later becoming loosly planispiral with secondary shell material between the whorls; periphery with spinose projections mostly in a single plane; wall calcareous, perforate with pillars in some species ending at the surface in raised bosses; aperture in the adult consisting of rounded openings in the chamber wall.

Siderolites calcitrapoides LAMARCK, pl. 7, fig. 16, pl. 10, fig. 4, 5.

Siderolite calcitrapoide LAMARCK: FAUJAS SAINT FOND 1799, p. 134, pl. 34, fig. 5—12.

Calcarina calcitrapoides (LAMARCK) REUSS 1862, p. 315, pl. 4, fig. 1—4.
EGGER 1899, p. 167, pl. 17, fig. 18, 38.
UMBGROVE 1925, p. 117.
HOFKER 1926, p. 14—17, fig. 1—9, 13.

Calcarina calcitrapoides (LAMARCK) var. *laevigata* REUSS 1862, p. 315, pl. 4, fig. 5.

Siderolites calcitrapoides LAMARCK: OSIMO 1907, p. 280, fig. 3, 4, 6, 10, 16, 17.
ARNI 1932, p. 214, 217, 218, pl. 2.
PFENDER 1934, p. 225, 226.
C. RENZ 1936, p. 43 and following pages, pl. 19, fig. 2—4, pl. 10 ,fig. 2.
O. RENZ 1936, p. 330.
O. RENZ 1936, p. 547, and following pages, pl. 31, fig. 2, 3, pl. 32, fig. 3—4, pl. 33, fig. 4.
W. A. VISSER 1937, p. 96, 97.
BOLLI 1944, p. 241.
SCHIJFSMA 1946, p. 105, pl. 8, fig. 1—3, pl. 10, fig. 1—5.

Baculogypsina calcitrapoides (LAMARCK) HOFKER 1949, p. 26, fig. 16—17.

Siderolites denticulatus DOUVILLÉ 1907, p. 598, pl. 18, fig. 6—8.

Test biconvex to subglobular, provided with spines, usually arranged in one plane around the periphery, sometimes irregularly dispersed over the surface. Usually four in number, but there are also specimens with three or

more than four spines, up to nine. Sometimes the spines are long and thin, sometimes short and thick, sometimes the spines have been joined to each-other by a thin border.

Chambers and sutures invisible at the outside.

Wall ornamented with knobs, dispersed over the whole surface.

The spines are ornamented with smaller knobs and longitudinal ribs.

Thin section:

Horizontal: planispiral, 2—3 whorls, in each an increasing number of chambers, gradually increasing in size as added. Between the whorls secondary shell material. The spines begin like pillars nearly in the centre. In the spines and in the walls of the chambers a complicated canal-system.

Initial chamber varies in diameter from 0,06—0,08 mm and from 0,1—0,11 mm. The spine number has no influence on the size of the initial chamber. A large initial chamber is followed by a smaller number of chambers (17—21), a smaller initial chamber is followed by a greater number of chambers (18—26).

Vertical: the latter whorls are distinctly planispiral. Pillars are sometimes present, extending from the centre to the surface.

Diameter of the whole test without spines: 0,24—1,4 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen.
Switzerland: Upper Cretaceous, Helvetian Nappes, Bielersee.
Italy: Upper Cretaceous, Appenines.
Greece: Upper Cretaceous, Leukas.
Holland: Maestrichtian (upper part of Mb—Md), South-Limburg.

Remarks: This form is described in detail by many authors (REUSS 1862, OSIMO 1907, HOFKER 1926 and 1949, ARNI 1932).

HOFKER does not agree with the opinion that the genus-name is *Siderolites*. In 1926 he calls it *Calcarina*, but according to CUSHMAN's Classification (1948) *Calcarina* is trochoid throughout and not planispiral in later stages (as *Siderolites* is). HOFKER in 1949 reconsiders his views and calls this form *Baculogypsina*.

According to him it has *Calcarina*- and *Baculogypsina*-characteristics, but as some specimens show the outgrowth of wild-growing chambers, characteristic of *Baculogypsina*, he prefers the genus-name *Baculogypsina*.

He does not use the name *Siderolites*, because some species of this genus belong to the Family *Camerinidae* and the Maestrichtian one is certainly not a representative of this family.

Siderolites, indeed is not a representative of the Family *Camerinidae*, but neither is this Maestrichtian form a *Baculogypsina*.

Calcarina is trochoid throughout, *Baculogypsina* has an outgrowth of secondary chambers, two characteristics, which are lacking in the form above described, according to my researches.

The correct genus-name for this species is *Siderolites* on account of the loosely planispiral test and the pillars, a fact upon which also OSIMO (1907) and ARNI (1932) agree.

In his description of 1949 HOFKER tries to demonstrate that the number of spines is an indication of the generation of the species. Increase of spines indicates decrease in size of initial chamber. He gives the following table:

Number of spines	Average diameter	Number of measured specimens
3	110	1
4	100	6
5	78	3
7	65	7

The measurements are the same as found by me. According to HOFKER's figure 15 (1949) the megalospheric generation has 2—7 spines, the microspheric generation has more than 6 spines, but he gives no measurements for the initial chambers. As I did not find a microspheric form I cannot uphold this last assertion nor can I disprove it.

HOFKER explains this relation by the fact that the spines begin in the centre of the test near the initial chamber, and that they are dependent on the number of chambers in the first coil. Two or three chambers are enclosed by two successive spines. When the number of chambers between two spines increases in later coils a new spine begins. Such a spine is not an indication of the size of the initial chamber. Therefore, according to HOFKER a section is always needed to show the real situation. HOFKER himself notices here that it is impossible to recognize the generation by the number of spines, which he tried to demonstrate.

This also explains my results: no relation between the size of the initial chamber and the number of spines; there are indeed 2—3 chambers between two spines and usually the spines begin in the centre.

I agree with HOFKER (1949) that *Siderolites calcitrapoides* var. *laevigata* and *Siderolites denticulatus* DOUVILLÉ are synonymous with *Siderolites calcitrapoides*. *S. denticulatus* is the form with a broad border between the spines, *S. calcitrapoides* var. *laevigata* has a smooth wall. There are many transitions between ornamented and rather smooth forms as well as between spined and bordered forms. Therefore there is no reason to separate these two forms from *S. calcitrapoides*.

FAMILY CYMBALOPORIDAE.

CYMBALOPORA VON HAGENOW 1851.

Test low, conical, in the early stages trochoid; dorsal side of chambers extending over and covering the earlier ones, later chambers arranged in alternating horizontal series, on the ventral side not meeting at the centre, leaving an open umbilicus; wall of the early portion agglutinated with quartz grains and calcareous fragments and with a calcareous cement over a coarsely perforate thick, chitinous base; apertures in the young ventral, single, in the adult chambers along the sides and the inner end, often open into the umbilicus.

Cymbalopora radiata VON HAGENOW, pl. 9, fig. 1.

Cymbalopora radiata VON HAGENOW 1851, p. 104, pl. 12, fig. 18.
HOFKER 1931, p. 126, 7 textfig.
W. A. VISSER 1937, p. 96.
VAN RAADSHOVEN 1940, p. 12.
SCHIJFSMA 1946, p. 90.

Test round, dorsal side conic, ventral side flattened, provided with a wide and deep umbilicus.

Periphery acute.

Chambers numerous, only the last whorl is visible on the umbilical side, the apertures of the earlier chambers are all visible in the deep umbilicus.
Sutures only visible on the umbilical side, depressed, radiate.
Wall on the dorsal side rough, somewhat agglutinant.

Diameter: 1,37—0,37 mm.
Height: 0,4—0,15 mm.

Occurrence: Holland: Hervian and Maestrichtian (Mc—Md), South-Limburg.

FAMILY CASSIDULINIDAE.

Subfamily *Ceratobuliminae.*

PSEUDOPARRELLA CUSHMAN & VAN DAM 1948.

Test trochoid, close coiled, all chambers visible dorsally, only those of the last-formed whorl from the ventral side, very slightly if at all umbilicate; sutures on the dorsal side oblique, ventrally nearly radial; wall calcareous, perforate, aperture on the ventral side of the peripheral face, somewhat loopshaped, elongate, nearly parallel to the plane of coiling.

Pseudoparrella limburgensis sp. n., pl. 7, fig. 10.

Test round, dorsal side flattened or slightly convex, ventral side strongly convex, nearly conic, umbilical area filled with clear shell material.
Periphery subacute.
Chambers indistinct due to poor preservation, 7—8 in the last whorl, gradually increasing in size as added, 2—3 whorls, chambers slightly oblique on the dorsal side.
Sutures indistinct, not depressed, radial on the ventral side, slightly oblique on the dorsal side.
Wall smooth.

Diameter: 0,37—0,6 mm.
Height: 0,22—0,41 mm.

Holotype: No. 18861 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg, B 19 (Md).
Occurrence: Mc—Md.

Remarks: VAN RAADSHOVEN (1940) describes this species as *Eponides nanus*, described by REUSS from the Tertiary of Austria in 1850 (ELLIS & MESSINA Catalogue), but *Eponides nanus* has a more acute periphery, a biconvex test and an aperture, differing from the *Pseudoparrella*-aperture of this new species.

Pseudoparrelella meeterenae sp. n., pl. 7, fig. 9.

Test oval to pentagonal, compressed, ventral side somewhat more than the dorsal side. Ventral side provided with a very small umbilicus.
Periphery subacute.
Chambers distinct on both sides. Ventral side: 5 visible, dorsal side: about 2 whorls of very oblique chambers, gradually increasing in size as added.
Sutures distinct; on the ventral side slightly depressed and curved, on the dorsal side oblique and curved.
Wall very smooth, clear and distinctly perforate.

Diameter: 0,44—0,22 mm.
Height: 0,1—0,07 mm.

Holotype: No. 18862 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Sint Pietersberg B 23 (Md).
Occurrence: Mb—Md.

Remarks: This species is smaller than *Pseudoparrella minisae* sp. n.; the chambers are arranged more obliquely. The specimens are well preserved.
The new form resembles *Pseudoparrella cretae* (FINLAY) and *Pseudoparrella ripleyensis* SANDIGDE. On account of the differences (*P. cretae* and *P. ripleyensis* are more biconvex and have a less acute periphery) this must be a new one.
I have called it *Pseudoparrella meeterenae* in honour of my friend and fellow-student Miss G. S. WESTEROUEN VAN MEETEREN, who has been a great help to me.

Pseudoparrella minisae sp. n., pl. 7, fig. 8.

Test round, ventral side more convex than the dorsal side. Dorsal side sometimes flattened, no umbilicus.
Periphery acute to keeled, sometimes lobate.
Chambers when well preserved, distinct on both sides, 8—10 in the last whorl, about 2 whorls, gradually increasing in size as added.
Sutures, when well preserved, distinct, limbate, radial and slightly curved on the ventral side, ending in a clear umbonal area in the centre, strongly oblique on the dorsal side.
Wall very smooth.

Diameter: 0,3—1,00 mm.
Height: 0,15—0,55 mm.

Holotype: No. 18863 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.
Type-locality: Geulhem, G 17 (Md).
Occurrence: Mc—Md.

Remarks: This species resembles somewhat the American *Pseudoparrella navaroana*. described by CUSHMAN (1938, CCLF, p. 66, pl. 11, fig. 5). *P. navaroana*, however, has a distinct keel and its chambers are less oblique than the chambers of this new form.
I have given it the name *Pseudoparrella minisae* in honour of Mrs. Dr W. A. E. MINIS—VAN DE GEYN, the keeper of the "Natuurhistorisch Museum" at Maastricht, who has rendered me great services in collecting my material and publishing this research.

ALABAMINA TOULMIN 1941.

Test trochiform, usually biconvex, umbilical area closed, periphery bluntly acute or narrowly rounded; all chambers visible from the dorsal side only; dorsal sutures oblique, straight or very curved, ventral sutures radiate, straight or slightly curved; wall calcareous, finely perforate; aperture a long narrow opening on the ventral side along the base of the septal face, with supplementary false aperture, consisting of a deep indentation of the wall of the septal face, which is parallel to the periphery on the ventral side and carries no opening into the interior of the chamber.

Alabamina dorsoplana (BROTZEN) BROTZEN, pl. 7, fig. 7.

Eponides dorsoplana BROTZEN 1940, p. 31, fig. 8: 2.
Eponidoides dorsoplana (BROTZEN) BROTZEN 1942, p. 38, fig. 12: 6.
Alabamina dorsoplana (BROTZEN) BROTZEN 1948, p. 102, pl. 16, fig. 3, textfig. 25—27.

Test round to oval, biconvex, the umbilical side more convex than the spiral one. The umbilical area closed.

Periphery bluntly acute, lobate.

Chambers distinct on both sides. Umbilical side: about 7 in number, triangular, very gradually increasing in size as added. Spiral side: about 3 narrow whorls, only the chambers of the last whorl distinct, oblique.

Sutures: slightly depressed, straight and very oblique on the spiral side, slightly curved on the umbilical side.

Wall smooth.

Diameter: 0,3—0,55 mm.
Thickness: 0,15—0,3 mm.

Occurrence: Sweden: Maestrichtian and Danian, Öresund.
Holland: Maestrichtian (upper part of Mb—Md), South-Limburg.

FAMILY CHILOSTOMELLIDAE.

Subfamily *Allomorphininae*.

ALLOMORPHINA REUSS 1850.

Test trochoid, adult with usually three chambers in a coil, chambers inflated and enlarging rapidly as added, often very involute; wall calcareous, perforate; aperture an elongate arched opening, below the border of the last-formed chamber on the ventral side, sometimes with a slight lip.

Allomorphina trigona REUSS, pl. 2, fig. 20.

Allomorphina cretacea FRANKE 1925, p. 28, pl. 2, fig. 26.
Allomorphina trigona REUSS 1850 (ELLIS & MESSINA Catalogue).
BRADY 1884, p. 438, pl. 55, fig. 24—26.
FRANKE 1928, p. 139.
GLAESSNER 1936, p. 111.
W. A. VISSER 1937, p. 97.
SCHIJFSMA 1946, p. 90.

Test subglobular, somewhat cone-shaped with a very blunted top and a triangular base. This base has 2 rounded angles and one acuminate, formed by the initial part.

Chambers distinct, about 9 visible in 3 whorls, very rapidly increasing in size as added. The last chambers forms nearly half the test.

Sutures distinct, depressed.

Wall smooth.

Aperture covered by a small narrow lip.

Height: 0,63—0,13 mm.
Breadth: 0,55—0,26 mm.
Thickness: 0,44—0,22 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (Ma—Md), South-Limburg.

QUADRIMORPHINA FINLAY 1939.

Test similar to Allomorphina, but with four chambers to the whorl.

Quadrimorphina allomorphinoides (REUSS) FINLAY, pl. 1, fig. 16.

Valvulina allomorphinoides REUSS 1860, p. 223, pl. 11, fig. 6.
Discorbina allomorphinoides (REUSS) FRANKE 1925, p. 91, pl. 8, fig. 11.
FRANKE 1928, p. 189, pl. 18, fig. 7.
Valvulineria allomorphinoides (REUSS) WHITE 1928, p. 304, pl. 41, fig. 8.
CUSHMAN 1931 (CCLF), p. 43, pl. 6, fig. 2.
BROTZEN 1936, p. 153, pl. 11, fig. 1, text-fig. 56.
CUSHMAN & HEDBERG 1941 (CCLF), p. 96, pl. 23, fig. 9.
SCHIJFSMA 1946, p. 89.
CUSHMAN 1946, p. 138, pl. 57, fig. 6, 7.
Quadrimorphina allomorphinoides (REUSS) CUSHMAN & TODD 1949 (CCLF), p. 69, pl. 57, fig. 10—12.

Test broadly oval, subglobular, the apertural side flattened to concave.
Chambers distinct, four visible on the apertural face, three visible on the opposite side, rapidly increasing in size as added. The last chamber occupies nearly half the test.
Sutures distinct, slightly depressed.
Wall smooth.

Length: 0,28 mm.
Breadth: 0,24 mm.
Thickness: 0,22 mm.

Only two specimens out of one sample (G 8).
Occurrence: Germany: Upper Cretaceous, Westphalia.
Sweden: Lower Senonian, Eriksdal.
Holland: Hervian and Maestrichtian (Md), South-Limburg.
U.S.A.: Upper Cretaceous, Gulf Coast Region.
Mexico: Upper Cretaceous, Tampico Embankment.

Remarks: This species is the genotype of *Quadrimorphina* FINLAY 1939. MARIE (1941, p. 230) describes a new genus, *Gyromorphina*, based on the same species: *Valvulineria allomorphinoides* (REUSS). The difference between these two genera is the chamber-nummer of one coil. CUSHMAN (Classification 1948) describes 4 in one coil, MARIE, however, more than 3 in one coil. If these two genera after further research turn out to be the same, the name *Gyromorphina* must be abandoned because the name *Quadrimorphina* has priority.

Subfamily *Seabrookiinae*.

CHILOSTOMELLINA CUSHMAN 1926.

Test composed of a few inflated chambers, the last-formed almost completely enveloping the preceding ones, and the chambers rapidly increasing in size as added; wall calcareous, thin, finely perforate; aperture small, crescentiform, the sides of the chamber with a series of re-entrants at each side.

Chilostomellina senoniensis (HOFKER), pl. 2, fig. 23.

Sphaeroidina bulloides (not D'ORBIGNY) VAN RAADSHOVEN 1940, p. 12.
Pullenoides senoniensis HOFKER (manuscript[1]).

Test globular.

Chambers inflated, arranged in a nearly involute way, rapidly increasing in size as added. The last chamber is very big and forms nearly the half test, clasping the last 3 or 4 chambers and covering the preceding ones. In consequence only 3—4 chambers are visible on the outside of the test.

Sutures distinct, depressed. The sutures of the last chamber are provided with many small crescentiform apertures, a main aperture is lacking.

Wall smooth, finely perforate.

Diameter: 0,3—0,63 mm.
Thickness: 0,36—0,53 mm.

Occurrence: Holland: Maestrichtian (Mc), South-Limburg.

Remarks: VAN RAADSHOVEN (1940) described this species as *Sphaeroidina bulloides*, but *Sphaeroidina* lacks the many apertures along the suture of the last chamber, therefore this species is not *Sphaeroidina*.

It has, however, the characteristics of *Chilostomellina*. The number of chambers is not to be determined, because the inner whorls are invisible and my number of specimens is too scanty (four) for grinding. Through a gap in the test of one specimen more chambers are visible, but I cannot count them.

In his manuscript[1]) HOFKER gives this species a new genus-name: *Pullenoides*. He compares it with *Chilostomellina*, *Pullenia*, *Candeina* and *Sphaeroidina*. With all these genera his *Pullenoides* has some characteristics in common. According to HOFKER the following ones:

"*Pullenia:* The first chambers are arranged in a somewhat irregular spiral, later the arrangement is planispiral.

Candeina: The aperture is multiple, many of them along the sutures of the last chamber (but a great difference is, according to me, the fact that *Candeina* is trochoid with all chambers visible at one side).

Sphaeroidina: The chambers are not arranged in a single plane, but irregularly, similar to the arrangement of the first chambers of HOFKER's *Pullenoides*.

Chilostomellina: The aperture is multiple and the arrangement of the chambers is planospiral."

HOFKER distinguishes 3 generations and gives some sections of these. As already stated, I have not made thin-sections, because my material is too scanty. Therefore I cannot prove his statements and I cannot reject his new genus, but on considering the characteristics found by me and the characteristics given by CUSHMAN (Classification, 1948) I prefer to call this species *Chilostomellina*.

PULLENIA PARKER & JONES 1862.

Test in the adult planispiral, close coiled; chambers completely involute, a few making up the coil; wall calcareous, perforate; aperture an elongate crescentic opening, at the inner margin of the last-formed chamber.

[1]) See note, page 208.

Pullenia quaternaria (REUSS), pl. 2, fig. 21.

Nonionina quaternaria REUSS 1851 (ELLIS & MESSINA Catalogue).
Pullenia quinqueloba FRANKE 1928, p. 194, pl. 18, fig. 13.
Pullenia quaternaria (REUSS) CUSHMAN 1936 (CCLF), p. 74.
CUSHMAN & TODD 1943 (CCLF), p. 2, pl. 1, fig. 1—4.
Pullenia sphaeroides (D'ORBIGNY) VAN RAADSHOVEN 1940, p. 12.

Test round, slightly compressed on both sides, apertural face about a third of the whole height of the test.

Periphery rounded.

Chambers distinct, 5 in number in the last whorl, broad, triangular, gradually increasing in size as added.

Sutures distinct, depressed.

Wall very smooth.

Diameter: 0,26—0,41 mm.
Thickness: 0,15—0,26 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part.
Holland: Maestrichtian (upper part Mb—Md), South-Limburg.

Remarks: CUSHMAN & TODD (1943) give an extensive description of the species belonging to the genus *Pullenia*. According to them there are four Upper Cretaceous species of Europe, each differing very little from the other, namely *Pullenia quaternaria, Pullenia eggeri, Pullenia marssoni* and *Pullenia reussi*.

The dimensions are nearly the same: respectively: 0,28—0,52 mm, 0,45—0,52 mm, 0,48—0,55 mm and 0,25—0,5 mm.

The number of chambers is nearly the same: respectively: 5, 4, 5, 4 to 5.

The test is slightly compressed or subspherical, the sutures are slightly or very slightly depressed.

The only difference is the ratio of length to thickness of the test (A) and the ratio of height of the apertural face to the height of the last chamber (B).

A is for	*P. quaternaria*	1:1,38 to 1:1,70
	for *P. eggeri*	1:1,1 to 1:1,15
	for *P. marssoni*	1:1,3 to 1:1,45
	for *P. reussi*	1:1,1 to 1:1,38.
B is for	*P. quaternaria*	1:3
	for *P. eggeri*	1:2
	for *P. marssoni*	1:3
	for *P. reussi*	1:2,5.

Therefore I can distinguish two compressed forms (*P. quaternaria* and *P. marssoni*) and two spherical ones (*P. eggeri* and *P. reussi*).

The compressed ones have always 5 chambers and differ only a little bit in dimension.

The spherical ones have 4 or 4 to 5 chambers and differ also a little bit in dimension.

I can distinguish in my material also a few spherical specimens besides many compressed ones. The compressed forms have 5 chambers, ratios and dimensions are according to the ranges given by CUSHMAN & TODD for *P. quaternaria* and *P. marssoni*.

The spherical forms have 4 chambers and a fifth half covered by the last chamber, a characteristic for *P. reussi.* Also the ratios and dimensions are in accordance.

I prefer for the compressed form, described above the name *P. quaternaria,* because CUSHMAN & TODD describe *P. marssoni* as larger and less compressed than *P. quaternaria,* characteristics, which are not apparent from the dimensions and the ratios.

I prefer for the spherical form, described hereafter, the name *P. reussi,* because CUSHMAN & TODD have given as its characteristic the fifth chamber, nearly covered by the last, and because the Limburg form lacks the large last chamber, which is a characteristic of *P. eggeri* as given by the same authors. This last characteristic, however, is not evident from the figures. In spite of the article of CUSHMAN & TODD it is difficult to be certain, that we are dealing with these species, because the differences between them are very small.

FRANKE (1928) combines the species *Pullenia sphaeroides* D'ORBIGNY and *Pullenia quaternaria* REUSS in one species, which he calls *P. sphaeroides.* According to him this species is spherical and has 4 to 5 chambers. He found a second form, called by him *Pullenia quinqueloba,* which is compressed and has 5 chambers. I suppose, that he had the same two species as found by me in the Limburg Cretaceous, but FRANKE gives them other species-names.

Pullenia reussi CUSHMAN & TODD, pl. 2, fig. 22.

Pullenia reussi CUSHMAN & TODD 1943 (CCLF), p. 4, pl. 1, fig. 10—13.
Pullenia sphaeroides D'ORBIGNY: EGGER 1899, p. 174, pl. 21, fig. 27—28.
FRANKE 1925, p. 93, pl. 8, fig. 17.
FRANKE 1928, p. 193, pl. 18, fig. 12.

Test round, subspherical. The apertural face is about half the height of the whole test.

Periphery rounded.

Chambers distinct, four visible, a fifth is partly covered by the last chamber. They are broad, triangular, gradually increasing in size as added.

Sutures distinct, radial, depressed.

Wall smooth.

Diameter: 0,22—0,55 mm.
Thickness: 0,18—0,41 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
Holland: Maestrichtian (upper part Mb—Md), South-Limburg.

Remarks: See for remarks: those of *Pullenia quaternaria.*

FAMILY GLOBIGERINIDAE.

Subfamily *Globigerininae.*

GLOBIGERINA D'ORBIGNY 1826.

Test trochoid throughout, umbilicate; chambers in the young especially of the microspheric form in a flattened trochoid form like Discorbis, usually smooth and the wall thin, later chambers globular; wall calcareous, thick and cancellated, in well-preserved, especially pelagic specimens, clothed with long, slender spines coming from the angles of the cancellated surface areas, the base of such areas with pores of the wall; aperture large, opening into the umbilicus.

Globigerina bulloides D'ORBIGNY, pl. 6, fig. 15.

Globigerina bulloides D'ORBIGNY 1825 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 170, pl. 21, fig. 5—7.
EGGER 1910, p. 120, pl. 4, fig. 12.
For more references vide ELLIS & MESSINA Catalogue.

Test oval, biconvex, ventral side provided with an open umbilicus, into which the aperture debouches.
Periphery strongly rounded.
Chambers inflated, four in the last whorl, about two whorls, rapidly increasing in size as added.
Sutures distinct, very depressed, straight.
Wall rough owing to the coarse perforation.

Only two specimens.
Diameter: 0,26 and 0,3 mm.
Thickness: 0,15 and 0,22 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen and Regensburg.
Holland: Maestrichtian (Md), South-Limburg.
For further occurrence vide ELLIS & MESSINA Catalogue.

GLOBIGERINELLA CUSHMAN 1927.

Test trochoid in the young, at least in the microspheric form, later planispiral; aperture single, large, opening into the umbilicus in the young, in the adult median; fine spines covering the test in well-preserved specimens.

Globigerinella aspera (EHRENBERG), pl. 8, fig. 15.

Planerostomum asperum EHRENBERG 1854 (ELLIS & MESSINA Catalogue).
Rotalia aspera (EHRENBERG) BEISSEL 1891, p. 73, pl. 14, fig. 1—6.
Globigerina aspera (EHRENBERG) EGGER 1899, p. 170, pl. 21, fig. 18—20.
FRANKE 1928, p. 192, pl. 18, fig. 10.
MARIE 1937, p. 265.
Globigerinella aspera (EHRENBERG) CARMAN 1929, p. 315, pl. 34, fig. 6.
CUSHMAN 1931 (CCLF), p. 44, pl. 6, fig. 5.
CUSHMAN 1932, p. 342.
BROTZEN 1936, p. 170, pl. 13, fig. 2, textfig. 62.
MARIE 1941, p. 235, pl. 36, fig. 336.
SCHIJFSMA 1946, p. 94, pl. 6, fig. 8.
Globigerinella voluta (not WHITE) SANDIGDE 1932, p. 284, pl. 44, fig. 1, 2.

Test oval, provided with a wide umbilicus on both sides.
Periphery broadly rounded.
Chambers distinct on both sides, 14 in number, rapidly increasing in size as added, 2½ whorl. Last chambers very inflated.
Sutures distinct, straight, depressed.
Wall rough.

Diameter: 0,15—0,3 mm.
Thickness: 0,05—0,15 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
France: Craie Blanche, Basin of Paris.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Mb), South-Limburg.
U.S.A.: Upper Cretaceous, Annona, Wyoming.
Antigua: Upper Cretaceous.

FAMILY GLOBOROTALIIDAE.

GLOBOTRUNCANA CUSHMAN 1927.

Test trochoid in the young; chambers usually globose, rough and cancellated, adult usually much compressed, dorsal and ventral sides either flat or convex, ventral side sometimes slightly concave, periphery truncate, usually with a double keel on dorsal and ventral sides; aperture ventral, in well-perserved specimens with a thin plate-like structure over the umbilical area; apparently pelagic in part.

Globotruncana marginata (REUSS) THALMANN, pl. 8, fig. 13.

Rosalina marginata REUSS 1845 (ELLIS & MESSINA Catalogue).
Globigerina marginata (REUSS) EGGER 1899, p. 171, pl. 21, fig. 12—14.
FRANKE 1928, p. 192, pl. 18, fig. 9.
Globotruncana canaliculata var. *ventricosa* (not WHITE) PLUMMER 1931, p. 199, pl. 13, fig. 10.
Globotruncana marginata (REUSS) THALMANN 1934, p. 414.
CUSHMAN 1944 (CCLF), p. 15, pl. 3, fig. 9.
CUSHMAN & DEADERICK 1944, p. 340, pl. 53, fig. 29.
CUSHMAN 1946, p. 150, pl. 62, fig. 1, 2.
Rosalinella marginata (REUSS) SCHIJFSMA 1946, p. 97, pl. 7, fig. 10.

Test somewhat compressed, dorsal side more flattened than ventral side, ventral side provided with a small deep umbilicus.

Periphery provided with an indistinct double keel.

Chambers distinct on both sides, slightly inflated, especially on the ventral part, 5 in number in the last whorl, gradually increasing in size as added, 2 whorls.

Sutures distinct, slightly depressed, oblique on the dorsal side, straight and radial on the ventral side.

Wall rough.

Only three poorly preserved specimens with the following dimensions:
Diameter: 0,2—0,22 mm.
Thickness: 0,07—0,08 mm.

Occurrence: Germany: Gault and Senonian, N.W. part, Oberbayerische Alpen.
Holland: Hervian and Maestrichtian (Mb), South-Limburg.
U.S.A.: Upper Cretaceous, Texas, Arkansas, Gulf Coast Region.

Remarks: MARIE (1941) gives the genus of this form the new name *Rosalinella*, which is not accepted by CUSHMAN in his Classification of 1948.

FAMILY ANOMALINIDAE.

Subfamily *Anomalininae*.

ANOMALINA D'ORBIGNY 1826.

Test in the young trochoid, adult often nearly involute dorsally as well as ventrally; chambers added nearly in a planispiral manner, the inner coils of the dorsal side often appearing as a central raised boss; wall calcareous, perforate; aperture in the young ventral, in the adult becoming peripheral, at the base of the last-formed chamber in the median line, sometimes with a boss of clear material over the umbilical region.

Anomalina complanata REUSS, pl. 5, fig. 15.

Anomalina complanata REUSS 1850 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 153, pl. 18, fig. 1—3.
FRANKE 1928, p. 180, pl. 16, fig. 2.
CUSHMAN 1932, p. 343.
FAHRION 1937, p. 201.
HENSOLDT 1938, p. 359, 362.
Rosalina complanata (REUSS) REUSS 1860, p. 86, pl. 11, fig. 3.
Truncatulina complanata (REUSS) FRANKE 1925, p. 84, pl. 7, fig. 10.
Cibicides complanata (REUSS) BROTZEN 1945, p. 55, pl. 2, fig. 4, 5.

Test round, compressed, ventral side convex, dorsal side flattened. Umbilicus filled up with shell material.

Periphery acute, not keeled.

Chambers numerous, gradually increasing in size as added. On the dorsal side 2½ coil visible, 10—12 chambers in the last coil.

Sutures distinct, radial on both sides, slightly curved, limbate.

Wall smooth, perforate.

Diameter: 0,17—0,48 mm.
Height: 0,05—0,15 mm.

Occurrence: Germany: Upper Cretaceous, N.W. part, Oberbayerische Alpen.
Sweden: Maestrichtian, Höllviken.
Holland: Maestrichtian (Mb—Md), South-Limburg.
U.S.A.: Annona Chalk.
Africa: Upper Cretaceous, Tanganjika Territorium.

Remarks: This species differs from *Cibicides voltziana* by its narrow, small chambers, never inflated.

Anomalina grosserugosa (GÜMBEL) BRADY, pl. 6, fig. 2.

Truncatulina grosserugosa GÜMBEL 1868 (ELLIS & MESSINA Catalogue).
Anomalina grosserugosa (GÜMBEL) BRADY 1876, p. 673, pl. 94, fig. 4, 5.
CARSEY 1926, p. 46, pl. 3, fig. 3.
FRANKE 1928, p. 182, pl. 17, fig. 1.
Cibicides grosserugosa (GÜMBEL) W. A. VISSER 1937, p. 96.

Test round, compressed, dorsal side slightly convex, inner whorl sometimes lower, sometimes higher than the last whorl.

Ventral side convex to flattened, provided with a deep umbilicus sometimes filled up with shell material.

Periphery subacute to rounded.

Chambers distinct, 8—10 in the last whorl, gradually increasing in size as added, 2—3 whorls. Last chambers inflated, especially on the ventral side.

Sutures indistinct, limbate, except those between the last chambers which are slightly depressed.

Wall nearly granulate owing to the coarse perforation on both sides.

Diameter: 0,33—0,48 mm.
Thickness: 0,19—0,3 mm.

Occurrence: Germany: Upper and Lower Senonian, N.W. part.
Holland: Maestrichtian (upper part Mb, upper part Md), South-Limburg.

PLANULINA D'ORBIGNY 1826.

Test in the young trochoid, adult much compressed, evolute; earlier chambers visible from both sides in the megalospheric form with the central area raised on the dorsal side; wall calcareous, coarsely perforate; aperture at the base of the chamber at the median line.

Planulina tenuissima (REUSS), pl. 6, fig. 3.

Truncatulina tenuissima REUSS 1862, p. 317, pl. 3, fig. 2.
FRANKE 1925, p. 86, pl. 7, fig. 11.
FRANKE 1928, p. 178, pl. 16, fig. 5.

Test oval, much compressed, dorsal side slightly convex, ventral side flattened to concave, provided with a wide shallow umbilicus, exposing the inner whorls.

Periphery acute.

Chambers numerous, 8—10 in the last whorl, 2—3 whorls, rapidly increasing in size as added in the last whorl. The last chambers with lips, produced into the umbilicus.

Sutures distinct on the ventral side, radial and depressed. Indistinct on the dorsal side, not depressed, slightly oblique.

Wall coarse owing to the coarse perforation, looking like agglutinant.

Diameter: 0,3—1,2 mm.
Thickness: 0,07—0,13 mm.

Occurrence: Germany: Upper Turonian, Pommeriana.
Holland: Maestrichtian (Mc—Md), South-Limburg.

Planulina sp., pl. 7, fig. 15.

Test oval, slightly biconvex.

Periphery acute, strongly lobate.

Chambers distinct on both sides, 8 on the ventral side, 2 whorls on the dorsal side, rapidly increasing in size as added.

Sutures distinct, radiate, slightly curved, especially at the periphery, depressed.

Wall coarse owing to the coarse perforation.

Diameter: 0,4 mm.
Thickness: 0,08 mm.

Only one specimen:

Holotype: No. 18865 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Geulhem, G 11 (Md).

Subfamily *Cibicidinae*.

CIBICIDES MONTFORT 1808.

Test planoconvex, trochoid, usually attached by the flattened dorsal side; wall calcareous, coarsely perforate; aperture peripheral, at the base of the chamber, sometimes extending ventrally, but typically with a long slitlike extension dorsally between the inner margin of the chamber and the previous whorl, nearly the length of the chamber.

Cibicides constrictus (VON HAGENOW) CUSHMAN, pl. 6, fig. 5.

Rotalia constrictus VON HAGENOW 1842 (ELLIS & MESSINA Catalogue).
REUSS 1860, p. 329, pl. 5, fig. 7.
Truncatulina constricta (VON HAGENOW) FRANKE 1925, p. 84, pl. 7, fig. 8.
FRANKE 1928, p. 178, pl. 16, fig. 13.
Cibicides constricta (VON HAGENOW) CUSHMAN 1931, p. 315, pl. 36, fig. 7.
Cibicides constrictus (VON HAGENOW) CUSHMAN 1946, p. 160, pl. 65, fig. 13.

Test round, planispiral, slightly biconvex, the inner whorls invisible, covered by a plug of shell material on both sides.

Periphery subacute.

Chambers numerous (about 12 in the last whorl), very gradually increasing in size as added.

Sutures distinct, slightly curved, depressed between the last chambers.

Wall smooth, finely perforate.

Diameter: 0,26—0,55 mm.
Thickness: 0,17—0,13 mm.

Occurrence: Germany: Upper Senonian, N.W. part.
Holland: Maestrichtian (Mc—Md), South-Limburg.
U.S.A.: Navarro, Saratoga Chalk, Arkansas; Taylor marl, Texas.

Cibicides excavata BROTZEN, pl. 6, fig. 6.

Truncatulina sp. BEISSEL 1891, p. 75, pl. 15, fig. 4—11.
Truncatulina beaumontiana (not D'ORBIGNY) FRANKE 1928, p. 176, pl. 14, fig. 6.
Cibicides excavata BROTZEN 1936, p. 189, pl. 13, fig. 7.
SCHIJFSMA 1946, p. 100, pl. 6, fig. 7.

Test oval, planoconvex, dorsal side flattened, provided with a distinct umbilicus, ventral side convex, with a small umbilicus.

Periphery rounded, lobate.

Chambers distinct, gradually increasing in size as added, about six in number in the last whorl, the last three rather inflated. Inner whorls indistinct. The last chambers are much broader than high and the apertural face is clasping the earlier whorl.

Sutures distinct, radial, depressed between the last inflated chambers.

Wall smooth, perforate.

Diameter: 0,48 mm.
Thickness: 0,3 mm.

Occurrence: Germany: Senonian, Westphalia and Pommeriana.
Sweden: Lower Senonian, Eriksdal.
Holland: Maestrichtian (Md), South-Limburg.

Cibicides involuta (REUSS), pl. 6, fig. 4.

Rotalina involuta REUSS 1850 (ELLIS & MESSINA Catalogue).
REUSS 1863, p. 82.
EGGER 1899, p. 160, pl. 19, fig. 10—12.
Rotalia involuta (REUSS) REUSS 1862, p. 313, pl. 2, fig. 4.
VAN RAADSHOVEN 1940, p. 12.
Truncatulina involuta (REUSS) FRANKE 1925, p. 84, pl. 7, fig. 9.
FRANKE 1928, p. 177, pl. 16, fig. 4.
HENSOLDT 1938, p. 361.
Anomalina involuta (REUSS) APPLIN 1933, p. 219.
CRESPIN 1938, p. 395.
Cibicides involuta (REUSS) HOFKER 1949 (pars), p. 21—25, fig. 21 A, B, C, D, E.

Test round, ventral side convex, dorsal side flattened, no umbilicus.
Periphery rounded to subacute, sometimes lobate.
Chambers not always distinct; on the ventral side 8—9 chambers gradually increasing in size as added. On the dorsal side two and a half coil, only the last four chambers distinct.
Wall smooth, coarse with many wide pores.

Diameter: 0,4—0,9 mm.
Height: 0,15—0,3 mm.

Occurrence: Germany: Lower and Upper Senonian, Westphalia, Hannover, Pommeriana, E. Preussia.
Holland: Maestrichtian (Ma—Md), South-Limburg.
U.S.A.: Upper Senonian, South Dakota.
Australia: Upper Cretaceous, N.W. basin.

Remarks: See remarks of *Eponides hemisphaerica*.

Cibicides polyraphes (REUSS), pl. 6, fig. 7.

Rotalina polyraphes REUSS 1845 (ELLIS & MESSINA Catalogue).
REUSS 1863, p. 82.
EGGER 1899, p. 161, pl. 20, fig. 35—37.
Anomalina polyraphes (REUSS) FRANKE 1925, p. 86, pl. 7, fig. 17.
FRANKE 1928, p. 182, pl. 17, fig. 6.

Test round, nearly involute, planoconvex, ventral side provided with a small umbilicus.
Periphery subacute to rounded.
Chambers numerous, oblique, high and narrow, gradually increasing in size as added. 7—10 in the whorl, 2—3 whorls.
Sutures slightly limbate, curved and oblique on both sides.
Wall smooth, finely perforate.

Diameter: 0,22—0,3 mm.
Thickness: 0,15—0,2 mm.

Occurrence: Germany: Pläner mergel, Bohemia; Upper Senonian, Oberbayerische Alpen; Gault-Senonian, Westphalia, Pommeriana.
Holland: Maestrichtian (Mb—Md), South-Limburg.

Remarks: See remarks of *Eponides hemisphaerica*.

Cibicides roestae sp. n., pl. 6, fig. 9.

Test round, convex on the ventral side, flattened on the dorsal side, no umbilicus.

Periphery acute, lobate. Adult specimens provided with a narrow serrate keel.

Chambers indistinct, when visible, only the chambers of the last whorl, about 8 in number, gradually increasing in size as added.

Sutures indistinct, oblique on the ventral side, straight on the dorsal side, slightly limbate, at least the last ones.

Wall on both sides ornamented with irregular small knobs, especially in the centre of the test, covering the inner whorls, smaller on the dorsal side than on the ventral side. When there is a keel present, this is smooth.

Aperture small and indistinct, at the periphery, not extending to the ventral or dorsal side.

Diameter: 0,55—0,22 mm.
Thickness: 0,26—0,15 mm.

Holotype: No. 18820 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Occurrence: Mc—Md, abundantly in Md.

Remarks: At first sight this species much resembles *Rotalia tuberculifera* REUSS.

It is not a *Rotalia*, because it has a flat dorsal side and a convex ventral side (*Rotalia* has a nearly biconvex test) and because it has an aperture at the periphery (*Rotalia* has an aperture on the ventral side of the test).

The ornamentation of *Rotalia tuberculifera* follows the sutures, the ornamentation of *Cibicides roestae* covers the sutures. I have called this form *Cibicides roestae* as a compliment to Miss COR ROEST, who has drawn with great application all figures in this publication.

Cibicides voltziana (D'ORBIGNY), pl. 6, fig. 8.

Rotalina voltziana D'ORBIGNY 1840 (ELLIS & MESSINA Catalogue).
EGGER 1899, p. 159, pl. 22, fig. 26—28.
EGGER 1910, p. 115, pl. 2, fig. 13—15.
Truncatulina voltziana (D'ORBIGNY) FRANKE 1928, p. 177, pl. 16, fig. 7.
Cibicides voltziana (D'ORBIGNY) MARIE 1937, p. 265.
BROTZEN 1940, p. 24, fig. 7.
MARIE 1941, p. 240, pl. 37, fig. 345—349.
BROTZEN 1945, p. 54.
SCHLIJFSMA 1946, p. 102, pl. 5, fig. 6.
BROTZEN 1948, p. 79.

Test round, dorsal side flattened with a small knob in the centre, ventral side convex, umbilicus filled with hyaline substance.

Periphery acute to subacute, last part sometimes lobate.

Chambers mostly distinct, about 10 in number on the ventral side, gradually increasing in size as added, one coil visible from the dorsal side, the others covered by a plug of shell material.

Sutures indistinct, curved not depressed.

Wall smooth, finely perforate.

Diameter: 0,3—0,7 mm.
Height: 0,2—0,44 mm.

Occurrence: Germany: Upper Cretaceous, Oberbayerische Alpen, Regensburg; Upper Cenomanian and Lower Turonian, Rheinprovince.
France: Craie Blanche, Basin of Paris.
Sweden: Maestrichtian and Danian, South-Sweden.
Holland: Hervian and Maestrichtian (Ma—Md), South-Limburg.

FAMILY PLANORBULINIDAE.

LINDERINA SCHLUMBERGER 1895.

Test in the adult nearly bilaterally symmetrical, in the young attached, coiled, very earliest chambers slightly trochoid, closely spiral, later with annular series of chambers, but developing a thick layer of clear shell material over the central portion of the test on the two flattened sides; wall calcareous, coarsely perforate; apertures in the adult formed by the coarse perforation of the peripheral border.

Linderina douvilléi SILVESTRI, pl. 6, fig. 10, pl. 10, fig. 11.

Linderina sp. DOUVILLÉ 1900, p. 601, pl. 18, fig. 18.
Linderina douvilléi SILVESTRI 1910 (ELLIS & MESSINA Catalogue).
Monolepidorbis douvilléi (SILVESTRI) ASTRE, p. 390.

Test round, at one side more or less conic, the other flattened to concave, sometimes curved like a shrivelled leaf.

Periphery rounded, lobate.

Chambers numerous, sometimes visible, glimmering through at the outside, but then only near the periphery.

Wall smooth, perforate.

Thin-section:

Vertical: chambers visible as a curved equatorial plane, gradually increasing in size from the centre to the periphery. No lateral chambers visible, only a vague thickening of shell material without distinct structure.

Because of the curved form of the equatorial plane and of the test itself it is difficult to get a horizontal section.

The structure seems to be somewhat like *Lepidorbitoides*, without a distinct nucleoconch. Form of the chambers: shortly spatuliform.

Diameter: 0,55—0,26 mm.
Height: 0,11—0,08 mm.

Occurrence: France: Campanian, Belvès.
Holland: Maestrichtian (upper part of Mb, Mc and Md) South-Limburg.

Remarks: There is some difference of opinion about the characteristics of this genus.

SCHLUMBERGER (1902), the original describer of this genus and GLAESSNER (1933) both speak of a single layer of chambers with dorsal and ventral walls extending towards the centre covering the preceding chambers.

CUSHMAN (1948, Classification) says: an annular series of chambers developing a thick layer of clear shell material over the central portion of the test on both sides.

This last description agrees with the Limburg *Linderina*, in spite of the poor preservation and the consequently poor section.

But because of this poor preservation and these poor sections I cannot see whether the Limburg *Linderina* agree with SCHLUMBERGER's description or not.

CUSHMAN (1948, Classification) also speaks of *Monolepidorbis*, needing further study, which seems closely allied to *Linderina*.

ASTRE (1927) describes this genus as one with only one layer of chambers on both sides with thickened walls, more or less provided with holes. These holes are not visible in my thin-sections.

ASTRE (1927) calls the *Linderina* described by DOUVILLÉ (1910) *Monolepidorbis douvillei*. According to him therefore this species described above, is a *Monolepidorbis*.

Pending for further researches I provisionally prefer the genus-name *Linderina*.

GYPSINA CARTER 1877.

Test a generally spherical mass of compressed chambers, sometimes arranged in more or less radial rows, early attached, on a small object completely covering it and forming a spherical mass, but becoming free early and becoming spherical; apertures formed by the coarse pores of the wall.

Gypsina cretae (MARSSON) FRANKE, pl. 6, fig. 11.

Acervulina cretae MARSSON 1878 (ELLIS & MESSINA Catalogue).
Gypsina cretae (MARSSON) FRANKE 1925, p. 92, pl. 8, fig. 14.
FRANKE 1928, p. 191, pl. 18, fig. 6.

Test irregular in form, flattened at one side, convex at the other.

Periphery acute, lobate.

Chambers globular, numerous, irregularly arranged like soapbubbles on a flat surface.

Sutures depressed.

Wall smooth, coarsely perforate.

Diameter: 0,5—0,52 mm.

Occurrence: Germany: Upper Senonian, Rügen, Rheinprovince.
Holland: Maestrichtian (Mc—Md), South-Limburg.

FAMILY ORBITOIDIDAE.

Subfamily *Orbitoidinae*.

OMPHALOCYCLUS BRONN 1852.

Test biconcave lenticular; embryonic chambers of microspheric test planispiral, of megalospheric test quadrilocular; in the central part of the test there is either a double layer of chambers, or a single layer, which as growth progresses becomes double, and then a median layer may be intercalated between lateral layers. Although the peripheral part of the test in adult specimens is more than one layer of chambers thick, the lateral chambers are not different from the median, as in the other subfamilies of the Orbitoids. The median layer is composed of concentric rings of chambers, whose outer walls are only slightly curved, or are nearly straight. The median chambers communicate with each other by means of stolons, and with the lateral chambers through apertures in the flours of the latter; those on the periphery open to the outside through marginal apertures, which rather regularly alternate in position, and are arranged in one two, three or four rows. Both the roofs and flours of the chambers are pierced by very fine perforations,

similar to those of the more typical Orbitoids. The superficial chambers are arranged in concentric rings, those in one ring alternating in position with those in adjacent rings. Each chamber communicates with two chambers of both the preceding and the succeeding ring. There are also cribriform perforations. In old specimens a secondary deposit is laid down in the interior of the chambers, and sometimes obliterates the original structure of the test producing in its median part a network of canals and irregular cavities. On the outer surface, a netwerk of lozenge-shaped meshes is produced by the immediately underlying layer. Pillars, which may be lamellate, may be formed and produce wavy, radiating costae.

Omphalocylus macropora (LAMARCK), pl. 9, fig. 2, pl. 11, fig. 7, 8.

Orbulites macropora LAMARCK 1816 (ELLIS & MESSINA Catalogue).
VON HAGENOW 1851, p. 103, pl. 12, fig. 17.
REUSS 1862, p. 320, 324.
Orbitolites macropora (LAMARCK) DOUVILLÉ 1902, p. 307, 309, 310, 311.
Omphalocyclus macropora (LAMARCK) GROSSOUVRE 1904, p. 514.
DOUVILLÉ 1920, p. 230—232, pl. 8, fig. 5—9, text-fig. 35—37.
VAUGHAN 1934, p. 70.
PALMER 1934, p. 68.
O. RENZ 1936, p. 81 and following pages.
O. RENZ 1936, p. 560, pl. 32, fig. 1, 2.
C. RENZ 1936, p. 419.
VAN RAADSHOVEN 1940, p. 12.
RUTTEN 1941, p. 38, pl. 1, fig. 6.
SCHIJFSMA 1946, p. 108, pl. 8, fig. 4, 5, pl. 10, fig. 6—8.
HOFKER 1949, p. 60, fig. 23.
Sporadotrema minutum HOFKER 1926, p. 62, fig. 1—20.

Test round, thick, flattened or slightly concave on both sides.

Periphery very blunt, round, showing sometimes two rows of openings of the chambers of the margin.

Chambers sometimes visible on both sides, because the outer wall is mostly broken, large and irregular.

Wall when not broken provided with ridges along the sides of the chambers.

Thin-section:

Horizontal: a very large nucleoconch, quadrilocular, ringed in a thick wall, diameter 0,63—0,44 mm. Median chambers flat, ogival, stolons mostly distinct.

Vertical: median chambers hardly different from the lateral chambers, only one row of lateral chambers on both sides. Apertures between the lateral chambers are not visible.

I have not found microspheric specimens.

Diameter: 0,81—1,4 mm.
Thickness: 0,4—0,50 mm.

Occurrence: Switzerland: Maestrichtian, Bielersee.
Greece: Maestrichtian, Leukas.
Italy: Upper Cretaceous, Central Appenines.
Holland: Hervian and Maestrichtian (Md), South-Limburg.

Remarks: Only the small specimens of this species are in my material, in accordance with the A_2 form of HOFKER (1949). He gives the measure-

ment of the proloculus. I can only measure the whole nucleoconch, because the chambers of the nucleoconch mostly disintegrated during the grinding. The whole nucleoconch is about 3 times longer than HOFKER's proloculus.

ORBITOIDES D'ORBIGNY 1847.

Test lenticular, more or less compressed, symmetrical or asymmetrical, surface ornamented with vermicular pillars or radiating costae. Embryonic chambers enveloped in a thick shell, at first quadrilocular, later they may become bilocular, by atrophy and fusion of three of the initial chambers, and the production of a smaller, embraced by a larger chamber. Equatorial chambers with a curved outer wall and inwardly converging lateral walls, radial diameter shorter than the transverse. Communication between the chambers by a few round, lateral apertures.

Orbitoides apiculata SCHLUMBERGER, pl. 9, fig. 4, pl. 11, fig. 1, 3.

Orbitoides apiculata SCHLUMBERGER 1901, p. 465, 466, pl. 8, fig. 1, 4, 6, pl. 9, fig. 1, 4.
DOUVILLÉ 1920, p. 216, 217, fig. 4—9, 12, 15—18.
ARNI 1933, p. 108.
O. RENZ 1936, p. 547, 557, pl. 30, fig. 1, 2.
LIEBUS 1938, p. 143—147, 6 textfig.
VAN RAADSHOVEN 1940, p. 12.
SCHIJFSMA 1946, p. 116, pl. 9, fig. 1—6, pl. 10, fig. 11.
Orbitella apiculata (SCHLUMBERGER) DOUVILLÉ 1915, p. 667, 670, fig. 7—12.
Lepidorbitoides faujasi (DEFRANCE) W. A. VISSER 1937, p. 96.
Orbitoides faujasi (DEFRANCE) HOFKER 1926, (pars) p. 38—42, pl. 1, fig. 5, 6.

Test round, at one side flattened, at the other provided with a rather distinct knob.

Periphery acute to subacute.

Chambers at the outside invisible.

Surface ornamented with small dispersed pustules.

Thin-section:

Horizontal: two chambers visible of the nucleoconch, ringed in a thick wall. Diameter 0,63—0,59 mm.

Equatorial chambers ogival, rather large with four distinct stolons between each other.

Vertical: Three chambers of the nucleoconch visible.

The equatorial chambers more high than broad, or as high as broad, increasing in height to the periphery.

Height: 0,1—0,2 mm; breadth: 0,06—0,14 mm.

Lateral chambers long and narrow. No apertures visible between those.

Length: 0,12—0,16 mm; height: 0,4—0,08 mm.

The equatorial plane is not present in the middle of the test, but near the flattened side. On both sides pillars, more at the side with the central knob.

Diameter: 1,5—2,3 mm.

Occurrence: France: Maestrichtian, Maurens.
Switzerland: Upper Cretaceous, Helvetic nappes, Bielersee.
Greece: Maestrichtian, Thessalische Pindos, Leukas.
Austria: Maestrichtian, Wienerwaldflysch.
Holland: Hervian and Maestrichtian, (Md), South-Limburg.

Remarks: The central knob, described by SCHLUMBERGER (1901) is not

always equally distinct. LIEBUS (1938) remarks that *Orbitoides apiculata* has sometimes a lenticular form, hardly distinguishable from *Orbitoides media*.

For further remarks see the remarks of *Lepidorbitoides minor*.

Orbitoides brinkae sp. n., pl. 9, fig. 5, pl. 11, fig. 2, 5.

Orbitoides faujasi (DEFRANCE) form A_2 HOFKER 1926, p. 38, pl. 1, fig. 1, 2, pl. 2, fig. 1, 2.

Test round, one side more convex than the other.

Periphery rounded, often a row of gaps along the margin, because the chambers at the periphery are broken, slightly lobate.

Chambers at the outside invisible, except often the last ones along the margin.

Surface provided with small dispersed pustules.

Thin-section:

Horizontal: a very large and inflated nucleoconch, ringed in a thick wall. In this 2 chambers visible, diameter 0,52—0,44 mm, this nucleoconch takes the largest part of the test.

Equatorial chambers in consequence rather few in number, ogival, four stolons visible. Length: 0,1—0,14 mm; breadth: 0,1—0,14 mm.

Vertical: The nucleoconch of which three chambers are visible forms nearly the whole test.

Equatorial chambers more high than broad (0,14 × 0,1 mm).

Lateral chambers very few in number, small, long and narrow; size: 0,06 × 0,04 mm.

No pillars.

Diameter: 0,77—1,33 mm.

Holotype: No. 18820 in the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden.

Type-locality: Sint Pietersberg, K 4 (Md).

Occurrence: Md.

Remarks: HOFKER (1926) described this form as form A_2 of *Orbitoides faujasi*. His figures and descriptions agree with my specimens.

In his description of 1949 of the same form, the agreement with my specimens is not evident, but in an interview with HOFKER he told me that the A_2 form, then described, is the same as the A_2 form described in 1926.

As regards the differences from *Lepidorbitoides minor* (wrongly called by HOFKER *Orbitoides faujasi*, see the remarks on *Lepidorbitoides minor*), viz. the nucleoconch, consisting of 4 chambers, (*L. minor* has a nucleoconch of 2 chambers, of a different form), the biconvex, nearly inflated test (*L. minor* has a biconvex to planoconvex test), the form of the chambers and the absence of pillars in my opinion this form is not another generation of *Lepidorbitoides minor*, but a new form.

I have given it the name *Orbitoides brinkae* in honour of my friend and fellow-student Miss Dr C. BRINK.

LEPIDORBITOIDES SILVESTRI 1907.

Test small to medium size, flat to inflated, lenticular, circular or stellate. Surface papillate, with or without raised ridges. Nucleoconch bilocular, the first chamber is subspherical, second chamber somewhat larger, slightly reniform, partially embracing the initial one. In some species there is a series of chambers slightly larger than the equatorial chambers partly embracing the embrionic chambers; in others, there may be

only one such chamber, or there may be none. The equatorial chambers have curved outer walls and truncate or pointed inner ends, depending on whether the sides of the chambers in the same circles do or do not meet, but in some specimens they may become spatuliform or even hexagonal. Gradation may occur in the same specimen. Communication between the equatorial chambers is by means of six stoloniferous apertures. Roofs and floors of the equatorial chamber and the roofs of the lateral chambers are cribriform, perforate. Pillars present.

Lepidorbitoides minor (SCHLUMBERGER), pl. 9, fig. 3, pl. 11, fig. 4, 6.

Orbitoides faujasi (DEFRANCE) REUSS 1862, p. 310, pl. 4, fig. 7—9, pl. 5, fig. 1—5.
HOFKER 1926, (pars) p. 38—42, pl. 1, fig. 3, 4, pl. 2, fig. 3, 6, 7.
HOFKER 1949, p. 43—60, fig. 20.

Orbitoides minor SCHLUMBERGER 1901, p. 406, pl. 8, fig. 2, 3, 5, pl. 9, fig. 2, 3.
DOUVILLÉ 1902, p. 309—312.
GROSSOUVRE 1904, p. 514.

Lepidorbitoides socialis (LEYMERIE) race *minor* DOUVILLÉ 1920, p. 224—225, fig. 27.
RUTTEN 1935, p. 186, 1 textfig.

Lepidorbitoides minor (SCHLUMBERGER) DOUVILLÉ 1915, p. 670.
THIADENS 1937, p. 106.
TAN SIN HOK 1939, p. 73, 74, pl. 1, fig. 4, 5.
VAN RAADSHOVEN 1940, p. 12.
RUTTEN 1940, p. 263—267, fig. 2.
RUTTEN 1941, p. 48—49, pl. 2, fig. 3.
SCHIJFSMA 1946, p. 119, pl. 9, fig. 7—10.

Lepidorbitoides spec. indet. W. A. VISSER 1937, p. 96.

Test round, biconvex, with a rounded periphery or an acute periphery, sometimes inclining to planoconvex.

Chambers usually invisible at the outside, sometimes glimmering through at the margin.

Surface covered by sometimes more, sometimes fewer small pustules.

Thin-section:

Horizontal: The nucleoconch consists of 2 chambers, ringed in a thick wall; diameter 0,18—0,33 mm, mostly 0,22 or 0,26 mm.

The equatorial chambers are small, ogival, nearly round, mostly with four distinct stolons; breadth: 0,05—0,06 mm, height: 0,03—0,06 mm.

Vertical: The equatorial chambers hardly increase in height to the periphery, more broad than high; size: 0,06 × 0,03 mm.

The lateral chambers have been equally developed on both sides of the test, long and narrow, apertures between them are not visible. Size: 0,04 × 0,02 mm.

Diameter: 0,63—1,7 mm.
Thickness: 0,18—0,37 mm.

Occurrence: Spain: Upper Cretaceous, N. part.
Holland: Hervian and Maestrichtian (Md), South-Limburg.
Madagascar: Upper Cretaceous.
South-India: Upper Cretaceous.

Remarks: Researches on the *Orbitoids* of the Dutch Maestrichtian have been published by many authors.

REUSS (1862) describes in detail *Orbitoides faujasi* from Maestricht. If we consider the description, he here deals with *Orbitoides apiculata* as well as with *Lepidorbitoides minor*. The dimensions of his specimens vary from 0,8—6 mm. The tests of his specimens are biconvex (*L. minor*) or plano-convex with a distinct knob at one side (*O. apiculata*).

SCHLUMBERGER (1901) accurately describes the species known at the time as Maestricht *Orbitoids*. He calls them *Orbitoides apiculata* and *Orbitoides minor*. From this description it is apparent that he starts from a collection out of Maestricht, obtained from DEFRANCE. In this collection DEFRANCE has *Licophris faujasi* (the old name for *Orbitoides faujasi*), not from Maestricht, but from Mirambeau (France). SCHLUMBERGER recognizes this species as *Orbitoides media*. The species-name *faujasi* must be abandoned, as not suiting the rules of nomenclature. Moreover DEFRANCE has in this collection, given to SCHLUMBERGER 10 specimens of *Discolithes lentiforme* and 9 specimens of *Licophris lenticularis*, all from Maestricht. But of these nineteen specimens 18 turn out to be of the same species (then described by SCHLUMBERGER as *Orbitoides minor* sp. n.) and one of another species (then described by SCHLUMBERGER as *Orbitoides apiculata* sp. n.).

DOUVILLÉ (1915) introduces the new genus-names *Orbitella* and *Lepidorbitoides*. On account of the nucleoconch *Orbitoides apiculata* turns out to be an *Orbitella* and *Orbitoides minor* a *Lepidorbitoides*.

DOUVILLÉ again describes both species in 1920, making *Lepidorbitoides minor* a variety of *Lepidorbitoides socialis* (LEYMERIE), a species out of the Haute Garonne (France). The *Orbitella* later becomes again *Orbitoides*. According to DOUVILLÉ *Orbitoides apiculata* occurs in Maestricht and Maurens (France), whence also SCHLUMBERGER describes this species. Besides in Maestricht *Lepidorbitoides minor* can be found in Madagascar and South-India.

HOFKER (1926) describes the *Orbitoids* of Maestricht and as many as four forms, of which there is one abnormality. The three other ones are said to be the three generations of *Orbitoides faujasi*. Here HOFKER returns to the name, left by SCHLUMBERGER (1901).

HOFKER chooses this name, because (REUSS 1862) uses it for the *Orbitoids* found by him at Maestricht. This is an established fact. HOFKER supposes, that other authors, using the species-names *minor* and *apiculata* (SCHLUMBERGER, DOUVILLÉ and others) had at their disposal too little Maestricht material to equalize with certainty the Maestricht species with the species found by them elsewhere. SCHLUMBERGER's original descriptions, however, are based on material from Maestricht, as explained above. Therefore HOFKER's supposition is of no value. When comparing HOFKER's figures and descriptions with my specimens fig. 3 and 4 of plate 1 agree with the *Lepidorbitoides minor* described above; fig. 1 and 2 of plate 1 agree with *Orbitoides brinkae* sp. n. and fig. 5 and 6 of plate 1 agree with *Orbitoides apiculata*, both described above.

RUTTEN (1935) describes *Lepidorbitoides minor*, when showing that *Lepidorbitoides* is synonymous with *Orbitocyclina* VAUGHAN. He finds stoloniferous apertures between the equatorial chambers and pores communicating through roofs and floors of the chambers.

W. A. VISSER (1937) mentions two *Orbitoids*, a large one and a small one from Maestricht and Kunrade (South-Limburg). He calls the large one *Lepidorbitoides minor*, the small one *Lepidorbitoides* spec. indet. On grinding these species the large one proves to be an *Orbitoides*, owing to the distinct knob at one side: *Orbitoides apiculata*. The small one is *Lepidorbitoides minor*.

THIADENS (1937) gives the differences between *Lepidorbitoides socialis* and *Lepidorbitoides minor*. *L. socialis* occurs in the South of France, *L. minor* in Holland and the North of Spain.

SCHIJFSMA (1946) describes four *Orbitoids* from the Hervian (Middle-Campanian) of South-Limburg: *Orbitoides apiculata, Orbitoides media, Lepidorbitoides minor* and *Lepidorbitoides socialis*.

Although SCHIJFSMA probably did not get these forms from the Hervian but by error from younger layers of the Limburg Cretaceous, they nevertheless come from the Upper Cretaceous of Limburg. SCHIJFSMA himself notices the very small difference between his *Lepidorbitoides minor* and *Lepidorbitoides socialis*. Moreover, he is wrong in his review of the publication of HOFKER (1926), saying that 2 figures (pl. 1, fig. 7 and 9), coming from one specimen belong to two species. The description of *L. minor* and *L. socialis* agrees with my *Lepidorbitoides minor*.

HOFKER (1949) gives again a very detailed description of his *Orbitoides faujasi* with its trimorphism. He criticizes SCHIJFSMA (1946). Rightly, when he corrects SCHIJFSMA about the two fgures of one specimen, which according to SCHIJFSMA, belong to 2 species; wrongly, when HOFKER describes the equatorial chambers of the 4 species of SCHIJFSMA. According to SCHIJFSMA at *O. media* the equatorial chambers are gradually increasing in size to the periphery, at *O. apiculata* they rapidly increase in size to the periphery and at *L. minor* and *L. socialis* they very gradually increase in size to the periphery.

According to HOFKER SCHIJFSMA is supposed to have found equatorial chambers increasing in size at *O. apiculata* and probably at *O. media*. The equatorial chambers keep the height at *O. media* and *L. minor*. Apart from the fact that HOFKER contradicts himself at *O. media*, he has not read the publication of SCHIJFSMA concerning *O. media* and *L. minor*.

HOFKER measures many specimens externally and by means of graphics he arrives at the conclusion of trimorphism. He, however, does not measure the nucleoconch. He describes them only as very large, not so large and relatively small. In an interview with him he told me that he found the same measurements as given in his publication of 1926.

Also his form A_2 of 1926, biconvex with a very large nucleoconch (pl. 1, fig. 1 and 2) is lacking in the description of 1949. The megalospheric form with a somewhat smaller proloculus seems to be *Lepidorbitoides minor*. The megalospheric form with a somewhat larger proloculus is *Orbitoides apiculata*.

For the determination of my material I start from the original description of SCHLUMBERGER (1901). I only found the small forms of the *Orbitoids*: many *Lepidorbitoides minor*, a few of *Orbitoides apiculata* and *Orbitoides brinkae* sp. n. The two last are much larger than *Lepidorbitoides minor* I found no microspheric forms of these species.

CHAPTER III.

STRATIGRAPHY.

§ 1. The Maestrichtian.

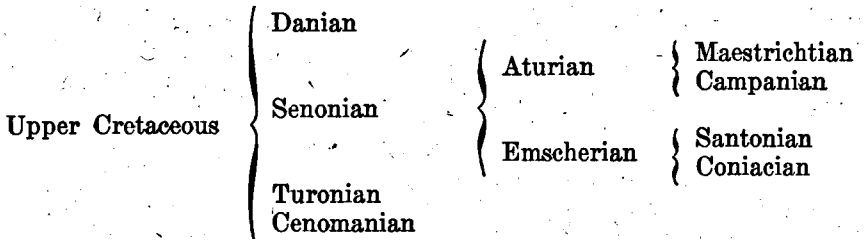
The name "le système maestrichtien" was given in 1849 by DUMONT to the youngest part of the Cretaceous, outcropped in Holland and Belgium. He describes it in the following words:

"Le système maestrichtien dont le nom rappelle celui de la ville de Maestricht, où il est depuis longtemps connu par les fossiles qu'il contient, commence dans quelques localités de la province de Limbourg par de la glauconie sableuse ou du calcaire glauconifère; il comprend le calcaire grossier exploité aux carrières de Maestricht, celui de Folx-les-Caves et de Ciply, et correspond au calcaire pisolitique du basin de Paris."

As early as 1822 D'OMALIUS D'HALLOY[1]) had recognized the marl of Maestricht as "Cretaceous". D'ARCHIAC[2]) was the first to classify this Cretaceous among the youngest deposits of the Senonian, which D'ORBIGNY also states in his Cours élémentaire de Paléontologie et de Géologie stratigraphiques of 1852.

The place of the Maestrichtian remained has fixed, but there exists a slight difference of opinion in how far the Maestrichtian is a zone of the Senonian or a stage in itself.

GIGNOUX (1936) divides the Upper Cretaceous as follows



Here the Maestrichtian would be characterised by *Belemnitella mucronata* and the Campanian by *Goniatheutis quadrata,* and the Maestrichtian was to agree with the Mucronata-Senonian and the Campanian with the Quadrata-Senonian of Germany.

MULLER & SCHENCK (1943) on the other hand consider the Maestrichtian as a separate stage:

[1]) J. J. D'OMALIUS D'HALLOY, Annales des mines, tome 7, 1822.
[2]) D'ARCHIAC, Mémoires de la Société de France, tome III, 1839.

Upper Cretaceous	Danian	
	Maestrichtian	
	Senonian	Campanian
		Santonian
		Coniacian
	Turonian	
	Cenomanian	

In this classification only the older part of the Maestrichtian together with the younger part of the Campanian is characterized by *Belemnitella mucronata*. The younger part of the Maestrichtian has here as a guide-fossil *Belemnitella lanceolata*.

In South-Limburg, however, we meet with *Belemnitella mucronata* in the whole of the Maestrichtian.

GIGNOUX (1936) and MULLER & SCHENCK (1943) therefore agree as to the place of the Maestrichtian in the Cretaceous: older than the Danian and younger than the Campanian.

BROTZEN (1936) compares the Senonian in Western-Europe with that of Middle- and Northern-Europe. He arrives at the following conclusion:

Middle- and Northern-Europe	Western-Europe
	Maestrichtian
Mucronata-Senonian	Campanian
Quadrata-Senonian	
Granulata-Senonian	Santonian
Emscherian	Coniacian

The Mucronata-Senonian therefore does not quite coincide with the Maestrichtian.

In Holland we cannot speak of Mucronata-Senonian and Quadrata-Senonian side by side, according to SCHLIJFSMA (1946), because there is a special horizon in the Campanian, in which both *Belemnitella mucronata* and *Goniatheutis quadrata* occur. This very horizon occurs in Holland. According to him the situation is as follows:

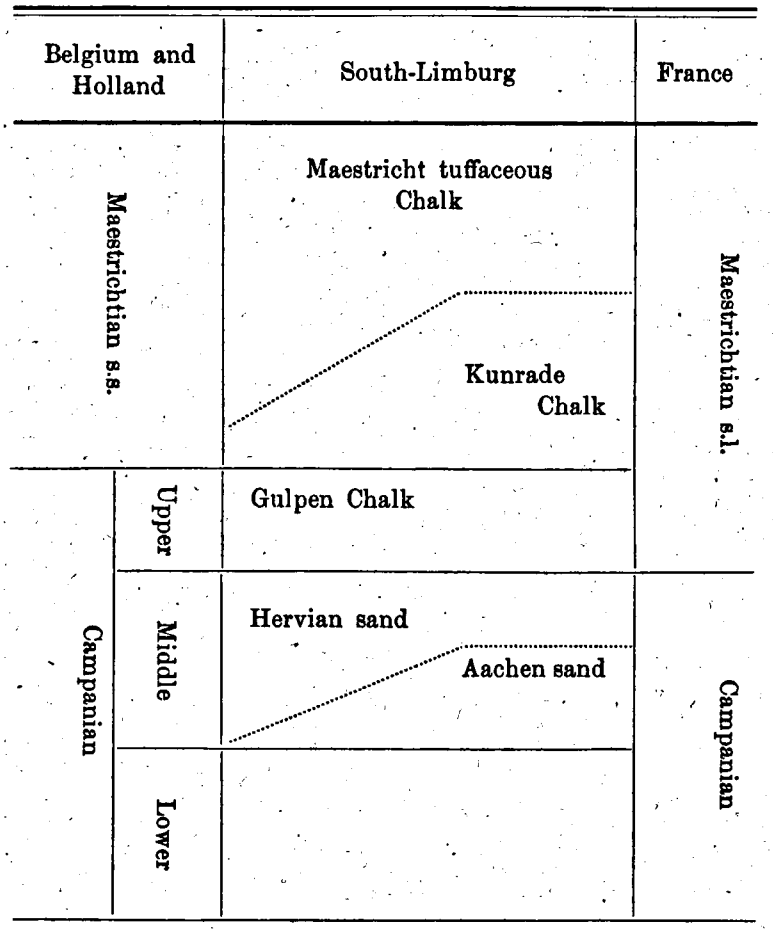
Mucronata-Senonian	Maestrichtian	*Belemnitella mucronata*
	Upper-Campanian	
	Middle-Campanian	*B. mucronata* and *G. quadrata*
Quadrata-Senonian	Lower-Campanian	*Goniatheutis quadrata*

The oldest Cretaceous deposits in Limburg (Hervian sand and Aachen sand) are said to be of Middle-Campanian age.

UMBGROVE (1926b) observes that the French call the whole of the Upper-Senonian, characterized by *Belemnitella mucronata,* Maestrichtian, being therefore in accordance with the explanation of GIGNOUX (1936), mentioned above. The Belgians on the other hand speak of Maestrichtian s.s. and that is the younger part of the French Maestrichtian s.l. The latter opinion seems more correct to me, also because DUMONT in 1849 only called the younger part of the Senonian Maestrichtian. This Maestrichtian s.s. is what we in Holland call Maestricht tuffaceous Chalk.

In South-Limburg only the Campanian and the Maestrichtian have been outcropped.

STARING (1860), UBAGHS (1879), UHLENBROEK (1912), UMBGROVE (1926b), SCHIJFSMA (1946), FRANCKEN (1947) and FABER (1948) give divisions, which I summarize in the following figure:



BINKHORST VAN DEN BINKHORST (1859) and STARING (1860) take it that the Maestricht tuffaceous Chalk only differs in facies from the Kunrade Chalk.

UBAGHS (1879) and UHLENBROEK (1912) think that the Kunrade Chalk agrees as to age with the oldest part of the Maestricht Chalk.

UMBGROVE (1926b) and VOIGT (1929) argue that the Kunrade Chalk is older than the Maestricht Chalk.

FRANCKEN (1946) thinks that the Kunrade Chalk is of the same age as the oldest Maestricht Chalk because of a gradual transition from the Kunrade formation into the Maestricht Chalk on the Northern bank of the Geul-valley between Schin op Geul and Valkenburg.

As to my own research I restricted myself to a study of the *Foraminifera* out of the Maestricht Chalk. I have examined a number of extracted samples out of the Kunrade Chalk, which were available in the "Rijksmuseum van Geologie en Mineralogie" at Leiden. The species present there were for the greater part similar to those of the Maestricht Chalk. The percentages, however, differed considerably. *Lagena acuticostata*, for instance, which I only twice found in the Maestricht Chalk, occurred here in great numbers, whereas *Rotalia tuberculifera* and *Siderolites calcitrapoides*, the two most common forms of the Maestricht Chalk, were present only in a few specimens. There were many species and great numbers of specimens of the *Polymorphinidae*, and the size of the *Buliminidae* was striking. Agglutinants occurred in still smaller number than in the younger part of the Maestricht Chalk.

W. A. VISSER (1937) found also that all species, except one, met with by him in the Kunrade Chalk, occur in the Maestricht Chalk. Accurate *Foraminifera*-research will be able to solve the problem whether we here deal with a difference in age or only in facies.

UMBGROVE (1926b), VOIGT (1929) and SCHIJFSMA (1946) give stratigraphical surveys of the Limburg Cretaceous and that of adjacent countries. From this it appears, that the Maestricht Chalk is of the same age as

"Tuffeau de Symphorien" (Hainault).

"Schreibkreide" in Balticum and N.W. Germany.

"Schreibkreide" bored at Malmö (Sweden).

According to BROTZEN (1936) also the American Cretaceous levels Navarro, Ripley and Velasco are of Maestrichtian age.

GRIMSDALE (1947), however, is of opinion that the Velasco-formation is of Old-Tertiary age.

§ 2. Lithological Description of the Maestricht Chalk.

Because of the lithological differences the Maestricht tuffaceous Chalk is divided into four horizons, which are first mentioned by UHLENBROEK (1912). He makes a classification from old to young Ma, Mb, Mc and Md. FRANCKEN (1947) gives an elaborate description of it, of which I append an abridgment:

Horizon	Thickness	Lithological description
Md	to 20 m	rather coarse-grained marl with varying number of rather hard *Bryozoa*-beds. (according to FRANCKEN (1947) these beds do not maintain a constant stratigraphical horizon).
Base	0—2,80 m	One or more *Bryozoa*-beds, present at a constant stratigraphical horizon, yellow-brown in colour, firmly cemented.

Horizon	Thickness	Lithological description
Mc	7,5—10 m	medium-grained, very homogeneous marl with in the middle a *Echinidea*-breccia, which does not maintain a constant stratigraphical horizon. In the lower part scattered flints.
Base	0,20—3 m	fossiliferous layer, which maintains a constant stratigraphical horizon, brownish-yellow to brown in colour, always firmly cemented. (according to UBAGHS (1879) the *Bryozoe Stellocavea* must occur here).
Mb	16—more than 19 m	medium-grained marl, some meters under the top flint-concretions, lower distinct flint-horizons, disappearing towards the base. (according to FRANCKEN (1947) this base is only present in the Sint Pietersberg).
Ma	0—3,5 m	coprolite-bed, a thin not quite continuous, fossiliferous, soft green-brown layer, characterized by coprolites.

Of the material examined here that of section I, II and III (Sint Pietersberg and Geulhem) came out of Md and Mc. The base of Md was found in the samples K 9, B 11, B 12 and G 6. The samples K 4, K 6, K 7, K 8, B 23 and G 11 were derived from *Bryozoa*-beds in Md. The samples K 10 and B 3 were from the *Echinidea*-breccia in Mc.

The section IV, taken in the Savelsbos (Gronsveld), was of Mb age, except S 29, taken from the base of Mc.

As already stated, the section V from Slavante was taken out of the Coprolite-bed (Ma).

§ 3. Statistical Research.

In order to obtain a survey of the meaning of the various species a table and a diagram of each section were made.

The table (plate 12, 13, 14 and 15) shows the number of specimens of every species which was found. For this purpose all species found have been alphabetically arranged along the top of the table; in the vertical direction the numbers of the samples are given, behind which the number of specimens of every species is stated indicated by special symbols (1—2 specimens, 3—5 specimens, 6—20 specimens, 21—100 specimens and > 100 specimens).

The diagram (plate 16) depicts the percentage of a number of remark-

able forms in every sample. The percentage-number of each of these forms was calculated previously.

It is

$$\frac{\text{the number of specimens of a certain form in a certain sample}}{\text{the total number of } \textit{Foraminifera} \text{ in the same sample}} \times 100$$

Along the vertical axis of the diagram the numbers of the samples are written, along the horizontal axis the percentage-numbers of the different forms. The points, denoting the percentage-numbers of the same form are connected by a straight line.

The species which I took for these diagrams are

Rotalia tuberculifera
Siderolites calcitrapoides
Pseudoparrella minisae
Cibicides involuta
Reussella cushmani
Operculina fleuriausi.

I moreover entered in the diagram the percentage-numbers of:

the sum of all *Gavelinellae*
the sum of all *Polymorphinidae*
the sum of all *Orbitoididae*
the sum of all agglutinants.

For these last four numbers one has to consult the tables in order to determine what species have given this percentage-number.

The choice of these species was not arbitrary. It appeared from the tables that *Rotalia tuberculifera, Cibicides involuta* and the *Gavelinellae* in all sections occur; *Siderolites calcitrapoides* and *Pseudoparrella minisae* occur abundantly in the younger part, whereas *Reussella cushmani* is a characteristic form of the older part of the Dutch Maestrichtian. *Operculina fleuriausi* and the *Orbitoididae* especially occur in a fixed horizon of Md, the *Polymorphinidae* and the agglutinants appeared to show great differences throughout.

The tables supply me with the following statistical data:

Section I has a fauna of 78 species; per sample the average number of species is 33, the average number of specimens is 326.

Section II has a fauna of 93 species; per sample the average number of species is 34, the average number of specimens is 336.

Section III has a fauna of 104 species; per sample the average number of species is 43, the average number of specimens is 509.

Section IV has a fauna of 91 species; per sample the average number of species is 31, the average number of specimens is 476.

Section V has a fauna of 48 species; per sample the average number of species is 33, the average number of specimens is 285.

From the diagrams one may read two things:

1. the percentage of remarkable forms in every sample.
2. the percentage of these forms in the section.

From these simple figures may appear, what is proved later:

1. that there are remarkable differences between section I and II on the one hand and section III on the other hand.
2. that UHLENBROEK's division into four parts in broad lines is also expressed in the foraminiferal fauna.

§ 4. Stratigraphy of the Maestricht tuffaceous Chalk on the ground of the Foraminifera.

I intend to combine the sections I, II and III in the discussion of their fauna, as these sections belong to rock of the same age (Mc and Md), as already stated in § 2 of this chapter. After that a discussion of the fauna of the sections IV and V will follow.

The species, which always and generally abundantly occur, are in sections I, II and III (see plate 12, 13, 14):

Alabamina dorsoplana
Cibicides involuta
Cibicides voltziana
Discorbis supracretacea
Eponides carpenteri
Gavelinella binkhorsti
Gavelinella bosqueti
Gavelinella pertusa
Guttulina problema
Globulina lacrima
Gyroidina globosa
Linderina douvillei
Pseudoparrella minisae
Siderolites calcitrapoides
Rotalia tuberculifera
Textularia agglutinans
Textularia subconica.

For the section III only, there are added:

Anomalina complanata
Cibicides roestae
Gaudryina rugosa
Nonion troostae
Quinqueloculina antiqua
Spirolina senoniensis (only in the zone just above and just under G 6 in a rather great number).

The last mentioned forms also occur in the sections I and II, but in a much smaller number; the occurrence of *Quinqueloculina antiqua* is even restricted to a few samples (K 3, B 22, B 23 and B 25).

In all three sections, between the *Bryozoa*-beds found (so between K 9 and K 4, between B 11 and B 23 and between G 6 and G 11) there occurs a horizon, which is characterized by a great number of:

Lepidorbitoides minor
Operculina fleuriausi.

The diagrams of these sections I, II and III show the following (see plate 16):

Rotalia tuberculifera, the sum of the *Gavelinellae* and *Siderolites calcitrapoides* show the greatest percentage-numbers.

Rotalia tuberculifera is the most numerous under the lowest *Bryozoa*-bed. Just above the upper bed the percentage increases, followed by a rapid decrease.

The *Gavelinellae* show a similar picture and decrease in the horizon between the *Bryozoa*-beds, but above the upper *Bryozoa*-bed they occur especially, particularly in section III.

Siderolites calcitrapoides has much smaller percentage-numbers in section III than in section I and II. The correlation too between I and II is indistinct. Between the *Bryozoa*-beds this species is rather prominent.

In the percentage-numbers the occurrence of the *Orbitoididae* and of *Operculina fleuriausi* in the horizon between the *Bryozoa*-beds is notable naturally, especially in section I, where *Operculina fleuriausi* attains percentage-numbers of 18,2, 17,6 and 17,3 in respectively K 4, K 5 and K 6. In section II the highest values of the percentage-numbers of *Operculina fleuriausi* are only 6,4 (in B 20), 4,4 (in B 19) and 5,7 (in B 17), whereas at Geulhem (section III) they are lower still: 3,2 in G 9 and 2,2 in G 10.

Pseudoparrella minisae likewise gives high percentage-numbers in the horizon between the *Bryozoa*-beds.

Cibicides involuta has a small percentage-number as far as just above the upper *Bryozoa*-bed, in which place a sudden increase is followed by a strong decrease.

The agglutinants and the *Polymorphinidae* show only slight fluctuations; they are only characteristic by their small percentage-numbers in proportion to those of sections IV and V. The agglutinants show a sudden strong increase in K 3, the *Polymorphinidae* in K 1, K 2 and K 10.

Taking the above in consideration we notice in the three sections I, II and III three horizons, which I named after the most characteristic species in each horizon:

6. Horizon [1]) of *Gavelinella pertusa*, above the upper *Bryozoa*-bed.
5. Horizon of *Operculina fleuriausi*, between the upper and lower *Bryozoa*-bed.
4. Horizon of *Rotalia tuberculifera*, under the lower *Bryozoa*-bed.

It immediately appears from this tripartite that FRANCKEN (1947) is not quite correct in his conception that the *Bryozoa*-beds (or complex of *Bryozoa*-beds) occurring in the Md do not maintain a constant stratigraphical horizon. For I came across this *Bryozoa*-bed in all sections and in the foraminiferal fauna it forms a distinct parting plane.

STARING (1860), who was the first to mention this *Bryozoa*-bed, is therefore correct in his conception that this formed a parting plane.

The *Foraminifera*-research has not only led to this tripartite, but also led to the conclusion that the Maestricht Chalk changes from the Sint Pietersberg eastwards.

This is shown by:

[1]) According to ARKELL (W. J. ARKELL: The Jurassic system in Great Britain, Oxford, 1933) such a part of a zone names T e i l z o n e. The time in which this T e i l z o n e was deposited names T e i l c h r o n.

1e. the occurrence of *Quinqueloculina antiqua* and *Spirolina senoniensis.*
2e. the retiring of *Siderolites calcitrapoides, Operculina fleuriausi* and *Lepidorbitoides minor.*

Of the horizons mentioned above 6 and 5 are of Md age, and 4 of Mc age.

Besides the species from which the horizon derives its name the following species are characteristic:

For the Horizon of *Gavelinella pertusa:*
Cibicides roestae (this form occurs in the whole section at Geulhem (section III) but especially very abundantly in this horizon).

For the Horizon of *Operculina fleuriausi:*
Lepidorbitoides minor
Orbitoides brinkae
Omphalocyclus macropora.
At Geulhem (section III) this horizon is less obvious than in the Sint Pietersberg (section I and II).

For the Horizon of *Rotalia tuberculifera:*
Linderina douvilléi
For Geulhem (section III) may be added:
Leptodermella maestrichtiensis.

The sections IV and V have been combined in one table, because section V consists of but three samples.

In section IV the following species always occur and often abundantly (see plate 15):

Bulimina reussi (not in S 10, S 12 and S 29)
Cibicides involuta (not in S 29)
Discorbis supracretacea
Gavelinella ammonoides
Gavelinella bosqueti
Gavelinella pertusa
Gavelinella stelligera
Guttulina problema (not in S 29)
Leptodermella maestrichtiensis
Nonion troostae (not in S 29)
Reussella cushmani (not in S 29)
Rotalia tuberculifera, which especially in the lower part of the section is very small in dimension.

Moreover in slight quantities:

Globigerinella aspera
Gümbelina globulosa.

The upper samples (S 22, S 25, S 27, S 28 and S 29) contain:
Alabamina dorsoplana
Siderolites calcitrapoides.

The diagram (see plate 16) may be divided into two fairly distinct parts:

Rotalia tuberculifera, the agglutinants and the *Gavelinellae* have percentage-numbers varying from 10—40. *Reussella cushmani, Cibicides involuta* and the *Polymorphinidae* always remain with their percentage-numbers under 10.

The agglutinants are very important as far as S 25, especially *Leptodermella maestrichtiensis* after that the percentage-number strongly decrease.

The percentage-numbers of the *Gavelinellae* increase with some fluctuations to the layer S 18; then the percentage-numbers diminish to increase again strongly in S 29.

The percentage-numbers of *Rotalia tuberculifera* fluctuate inversely to those of the *Gavellinellae*: in S 18 it reaches a minimum, then the percentage-number increases, to decrease again in S 29.

The occurrence of *Alabamina dorsoplana* and *Siderolites calcitrapoides* in the younger layers of this section and the rapid decrease of *Reussella cushmani* in the same layers makes me draw the boundary line at S 22, and my opinion is strengthened by the lithological description of these layers. After S 22 no flints occur anymore in the marl, a characteristic of the upper part of Mb. Moreover S 22 itself is conspicious for the extremely large number of species found there (45 to an average of 31 in the other samples of this section).

I therefore distinguish in section IV:

3. Horizon of *Alabamina dorsoplana*
2. Horizon of *Reussella cushmani.*

Horizon 2 is of Mb age, Horizon 3 forms a transition from Mb to Mc. Mb and Mc, having many species in common, it is difficult to assume a correct parting plane. This plane was up till now put at the fosssiliferous layer with *Stellocavea.* As similar fossiliferous layers still occur in Mc and Md also, and as the flints suddenly cease to occur some meters under the lowest of these layers it may be more correct to put this parting plane between Mb and Mc a little lower. The foraminiferal fauna also proves it. A transition-zone should be allowed between Mb and Mc because the Horizon of *Alabamina dorsoplana* still contains typical Mb-*Foraminifera* (*Reussella cushmani, Globigerinella aspera,* and *Gümbelina globulosa* for instance).

The Horizon of *Alabamina dorsoplana* is also characterised by *Operculina labanae,* which, however, also occurs scattered in Mc and Md. Larger *Rotalia tuberculifera* than in the following horizon occur.

The Horizon of *Reussella cushmani* is, as already stated above, also characterized by:

Gavelinella ammonoides
Gavelinella stelligera
smaller *Rotalia tuberculifera.*

The last section (V) greatly differs from those discussed so far.

The species occurring continually and often abundantly are (see plate 15):

Arenobulimina ovoidea
Cibicides involuta
Dentalina marcki
Eponides beisseli
Guttulina problema
Orbignyna aquisgranensis f. *typica* and f. *conica*
Plectina ruthenica
Pseudovalvulineria lorneiana.

The percentage-numbers (see plate 16) point to a very small quantity of *Gavelinellae,* a great quantity of *Polymorphinidae,* which, however, decreases towards the upper layer; a great quantity of *Cibicides involuta* and a very great quantity of agglutinants.

The three samples of this section (V) form together the oldest horizon of the Maestricht Chalk:

1. Horizon of *Eponides beisseli,* because this form only occurs here and then abundantly.

The other characteristic forms of this horizon also occur scattered in the Horizon of *Reussella cushmani.* They are:

Arenobulimina ovoidea
Orbignyna aquisgranensis
Plectina ruthenica.

This horizon comprises more than the Coprolite-bed alone, because the samples 17434 and 17435 have been taken from above this striking layer, which moreover contains the characteristic *Foraminifera.* It moreover explains why W. A. VISSER (1937) in Mb still finds characteristic forms in this last horizon such as *Eponides beisseli, Arenobulimina ovoidea* and *Orbignyna aquisgranensis.*

At the end of this argument it is appropriate to remark that *Cibicides involuta* and *Guttulina problema* are the two forms which always and in marked quantities occur in the Maestricht Chalk.

§ 5. Facies of the Maestricht Chalk.

UMBGROVE (1926a), VOIGT (1929), W. A. VISSER (1937) and FRANCKEN (1947) state, that the Maestricht Chalk was deposited in a tropical sea.

UMBGROVE (1926a) considers the *Bryozoa*-beds as a stratigraphical complex of which the *Anthozoa* found by him also form part. These beds are supposed to have been deposited in a very shallow warm sea, because the *Anthozoa* needs light and warmth for growth. Considering figure 8 of UMBGROVE (1926b) we see that he is of the opinion that the older part of the Maestricht Chalk has been deposited in deeper water than the younger in which the *Bryozoa*-beds occur. That is why UMBGROVE (1926b) speaks of coral-reef facies.

W. A. VISSER (1937) bases his opinion concerning the facies of the Maestricht Chalk on his *Foraminifera*-finds. He starts from the supposition that the Cretaceous forms, which recently occur, lived under the same conditions during the Cretaceous-period as they do at present. He combines Ma and Mb just as Mc and Md. The older part is supposed to have been deposited in a deeper sea than the younger chiefly because *Allomorphina trigona* occurs in Ma and Mb, whereas it is absent in Mc and seldom occurs in Md. According to W. A. VISSER (1937) *Allomorphina trigona* lives in water of 150—1100 fathoms deep.

FRANCKEN (1947) correctly notices that according to the range-chart of W. A. VISSER (1937) *Allomorphina trigona* does occur in Mc, though very rarely. Yet FRANCKEN (1947) agrees with W. A. VISSER (1937) on the sea-depth of the Dutch Maestrichtian, because the reef-building corals in Md and the locally very great abundance of Ostreas in the basic layers of Mc are an indication of a shallow sea in that period.

In order to gain some insight into the ecology of the *Foraminifera* I

compared the data NORTON (1930) gave on this subject, with the forms found by me.

It appears that

11 of the families out of the Maestricht Chalk now live in shallow (to 100 fathoms) warm water. These families are:

Textulariidae
Valvulinidae
Polymorphinidae (at any rate *Guttulina problema*)
Camerinidae
Peneroplidae
Rotaliidae (at any rate *Discorbis, Valvulineria, Gyroidina* and *Rotalia*)
Calcarinidae
Cymbaloporidae
Planorbulinidae
Orbitoididae

4 families now live in slightly deeper (to 500 fathoms) water. These are:

Saccamminidae
Verneuilinidae
Lagenidae
Cassidulinidae

5 families now live in deep (> 500 fathoms) and generally also colder water. These are:

Lituolidae
Heterohelicidae
Chilostomellidae (statements of *Pullenia* only)
Globorotaliidae

In the Maestricht Chalk only a very small number of specimens belong to these families.

3 families now live under very different conditions. They are:

Buliminidae, of which *Bulimina* and *Buliminella* prefer deep rather cold water. Of which *Virgulina* occurs in very shallow water and *Reussella* occurs in water of 20 to 170 fathoms.

Nonionidae, which now generally live in cold water; there are species, however, which prefer warm shallow water.

Anomalinidae, which now have a wide depth- and temperature-range.

On comparing these results with my discussion in the previous §'s I arrive at the conclusion that

1e. the Horizon of *Eponides beisseli* must have been deposited in a very shallow sea. For it is remarkable that in this horizon occur *Arenobulimina ovoidea, Plectina ruthenica* and *Orbignyna aquisgranensis,* three genera of the family of the *Valvulinidae,* of which NORTON (1930) states that it lives in water of a depth of 0—5 fathoms and a temperature of 21°—31°.

That *Allomorphina trigona* abundantly occurs here points to the fact, that this form is not restricted to deep water only. The fact that most specimens are eroded support the supposition that the shore in this period must have been very near.

2e. the Horizon of *Reussella cushmani* must have been deposited in a deeper sea which was still fairly warm. *Reussella* lives in water of 20 to 170 fathoms deep; great quantities of *Leptodermella maestrichtiensis,* belonging to the family of *Saccamminidae* which live in water of 100 to 300 fathoms, are found here besides. The slight number of *Globigerinella aspera* and *Gümbelina globulosa* also points to it.

3e. the Horizon of *Alabamina dorsoplana* was deposited in a shallowing sea, for *Operculina labanae* and *Siderolites calcitrapoides* are typical shallow-sea-forms.

4e. the Horizon of *Rotalia tuberculifera* has been deposited in a shallow sea. The family of *Planorbulinidae,* to which *Linderina douvillei* belongs lives in water of 1—60 fathoms, in a sea, therefore, which is decidedly shallower than the sea of the Horizon of *Reussella cushmani.*
At Geulhem the situation is less distinct. *Siderolites calcitrapoides* occurs in small quantities only; on the other hand many *Leptodermella maestrichtiensis* occur which points to some depth. The occurrence of *Quinqueloculina antiqua* and *Spirolina senoniensis,* however, points to a very shallow sea.

5e. the Horizon of *Operculina fleuriausi* was deposited in a very shallow sea. *Operculina fleuriausi* and *Lepidorbitoides minor* live in water of 1—40 fathoms. A strange element of the fauna of this horizon is perhaps *Pseudoparrella minisae,* belonging to the family of *Cassidulinidae,* which according to NORTON (1930) mostly occurs in water of more than 60 fathoms deep.

6e. the Horizon of *Gavelinella pertusa* was deposited in slightly deeper water because *Lepidorbitoides minor* and *Operculina fleuriausi* have disappeared. The sea may have become a little shallower at the end of this horizon because then *Quinqueloculina antiqua* occurs in some samples of section I and II. It only applies to the Sint Pietersberg, at Geulhem the number of *Quinqueloculina antiqua* does not change.

Although HENSON (1950b) warns against a rash application of the results of his investigation in the Middle East outside the area where he worked, yet I cannot refrain from pointing out the striking resemblance between the reef-facies he discusses and the facies treated by me above.

HENSON (1950b) makes distinctions between the facies from the shore down to the sea:

I. in a fringing reef:
   1. back-reef shoals, with a fauna characterized especially by *Miliolidae* and *Peneroplidae* (Miliolid-Peneroplid-facies).
   2. reef-wall, with reefbuilding organisms.
   3. reef-talud slope with reefbuilding organisms of the deeper water.
   4. fore-reef shoals with a fauna charaterized by large *Foraminifera* as *Camerinidae* and *Orbitoididae* (Camerinid-Orbitoid-facies).
   5. fore-reef transition zone with mixed faunas of 4 and 6.
   6. fore-reef basin with a fauna of *Globigerinidae* and very small pelagic forms (Globigerinal facies).

II. in a open shoal-reef:

1. open littoral with a varied fauna of *Peneroplidae, Miliolidae, Alveolinidae* and others.
2. open-reef shoals with a fauna of large *Foraminifera,* mixed with littoral organisms (Camerinid-Orbitoid facies).
3. fore-reef transition zone with a mixed fauna of 2 and 4.
4. open basinal with a fauna of *Globigerinidae* and small pelagic forms (Globigerinal facies).

On the boundary line between 1 and 2 occurs on the top the so-called top-reef shoals with *Miliolid-Peneroplid* facies.

HENSON therefore chiefly distinguishes 3 facies:

1. Miliolid-Peneroplid facies (back-reef or top-reef).
2. Camerinid-Orbitoid facies (fore-reef).
3. Globigerinal facies (fore-reef basin or open basin).

In the figures of the thin-sections which HENSON gives, we are immediately struck by the dwarf fauna of the Globigerinal facies, whereas in two other facies mentioned, the genera after which these facies have been named, naturally prevail.

In the Maestricht Chalk I believe to have met with these three facies. It is a fact that reefs occurred at the time of the deposition of the Dutch Maestrichtian. UMBGROVE (1926a, 1926b) mentions a coral-reef facies. It is not out of the question therefore that there may be a conformity with the reef facies of the Middle East.

The Miliolid-Peneroplid facies is that of section III (Geulhem), in which *Quinqueloculina antiqua* and *Spirolina senoniensis* occur in the whole section. A slight indication of this facies is found in the youngest layers of the Horizon of *Gavelinella pertusa.*

As a representative of the Camerinid-Orbitoid facies we may consider the Horizon of *Operculina fleuriausi,* which is characterized by large *Orbitoids* and the form from which its name is derived.

As an analogy with the Globigerinal facies we may consider the Horizon of *Reussella cushmani,* which apart from a few *Globigerinella aspera* and *Gümbelina globulosa* is conspicuous for the curious dwarf fauna-forms for which *Rotalia tuberculifera* is especially mentioned.

The question is, however, whether we are here concerned with a fringing reef or an open shoal-reef.

On examining the difference in faunas between the Sint Pietersberg and Geulhem, we see that Geulhem shows the typical Miliolid-Peneroplid facies, which the Sint Pietersberg lacks. Geulhem is therefore representative of the back-reef or the top-reef. If we assume that we are concerned with a fringing reef, then a reef is supposed to have existed between Geulhem and the Sint Pietersberg in the Maestrichtian-period. The existence of such a reef is unknown however.

If we start from the supposition that we are concerned with an open shoal-reef then we must assume that the sea near the Sint Pietersberg was deeper than at Geulhem, that therefore the coast was nearer to Geulhem than to the Sint Pietersberg. This agree with the theory that in the Senonian-sea of the Southern Netherlands lays a peninsula covering North-Limburg. The southern bank of it approximately runs along the line Sittard—Kunrade (see FABER 1948, fig. 101).

This supposition also explains why the Horizon of *Operculina fleuriausi* at Geulhem is less conspicuous than in the Sint Pietersberg. The entire fauna of section III (Geulhem) shows the Miliolid-Peneroplid fauna, forms the transition from the littoral deposit to the deeper open-reef shoals. When the sea during the deposit of this horizon became shallower, the Miliolid-Peneroplid-fauna was not eliminated, however, because it felt at home in shallow water.

When I apply the results of HENSON's research on the Maestricht Chalk, I can state the following data:

The Maestricht Chalk begins with a very shallow sea, which leaves behind a eroded fauna (Horizon of *Eponides beisseli*).

Then a great transgression takes place; the deposit of the Horizon of *Reussella cushmani* takes place in rather deep water. In this stage there are sure to be reefs nearer the coast.

Thereupon the sea retreats, the Horizons of *Alabamina dorsoplana* and *Rotalia tuberculifera* have a facies of a rather shallow sea, whereas at Geulhem this period already shows a Miliolid-Peneroplid facies. Reefs are beginning to grow of which the layer, out of which sample S 29 was taken, is a first indication. The sea retreats more and more so that the Horizon of *Operculina fleuriausi* obtains the typical Camerinid-Orbitoid character. The varying number of hard *Bryozoa-beds* proves that there are reefs in the neighbourhood and on the spot.

After this period a faint transgression takes place making the Camerinid-Orbitoid facies disappear. The coast remains close enough to Geulhem for the Miliolid-Peneroplid fauna to keep alive. At the end of this period we notice a faint indication of the regression of the sea on account of the occurrence of *Quinqueloculina antiqua* in the younger layers of the sections I and II (Sint Pietersberg).

§ 6. Occurrence of the Foraminifera of the Maestricht Chalk in other Cretaceous areas.

Of the species found in the Maestricht Chalk sixteen are exclusively found in South-Limburg.

These are:

Chilostomellina senoniensis
Cymbalopora radiata
Discorbis supracretacea
Guttulina paalzowi
Pseudopolymorphina digitata
Pseudopolymorphina soldanii.

With the species newly met here:

Cibicides roestae
Lamarckina bienfaiti
Leptodermella maestrichtiensis
Nonion troostae
Operculina labanae
Orbitoides brinkae
Pseudoparrella limburgensis
Pseudoparrella meeterenae
Pseudoparrella minisae
Sigmomorphina kronenburgae.

Guttulina caudata, *Globulina rotundata* and *Guttulina uviformis* on the other hand are found in the Cretaceous only in this locality, in other localities they are found in younger formations.

I leave unmentioned the few species which I only determined on genus because they occurred in a single specimen only.

I tabulated the other species found. By Germany (1) I mean the North Western part, viz. the basin of Munster, Hannover, Rügen etc. but also Aachen.

By Germany (2) I mean the Oberbayerische Alps.

By North-America is meant the different Cretaceous occurrences in the United States and Mexico; by South-America those of Trinidad, Venezuela, Colombia, Peru etc.

By Africa is meant the Cretaceous of the Tanganjika-Territorium and Madagascar, by the Middle East the Cretaceous occurrence in Palestine, Syria, Iraq and Egypt.

All the occurrences mentioned are only those of the Upper Cretaceous in the above mentioned countries. The exact localities may always be found in Chapter II with the species description.

	Germany (1)	Germany (2)	France	England	Sweden	Switzerland	Austria	Poland	Spain	Italy	Greece	North-America	South-America	Africa	Middle East	New Guinea	Australia
Alabamina dorsoplana	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Allomorphina trigona	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anomalina complanata	×	—	—	—	×	—	—	—	—	—	—	×	—	×	—	—	—
Anomalina grosserugosa	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Arenobulimina ovoidea	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bolivina incrassata	×	—	×	—	×	—	—	—	—	—	—	×	×	×	—	—	—
Bulimina intermedia	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bulimina parva	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bulimina reussi	×	—	—	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Bulimina stokesi	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—
Buliminella imbricata	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Buliminella obtusa	—	—	×	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Cibicides constrictus	×	—	—	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Cibicides excavata	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Cibicides involuta	×	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	×
Cibicides polyraphes	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cibicides voltziana	×	×	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Conorbina squamiformis	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Conorbina sulcata	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dentalina incrassata	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dentalina legumen	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dentalina marcki	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Dentalina monile	×	—	×	—	—	—	—	—	—	—	—	×	×	—	—	—	—
Dentalina proteus	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Discorbis cretacea	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Germany (1)	Germany (2)	France	England	Sweden	Switzerland	Austria	Poland	Spain	Italy	Greece	North-America	South-America	Africa	Middle East	New Guinea	Australia
Discorbis stelligera	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dorothia pupoides	×	×	—	×	—	—	—	—	—	—	—	×	—	×	—	—	—
Enantiomarginulina elongata	×	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eponides beisseli	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eponides carpenteri	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—
Eponides hemisphaerica	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Frondicularia archiaciana	×	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frondicularia biformis	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gaudryina laevigata	×	—	—	—	×	—	—	—	—	—	—	×	×	—	—	—	—
Gaudryina rugosa	×	—	×	—	—	—	—	—	—	—	—	×	—	—	×	—	×
Gavelinella ammonoides	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gavelinella binkhorsti	—	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Gavelinella bosqueti	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Gavelinella pertusa	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gavelinella stelligera	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gavelinella tumida	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Globigerina bulloides	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Globigerinella aspera	×	×	×	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Globotruncana marginata	×	×	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Globulina exserta	—	—	—	×	—	—	—	—	—	—	—	×	—	—	—	—	—
Globulina gravis	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—
Globulina lacrima	×	—	×	×	×	—	—	—	—	—	—	×	×	—	—	×	—
Glob. lacr. v. horrida	×	—	—	×	—	—	—	—	—	—	—	×	—	—	—	—	—
Glob. lacr. v. subsphaerica	×	—	—	×	—	—	—	—	—	—	—	×	×	—	—	—	—
Globulina prisca	×	—	×	×	×	—	—	—	—	—	—	×	—	—	—	—	—
Gümbelina globulosa	×	×	—	×	—	—	—	—	—	—	—	×	×	—	—	—	×
Guttulina adhaerens	—	—	—	×	—	—	—	—	—	—	—	×	×	—	—	—	×
Guttulina problema	×	—	—	—	×	—	—	—	—	—	—	×	—	—	—	—	×
Guttulina trigonula	×	—	—	×	×	—	—	—	—	—	—	×	—	—	—	—	—
Gypsina cretae	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gyroidina depressa	—	—	—	—	—	—	—	×	—	—	—	×	×	—	—	—	—
Gyroidina globosa	×	—	—	—	—	—	—	—	—	—	—	×	×	—	—	—	—
Gyroidinoides nitida	×	—	×	—	×	—	—	—	—	—	—	×	—	—	—	—	×
Lagena acuticostata	—	×	—	—	×	—	—	—	—	—	—	×	—	—	—	—	—
Lagena aspera	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Lagena globosa	×	—	—	—	×	—	—	—	—	—	—	×	×	—	—	—	—
Lagena lineata	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Lenticulina acuta	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lenticulina rotulata	×	×	×	—	—	—	—	—	—	—	—	—	×	×	—	—	—
Lepidorbitoides minor	—	—	—	—	—	—	—	—	×	—	—	—	—	×	—	—	—
Linderina douvillei	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lituola nautiloidea	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Marginulina paralella	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

	Germany (1)	Germany (2)	France	England	Sweden	Switzerland	Austria	Poland	Spain	Italy	Greece	North-America	South-America	Africa	Middle East	New Guinea	Australia
Marginulina trilobata	×	—	×	—	×	—	—	—	—	—	—	—	×	—	—	—	—
Marssonella oxycona	×	—	—	—	—	—	—	—	—	—	—	×	×	—	—	—	—
Nodosaria prismatica	×	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—
Nonionella ansata	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Omphalocyclus macropora	—	—	×	—	—	×	—	—	—	×	×	—	—	—	—	—	—
Operculina fleuriausi	—	—	—	—	?	—	—	—	—	—	—	—	—	—	—	—	—
Orbignyna aquisgranensis	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Orbitoides apiculata	—	—	×	—	—	×	×	—	—	—	×	—	—	—	—	—	—
Planularia osnabrugensis	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Planularia truncata	×	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Planulina tenuissima	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Plectina ruthenica	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Pseudoglandulina paralella	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pseudopolymorphina incerta	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Pseudopolymorphina leopolitana	—	—	—	×	—	—	—	×	—	—	—	—	—	—	—	—	—
Pseudovalvulineria lorneiana	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pullenia quaternaria	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pullenia reussi	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pyrulina acuminata	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pyrulina cylindroides	×	—	—	×	—	—	—	—	—	—	—	×	×	—	—	—	—
Quadrimorphina allomorphinoides	×	—	—	—	×	—	—	—	—	—	—	×	×	—	—	—	—
Quadrulina rhabdogonoides	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—
Quinqueloculina antiqua	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Quinqueloculina stolleyi	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Reussella cushmani	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Rotalia tuberculifera	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Siderolites calcitrapoides	—	×	—	—	—	×	—	—	—	×	—	—	—	—	—	—	—
Sigmomorphina semitecta var.terq.	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Sigmomorphina soluta	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Spiroplectammina baudouiana	×	×	×	—	×	—	—	—	—	—	—	—	×	—	—	—	—
Textularia agglutinans	×	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia conulus	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia foeda	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia subconica	×	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Tristix globuliferum	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Tritaxia dubia	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Virgulina tegulata	×	×	×	—	×	—	—	—	—	—	—	—	×	×	—	—	—

If we add up all the common species of each country or each area, it appears that the Maestricht Chalk has in common with the Cretaceous of

the N.W. part of Germany	71 species.
the Oberbayerische Alps	23 species.
France	28 species.
England	15 species.
Sweden	27 species.
Switzerland	3 species.
Austria	2 species.
Poland	2 species.
Spain	1 species.
Italy	2 species.
Greece	2 species.
North-America	34 species.
South-America	18 species.
Africa	6 species.
Middle East	2 species.
New Guinea	1 species.
Australia	7 species.

The Maestricht Chalk foraminifera fauna has therefore the greatest number of species in common with the Upper Cretaceous of Germany. Yet this agreement is less conspicuous than it may seem, because the Upper Cretaceous of Germany has in the first place been very extensively examined by REUSS, EGGER and FRANKE in comparison with the other areas. Secondly because the entire Upper Cretaceous (Cenomanian up to and including Senonian) has been examined, whereas in other Cretaceous areas only part of the Senonian has been examined.

The fifteen species which the Maestricht Chalk has in common with the English Cretaceous is, no doubt, a slight percentage of the common fauna. These 15 species chiefly consist of representatives of the *Polymorphinidae*, of which CUSHMAN & OZAWA (1930) mention extensive occurrences, but I am not aware of a paper on the Upper Cretaceous *Foraminifera* of England.

The forms which the Maestricht Chalk has in common with the French Upper Cretaceous are very conspicuous. All these but two (*Orbitoides apiculata* and *Omphalocyclus macropora*) originate from the basin of Paris, namely out of the Upper Campanian. So the French forms are older than those of the Maestricht Chalk. They occur especially in Ma and Mb (*Arenobulimina ovoidea, Gavelinella stelligera, Gyroidinoides nitida, Spiroplectammina baudouiana* and others), all but three (*Enantiomarginulina elongata, Frondicularia archiaciana* and *Frondicularia biformis*) which each occur only once and therefore carry no weight. This supports the theory that the Cretaceous sea reaches our country first from the South; then from the North.

On examining the 31 species which the Maestricht Chalk has in common with the Swedish Upper Cretaceous we find forms both from the younger and from the older part. The Danian forms from Sweden, which BROTZEN describes, and which also occur in the Maestricht Chalk are: *Cibicides voltziana, Alabamina dorsoplana, Guttulina problema, Globulina lacrima* and *Sigmomorphina soluta*. None of these forms, however are typical Danian-species.

Cibicides voltziana is also described by MARIE (1941) as coming from the

Craie Blanche of Paris and SCHLIJFSMA (1946) mentions it coming from the Hervian of South-Limburg.

Alabamina dorsoplana occurs in Sweden both in the Maestrichtian and the Danian, but more abundantly in the Danian. Only in the younger part of the formation we come across it in the Maestricht Chalk, *Guttulina problema* and *Globulina lacrima* are typical Maestrichtian forms also known from other areas, *Sigmomorphina soluta* occurs in Sweden in the Danian only. In the Maestricht Chalk this form occurs in all horizons but nowhere abundantly. It seems to me, that these facts are no indications of the younger part of the Maestricht Chalk being of the Danian age.

CUSHMAN has drawn attention to the agreement of the European Cretaceous to that of the American in various publications. In view of the great distance and in view of the quite different facies the 34 forms in common with North-America and the 18 with South-America are indeed striking.

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All species mentioned in this publication have been alphabetically arranged here. All species found and the page of their description are in bold type.

PLATES 1—11.

All specimens drawn and photographed have been entered into the collection of the "Rijksmuseum van Geologie en Mineralogie" at Leiden under the numbers 18748—18865 and 18890—18925.