INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE

MÉMOIRES

MÉMOIRE N° 112

KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN

VERHANDELINGEN

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ON FORAMINIFERA

FROM

THE UPPER SENONIAN

OF SOUTH LIMBURG (MAESTRICHTIAN)

BY

JAN HOFKER

DR. PHIL. NAT.
PROFESSEUR DE LYCÉE À LA HAYE,
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TECHNICAL REMARKS

The Foraminifera were studied with a new method, described at first in my paper : The Foraminifera of the Malay Archipelago (*Vidensk Medd. fra Dansk naturh. Foren*, Vol. 93, 1933, pp. 74-75). The method was perfectionnated in the following way.

Forams were first laid in boiling paraffine, melting-point 58° C. The air in this way being removed, they are placed in paraffine on a slide, and especially when one is dealing with small forms, ground down on a fine chalk stone, used generally for rasors. The stone is wet with rhicinus-oil.

When the part of the shells which one wants to study is reached, the slide is heated so that the paraffine becomes once more liquid. A second slide is brought on temperature, paraffine is melted on it, and the slide with the object is held upside down over it, so that the two drops of paraffine reach each other. The object sinks down on the second slide in the now wanted position. Very beautiful thin slides are obtained in this way with a minimum of trouble.

When slides are wanted with filled-up canalsystems or chambers, the slides are obtained in the same way, but they are made somewhat thicker. The slide then is laid in a bath of acetic or chloric acid, till all chalk-material is solved. Even the fossil material of Maastricht showed very beautiful preparations in this way, so that several unsettled questions could be solved.

In the case transverse sections are wanted from small objects, these shells are imbedded in the usual way in a small vessel with paraffine. Then the contents of the vessel are cooled, and at the place, where the shells are situated (very small shells may be imbedded laying on a small piece of chalk) a square of paraffine is cut out. This piece of paraffine is mounted on a slide, one of its sides down, and the object ground down in the usual way.

DISCUSSION OF THE SPECIES OF FORAMINIFERA, OCCURRING IN THE UPPER SENONIAN CHALK OF MAESTRICHT.

In this paper I deal with the collection of Foraminifera, gathered at different localities of the Senonian layers of chalk, from the Institut royal des Sciences naturelles de Belgique. The collection was gathered by BOSQUET, UBAGHS, NYST, HERDEREN, CORNET, MALAISE, thus also bearing a historical value. The localities were Saint Pietersberg near Maestricht, Canne, Sichen, Gronsveld, Bemelen, Keer, Geulhem, Fauquemont, Folx-les-Caves, Schin op Geul.

Many labels in the tubes with material were in the handwriting of UBAGHS.

New species found up are the following ones :

Webbinella cretacea, Haplostiche trigona, Peneroplis senoniensis.

Several species, mentioned by other authors, have been traced to be only forms or varieties of other species. These are the species :

Haplophramium æquale, being presumably nothing but the microspheric form of *H. grande*.

Robulus (or *Lenticulina*) *multiseptus*, being the microspheric form of *Robulus rotulata*. *Lenticularia gibba*, being one of the megalospheric forms of *Robulus rotulata*, while *Cristellaria ovalis* is presumably a synonym of the microspheric form of *R. rotulata*.

Marginulina ensis is nothing else than the microspheric form of *Nodosaria monile*, another *Marginulina* showed to be the microspheric form of *N. vertebralis*. The genus *Dentalina* was obliterated throughout, all specimens belonging to *Nodosaria vertebralis* and *N. monile*.

Lagena globosa must be the megalospheric first chamber of *Nodosaria monile*, while *Lagena acuticosta* is the first chamber of *Nodosaria vertebralis*, in case that these *Lagenæ* occur in the Maestrichtian layers.

Pseudopolymorphina digitata is nothing else than some *Polymorphina* with reproduction-chamber; these forms also occur of several other *Polymorphinæ*. Other *Polymorphinæ* than those mentioned in my paper on the *Polymorphidæ* from Maestricht must fall away. Those are :

Pyrulina fusiformis, *Guttulina roemeri*, *G. paalzowi*, *G. caudata*, *G. elliptica*, *G. bulloides*, *Globulina gravis*, *G. prisca*, *G. lacrima*, *G. porrecta*.

Faujasina carinata does not exist; it is probable, that Bosquet described some form of *Amphistegina fleuriausi* under that name.

Operculina cretacea must be some form of *Amphistegina fleuriausi*, described fully in my paper on this subject. Quite the same is the case with *Operculina complanata*, described erroneously by VISSER when dealing with *Amphistegina fleuriausi*.

Gümbelina globulosa must be one of the forms of *Textularia faujasi*.

Gyroidina depressa, *G. nitida* and *G. globosa* may be nothing but some forms of *Truncatulina involuta; Rotalia hemispraerica* and *Rotalia involuta* are forms of the same species, called here *Truncatulina involuta*.

Lepidorbitoides minor, *Orbitoides apiculata* and *O. media* belong to one species, *Orbitoides faujasi*.

Some species had to alter their name, as investigation found out that they belong to other genera than was suggested by former authors. This was the case in :

Textularia faujasi, formerly indicated as *Gaudryina.*
Robulus rotula, indicated as *Lenticularia.*
Pulvinulina binckhorsti and *P. bosqueti*, mentioned as *Discorbis.*
Truncatulina involuta, mentioned as *Rotalia.*
Nonion tuberculifera, described as *Rotalia tuberculifera.*
Baculogypsina calcitrapoides, described as *Siderolites calcitrapoides*, while *S. lævigata* is only a variety of this species.
Lepidorbitoides minor is a real *Orbitoides.*
Omphalocyclus macropora is a *Sporadotrema.*

LIST OF SPECIES OF FORAMINIFERA, OCCURING IN THE UPPER SENONIAN CHALK OF MAESTRICHT, ACCORDING TO THE COLLECTIONS OF THE INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE.

Webbinella cretacea nov. spec.
Haplophragmium grande REUSS.
Haplophragmium irregulare (ROEMER).
Haplostiche trigona nov. spec.
Textularia conulus REUSS.
Textularia faujasi REUSS.
Gaudryina oxycona REUSS.
Gaudryina pupoides D'ORBIGNY.
Biloculina fragilis HOFKER.
Quinqueloculina reticulo-striata CUSHMAN.
Miliola tricarinata D'ORBIGNY.
Polyphragma cribrosa (REUSS).
Robulus rotula LAMARCK.
Marginulina bacillum (REUSS).
Nodosaria vertebralis BATSCH.
Nodosaria monile v. HAGENOW.
Nodosaria filiformis REUSS.
Pyrulina cylindroides (ROEMER).
Pyrulina fusiformis (ROEMER).
Sigmoidella elegantissima (PARKER et JONES).
Pseudopolymorphina soldanii (D'ORBIGNY).
Pseudopolymorphina leopolitana (REUSS).
Guttulina problema (D'ORBIGNY).
Guttulina trigonula (REUSS).
Globulina gibba D'ORBIGNY.
Globulina rotundata (BORNEMANN).
Globulina myristiformis WILLIAMSON.
Uvigerina westphalica FRANKE.
Bolivina tegulata REUSS.
Turrispirillina cretacea (REUSS).
Pulvinulina binckhorsti (REUSS).
Pulvinulina bosqueti (REUSS).
Truncatulina involuta REUSS.
Nonion tuberculifera (REUSS).
Amphistegina fleuriausi D'ORBIGNY.
Baculogypsina calcitrapoides (LAMARCK).
Cymbalopora radiata v. HAGENOW.
Allomorphina trigona (REUSS).
Miniacina minutum (CHAPMAN).
Peneroplis senoniensis nov. spec.
Orbitoides faujasi DEFRANCE
Sporadotrema macropora (LAMARCK).

Webbinella cretacea nov. spec.

This species occurred in the material in 5 specimens, all attached to Bryozoic stems. The half-globular shell consists of fine calcarious material, without pores, and forms fine stolon-shaped protruding outgrowths at its base along the surface of the body, on which it is attached. Between these fine outgrowths very narrow openings are found.

Since it is always probable, that all these forms, connected with *Webbinella*, are nothing else than cysts of other *Foraminifera*, the establishing of a species in these groups is always somewhat doubtful.

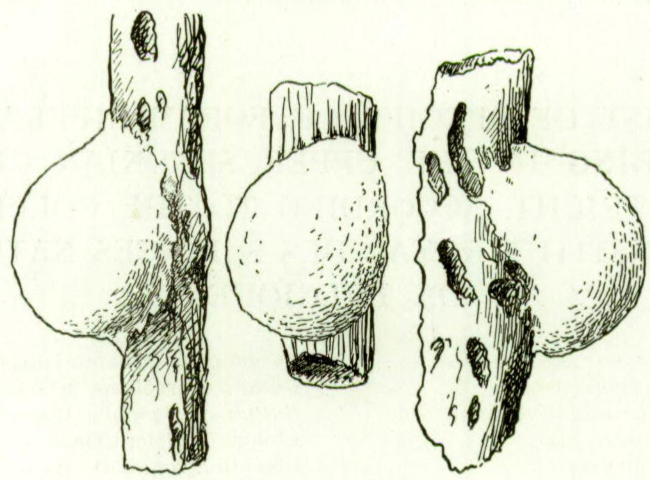

FIG. 1. — *Webbinella cretacea* n. sp.
Three specimens, showing their attachment on Bryozoic stems. ×20.

It is possible that *Webbinella subhemisphærica* FRANCKE, 1936 (Foram. d. deutsch. Lias, Geol. Landesanstalt, Abh., 1936) is identical with our species.

Haplophragmium grande REUSS.

Haplophragmium grande = *H. æquale* REUSS, A. E., 1860, *Die Foram. d. westphäl. Kreide.* (Sitz. ber. d. kais. Akad. d. Wiss., Wien, 1860, vol. XL, p. 218, pl. 15, fig. 27.)

Test with smooth surface, cylindrical. Some specimens somewhat club-shaped, others short and blunt. Aperture a single opening in the centre of the end of the shell, without neck.

Two forms could easily be distinguished, the one blunt, short, the other more slender and club-shaped. In both the shell is slightly segmentated by the sutures of the last-formed chambers.

Walls always consisting of fine, closely cemented material, and rather thin.

1. Short, stout form. This form seems to be the A_2-form, as the proloculus is relatively large. It is followed by a set of spirally arranged chambers, with

relatively thick walls, mostly 5 in number. Afterwards three or four uniserial chambers are added. Aperture a terminal oval opening. A_2-form.

2. Slender form. First chamber small, followed by an irregularly arranged set of chambers, more or less coiled up. These chambers are followed by 5 or

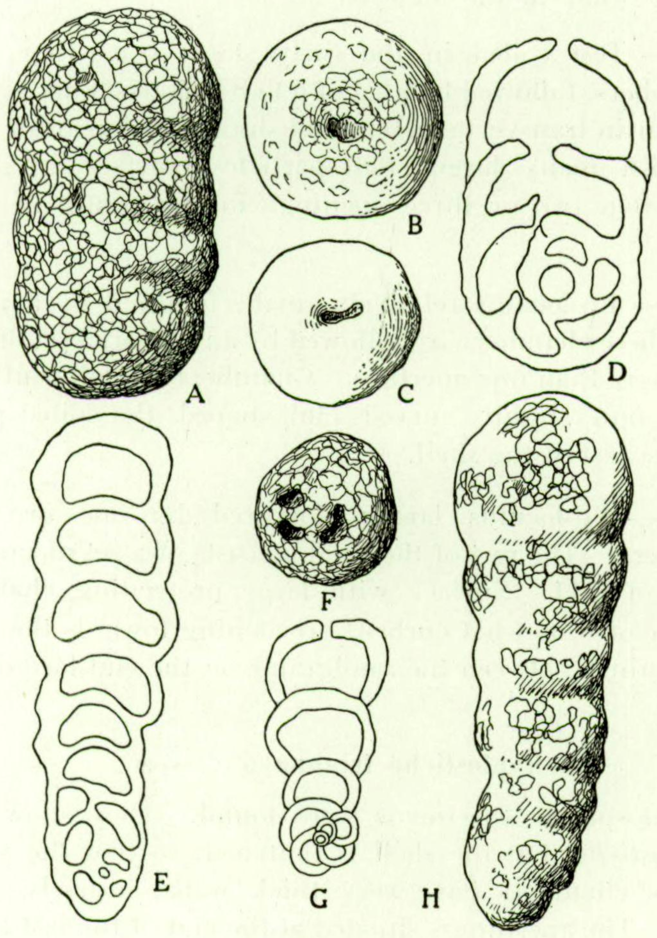

FIG. 2. — *Haplophragmium grande* REUSS.
A-D : *forma* A_2.
A : side-view: B : apertural face; C : idem; D : longitudinal section. ×40.
E-H : *forma* A_1.
E : longitudinal section; F : apertural face; G : schematic section; H : side-view. ×40.

6 uniserial ones, most of which are simple, but in adult forms they may become somewhat labyrinthic in shape. Walls always smooth exterially. A_1-form.

3. The microspheric form was not found up in the material, but it would not be astonishing, when later investigations would show that the form, hitherto known as *Haplophragmium æquale* REUSS from the Maestrichtian chalk is microspheric and then this form is the microspheric generation of *Haplophragmium grande*.

Haplophragmium irregulare Reuss.

Reuss, A. E., 1860, *Die Foram. d. westphäl. Kreide.* (Sitz. ber. d. kais. Akad. d. Wiss., Wien, 1860, vol. XL, p. 219, pl. 10, fig. 9; pl. 11 fig. 1.)

Three forms occur in the material :

Forma B. — Test coiled in the early stage, consisting of two coils of labyrinthic chambers, followed by a set of 5 to 8 uniserial ones. These chambers are nearly circular in transverse section and show no labyrinthic inner structure. Walls thick, with many large chalk-particles, surface irregular. Aperture mostly single, often two or three openings in the centre of the face of the chamber.

Forma A_1. — Proloculus relatively small, followed by a very short spiral of chambers. These chambers are followed by an uniserial set of about 7 chambers, most with more than one aperture. Chambers not labyrinthic. The whole shell about 1 ½ mm, slightly curved, club-shaped, the coiled part not distinguishable from the rest of the shell.

Forma A_2. — Proloculus larger, followed by one or two irregularly arranged chambers. The rest of the shell consists of a set of uniserial chambers in the number of 9-11. Surface with large protruding chalk-grains. Shell straight club like or somewhat curbed, broadening towards the end. Aperture one or more openings between the sandgrains on the end-face of the lastformed chamber.

Haplostiche trigona nov. spec.

Three megalospheric specimens were found. They show the features of the genus *Haplostiche*, but the shell is flattened, so that the section shows an oval form. The chambers have very thick walls, coarsely cementing large grains of chalk. The aperture is situated at the end of the last formed chamber, an irregular oval opening. Chambers covering most of the surface of the former ones, showing thus one of the most typical characteristics of the genus. Sutures not distinct. As only a megalospheric form was found, the real systematic place of the species remains somewhat doubtful. Length of the shell about 2 mm.

This species shows some resemblance with *H. compressa* Seguenza, 1880 (R. Accad. Lincei Ital., 1880, Ser. 3, Vol. 6, p. 309).

Schijfsma mentions it erroneously as *Flabellammina* (Schijfsma, E., 1946, The Foraminifera from the Hervian of South Limburg, Diss. Leiden, 1946). He compared his specimens with *Fabellammina compressa* (Beissel), but made no sections, thus ignoring the real structure of the shell. There is, however,

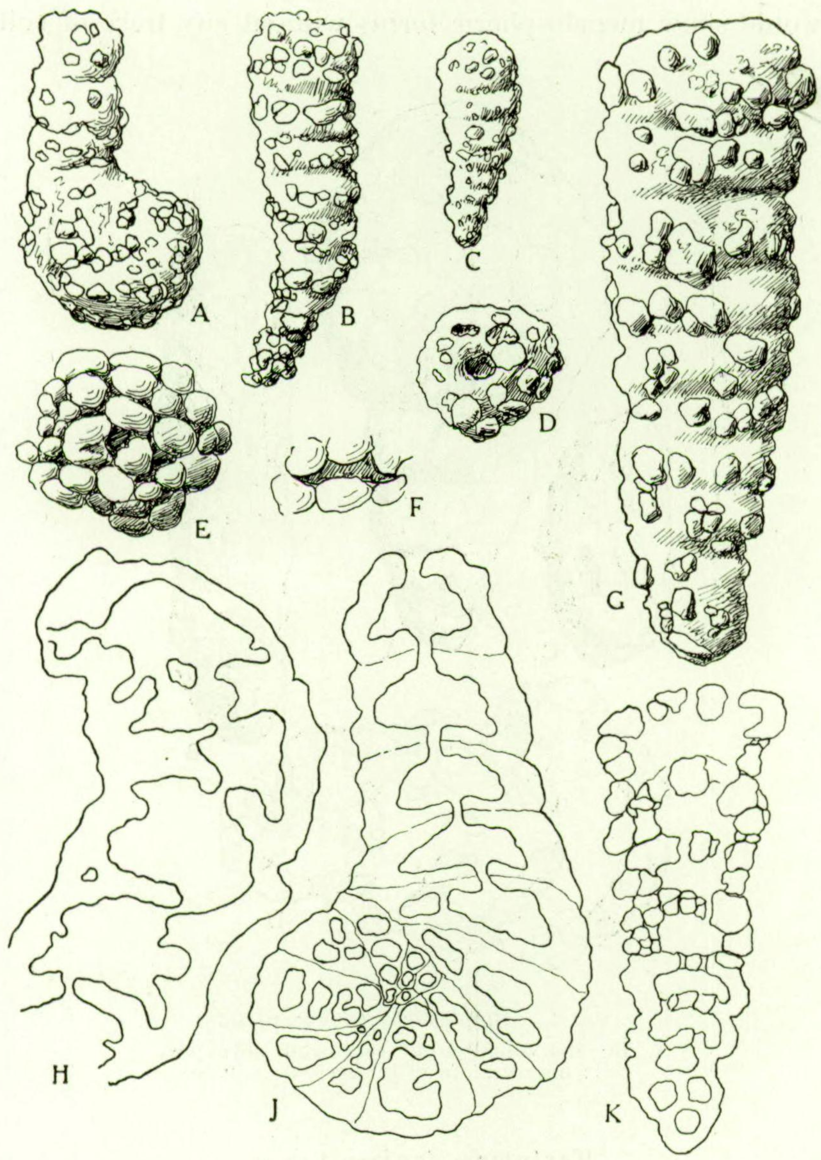

FIG. 3. — *Haplophragmium irregulare* REUSS.

A : microspheric form; B : *forma* A_2; C : *forma* A_1. ×20. — D : apertural face of *forma* B; E : the same, *forma* A_2; F : apertural slit; G : *forma* A_2. ×40. — H : end of *forma* A_2, showing somewhat labyrinthic chambers. ×40. — J : section through *forma* B; K : section through *forma* A_2. ×40.

some probability as to the microspheric form being Flabelline with coiled first part of the shell. In that case the species had to be named *Flabellina*, but than the genus would show megalospheric forms without any trace of coil.

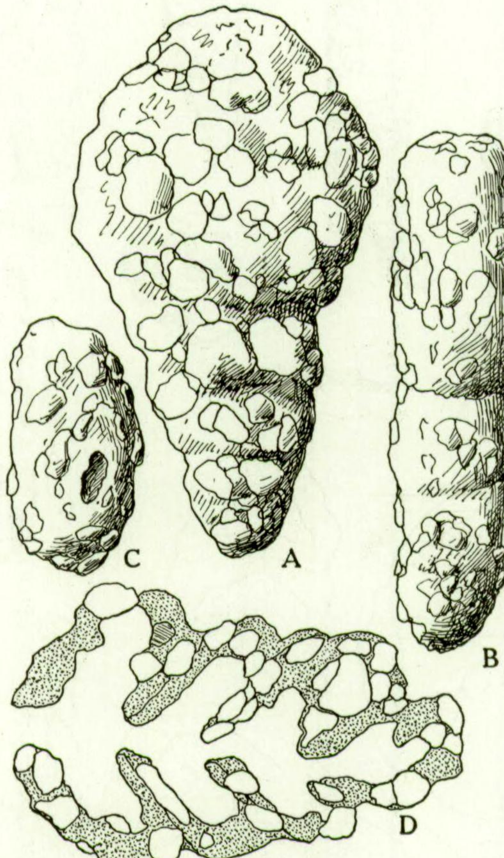

FIG. 4. — *Haplostiche trigona* n. sp.
A, B : individual from face and side-view;
C : apertural face; D : section. ×40.

Textularia faujasi Reuss.

Reuss, A. E., 1861, *Foram. d. Kreidetuffs von Maastricht.* (Sitz. ber. d. kais. Akad. d. Wiss., Wien, vol. XLIV, 1861, p. 320, pl. 3, fig. 9.)

In a preliminary note on the *Textularids* of the Senonian of Maestricht (Natuurhistorisch Maandblad, Vol. 20, 1931, n° 5, p. 78) I mentioned a large *Textularid*, which I figured also, having only at my disposition some broken shells, lacking the initial part. It showed very much likeness with *Gaudryina subrotundata* Schwager from the Caribbean Sea, and so I concluded it to be some species of *Gaudryina*.

I pointed out already, that a remarkable difference between *G. subrotundata* (*G. flintii* Cushman) and the fossil species consisted in the mouth, since in the recent species it forms a circular opening, while the fossil form shows a split-like opening at the ventral base of the last-formed chamber.

I mentioned already in that paper that I intended to study a larger material of the species and that material was the beautiful collection of the Museum of Brussels. Here I had to deal with a collection of several hundreds of specimens, most of them however broken too.

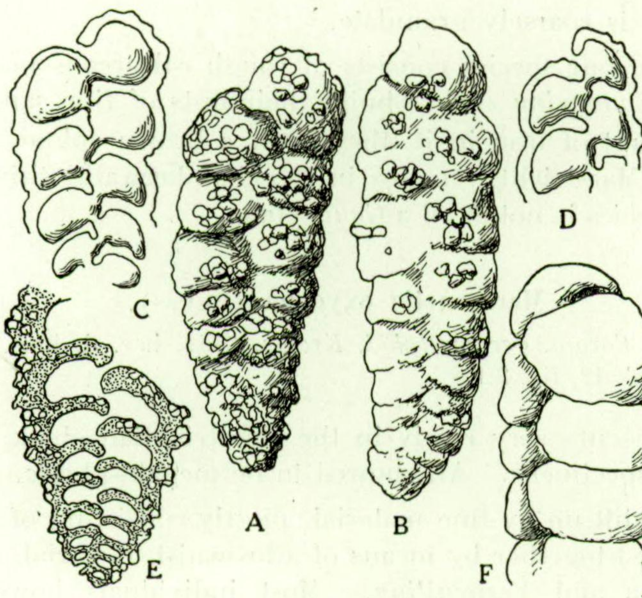

Fig. 5. — *Textularia faujasi* Reuss.
A, B : two shells. ×20. — C, D : shells filled up with paraffine; E : first part of a shell, showing first textularide chambers, section. ×40. — F : shell showing the slit-like aperture. ×40.

No individuals were found with the initial chamber, but several of them showed at any way the third or fourth chamber of the shell. So it seems, that the species is a long-living one, in which the first chambers erode at later stages.

Not the slightest indication was found of a *Gaudryine* beginning of the shell, as is the case in *Gaudryina subrotundata*, and therefore I must conclude, that this large and frequent species of *Textularia* is not a *Gaudryina* at all. For in the region, in which real *Gaudryinæ* always show the triserial arrangement of the chambers, here only the biserial arrangement was found.

As modern authors have looked at this species as being the *Textularia* (*Gaudryina*) *faujasi* of Reuss, I mentioned this species as *Textularia faujasi* Reuss.

DESCRIPTION :

Shell large, up to 4 mm. Chambers in later parts with very distinct sutures, inflated, latest chamber with narrow slit at the base of the chamber. The first sets of chambers always corroded and lacking, later chambers covered with a layer of chalk grains, so that their sutures are indistinct. The material of the shell consists of chalk-particles. The chambers are connected with each other only by the single foramina, pores are totally absent. In longitudinal section the chambers are low in the first portion of the shell but later they become higher, their highest part situated towards the middle of the shell. The outer surface is coarsely granulate.

As the wall of our species consists of rough calcareous material, and real *Verneuilina* and *Gaudryina* always build their tests of fine sandgrains, always with a large amount of iron in it (they show a brown colour which in fossil material, even in Maestricht, remains in the chamberwalls) this too is an indication that our species is not at all a *Gaudryina*.

Marssonella oxycona (REUSS).

REUSS, A. E., 1860, *Foram. der westphäl. Kreide.* (Sitz. ber. d. kais. Akad. d. Wiss., Wien, p. 229, pl. 12, fig. 3.)

This species occurs very rarely in the Maestrichtian chalk. It was at my disposition in 10 specimens. All showed to be megalospheric.

The shell is built up by fine material, mostly consisting of fine sandgrains which are cemented together by means of a brownish material, as is always the case in *Gaudryina* and *Verneuilina.* Most individuals however were now coloured yellowish, only in sections the inner walls are still stained brown. The walls are thin which is a characteristic of *Gaudryina.* The shell, with a length of about 0,75 mm., is typically conical, with a nearly circular apertural face which is flat with sharp edged margin. The aperture is a narrow slit at the inner margin of the last-formed chamber, covered by a kind of tooth. The initial chamber is followed by two sets of triserial small chambers, followed by a series of biserial chambers, the latter flat and intercallating. The conical shape and the smooth surface of the shells are the most typical features, by which they can be easily distinguished from *Textularia conulus.* The type specimen at the Geological Survey at Haarlem, Holland, shows, that SCHIJFSMA's *Textularia turris* is nothing else than *Marssonella oxycona,* described here (SCHIJFSMA, These 1946, pp. 31-32, Pl. I, fig. 3) though his figure does not suggest so.

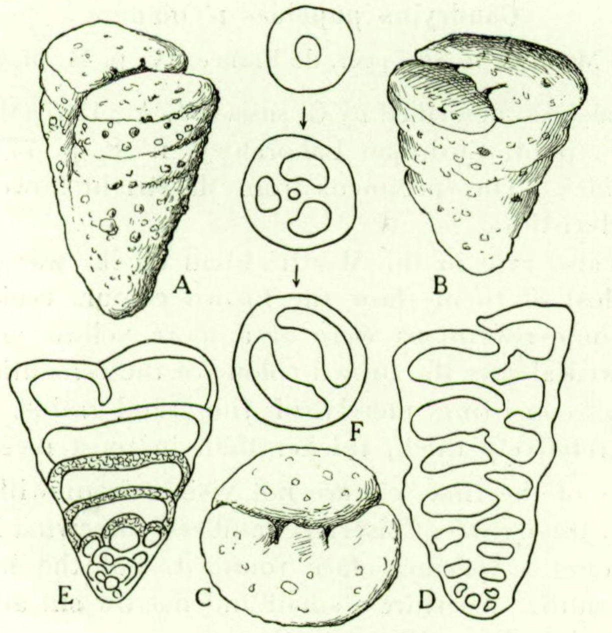

FIG. 6. — *Marssonella oxycona* (REUSS).

A, B : total shells; C : apertural face; D : section, median; E : section, more tangential; F : three successive sections from the initial end of the shell. ×40.

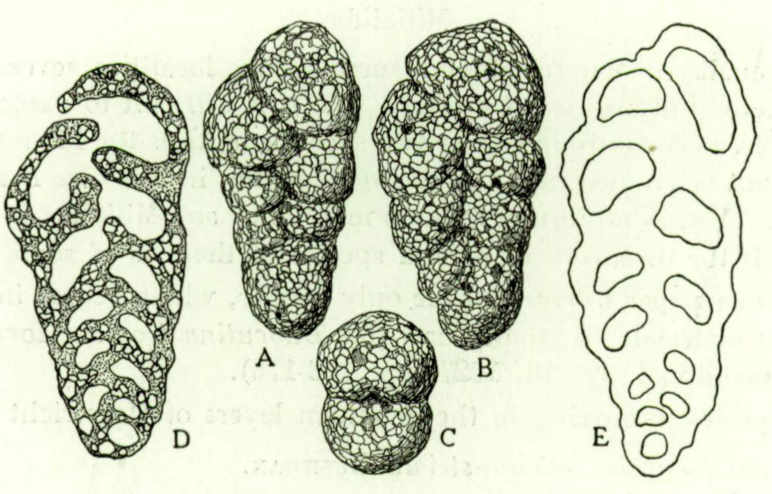

FIG. 7. — *Gaudryina pupoides* D'ORBIGNY.

A, B : shells, side-view; C : apertural face, D, E : sections. ×40.

Gaudryina pupoides D'ORBIGNY.

D'ORBIGNY, A., 1840, Mém. de la Soc. géol. de France, IV, p. 44, pl. 4, fig. 22-24.

The species has been described by CUSHMAN, J. A., 1937 (Monogr. of the fam. *Valvulinidæ*, Spec. publ. Cushman Laboratory, n° 8, p. 77) under the name of *Dorothia pupoides*. The specimens from Maestricht however show the real *Gaudryina* characteristics.

This species, also rare in the Maestrichtian chalk, was available in about 20 specimens. Most of them show the brown colour, typical for the genus *Gaudryina*, but some specimens were of a more yellow outer colour. The inward walls showed always the brown colour of the cementing material. The walls are smooth, consisting merely of fine sand-grains, closely cemented together. Walls relatively thick, thicker than in most recent *Gaudryinæ*.

The chambers of the first sets are not visible from without and they are followed mostly by three rows of biserial chambers, somewhat inflated, especially the last formed ones. Apertural face rounded, but the height of it about 1 ½ times the breadth. Aperture a small and narrow slit at the inner margin of the last-formed chamber, without tooth.

The longitudinal section shows only two sets of triserial chambers, followed by 5 sets of biserial ones. Walls of the chamber thick, especially the inner ones, the fine sandgrains being mostly lucid in the dark brown cement. Walls very hard, when ground down.

Miliolidæ.

In the chalk of Maestricht and surrounding localities several species of *Miliolidæ* occur, but always very rarely. So it is difficult to name the species, as most species occur only in one or two specimens, thus the bionomics of these species can not be studied, and the giving of names in this case is always somewhat trivial. Yet, as no former authors mentioned any Miliolids from the chalk of Maestricht, the discovery of several species of them is of some importance.

In a former paper I described the only species, which occurs in some abundance in the material, viz. the remarkable *Biloculina fragilis* HOFKER (Natuurhistorisch Maandblad, Jg. 16, 1927, pp. 173-176).

Other species, occurring in the Senonian layers of Maastricht are :

1. *Quinqueloculina reticulo-striata* CUSHMAN.
2. *Triloculina* (*Miliola*) *tricarinata* D'ORBIGNY.
3. *Miliola* spec.

Nodosaria (Marginulina !) vertebralis (Batsch).

In my paper on the *Nodosariæ* from the Maestrichtian chalk (Natuurhistorisch Maandblad, Nov. 1932) and in my paper dealing with the Foraminifera from the Key-Archipelago (Vidensk Medd. fra Dansk naturh. Foren, Bd. 93, 1933) I described this species. In the recent material I found the microspheric form, having the shape of a *Marginulina*. In the senonien material in 1932 I was not so successfull, as I could not find any microspheric shell. But in the material with which I am dealing now, I found up three specimens similar to those, found in the Key-material. Thus the species is now fully known. In my report in 1932 I gave the suggestion that the microspheric form would be identical with *Marginulina philippensis* Cushman, since in recent material this was the case. I now found that a name had already been given to the fossil form too, viz. *Marginulina bacillum* Reuss.

So *M. philippensis* and *M. bacillum* are synonyms with *Nodosaria vertebralis*. I can give now a detailed description of this most common species of the Senonian of Maastricht.

Forma B. — Small shells with a length up to 1 ½ mm. Shell compressed, formed by a coiled set of very small chambers, followed by 7-8 uncoiled ones. First chamber with a diameter of 19 μ. The shell shows fine longitudinal costæ characteristic of *Nodosaria*.

Forma A_1. — Shell most relatively small, from 1 ½ to 5 mm, somewhat dentaliniform, with long pointed end. The number of the costæ is relatively small, and often poorly developed, giving rise to the suggestion of some authors (Reuss f.i) to establish a different genus, *Dentalina proteus*. The sutures of the first chambers in most cases very indistinct, and then the costæ run straight along the shell.

Forma A_2. — Shell large, up to 10 mm. The prolocular end mostly rounded, the first chamber often with a short point. Costæ distinct and numerous, sutures very distinct, chambers in this way often inflated. The shells are very variable as to the localities they are found.

In my paper mentioned (1932) I dealt with nomenclature. *Nodosaria Zippei, Dentalina acuta, D. multicostata, D. communata* are synonyms with *Nodosaria vertebralis*.

In my paper on the Foraminifera of the Ammontatura (Pubbl. Stat. Zool. di Napoli, Vol. XII, 1932) I stated, dealing with *Nodosaria scalaris*, that the proloculi of megalospheric forms of the A_2-generation are formed by building a chamber out from the foramen of an individual. Thus a first chamber of the new generation is formed, which chamber closely resembles a *Lagena costata*.

In my material I found many young specimens of megalospheric *Nodosara vertebralis*, and together with them some shells, which some authors have mentioned from the chalk of Maestricht as *Lagena acuticosta* WILLIAMSON. Since the costæ do not differ from those of the young doubtless *Nodosaria vertebralis*, I am convinced that these shells are nothing but first chambers of this species and not *Lagena acuticosta*.

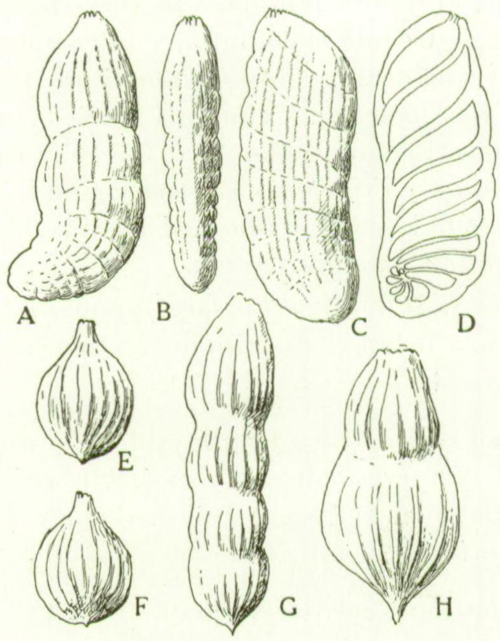

FIG. 8. — *Nodosaria vertebralis* (BATSCH).
A-D : microspheric generation; A : side-view; B : ventral side; C : another individual; D : section. ×40. — E, F : first chambers of megalospheric shells, known as *Lagena*; G, H : young megalospheric specimens. ×40.

In the same way I found young shells of *Nodosaria monile, together* with *Lagena globosa* (Montagu); these also are mentioned by other authors. In the same way I am convinced, that these *Lagenæ* are nothing else than first chambers of *Nodosaria monile*.

« Species » as *Lagena simplex* REUSS always turned out to be generations and young of *Globulina rotundata* or *G. gibba*. I am convinced that real *Lagena* does not occur in the Maestrichtian layers.

Robulus rotula (LAMARCK).

This species is fairly common in the material. Other species mentioned from the chalk of Maestricht are *L. nuda* REUSS and *L. spachholtzi* REUSS. They show such slight differences, that I was not able to separate them from the common form, while their embryonic apparatus showed them to be nothing else

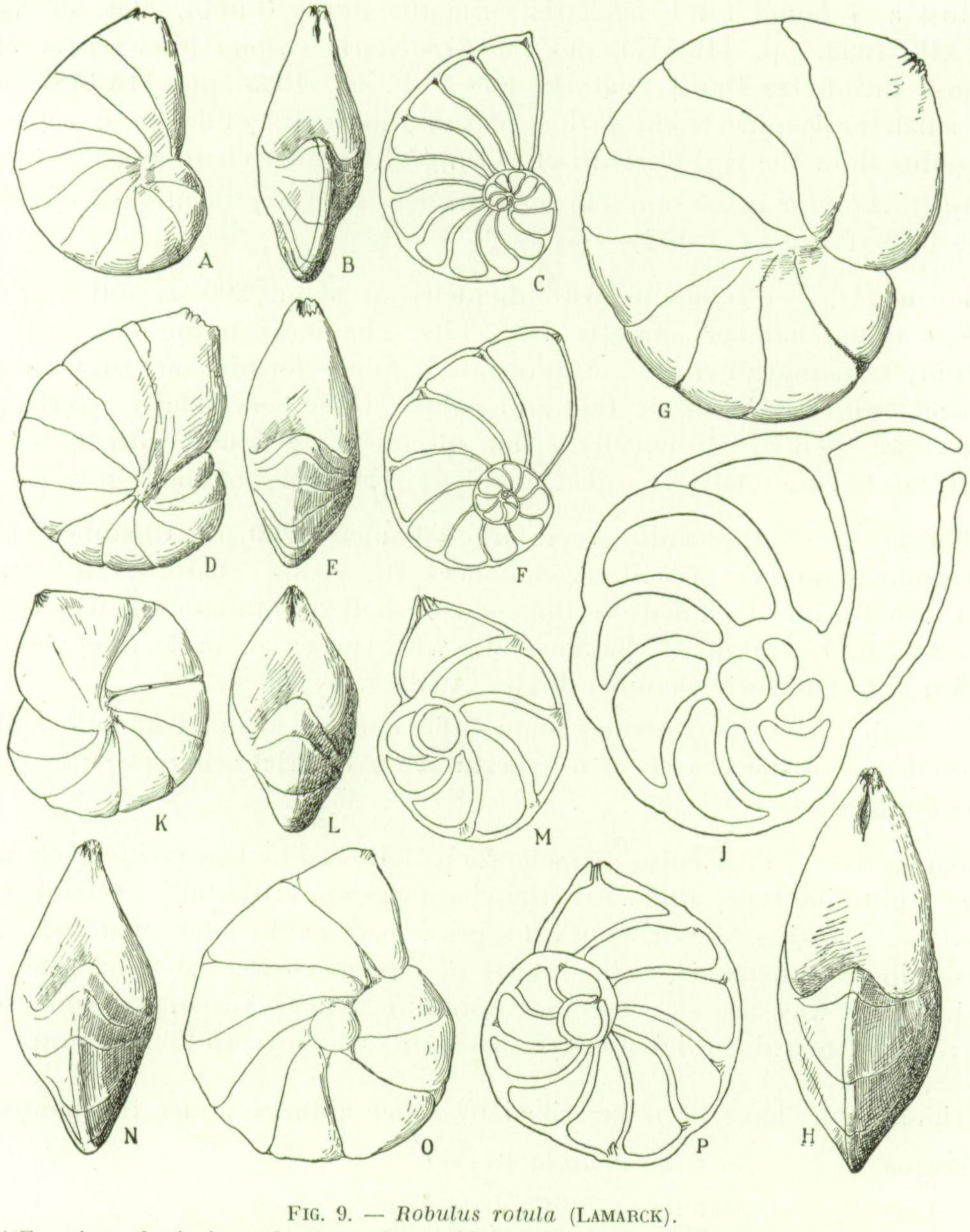

FIG. 9. — *Robulus rotula* (LAMARCK).
A-F : microspheric form, know as *C. spachholtzi* REUSS; A, B : shell; C : section. ×27. — D, E : shell; F : section. ×27. — G-J : *forma* A_2; G, H : shell; J : section. ×27. — K-P : *forma* A_1; K, L : small individual; M : section; N, O : larger shell; P : section. ×27.

than the three forms of a single species. The material was not large enough to make a statistic study as to their being three different species or not, but the fact, that they are found in the same material, that their differences are only very slight and that their embryonic differences show the characteristics, due to trimorphism, obliged me to throw these three species together into a single one, for which I chose the more common form, *R. rotula* LAMARCK.

Just as I found for *Cristellaria variabilis* Reuss (Pubbl. Stat. di Napoli, Vol. XII, 1932, pp. 116-117) and for *Cristellaria costata* (Fichtel et Moll) (Vidensk medd. fra Dansk. naturh. Foren, P. 93, 1933, pp. 116-118), forms with small proloculus begin with a *Marginuline* coil, while those with large proloculus show the real *cristallirian* coiling of the first chambers.

In *R. rotula* it is the same, if one considers the three mentioned « species » as the three forms of a single species.

Forma A_1. — Proloculus with diameter of about 200 μ, followed by a single coil of chambers, mostly 7-9. First chambers triangular, next ones becoming trapezoid in shape. Sutures of chambers forming an angle of about 45° back with the wall of the proloculus. Chambers totally overlapping, thickness of shell ½ of diameter. One specimen was found with 9 chambers in coil, but having totally 11 coiled chambers. Diameter of shell up to 1,4 mm.

Forma A_2. — Proloculus very large, diameter 260 μ. Chambers totally overlapping, number of coiling chambers 10, visible chambers 9. Sutures smooth, shell with edged margin, thickness of shell 2/5 of diameter, which grows up to 2,25 mm. Angle of chamberwalls with surface of proloculus about 60° backward, last formed chamber high. Walls very thick.

In both forms the aperture shows the normal form of *Robulus*, at the marginal end of the chamber; no apertural chamberlet, characteristic for the genus *Lenticularis*.

Forma B. — Proloculus diameter 25 μ, followed by three or four chambers of the vaginuline type, afterwards the chambers are cristelline. Chamberwalls transverse, showing the tendency to grow backward, later chambers high. Walls thin, 11 chambers visible, total of chambers 19. Shells higher than broad, in this way also showing the vaginuline type. Aperture normal, shells with rounded margin, thickness 2/5 of length, which is up to 1,15 mm.

These forms have been described by other authors under the names of :

Forma A_1. — *Cristellaria nuda* Reuss;

Forma A_2. — *Cristellaria rotula* Lamarck;

Forma B. — *Cristellaria spachholtzi* Reuss.

I believe furthermore, that the species, described by Schijfsma (1946) as *Lenticularis ordinaris* is nothing else than a small individual of *R. rotula*.

Marginulina bacillum Reuss.

This typical *Marginulina* always appears rarely in the gatherings from Maestricht and surroundings. Only megalospheric specimens could be found up. These specimens show two types. Some of them are small, attaining a length up to **2** mm., others are somewhat more slender, having a length up to

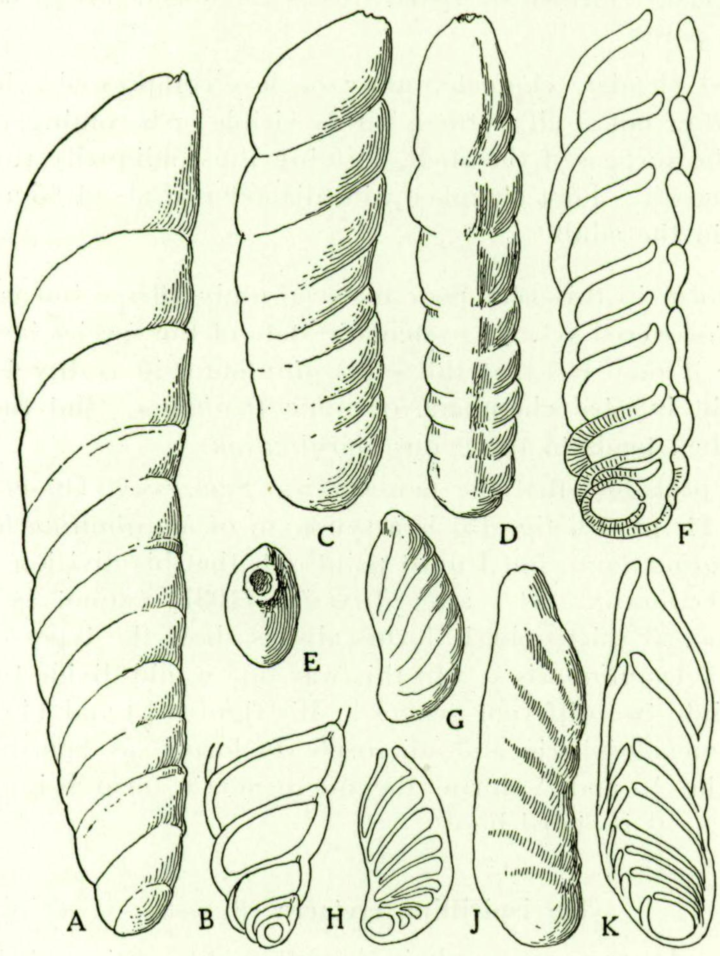

Fig. 10. — *Marginulina bacillum* Reuss.
A, B, G, H : *forma* A_1; C-F, J, K : *forma* A_2. ×40.

6 mm. The smaller form always had a relatively large proloculus, followed by only a single cristelline chamber, all following chambers being dentaline. The large form shows a much smaller proloculus, with a following chamber directly showing the dentaline type.

The sutures of most shells are somewhat projecting, in this way forming transverse costæ, especially in the forms with small proloculus. Especially in the form with large proloculus the tests are somewhat compressed, the transverse section being oval in shape.

DESCRIPTION OF THE TWO MEGALOSPHERIC FORMS OF *Marginulina bacillum* (REUSS) :

A_2. — Test elongate, compressed at both sides, chambers slightly inflated, sutures clearly visible, not or slightly projecting from the surface, test slightly curbed dorsally, up to 2 mm. Proloculus with a diameter of 190 μ, followed by a set of 6 to 8 dentaline chambers, the first formed one having the tendency of coiling. Aperture formed by radial slits at the dorsal face of each chamber. Wall with fine pores.

A_1. — Test slender, elongate, more or less compressed, chambers very slightly inflated or not at all, sutures hardly visible or becoming visible as they project from the surface of the shell, forming thus obliqually running costae. Wall mostly smooth. First chamber with diameter of about 65 μ, followed by 16 chambers, in the adult.

As the B-form in this very poor material (only 16 specimens were found) has not been discovered yet, the systematic state of the species is yet somewhat doubtful. For it may be, that this « *Marginulina* » in reality is a *Nodosaria* with very slight inflated chambers, or some *Dentalina*. But the compressed shape of the shell tends to the genus *Marginulina*.

It is very probable, that the new species, SCHIJFSMA (These, 1946, p. 63, pl. 2, fig. 13, 14; pl. 10, fig. 13) is a synonym of *Marginulina bacillum*. He called it *Vaginulina daini*, but I must point out, that his division of the genera *Marginulina*, *Vaginulina*, etc. after THALMAN (1937) cannot be of any real systematic value, as microspheric forms always show the types of « *Marginulinopsis* » and « *Vagulinopsis* ». In this way one would divide two forms of a single species into two different genera ! His figures 13 and 14, Pl. 2, do not represent the megalospheric and microspheric forms, as SCHIJFSMA suggests, but they are the A_2 and A_1-form, the microspheric form being shaped as a « *Vaginulopsis* », as is stated here.

Turrispirillina cretacea (REUSS).

This species always occurs rarely in the different localities. It forms a single spiral, coiled conically, but the top of the conus always rounded, thus forming a hollow semiglobular shell. As the wall is perforate with coarse pores, it is not a *Cornuspira*, as some authors have suggested, but a real *Turrispirillina*. No data about the bionomics can be given yet.

Megalospheric specimens show the typical *Turrispirillina* shape. Microspheric forms are much larger (up to 2 ½ mm. diameter) and are much more flattened.

Some specimens, described by SCHIJFSMA (1946) must belong to quite a different genus.

Cibicides involuta Reuss (1850) [1].

Reuss in his paper, *Foram. d. Kreidetuffs von Maestricht.* (Sitz. ber. d. kais. Akad. d. Wiss., Wien, vol. XLIV, 1862, pp. 313, 414; weiter in Maidinger's naturwiss. Abhandl., IV, 1850, p. 35.)

Reuss in his paper described three different species of *Rotalia,* which in reality showed to be species of *Cibicides,* having all three coarse pores, overlapping chambers at the ventral side, an umbilicus filled up with secundary chalk and an aperture forming a slit at the marginal end of the last chamber.

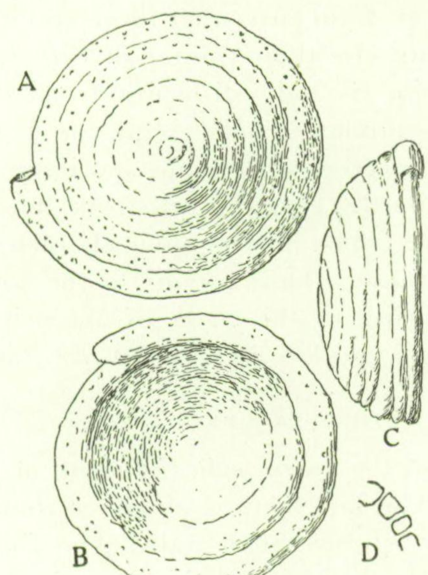

Fig. 11. — *Turrispirillina cretacea* (Reuss).
A : dorsal view; B : ventral view; C : side view. ×40.
D : section through wall. ×160.

I first separated the three species, the one having a relatively small diameter of the shells, only the sutures of the last formed chambers visible, and ventrally showing irregular projecting knobs in the umbilical region. This species was called *R. involuta* by Reuss.

The second species is somewhat larger, the ventral side more bulky, with a large amount of secundary chalk at the umbilicus, the dorsal side only showing the last formed chambers. This species was called *R. hemisphœrica* by Reuss.

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[1] *Truncatulina hemisphærica* Reuss (1862).
Truncatulina polyrapha Reuss (1850).

The third species is small in size, having the same diameter as *R. involuta* but showing at the ventral side the sutures of all chambers of the last coil, while the umbilical chalk material is very poorly developed. Thus the sutures are clearly visible, and Reuss called this species therefore *R. polyrhapha.*

When measuring shells of *R. hemisphœrica*, I found that a curve can be formed, showing a top only at one side, with the minor size. Thus I came to the conclusion that in the material. analysed in the way Reuss did, one half of the species, that with minor size, was lacking. These shells, especially the younger ones, were to be sought between the other *Cibicides* gathered. As I found that sections with the paraffine-method showed no differences between these three species of Reuss, I am sure, that those specimens, called *R. involuta* by him at least are nothing else than youngs of *Cibicides hemisphœrica.* The third form, *C. polyrhapha*, is only differing from *involuta* in lacking the development of much secundary chalk. But, as I have shown in several Foraminifera from the Zuiderzee in Holland, specimens of shallow water often lack secundary chalk while the typical form from the open ocean develops it; the lack of secondary chalk when all the other characteristics of the species are visible, is of no specific value. Thus I came to the conclusion, that the three species of *Cibicides*, occuring in the chalk of Maestricht in some abundance, form in reality only a single species, which I called *Cibicides involuta* Reuss.

Description of the outer features :

Shell, when young, at the dorsal side flattened, at the ventral side convex, with rounded margin. The last formed chamber rounded, with an apertural slit at the marginal base of the outer wall. The three or four last formed chambers are clearly visible at the dorsal side, showing a distinct suture towards the centre of the shell, this centre being covered with a layer of secundary chalk, so that the earlier coils are not visible from without. At the ventral side the chambers form only a narrow umbilicus filled up with chalk material. Poorly developed young shells show at the ventral side the sutures of the last coil very clearly but often the secundary chalk material is covering the centre of the shell, so that the sutures of these chambers are scarcely visible.

Older shells and especially those of the microspheric generation show especially at the ventral side a large development of secundary chalk. This secundary chalk however is not formed by any canalsystem, but only by the protoplasm streaming down along the outer surface, and streaming from the pores of the chamberwalls. In this way protruding knobs of chalk are found covering the centre of the shell, in some older shells even the whole surface of the ventral side (especially in microspheric specimens).

In transverse section the chambers of the first rows form a nearly flat spiral, but soon the chambers show the tendency to grow out towards the ventral side, leaving an umbilical region free which is filled with chalk. This

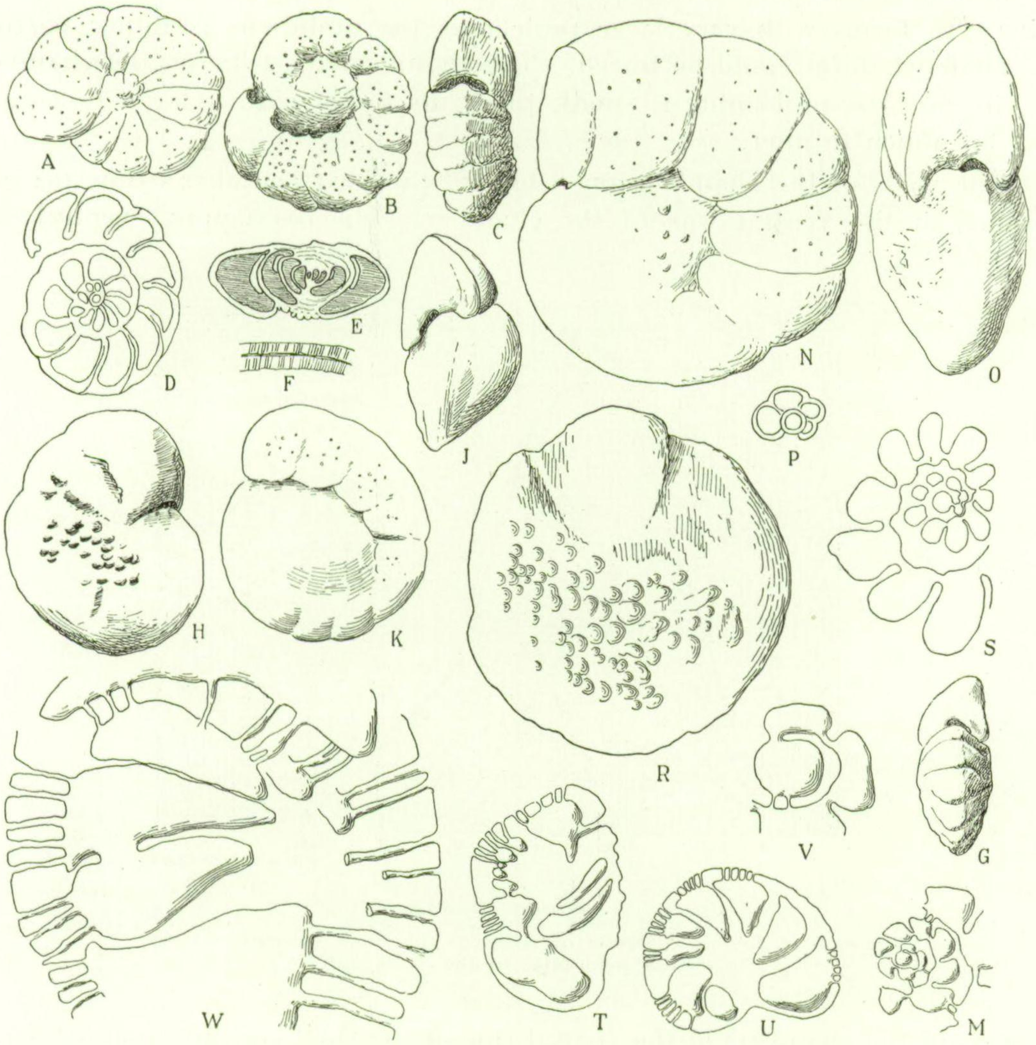

FIG. 12. — *Cibicides involuta* (REUSS).

A, B, C : typical individual of the *involuta* form; D, E : sections. ×13,5. — F : section through double wall between two chambers. ×27. — G : apertural view of the *polyrhapha* form. ×13,5. — H, J, K : typical individual of the *hemisphærica* form. ×13,5. — M : decalcified section through first coils of megalospheric form. ×27. — N, O : large megalospheric individual of the *hemisphærica* type; P : section through proloculus of the same individual. ×27. — R : dorsal side of microspheric specimen of *hemisphærica* type. ×27. — S : section through microspheric proloculus and following coils of the same specimen. ×160. — T : transverse section, decalcified; U : tangential section, decalcified. ×27. — V : macrospheric proloculus showing pores between adjacent coils; W : section, decalcified, showing pores in the umbilical region and between adjacent coils of chambers. ×160.

umbilical region is very large in microspheric forms, in megalospheric ones the umbilical free portion is smaller in proportion with the size of the proloculus. In forms with very large proloculus the umbilicus is rather narrow. No canals whatever could be traced. The chamberwalls between the chambers are, in case the proloculus is small, thick; in forms with a large proloculus they are much thinner.

The walls of the chambers open toward the next chamber by means of a foramen at the ventral side of the chamber. The overlapping ventral out-

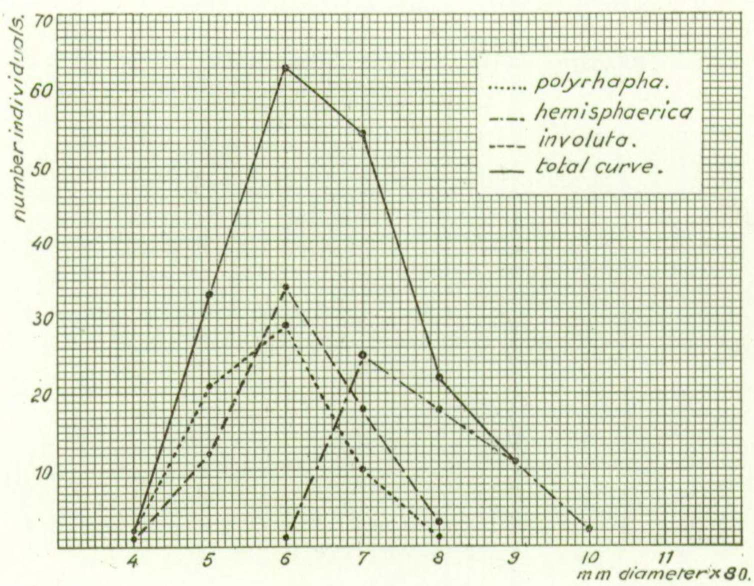

FIG. 13. — *Cibicides involuta* (REUSS).
Statistical data of diameter of shells of the three so-called species, in reality belonging to the same species.

growths of the chambers at the ventral side of the shell end into pointed sacks. Pores of the coarse variety are found between the chambers and the outer world, and between the chambers of two different rows.

In the microspheric form the first chamber shows a diameter of about 20 μ, followed by a spiral of chambers, the first formed chambers showing the typical arrangement in a spiral, of which the first chambers are generally somewhat smaller than the proloculus. The fullgrown shell shows, the proloculus included, 35 chambers or even more. The wall between the first coils of chambers is rather thin, later on it becomes thicker. But even the wall of the last formed coil is somewhat thinner than in the megalospheric form. The outer walls however are thicker, and, as the chambers in the microspheric form do not overlap in such an extreme manner as is the case in the megalospheric forms, the umbilical chalk is very highly developed.

In the megalospheric specimens studied, the proloculus measured in 6 specimens showed the following diameters in μ :

50, 52, 46, 45, 47, 61, average 52 μ.

The next chamber is situated closely near the proloculus and is flattened at the side, situated towards the proloculus. I therefore am convinced, that this second chamber formed with the proloculus the embryo, as I have proved it also to be in some rotaline forms in other papers.

In fullgrown specimens 19-42 chambers form the whole shell. The number of chambers thus is much smaller than that in the microspheric form. Though the latter is hardly distinguishable from the megalospheric in size. Shells which begin with the largest proloculus invariably show the smaller number of chambers. So an individual with a proloculus of 61 μ diameter showed a relatively large shell of the *hemisphœrica*-type with 19 chambers.

In the neighbourhood of the umbilical secundary chalk mass pores may find their way extending from the overlapping ends of the chambers through the lumen of the umbilicus towards the surface of the shell, thus suggesting some canal system. But never real canals were found, always these perforations of the umbilical chalk showed to be real pores from the outer surface of the chambers running along the umbilical chalk mass.

Statistical measurements of the length of the shells, measured in the axis of the last formed chamber, showed the following results.

Length in mm. in enlargement of 80 × :

	4	5	6	7	8	9	10	11
Rot. involuta :	1	12	34	18	3			
Rot. polyrhapha :	1	21	29	18	1			
Rot. hemisphærica :			1	25	18	11	2	1

In this way it was found, that *C. hemisphœrica* could not be a real species, as one half of the curve is lacking. The species *C. polyrhapha* and *C. involuta* on the other hand show curves, which are ending at the larger side just where the curve of *hemisphœrica* begins. Their curves however are quite between the same limits, so they cannot be otherwise than varieties, as there are no other differencies than the lack of secundary chalk material in *polyrhapha*. When, on the other hand, we put the three curves together, we obtain a curve, which shows much better a typical variation-curve :

4	5	6	7	8	9	10	11
2	33	64	61	22	11	2	1

Nonion tuberculifera (Reuss).

Described by Reuss (Sitz. ber. Akad. der Wiss, Wien, 1861, taf. 2, fig. 3) as *Rotalia tuberculifera*. His figures are incorrect, as the tubercules on the surface at the centre of the shell are much larger than figured. But the description agrees with the shells I studied.

I found only megalospheric specimens.

Shells small, diameter not more than about ½ mm., nearly circular in sideview. Margin showing the somewhat inflated chambers, and the older ones with a short point near the middle of the chamber. This point consists of clear chalk, and shows no canals whatever. The centre of the shell on both sides is covered with irregularly placed chalk-knobs, and often these knobs occur near the margin too. In many shells the sutures of the chambers are scarcely visible because of these knobs; most shells show 9 chambers in the last formed coil.

The aperture of the shell is found on the base of the apertural face of the last chamber, just above the margin of the shell which is somewhat protruding.

Transverse section shows the chambers arranged in a very slightly trochoid or planispiral arrangement. The megalospheric proloculus measures 100 μ. The pores of the chamberwalls are somewhat coarse, so that this *Nonion* belongs to the type of *Nonion stelligera* and *asterizans*, as I described them in 1922 in my report on the Foraminifera of the Zuiderzee. The chambers are communicating by a second foramen with the umbilical canal system, which occurs on both sides of the shell, thus indicating the real character as to the generic place of the species : *Nonion*. Between these conals, opening in the neighbourhood of the umbilus, the protruding knobs are formed and these openings Reuss will have described as the pores between these knobs.

Baculogypsina calcitrapoides (Lamarck).

In my paper on *Calcarina calcitrapoides* Lamarck (*Die Foraminiferen aus dem Senon Limburgens*, Natuurhistorisch Maandblad, Part 15, Nr 2, 1926) I dealt with this remarkable object. I found three distinct forms, with relativily large proloculus, free-growing spines or spines grown together into a ridge round the shell; with relatively large megalospheric proloculus, with more spines, which may also grow together into a ridge along the shell; a third form posesses a miscrospheric proloculus, the spines are numerous, or grown together, forming an irregular ridge around the shell.

I stated a very well developed canal-system, which was described as a Calcarine one. The cribriform pores of the chamberwalls are coarse, as is the case in all *Calcarinidæ*.

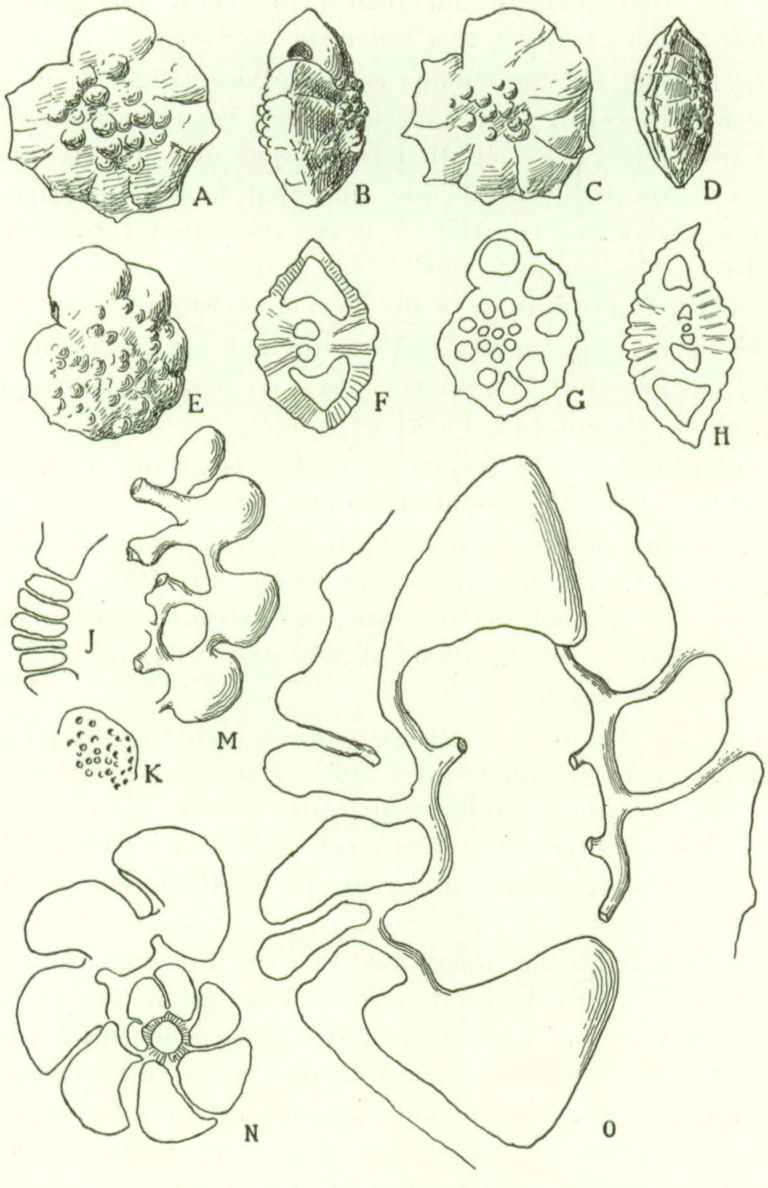

FIG. 14. — *Nonion tuberculifera* (REUSS).

A-E : several shells. ×20. — F, H : transverse sections. ×20. — G : horizontal section. ×20. — J : pores. ×240. — K : pores in the chamberwall. ×240. — M : chambers of second coil, showing secundary foramina towards canal system. ×240. — N : section of decalcified shell, first coils, with pores of proloculus. ×40. — O : transverse section, showing parts of umbilical canal-system. ×240.

I mentioned further-on, that REUSS stated, when dealing with the Maestrichtian species, that there is no reason to retain the genus *Siderolites, Calcarina calcitrapoides* being a real *Calcarina*.

In my first paper on the Siboga-Foraminifera (1929) I once more dealt with this species, in connection with *Calcarina spengleri* and *Baculogypsina tetraœdra*. I mentioned the fact, that in *C. spengleri* the chambers have the tendency to overgrow the ventral side, and that in *C. calcitrapoides* they do likewise on the dorsal one (p. 44). I never said, that I could not find any difference between *C. spengleri* and *C. calcitrapoides*, as SCHIJFSMA suggested in his paper on the Foraminifera of the Hervian (1946).

On p. 48 of my Siboga-report I mentioned : « *Calcarina calcitrapoides* also shows some characteristics which may give rise to the supposition that there is some close relation with *Baculogypsina*. »

I now have restudied this species on a very large material, deriving from nearly all localities of the Maestrichtian senonian level.

SCHIJFSMA (1946) discussed my figures, given in 1926, saying : « The pictures of HOFKER's *Calcarina calcitrapoides* LAMARCK (1926, fig. 10, 12 an 14) seem to me with more probability to represent *Siderolites denticulatus* DOUVILLÉ (Bull. Soc. géol. France, vol. 6, 1906, p. 598, pl. XVIII, fig. 6-8) (Rare in the maestrichtian of south Limburg). »

Now, my figures are drawn with the camera lucida from specimens, which occur in abundancy in the material I studied then and which occur in the material I am now describing, in large quantities. So I did not deal with a rare species of the Maestrichtian, but DOUVILLÉ, when describing his *Siderolites denticulatus*, was dealing with a different species than that, occurring in the chalk of Maestricht.

Many authors have already mentioned the fact, that *Calcarina calcitrapoides* from Maestricht had to be called *Siderolites*. I believe in this respect, that this may be right. But in one respect we have to bear in mind, that the older authors (f.i. LAMARCK) did but very little know about the organisation of the Foraminifera, and in this way their name-giving in many cases is very doubtfull, especially, as their figures are mostly incorrect. In another respect the genus *Siderolites* has been applied to very different species, some of which may belong to the *Camerinidœ*. In this way many authors have placed the species deriving from Maestricht in the family of the *Camerinidœ*, which is exceedingly wrong.

On the other hand, many characteristics of the species here dealt with are also found in *Baculogypsina* (which by some authors has also been called *Siderolites*, as they brought it in relation with the Maestrichtian form).

In this way I am inclined, to call the Maestrichtian species *Baculogypsina*. But *Baculogypsina* is a very real *Calcarine* genus, as I have pointed out in my Siboga-work. It has nothing whatever to do with *Camerinidœ*. To show this, I studied the inner structure of a large number of shells of the Maestrichtian form. Wat are the differences between the group of the *Camerinidæ* and that of the *Rotalidæ*, to which latter group the *Calcarinidæ* belong?

The *Camerinidæ* show very fine pores in the chamberwalls, the chambers are mostly nautiloidically coiled; on the marginal side of the chambers invariably runs the marginal chord systeem of canals. Septal walls of the chambers always double.

In the *Rotalidæ* the pores of the chamberwalls are very fine, as is the case in *Rotalia* and in some other genera but otherwise they are coarse. The chambers are built up in a trochoidally coiled spiral which may, however, become nearly flat. The chambers ventrically are in connection with a more or less developed umbilical canalsystem which enters also between the chamber-walls, when double. Never there is a marginal chord system, characteristic for all *Camerinidæ*.

Since the Maestrichtian form, although the spiral of chambers is flattened and therefore a Camarine development of the chambers may be suggested, lacks any traces of the marginal chord, and as the pores of the chamberwalls are very coarse, there can be no question whether the species belongs to the *Camerinidæ* or not : it does not.

As the genus *Siderolites* by many authors is believed to be real Camerinide genus, it will be wise not to use this name for the Maestrichtian species.

But what name would be the most practical one for this fossil species? As I mentioned already, some characteristics are quite those, given to *Baculogypsina*; other ones are applied to real *Calcarina*. The Maestrichtian genus shows peculiarities between those two genera. As I abhor the forming of new generic names for only a single species, it is a matter of feeling, how to deal with this question. As some specimens show the outgrowth of wildgrowing chambers, so characteristic of *Baculogypsina*, I am now inclined to call it *Baculogypsina calcitrapoides* (Lamarck). The canal system too shows the same structure as that of *Baculogypsina tetraœdra*.

Description of the outer form of the species :

This outer form is very variable, as is also found in recent *Baculogypsina* and in recent *Calcarina*. This fact is caused by the forming of spines. These spines, as I have already described in my *Siboga-Report*, are due to a peculiar outgrowth of the canal-system. This canal system is a function of the outgrowth of the earlier chambers. The outgrowth of these chambers furthermore is a function of the measure of the first chamber, as has been shown by Rhumbler and by Van Iterson.

One of the most peculiar functions of the canal system is a vegetative one. Respiration and feeding are ruled by the protoplasm, running in this system. But in the first place the chalk-distributon is manufactured by this protoplasm. In this way you always find masses of secondary chalk in the neighbourhood of the openings of these canals. As these canals run in several principal directions from the centre of the primordial shell, especially in these directions masses of chalk are deposited, and thus the spines come into existance. These canals develop from the first coils of the umbilical canalsystem, and this system is a function of the development of the first coils of chambers. One may find

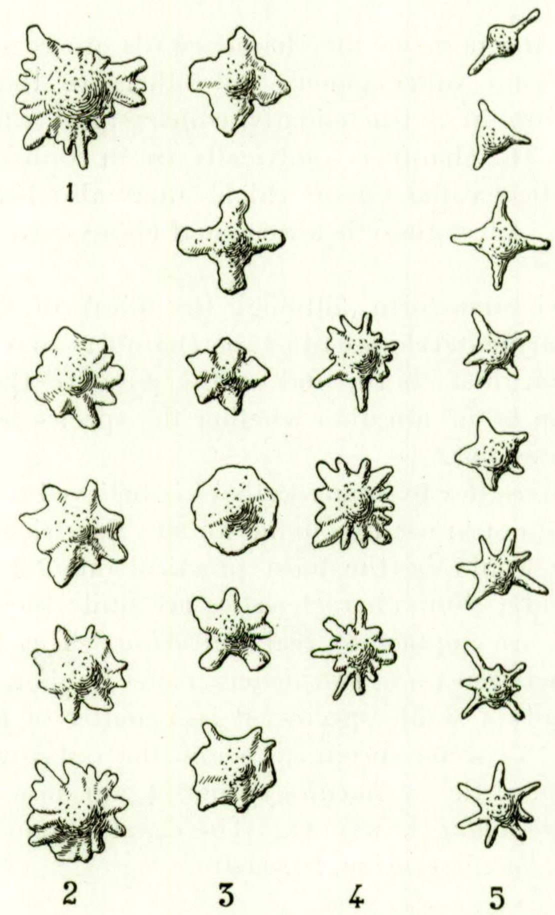

FIG. 15. — *Baculogypsina calcitrapoides* (LAMARCK).

Row 1 : microspheric specimen, *lævigata*-variety.
Row 2 : 4 microspheric specimens, *lævigata*-variety.
Row 3 : 6 megalospheric individuals, *lævigata*-variety.
Row 4 : 3 microspheric individuals, *calcitrapoides*-variety.
Row 5 : megalospheric specimens, *calcitrapoides*-variety, with 2-7 spines.
All specimens from the same locality : Maestricht. ×5.

out, that every two newly formed chambers form a canal or set of canals, ramifying to the margin of the shell. When there are many chambers in a single coil, as is the case in the microspheric form, the forming of strings of canals towards the margin in a single coil will be common. So more than six spines will be found in the microspheric specimens. In the individuals with a relatively small proloculus, the chambers of the first coil will be relatively small too, and their number will be relatively large. In these specimens the number of spines will reach from 6 to 8. In individuals with a relatively large proloculus, 8 chambers form the first coil, and so only four spines will be formed.

So the number of spines in *Baculogypsina calcitrapoides* is a measure too for the bulk of the first chamber, and consequently for the generation with which one is dealing.

I got the following data of the occurrence of the several numbers of spines in a large material deriving from Maestricht, Houtem, Bemelen, etc.

Number of spines :	2	3	4	5	6	7
Number of indiv. :	16	70	331	205	75	42

Another locality, in which the individuals make a somewhat poor impression (all other *Foraminifera* in this region, the Jeker-valley, give this impression) following data were obtained :

Number of spines :	3	4	5
Number of indiv. :	32	921	165

So in both sets of specimens the form with four spines is more common. Specimens with four spines, ground down and filled with paraffine, showed the following measures of the proloculus in μ :

81, 75, 112, 100, 110, 125,

so that the average diameter of the proloculus of this form is 100 μ. The spines are formed by the canals. These canals form a bundle in the centre of the spine, and furcate towards the peryphery of the spine. Their openings form fine groves on the surface of the spine, in the direction of the length of it. At the base of the spine it may be covered by wildgrowing chambers, and then the coarse cribriform pores of the chamberwalls may also be seen on the spine. Moreover it is covered with pustules, the endings of pillars of massive chalk-substance, as is shown beneath.

The centre of the shell, between the spines, always is more or less globular, or lens-shaped. Especially in the centre of the dorsal and the ventral sides one finds distinct pustules, formed by the ends of solid pillars growing from the first coils of chambers towards the surface.

Between these pustules the coarse perforation of the chamberwalls is often seen, but in more frequent cases this perforation ends into furrows, running at the surface between the pustules, forming later the canals between the chambers which are now near to the surface, and those which will be built later on, covering this surface mentioned.

The form with 5 spines, also occurring very abundantly in the material, shows to be megalospheric too. The three specimens measured, had a diameter of the proloculus in μ of : 56, 100 and 77 so that the average diameter is about 78 μ. This average is somewhat smaller than that of the individuals with four spines. A single specimen of three spines showed to possess an initial chamber of 110 μ diameter.

Specimens with more than 6 spines, mostly 7 or 8, showed to be mostly megalospheric. Proloculi measured had a diameter of

62, 50, 60, 62, 56, 75 and 87 μ,

thus having an average diameter of about 65 μ.

Recapitulating this facts, we have :

Three spines	110 μ
Four spines...	100 μ
Five spines	78 μ
Seven spines	65 μ.

So we may conclude, that when the volume of the proloculus decreases, the number of spines increases. Specimens of the microspheric generation, as mentioned above, show numerous spines.

As I pointed out already, the forming of the spines is due to the canal system, which grows more complex when the proloculus becomes smaller. This fact is undoubtedly the result of the shape of the first coils of chambers, as in most cases examined a radiating canal runs from the umbilical ones between each two or three successive chambers of the coils. This rule is also maintained in the older shell, so that, when in later coils more than two or three chambers are enclosed by two successive spines, a new spine is intercallated. Thus individuals with originally four spines may attain even six spines in the end. In this way they suggest to be individuals with a relatively small proloculus; however they always show a large one. In this one never can tell by the outer aspect of the shell, if the individual is really an individual with a small proloculus; only a section can clear the question. Ordinarily however the number of the spines is an index to the largeness of the proloculus, as is shown above. Yet the number of the spines is a variable one, as is shown now; this is also shown by the variability of the spines in general, as the variability shows always a curve with a single top, while the diameter of the proloculus in megalospheric Foraminifera shows a curve with at least two tops, as is made clear by myself and by Cosijn (1938).

Concluding we may say, that the number of spines, dealt with by considering the outer shape of shells, shows normal variability; when considered in sections, the number of primordial spines, those which are built up by the first coils of chambers, invariably is connected with the diameter of the proloculus; this number must be reigned by the same rules as this diameter, showing a curve with double top. But, as secondary spines are developed in later coils, this two-topped curve is overgrown by the normal variability.

In this way we have to distinguish primordial spines and secondary ones. Only the primordial spines show in their number a connection with the diameter of the proloculus.

In respect to this results 35 specimens of different forms were ground down, and the proloculus measured at paraffine-preparations. The following data were obtained :

Diameter of proloculus in μ :							
20-30	30-50	50-63	63-75	75-87	87-100	100-111-	112-115
Individuals :							
2	1	8	5	4	3	6	8

So we find when we measure the diameter of the proloculus a curve with two tops, just as was obtained by Cosijn and myself. The tops may be considered as typical A_1 and A_2-generations, while the two individuals with proloculus of about 25 μ are typically microspheric.

Most of the typical individuals of A_2-form are three — or four — spined. Those of the A_1-form bear six or seven spines. But, as I have pointed out, some of these individuals with more spines are in reality specimens of A_1, having only four spines with the first coils of chambers, the other spines being additional ones. This variation, due mostly to outer circumstances, e.g. the amount of chalk in the water, is the cause of a curve with single top, when one considers the numbers of spines in shells which are not ground.

I have already mentioned these facts in my account on the species in 1926; I now have confirmed this statement.

The microspheric specimens show the development of many spines which mostly are grown together to a more or less developed fringe round the shell. As in most Foraminifera the microspheric form shows the most primitive characteristics, one would be inclined to consider these features as the most characteristic ones of the species.

Many cases can be shown, in which Foraminifera show a high variability as to the development of chalk-material, especially in the forming of spines or pillars. The individuals of a species, found in brackish water (e.g. the Dutch Zuiderzee) show a very poor skeleton compared with those of the open ocean. Even the measures of the shells are less.

In some of the excavations in the « Jekerdal » in South Limburg all specimens found of *Orbitoides faujasi* as well as of *Baculogypsina calcitrapoides* are small, and the development of secondary chalk-material is very poor. I mentioned the fact already, that in this level the number of spines in the latter genus is from 3 to 5 only. In other localities of South Limburg however the shells of the Foraminifera are much larger, the development of chalk-material is abundant. These facts prove, that the chalk-material of these fossil species too is a function of the surroundings rather than of the specific factors of the species.

In all localities in which the development of secundary chalk is obvious, beside the normal shaped specimens forms occur, often in abundancy, in which the secundary chalk-material has caused the forming of a fringe of chalk round the shell, such as to give rise to shells which lack all appearance of spines when studied from outside. All transitions to the normal shells can be found, but I did not account for these abnormal shaped shells in my variation schemes.

Now, however, I have to deal with them.

In the material from Maestricht, Houtem, Bemelen, etc., in which 739 normal individuals were found up, 167 specimens were found, in which the spines and the outer periphery of the shell showed the tendency to melt together, but often is was very difficult to consider them as normal or abnormal individuals. Besides these intermediate individuals there occurred in the same material also 86 specimens, in which the spines with the periphery of the shell were melted together in a more or less regularly shaped fringe. The specimens are known in literature as *Siderolites denticulatus* DOUVILLÉ (1906) in respect to the spinal individuals (167) and as *Siderolites lævigata* LAMARCK (86). In my paper (1926) I believed, that *Siderolites lævigata* belonged to the same species as *Calcarina calcitrapoides*. I now am inclined, to think, that *S. denticulatus* belongs to the same species too. I studied numerous species in sections of these abnormal forms, but the inner structure of the chambers was quite the same as that in *Calcarina calcitrapoides*. Only the development of the secundary chalk-material was more abundant, giving rise to the fringe. The canals of the spines and those between the later coils of chambers are more abundantly developed, and the canals spride more broadly than in the normal forms. But these canals give rise to the development of the secundary chalk, and in this way the latter grows up to a single fringe. The only difference between *Baculogypsina calcitrapoides* and *S. lævigata* and *S. denticulata* thus is found in the development of the secundary chalk-material. Numerous spines are added to the primordial ones, which, in the round specimens, amount mostly too to four or five. As the secundary chalk is subdued to the surroundings of the shell, as these surroundings show in the material of Maestricht, that circumstances were favourable (in the locality of the Jekerdal these outgrown individuals were comparatively rare) it is obvious, that we are here dealing with a variety, not in the least with a distinct species. So I have no reason to alter my opinion, given in 1926, that these outgrown specimens belong to the same species as the normal ones. In biology one never creates new species for varieties of the normal one, as in this case one would raise Jordanonts to the level of species.

The proloculus always is globular, and is followed by another chamber, more or less triangular in shape, seen from the umbilical side of the shell. A coil of 10 to 12 chambers follows these too, regularly placed one after the other. In this first coil the chambers increase but slightly in size. This coil is separated from the next chambers by one of the spinal canal bundles, and now the

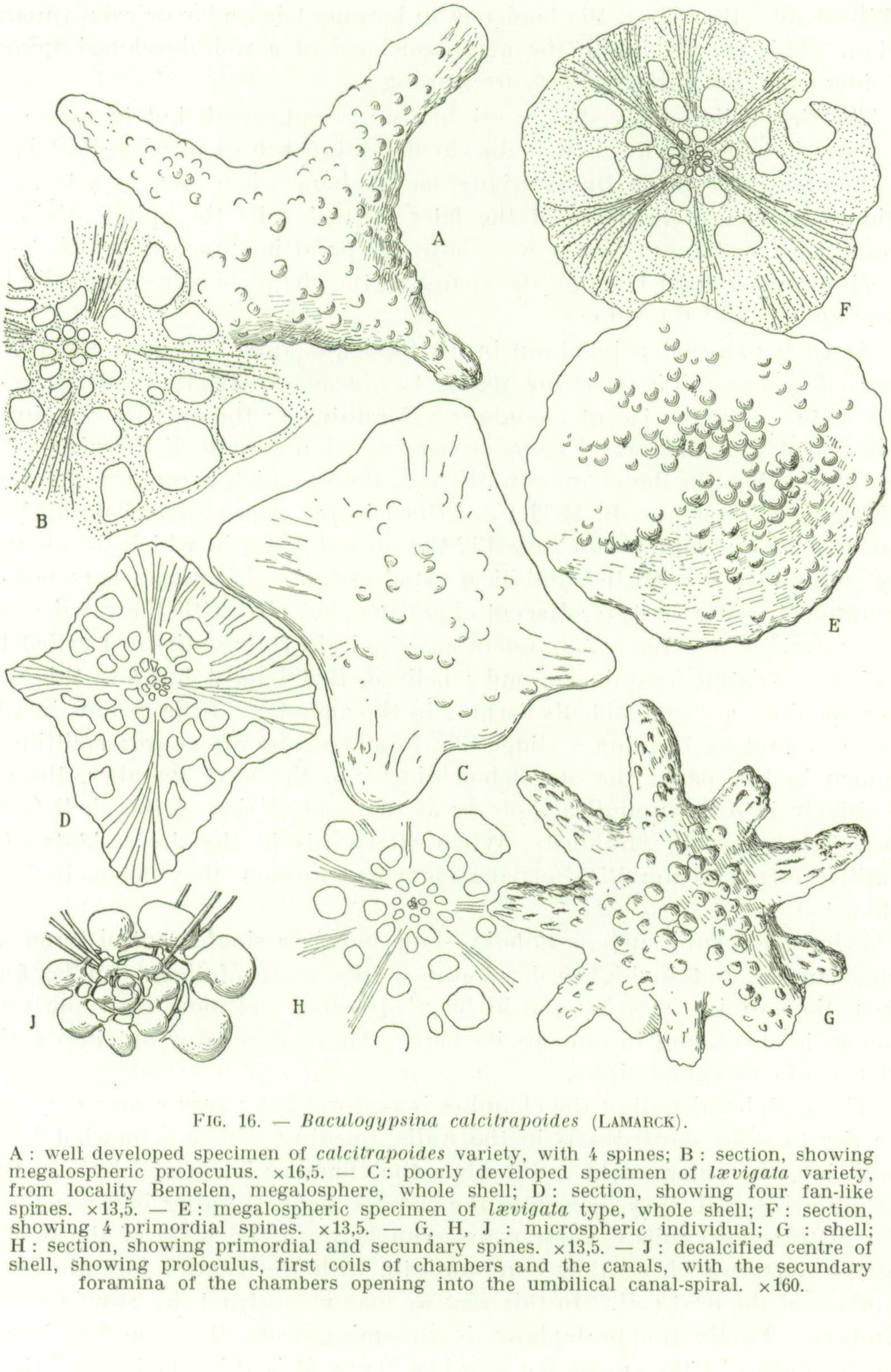

FIG. 16. — *Baculogypsina calcitrapoides* (LAMARCK).

A : well developed specimen of *calcitrapoides* variety, with 4 spines; B : section, showing megalospheric proloculus. ×16,5. — C : poorly developed specimen of *lævigata* variety, from locality Bemelen, megalosphere, whole shell; D : section, showing four fan-like spines. ×13,5. — E : megalospheric specimen of *lævigata* type, whole shell; F : section, showing 4 primordial spines. ×13,5. — G, H, J : microspheric individual; G : shell; H : section, showing primordial and secundary spines. ×13,5. — J : decalcified centre of shell, showing proloculus, first coils of chambers and the canals, with the secundary foramina of the chambers opening into the umbilical canal-spiral. ×160.

chambers become more irregularly shaped. They are higher, seen from the umbilical side, they show the tendency to become triangular or even square in section. This fact is due to the neighbourhood of a well-developed spine, at the sides of which the chambers are leaning.

The first coils mostly show a slight conical outgrowth but in many cases the spiral is totally flat. This is due to the outgrowth of overlapping sides of the chambers, becoming firstly triangular in shape when seen in a transverse section. In larger chambers of the later formed coils the spines divide the chamber in two flanges, but it was shown in paraffine-preparations that often the spine runs straight through the chamber, the chamber being normally built before and behind the spine.

As I have already pointed out in my Siboga-reports, and once again in my paper « *The Foraminifera of the Malay Archipelago* » (1933), I call large openings between two adjacent chambers « foramina »; the smaller openings in the walls of the chambers I called « pores ». I now will distinguish a third form of openings in the chamberwalls, e.g. those, which communicate directly with the canal system. In 1932 I described in my paper « *Die Foraminiferenfauna der Ammontatura* » on page 132 the several ways, in which the chambers may communicate with the umbilical canal system. Chambers may not only communicate with the two adjacent chambers, but also with the canal system. These openings into the canal system are single in *Pulvinulina*. I called these openings « ventral foramina », and I believe, that I must insist to this name; these openings are undoubtedly formed in the ancestors of the groups in which they are found by forming a slidge-like foramen, and afterwards splitting this foramen in two parts, the one debouching into the next chamber, the other primitively into the umbilical hole or at the ventral side of the shell (e.g. in *Cymbalopora* and in *Streblus*). When afterwards in the descendants of the primitive forms an umbilical canal system was formed, they debouche in this system too.

Primitive forms, such as *Rotalia*, show mostly a single ventral foramen in each chamber, but in higher developed species more of them can be found. This is the case in *Calcarina* and in *Baculogypsina*, and more than one ventral foramen is also found in our species here. They often grow out into a shape which could be called sipho.

The peripheral wall of the chamber is perforated by very coarse pores; they give rise to stout short canals in the walls, opening with a somewhat broader mouth into the outer world. But when the chamber is covered by a chamber of a following coil, they open into the canal system, running between the two walls of these two coils. These canals run between the walls of the next coil into the outer world, or they communicate with the ventral foramina of the chambers of the next coil. In this way we may reconstruct the growing of new chambers. Firstly the protoplasm is streaming from the chamber into the open by means of the coarse pores; when the wall is thickened from without, canals are saved, into which the coarse pores are opening. Afterwards, when a new chamber is formed, this chamber is furnished with protoplasm by means of the canals, in which the pores were opening. These canals form the ventral foramina of the shell, broadening towards the new chamber. In many sections I could find the several stages of the process just mentioned.

But, in the case that in reality the chambers of later coils are formed by the canal system, in which the pores of former chambers are opening, it will be very clear, that the debouching of big canals at the surface of the shell may also give raise to the building of new, irregular chambers, not being formed in the normal spiral. I have already described this phenomenon when dealing with *Calcarina spengleri* in my first part of the Siboga-report. In quite the same way in our fossil species in outgrown specimens these chambers may be found, distributed not only on the surface of the shell, but also on the spines. These chambers are always comparatively small, irregularly shaped, never overlapping, quite as I could describe them in *Baculogypsina tetraëdra*.

The third and fourth chamber of the initial coil form the first ventral foramina, thus giving rise to the first umbilical canals. They are formed not only on the ventral side of the shell but, though not so abundantly, on the dorsal side too. They give rise to an irregular spiral canal, as I described it e.g. in *Calcarina*. From this first spiral thin canal-bundles run between each set of two or three chambers of the initial coil towards the periphery of the shell, thus giving rise to the anastomising and richly developed system of the spines. Between the walls of the chambers canals are running irregularly towards the periphery too, often giving rise to the bundles of canals of secundary spines. In the spines one may distinguish a central anastomosing bundle of canals, from which at regular intervals broadening canals are running sideways to the surface of the spine. At the end of a spine the central canals open into the outer world too. In outgrown shells the canals, opening at the sides of the spine, give rise to irregular chambers. These chambers however never form layers of chambers, they always are situated into a single layer, covering the surface, especially at the base of the spine and on the margin of the shell too.

In some forms, formerly described by authors as *Siderolites lævigata*, the canal system of the spines is flattened, spreading out van-like along the margin of the shell, thus forming irregular spines or even a fringe.

No marginal-cord system whatever could be traced.

Especially in the umbilical region pillars of massive chalk are developed, running between the canals and between the overlapping ends of the chambers, straight to the surface of the shell. Their ends project on the surface, forming little white knobs of chalk. Between these knobs one may observe the openings of the canals and the coarse pores of the chambers as well. In the neighbourhood of the openings of canals often some coarse chalk material is built, thus making the surface rather rough.

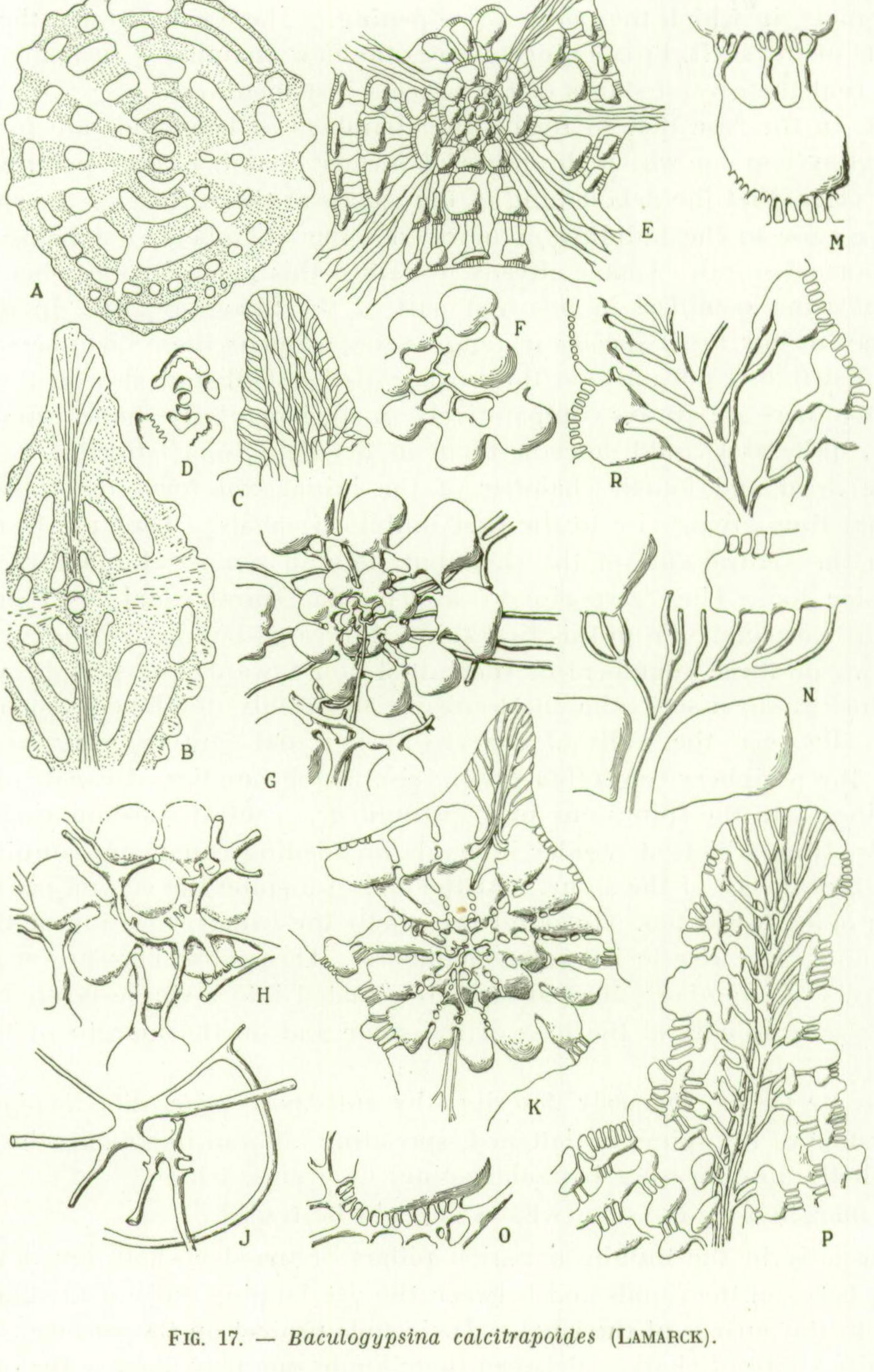

FIG. 17. — *Baculogypsina calcitrapoides* (LAMARCK).

SYSTEMATICAL ANALYSIS :

Rough coarse pores are always very characteristic. As we have here to deal with a real rotalide species, which forms of the *Rotaliinæ* show also coarse pores ? Coarse pores are only found in those *Rotaliinæ*, which I gathered in the sub-family of the *Orbitorotalininæ* in my paper on the Malay Foraminifera (1933, p. 125). In primitive forms such as *Truncatulina*, the shell mostly is of the conical shape. But here too some species show the outgrowth of overlapping chambers, thus the spiral of chambers becoming somewhat flattened, e.g. in *Truncatulina præcincta* (KARRER), as I described it in the last mentioned paper.

So the species from Maestricht indoubtedly is to be grouped into the *Orbitorotaliininæ*.

In this group I also placed the groups of the *Tinoporininæ* and of the *Calcarininæ*. As the *Tinoporininæ* show mostly, especially in megalospheric specimens, the raspberry type of embryonic aparatus, and as they lack any canal system, the species must be grouped within the *Calcarininæ*.

The *Calcarininæ* show a well-developed canal system, an umbilical system, with which the chambers are connected by ventral foramina. The first coils of rotaline chambers form a flat spiral, the umbilicus only being formed at the ventral side of the shell. Pores of the chambers often ending in short canals in the genus *Calcarina*. Spines well-developed, having also a canal system. Outgrown shells of *Calcarina* often show wild-growing chambers, not greatly differing from that of the species from Maestricht; only in the latter it is somewhat more developed than e.g. in *Calcarina mayori*, which species I described in my *Siboga-report* (1927). The species *Baculogypsina tetraëdra*, which was later wrongly called (see my paper on the *Malay Archipelago*, 1933, p. 128) by YABE *Baculogypsinoides spinosus*, shows a first spiral which is uttermost the same as in our fossil species, being flattened like a Nummulide shell. But later on the

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EXPLANATION OF FIGURE 17.

A : transverse section through megalospheric individual of normal type with 4 spines, but section between the spines. The pillars are clearly shown. ×20. — B : section through spines of normal megalospheric specimen with 4 spines. — C : canal system in spine, decalcified. — D : transverse section, decalcified, of megalospheric specimen of *lævigata*-type. ×20. — E : decalcified megalospheric specimen with 5 spines, showing the canal system. ×20. A spirally arranged umbilical canal runs along the chamber coils. From this spiral canal-bundles run through the spines, being off-springs from the spiral canals. The pores of these chambers open into a net of canals from which canals run towards the umbilical side of chambers of the next coils; between the chambers interseptal canals run towards the periphery, mingling up with those of spines, or those in which pores are debouching. — F : first coil of chambers, showing secundary foramina of chambers, developing the first coils of umbilical canal. ×120. — G : first sets of chambers of microspheric individual with canal system. ×120. — H : umbilical canal system, ventral side, from megalospheric specimen with 3 spines. — J : idem, from megalospheric specimen with 6 spines. ×120. — K : view into the whorls of chambers at the dorsal side, from within; early coils removed. The dorsal umbilical canal system is shown. Individual with 4 spines. ×20. — M-O : figures showing how chambers, pores and canals are connected; M : pores open into secundary foramina of chambers; N : pores open into interseptal canals; O : interseptal canals running into chambers; these chambers are always wild growing ones. ×120. — P : wild growing, typical baculogypsine chambers, on the surface of a spine of large typical specimen. These chambers are formed by the canal system of the spine, as the figure clearly shows. ×120. — R : wild growing, typical baculogypsine chambers on the fringes of a round *lævigata* specimen. Transverse section. The building of these chambers is quite the same as that on the spines of the specimens of the normal type. ×120.

chambers grow wildly, just as is the case in the last formed chambers of our species. The spines are well-developed, the pillars are never to be mentioned as a generic characteristic, being always very variably placed, only filling up the spaces between the canal system and the chambers.

So it will be obvious that the species, with which we are now dealing, is a species which in some respects, e.g. the many regularly coiled chambers, the overlapping of the chambers, could be placed in the genus *Calcarina*; but the largely developed canal system on both sides of the shell, the flat spiral of the first coils and the forming of wild-growing chambers in connection with the canal system, point to *Baculogypsina*.

Since the genus *Siderolites* mostly is connected with the *Nummulitidæ*, as I have pointed out, and as a marginal cord system is lacking totally, and as the genus *Siderolites* is not defined clearly by the first author, I believe it to be efficient to discard this generic name in this case; it will be a matter of arbitrariness, whether to call it *Calcarina* or *Baculogypsina*. It is a link between both genera, as is pointed out.

As, however, the central coils of chambers in *Baculogypsina* and in the species we are dealing with, show both the flat spiral type, I am inclined to call it a real *Baculogypsina*. Both genera are, it will be clear now, very much allied, so that it would be possible to call all types of both *Calcarina*.

The flattened types of the species, called by authors *Siderolites denticulata* and *Siderolites lævigata* are, in the best case, only variaties of the species, as all intermediate types can be found in a single locality and as the inner structure is only gradually differing in the development of secundary chalk material.

I must once more point out that these conclusions could only be drawn with the aid of a minutious study of the inner structure by means of the paraffine method.

I have here to mention the statistical investigation on *Baculogypsina calcitrapoides* by A. J. Cosijn (*On the phylogeny of the embryonic apparatus of some Foraminifera*, Leidsche Geol. Meded., Vol. XIII, **1942**, tab. II, p. 63). This author measured the proloculus of 46 specimens from a sample, having an average of radius of 47,51 μ, those from another sample possessing a radius of average 39,2 μ. He concludes, that in the currence of time the proloculus of *Baculogypsina* must have decreased. In the light of our recent investigations we must consider this conclusion as premature, as Cosijn does not mention the number of spines of the specimens of the two samples. It is possible, that in the first mentioned sample accidentally more specimens with four spines have been gathered, in the second mentioned in the contrary there may have been more individuals with more than four spines. Moreover the difference between the measured radii of the proloculus is explainable without any difference of time. This explanation may be appropriate too on other statistic data collected by Cosijn in his paper.

Allomorphina trigona (REUSS).

This species is rather common in the Maestrichtian chalk. It shows all the characteristics of the species. The walls are very smooth, and comparatively thin. I observed only megalospheric specimens, the proloculus having a diameter of about 110 μ. The two last-formed chambers only are visible from the outside.

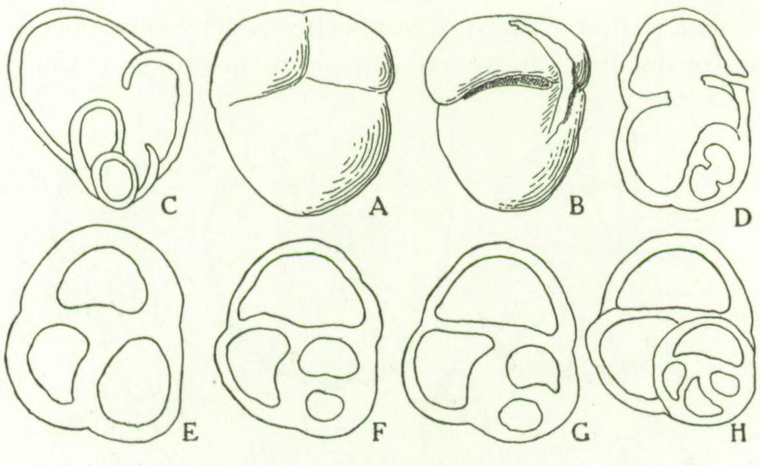


FIG. 18. — *Allomorphina trigona* (REUSS).

A : shell, side-view; B : apertural face; C : two different sections through proloculus; E-H : four successive sections, showing arrangement of chambers. ×40.

The species has been labelled by several investigators as *A. cretacea* REUSS. I could not see any difference between *A. cretacea* and *A. trigona*.

Peneroplis senoniensis nov. spec.

In the second part of my Siboga-report (1930, pp. 137-143) I gave an exhaustive account on the recent species, *Peneroplis pertusus* FORSKÅL. I came to the conclusion, that the aperture of the last chamber does not form a generic or even a specific characteristic. In forms with larger proloculus the aperture may be simple, and in forms with smaller proloculum of the same species the aperture may be more or less complex.

The number of chambers equally is of no use, as in forms with large proloculus this number is relatively small, in forms with smaller proloculus the number of chambers of the last formed coil is relatively high.

Peneroplis in this way becomes a very variable species, as is shown in the papers on this matter by DREYER, WINTER and myself.

To erect a new genus on a poor material would seem somewhat premature. It will be very possible, that this new species, *Peneroplis senoniensis*, will be nothing else than a *Peneroplis pertusus*. Only 10 individuals were found in the abundant material I could study, and all showed to be of a single megalospheric generation, with a proloculus of about 56 μ diameter.

In the case, that the new species is shown by later investigators to be nothing else than *Peneroplis pertusus*, this diameter of the proloculus belongs to the form with smaller megalospheric proloculus, which is, as I have pointed out in my Siboga-paper, as an exception, the A_2-form.

But this A_2-form in *Peneroplis pertusus* always shows a complex aperture, while the A_1-form is that with simple aperture. The new species, with small megalospheric proloculus, however, shows invariably in the 10 specimens

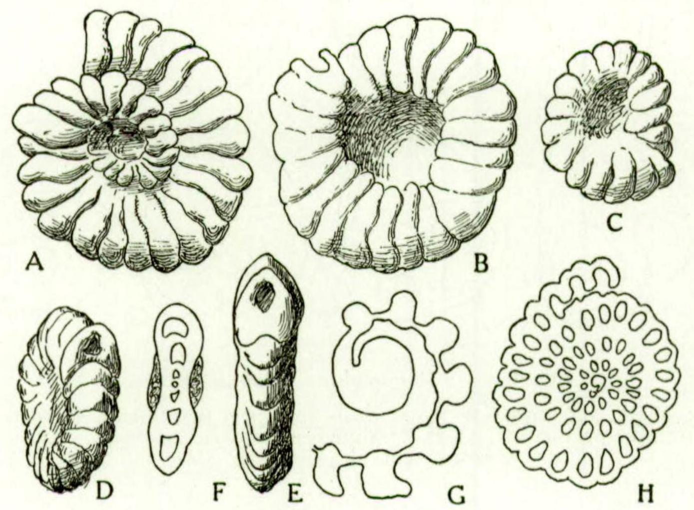


FIG. 19. — *Peneroplis senoniensis* n. sp.

A, B, C : several shells; D, E : apertural faces; F : transverse section; H : longitudinal section. ×40. — G : longitudinal section of first chambers. ×240.

observed, an aperture of the simple feature. It is therefore, that I was in some ways authorised to create a new species, as, in any case, the genus *Peneroplis* was up to this day only very doubtfully known from the Cretaceous.

The largest specimen of *P. senoniensis* measured 0,875 mm in diameter, most of them are smaller, the smallest diameter 0,5 mm. The number of the chambers of the last coil is very large in comparison with *Peneroplis pertusus*. For the largest number there is 18, while that in *P. senoniensis* varies from 18 to 24. In most specimens the chambers of the last coil overlap those of the former, leaving free a wide umbilucus. The aperture of the last chamber is an oval opening in the ventral part of the chamberwall. In some cases the aperture shows the tendency to become triangular in shape.

The first chamber is that of typical *Peneroplis*, a round chamber provided with a thin neck. The chambers communicate with each other by means of a foramen at the umbilical side of the chambers. Four coils of chambers are formed, they increase but slightly in size. The shell is flat with a sunken umbilicus on both sides, the chambers form a flat spiral. Walls between the chambers are thick, those between the coils too, just as in the case of *Peneroplis pertusus* in the A_1-form.

No microspheric specimen was obtained, so that the erection of this new species must be regarded with some doubt. Transverse sections do not show the thick umbilical secundary chalk masses, as are found in the A_2-form of *Peneroplis pertusus*. The umbilicus shows thin walls. Here too possibly lies a characteristic of this new species.

SHORT CHARACTERISTICS OF THE SPECIES *Peneroplis senoniensis* :

Rare in the Senonian of Maestricht and surroundings; shells flat and round, with somewhat protruding chamberwalls, chambers numerous, closed-coiled, overlapping a part of the former coils at both sides. Coils planispiral, aperture an oval or somewhat triangular opening at the umbilical part of the front wall on the last chamber. Margin rounded. Umbilicus on both sides. First chamber of megalospheric form about 56 μ diameter, provided with neck-chamber. In fullgrown specimens with a diameter of about 0,975 mm, the number of chambers of the last coil reaches up to 24.

This species was erroneously mentioned by VISSER (Natuurhist. Maandblad, Vol. 26, 1937, p. 88), as « *Operculina* spec. indet. ».

Orbitoides faujasi DEFRANCE.

In my publication on the Foraminifera of the Senonian of Limburg (Natuurhistorisch Maandblad, 1926, n° 4, pp. 38-42) I dealt with remarkable species. In the same periodical (1926, n° 7, pp. 79-80) I gave an additional note on the latter.

In the meantime several authors have published on what they believed to be the same species, though in many cases from very different localities, and they do not agree with my visions about the species.

As it is always possible that the view of an author is wrong, since he was dealing with a somewhat restricted material, I was obliged to study the species again and to look over a new material in respect of the views of other authorities in the subject.

SCHIJFSMA, who studied material from the Hervian levels of the same region, found in his material four distinct species [E. SCHIJFSMA, Foraminifera from the Hervian (Campanian) of southern Limburg; Thesis Leiden, 1946]. In this thesis all the literature between 1926 and now also has been analysed.

So I studied a very large material, belonging to the « Musée d'Histoire Naturelle de Belgique ». The total number of individuals studied amounted to about 1500.

According to SCHLUMBERGER (*Première note sur les Orbitoides;* Bull. de la Soc. de Géol. de France, 4e série, I, pp. 459-467, pl. VII-IX, 1901) in Maestricht at least two different species occur, *Orbitoides apiculata* SCHLUMBERGER and *Orbitoides minor* SCHLUMBERGER. Later authors have added some complexity in nomenclature by creating a different genus *Lepidorbitoides*, whereas the latter species now is called *Lepidorbitoides minor* (SCHLUMBERGER).

SCHIJFSMA distinguishes in his Hervian material four species, viz. *Orbitoides media* (D'ARCHIAC), *Orbitoides apiculata* SCHLUMBERGER, *Lepidorbitoides minor* (SCHLUMBERGER) and *Lepidorbitoides socialis* (LEYMERIE). Mentioning my figures from my publication of 1926 he concludes : « The drawings HOFKER has given are not satisfying. So according to plate I, p. 39, in my opinion we can attribute the fig. 7, 8 and 10 to the species *Orbitoides media*, fig. 1 and 2 to *Lepidorbitoides minor* and fig. 3-6 and 9 to *Orbitoides apiculata* ». Though I mentioned on p. 42 of that publication, fig. 9 is a section from the individual, figured on fig. 7, yet the fig. 7 is contributed by SCHIJFSMA to *O. media*, while he believes fig. 9 to belong to *O. apiculata*. Both figures however are demonstrating aberrant specimens, belonging to the « Doppelindividuen », described by RHUMBLER; in this way we never can expect them to bear the typical characteristics of the species! Nevertheless SCHIJFSMA (and also other modern authors) are very certain in their declarations about the typical characteristics of the four before mentioned species!

In my additional note, also mentioned by SCHIJFSMA, I pointed out already, that SCHLUMBERGER must have been erronious in his determination of Limburgian Foraminifera. I may add now to this view the fact, that he studied material not only deriving from Maestricht, but also from other, french and italian, localities. So it is very probable, that his « species » may be different from those, occuring in the Senonian chalk. SCHIJFSMA declares, that the species, found by him in the Hervian level, are very common in the Senonian one, especially *L. minor*, and *O. apiculata*. He also notes, that SCHLUMBERGER described *L. socialis*, but that his pl. VI, fig. 6 is in fact an *O. apiculata* and not *L. socialis*!

All these facts lead to the suggestion, that a very great confusion is reigning in this matter, and so I decided to study the Orbitoids, occuring in the Maestrichtian Senonian once again.

Firstly I tried to distinguish in my material, deriving from the Mount St. Pieter, Canne, Sichen, Gronsveld, Bemelen, Keer, Geulhem and collected by several wellknown older authors as BOSQUET, NYST, UBAGHS and F. HERDEREN, the four mentioned « species ».

I based my investigations on the new descriptions, given by SCHIJFSMA, as these are very clear. But I came to a very depressing conclusion : the four species are hardly distinguishable by means of these descriptions. I made the following list of the characters :

	O. media.	*L. minor.*	*L. socialis.*	*O. apiculata.*
Embryonic apparatus megalospheric.	Oval, in four parts.	Globular proluculus, followed by circular chamber, both with thick wall around.	Small spherical proloculus, half surrounded by second chamber, bigger, surrounded both by thick perforated wall.	Thick wall around, 4 parts. 3 chambers in transverse section.
Embryonic apparatus microspheric.	Small chamber, later chambers more or less regular, gradually increasing.	—	—	According to SCHLUMBERGER : first chamber very small, and nearly invisible.
Surface.	Small ribs from centre ramifying to periphery. Small knobs.	Covered with numerous pustules which are regularly dispersed over the entire surface.	Both sides covered with pustules, hardly distinguishable from *L. minor.*	Irregular, frequently ornamented with elongated and vermiform granulations with irregular star on the apex.
Outline.	Circular, housciform, biconvex, thickness about 1/3 of diameter.	Circular, discoidal, thickened in the centre, at both sides (biconvex).	Circular, discoidal, slightly conical in the centre.	Circular, discoidal, planconvex, with projecting knob on the convex side.
Equatorial chambers.	Crescent-shaped circumferences. Each new chamber of a cycle is situated just above the space between two chamberlets of the former row. Two or three lateral pores. Horizontally subdivided ?	Much smaller than in *apiculata*; they keep the same height.	Arranged in many cycli.	Divided towards the circumference, outline. such as in *media*. Subdivided as they reach the surface, but this cannot always be observed.
Lateral chambers.	Very flattened.	Very numerous. Flattened.	Very flattened. Regularly situated above each other and somewhat higher than in *minor*.	Very numerous and flattened.
Pillars.	From periphery to centre condense in such a way that the lateral chambers almost disappear.	Numerous in the whole transverse section. They cause the pustules on the surface.	—	Numerous pillars, which meet each other in the centre, forming a compact mass.
Diameter.	10-50 (?) mm.	5-6 mm.	10-16 mm.	10 mm.

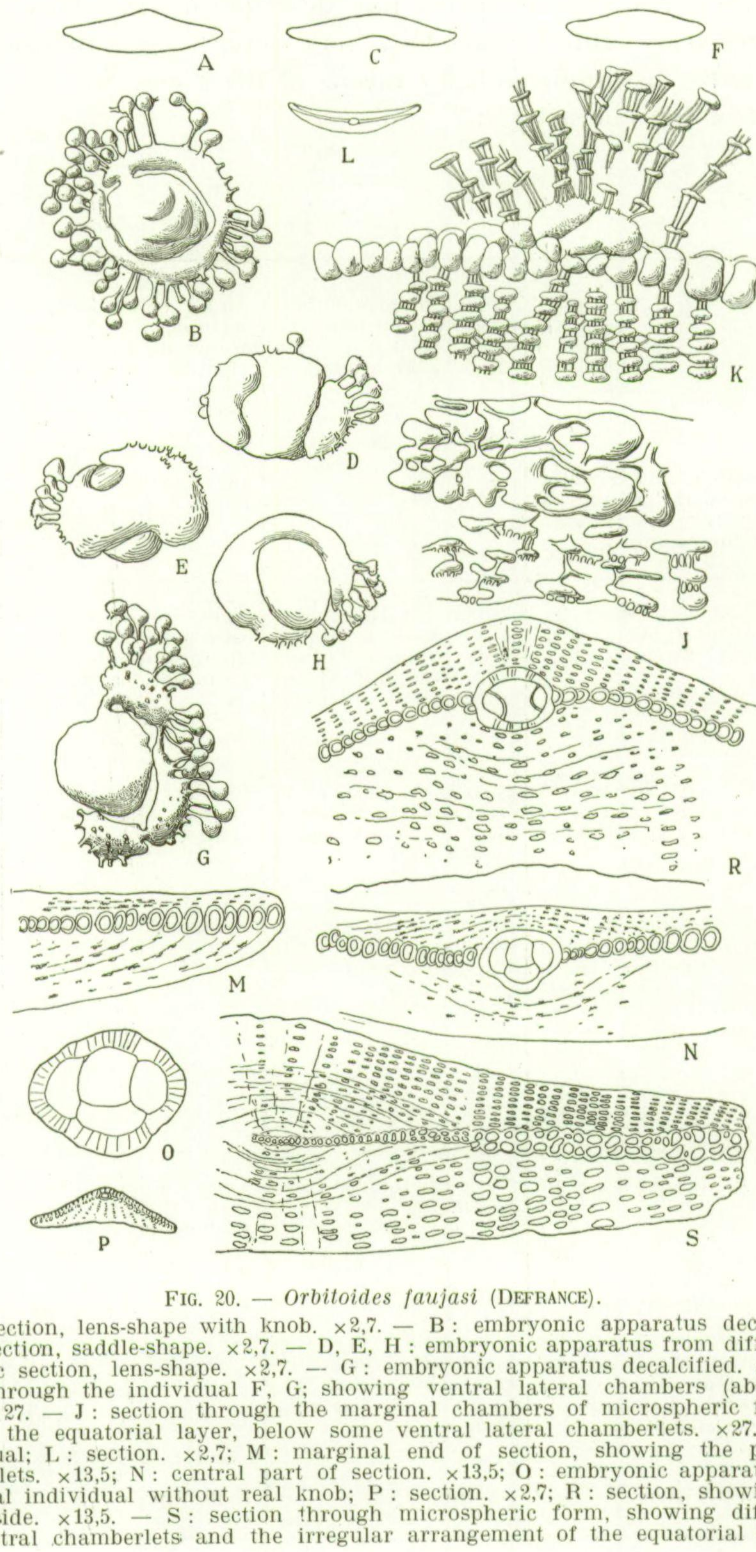


FIG. 20. — *Orbitoides faujasi* (DEFRANCE).

A : schematic section, lens-shape with knob. ×2,7. — B : embryonic apparatus decalcified. ×27. — C : schematic section, saddle-shape. ×2,7. — D, E, H : embryonic apparatus from different sides. ×27. — F : schematic section, lens-shape. ×2,7. — G : embryonic apparatus decalcified. ×27. — K : decalcified section through the individual F, G; showing ventral lateral chambers (above) and dorsal ones (below). ×27. — J : section through the marginal chambers of microspheric form, tangential, showing above the equatorial layer, below some ventral lateral chamberlets. ×27. — L-O : saddle-shaped individual; L : section. ×2,7; M : marginal end of section, showing the poorly developed dorsal chamberlets. ×13,5; N : central part of section. ×13,5; O : embryonic apparatus, section. ×27. — P, R : conical individual without real knob; P : section. ×2,7; R : section, showing largely developed ventral side. ×13,5. — S : section through microspheric form, showing difference between dorsal and ventral chamberlets and the irregular arrangement of the equatorial chambers. ×13,5.

Considering this list of characters of the four so called species of *Orbitoides* from Maestricht, one easily finds that the megalospheric apparatus in all species is surrounded by a thick wall (as is the case in much more species of Foraminifera), but that the apparatus of *media* and *apiculata* consists of four parts, while that of *minor* and *socialis* is divided in two parts.

Microspheric forms have been found in *apiculata* and *media* (according to SCHLUMBERGER and DOUVILLÉ, but from quite different localities, and in *media* in a size of about 50 mm, which large specimens have never been found in the Maestrichtian chalk). No microspheric specimens are known from the « species » *minor* and *socialis*. As I have pointed out already in my Siboga reports, a species should not be established only on megalospheric forms, as these forms only shows a part of the features, belonging to the species. Bearing this in mind, one has to discard those two species *minor* and *socialis*.

The surface-characters of *media* are somewhat doubtful. The crossing « sillons », the irregular pores on the surface, etc., from the type-description (see the description by SCHIJFSMA) do not refer to any species of *Orbitoides*, but are very remarkable features of *Omphalocyclus macroporus* (LAMARCK), the other frequent larger Foramiferum of Maestricht. The older authors have thrown together these two species, and even the mentioning of the fact, by D'ORBIGNY, that often the specimens split into two halves, is a typical feature of *Sporadotrema*. I never observed any « ribs on the surface » in *Orbitoides* from Maestricht. Only the apical knob, formed by a star of protruding pillars in *apiculata*, is worth mentioning as a characteristic, as in all forms the surface is covered more or less in a very varying manner, by pustules, also formed by the ends of the pillars.

The outline is discoidal in *media* and in *minor*, probable also in *socialis*. Only in *apiculata* the shell is plan-convex, with projecting knob.

The equatorial chambers are « subdivisées vers la circonférence » in *apiculata*, but this phenomenon cannot always be observed; in *minor* they are much smaller than in *apiculata*, and do not widen towards the outline, as they do in *apiculata*. That they are arranged in many cycli, as is mentioned for *socialis*, may also be reported for the other species. The description of the pores and the shape of these chambers for the species *media* is also applicable for the other species. In *media* it was observed, that the later equatorial chambers also subdivide. This may have been the case in the microspheric individuals in the material of SCHLUMBERGER; but this was obviously quite a different species.

The lateral chambers cannot be used as characteristic, for they are very superficially described in the publications, even in my own one, as I know now. They are, in all four species, much flattened, somewhat larger in *socialis*.

The pillars form a compact mass in the centre of *apiculata* and are very richly distributed in *media*, in such a way, that the lateral chambers almost disappear.

The diameters of *media, apiculata* and of *socialis* are nearly the same; no statistical investigations have stated their average diameter. Only that of *minor* is much smaller, as it is said to be 5-6 mm.

When studying the material at hand which, as already mentioned above, was a very large one, I could with the above-mentioned characters of the four species, arrange the different specimens into those four species with much difficulty.

Firstly I tried to separate them into those with a central knob, and those without such a knob, as this characteristic is a very peculiar one. So I selected from the material all typical specimens with knob and with more or less conical shape, viz. 249 specimens, and I mesured the diameters. These were arranged in sets of 1 mm difference, the smaller ones beginning with 3-4 mm, the larger ones ending with 15-16 mm. As it will be shown afterwards that those with a diameter from 11-12 up to 15-16 mm are invariably microspheric, only those up to 11 mm were taken into consideration, thus avoiding a curve with two tops.

The results were as follows :

3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	diameter in mm.
4	16	42	62	40	31	19	13	number of individ.

In quite the same manner I proceeded with those individuals, which could undoubtedly be placed in the range of individuals without central knob, thus apparently combining the species *media* and *socialis* (Schijfsma pointed out already, that he could not very well distinguish these two species). The results were :

1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	diameter in mm.
8	29	36	44	68	35	9	2	number of individ.

When considering the curves made with these results, we may easily find out that these two curves, superposed on each other, show the remarkable fact, that their tops differ only one mm, and that the curve from the individuals with knob shows the tendency to flatten at the right, that from the individuals without any knob, to flatten at the left side. This phenomenon leads us to the supposition, that those two curves are complementary to each other, that they belong to the same species in other words. The statistical analysis adds some points to this supposition.

The avarage of the variation of the specimens with a single knob is $6{,}5 \pm 1{,}66$, so ranging between 4,84 and 8,16 mm.

The avarage of the variation of the specimens without a knob is $5{,}5 \pm 1{,}26$, so ranging between 4,24 and 6,76.

In this way we can state also, that in reality these two « species » show a difference of diameter of only a single mm, while their variation is an overlapping one. In this way the diameter is of no use to distinguish these two so-called species.

In the material we also may separate the following forms on outer characteristics :

1. specimens conical, with a knob on the convex side, the other side flattened (*apiculata*).
2. specimens somewhat conical, with a knob on one of the sides, the other side convex, but without knob (*socialis*).
3. specimens lens-shaped. No knobs on either side (*media*).
4. specimens more or less saddle-shaped, mostly very thin towards the circumference (probably *minor*).

These four groups were also measured and grouped for statistical purpose. The results were as follows :

1.

3-4	4-5	5-6	5-7	7-8	8-9	9-10	diameter in mm.
1	6	15	37	20	13	8	number of specimens.

The average diameter is 6,1 ± 1,35.

2.

2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	diameter in mm.
1	5	25	40	56	59	31	7	5	number of specimens.

The average diameter is 6,22 ± 1,14.

3.

1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	diameter in mm.
12	22	43	57	81	69	36	9	5	number of specimens.

The average diameter is 5,3 ± 1,4.

4.

3-4	4-5	5-6	6-7	7-8	8-9	9-10	diameter in mm.
1	14	26	36	14	7	1	numbers of specimens.

The average diameter is 6,1 ± 1,135.

The curves of these four forms are overlapping throughout. The lens-shaped shells shows the lesser diameter, ranging form 3,9 to 6,7, while the largest one, the convex conical one, shows a ranging from 5,06 to 7,46. The tops of the curves of 1 and 4 are the same, that of 2 lies 1 mm further on, that of 3,1 mm back. So the diameter can not be used in either way as a character.

The individuals, either belonging to 1 or 2, with knob on one side, and with a diameter larger than 11 mm, showed all to be microspheric. As the flat ventral side and the convex one occur in this specimens from both forms which statistically are not distinguishable, neither in respect of the diameter, nor in respect of the features of the surface, it is without doubt that 1 and 2 form a single species, somewhat varying in respect to the development of the ventral side. All transitional forms between these two forms can be found in the same material.

From the two other forms, 3 and 4, no specimens larger than 11 mm could be found. It could be suggested, that these forms have type 1 or 2 as microspheric forms. In the material from the Museum in Leiden no specimens have been found belonging to these forms, being microspheric.

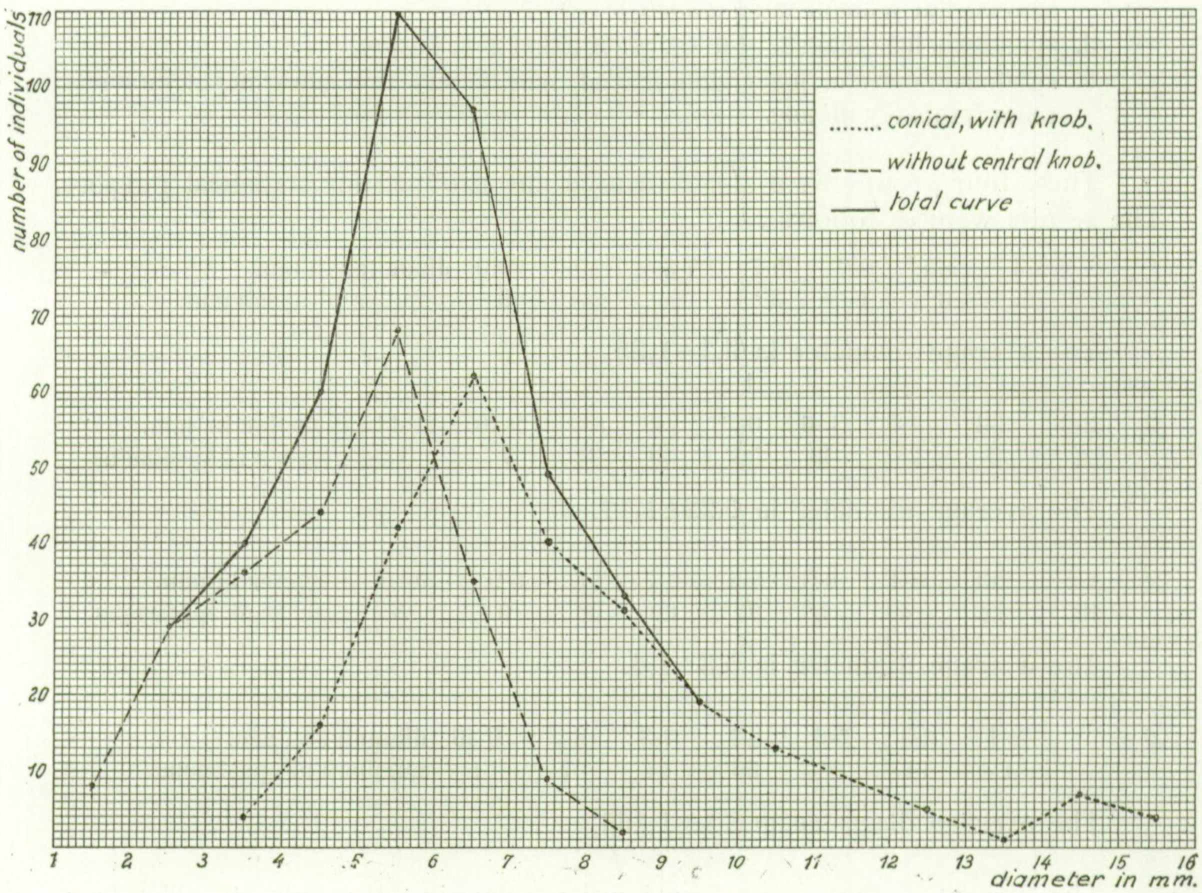


FIG. 21. — *Orbitoides faujasi* (DEFRANCE).

Statistical results of measuring diameters of shells with central knob and conical shape (*apiculata* + *socialis*) and those without central knob (*minor* and *media*).

We will now deal with the inner features of these four forms. As I mentioned already in my former paper on the matter (1926), in material of *Orbitoides* from Maestricht one always finds some abarrant specimens, which are irregularly grown out and show to be polynuclear forms. They must not be considered in a specific investigation.

1. Conical, with flat ventral side.

Some individuals are microspheric, the apparatus has been fully described and figured in my previous work.

Most of them are megalospheric. First chamber very large, second chamber in sections mostly twice sectioned, as it surrounds the first chamber; but it does not surround the first chamber totally, one of the sides of the first chamber being naked. Wall of the apparatus very thick. The apparatus is always found in the dorsal half of the shell, very near to the dorsal surface, and beneath the knob.

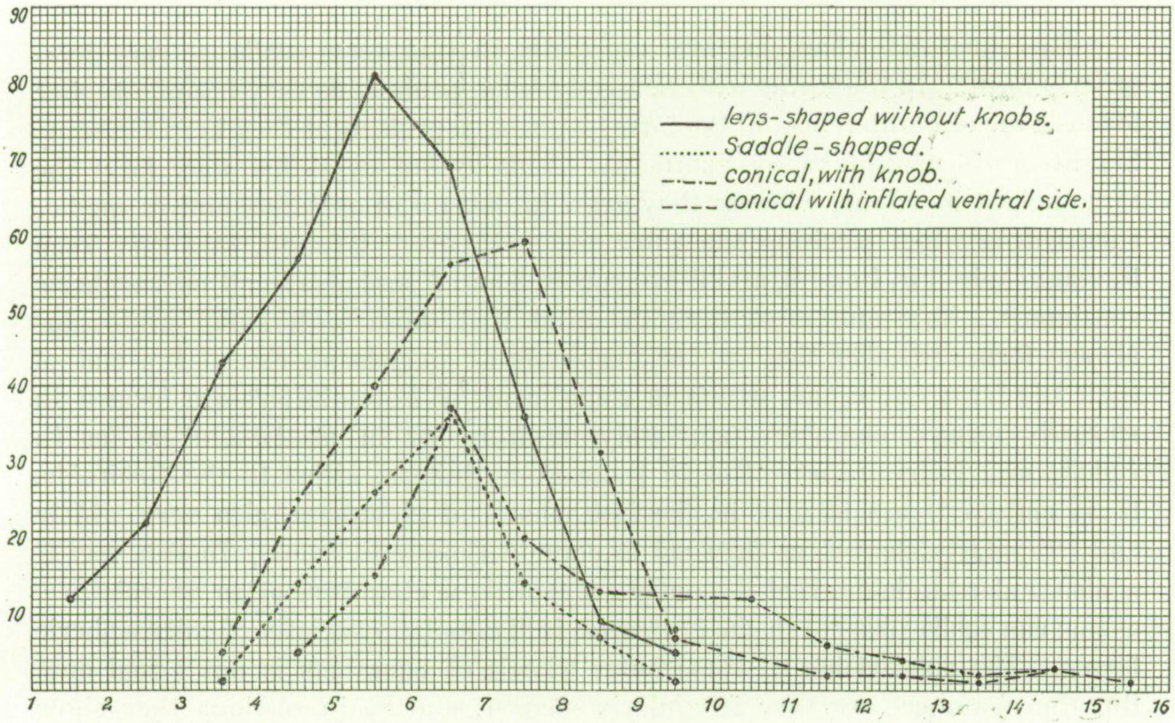


FIG. 22. — *Orbitoides faujasi* (DEFRANCE).

Statistic results of measuring diameters of the four « species » of *Orbitoides*, now taken as those individuals with lens-shape, those with saddle-shape, those with flat ventral side and knob, and those with knob and inflated ventral side. Here too the results show no distinct differences in diameter. Diameters of 11-16 mm. invariably are microspheric.

2. Conical specimens, but with a convex ventral side.

The first chamber is very large, the second chamber nearly totally surrounding the first one, but in a single plane, so that this second chamber is sausage-like. All stages between these forms 1 and 2 may be found up.

3. Lens-shaped specimens, without distinct knob on either side.

First chamber not so large as in the previous forms, followed by three elongated chambers, which chambers communicate with the following equatorial ones, as is the case with the sausage-like chamber in the former form. As one of these secondary chambers mostly lies inderneath the proloculus, transverse sections often show four separate chambers in the apparatus. Small specimens of this form may also belong to form 2, being young shells of this form.

4. Saddle-shaped forms.

First chamber always relatively small, followed always by three other chambers in the apparatus. Wall around the apparatus slightly thinner than in the other forms.

The equatorial chambers are, especially in transverse sections, very irregularly built. In the forms with relatively small proloculus they become higher towards the circumference, in the forms with large proloculus they keep the same height, as is mentioned by Schijfsma. This author says that they keep the same height in *minor*, whereas they grow higher up in *apiculata* and in *media*, subdividing when reaching the outer circumference. I found, that they keep the same height in 1 and 2, and they grow in 3 and 4, and also in all microspheric specimens. Now one must bear in mind that those with small proloculus always form, whether they are microspheric or megalospheric, at the end of their life large embryons, which in some forms of Foraminifera are formed in specially formed chambers (e.g. *Polymorphina*) or in *mud-chambers* (as in *Rotalia* and *Pulvinulina*). But in those Foraminifera, allied to the *Orbitoids*, these embryons are formed in the last whorls of chambers, also very widely and irregularly shaped, as they are to contain those embryons. In this way it is also understandable, that the outer walls of these chambers often are missing, as one can easily observe in the outgrown individuals, especially of microspheric forms. The subdivision of these outer whorls of chambers is not a real one. But the chambers are very irregularly shaped, and so in sections they show something like a subdivision.

Since the form 1 and 2 with large proloculus, and in this regard with equatorial chambers which do not increase towards the circumference (as the form with large proloculus, Forma A_2, forms gametes, which are always very small, and do not need much space) it is an additional reason to look at them as belonging to the same species as the forms 3 and 4 with smaller proloculus (forma A_1) which form embryons and need space in their last whorls of equatorial chambers. The forming of these embryons has been traced in living forms of some equally built species by Rhumbler.

Now the forms 1 and 2 show some features of the « species » of Schijfsma and others, *socialis* and *apiculata*, probably also of *media*. This species however shows, according to Schijfsma, equatorial chambers growing bigger towards the circumference!

On the other hand I meant to determine the forms 3 and 4, those with smaller first chamber and adequally with chambers, growing larger towards the periphery, as *media* and *minor*. But they show chambers increasing in contents towards the periphery, whereas SCHIJFSMA assures us, that they keep the same height!

But there is another very remarkable characteristic in all four forms, which has not yet been mentioned by any author, and which I only could find with this new method of grinding and filling up. This feature is the shape of the lateral chambers.

In the descriptions, given by various authors, the lateral chambers are described as very flattened. When studying normal sections of the shells, one easily finds that these chambers often give the impression as having been reduced by the abundancy of chalk-material interposed between them. This, however, cannot be the case, as the shape of those chambers has been formed at their building the surface of the young shell and the gradual increase of the shell is due to their building. Between them is intercallated the chalk-substance which forms thickened layers on the surface, thus adding a layer to the shell at each impulse of growth. But this impulse always begun with the growth of a new layer of lateral chambers. There are no indications as to the forming of chalk in the lumen of the chambers afterwards.

Now SCHIJFSMA and others have mentioned the fact that in the different so-called species the height of the lateral chambers is not always the same. Especially in *L. socialis* the lateral chambers were supposed to be somewhat heigher than in the other three species and more regularly situated above each other.

I studied those chambers on sections with the new impregnating-method. I found, that in all forms or species they show much the same aspect and yet I can understand, that in one section an author may have been inclined to consider them as higher and more regularly distributed chambers than in another section. In all cases the lateral chambers can be distinguished in two different sets, the dorsal and the ventral one. For all individuals, even the regularly built lens-shaped ones, show in transverse section a very peculiar difference between the dorsal and the ventral side. In the forms with a single knob these sides can be distinguished easily. The dorsal one is that with the knob. I called this side the dorsal one; for the fact lies here that most of the individuals, found in the thin layers of bryozoic chalk, are situated there with their knob above. So I am inclined to consider these individuals as having expired on the same place, as they are found in the chalk, so that, when living, they obviously were creeping on the bottom of the corral-see, flattened side down. But not only the typical conical specimens show this difference between the two sides, even the lens-shaped and saddle-shaped forms always show, invariably, the difference of these two sides, but now only when sectioned. As no other Orbitoids are known with this peculiar phenomenon, I believe it a very good and real characteristic of the species. But it is a characteristic which can be found in all the forms or so-called species of the Maestrichtian chalk.

This character may be described as follows.

On the dorsal side the lateral chambers are situated in regular rows, stretching from the equatorial chambers towards the surface. The rows are somewhat radiating just above the embryonic apparatus, thus giving space to chalk pillars which fill up the spaces. This is especially the case in the microspheric forms and in the forms with dorsal knob, being megalospheric.

These lateral chambers at the dorsal side are narrow and relatively small, their proportion between height and breadth being as 9:20 in average. They are connected with those of a following and a former layer by means of rough pores which in most cases are two or three times longer than the height of the chambers. With the chambers of the same layer they are connected by means of somewhat thicker foramina, each chamber having four or five of them.

On the ventral side the lateral chambers are much larger then those on the dorsal one. In some cases they can be situated in rows radiating from the equatorial chambers towards the periphery, but in most cases, especially near the circumference of the shell, they are arranged more irregularly. In this way the forming of pillars between rows of chambers is in all cases restricted to the centre, whereas near the circumference real pillars were never found. These chambers from the ventral side are much more flattened than those on the dorsal one, as their breadth in much larger. The proportion between height and breadth in the ventral chambers is about as 10:33 in average.

In all cases we must consider the fact that larger equatorial chambers give rise to larger lateral ones.

The ventral chambers, irregularly situated, also are connected with those of former and following rows by means of coarse pores, but they also are connected with them by irregular somewhat larger foramina, thus building an irregular network of chambers and tubes.

I am inclined to believe, that this difference between dorsal and ventral lateral chambers caused the somewhat queer entanglement in which some authors have arrived when taking them as a species-characteristic.

Once again we have shown, that the so-called different species in the chalk of Maestricht show a remarkable resemblance in respect to their lateral chambers.

In most cases studied, the ventral side is thicker than the dorsal one. This characteristic is due to the thicker walls of the ventral chambers, and to the fact, that the layers of chalk in the ventral side are thicker than on the dorsal one. In consequence the chambers in the ventral side are separated from those of the following and former layers by more chalk than on the dorsal side, and in this way the ventral side in many individuals is more bulky than the dorsal one. In many individuals the embryonic apparatus thus is situated nearer to the dorsal surface, a fact which without doubt is due to the peculiar life of the species. For either they lived attached on the surface of weeds or Bryozoes, or they were creeping along them, mostly situated ventral side down. A different outgrowth, with more chance to grow bulkier for the ventral side in this way was worked on by the gravitation.

No canal system other than that, formed by the pores and the foramina between the chambers, was found.

This study of *Orbitoides* of the chalk of Maestricht leads us to the conclusion, that in the Senonian layers of Maestricht and surroundings only a single species occurs which is, however, somewhat variably shaped. This fact is not very astonishing, as most species of Foraminifera show variable characteristics. This variability is due to several causes. Firstly there is the different way, in which the specimens of a species may breed. Just as it is the case in many other unicellular species, here sexual and asexual generations occur. Just as it is the case in many other unicellular organisms, a clone of individuals rising to sexual propagation differs in habits and characteristics from those individuals who stay at the beginning of that clone. Here the asexual clones are known as the B-form and the A_1-form, while the sexual one is named by me the A_2-form. Even in forms allied with *Orbitoides*, Rhumbler and others have found the propagation of megalospheric individuals by means of megalospheric embryons. In several cases I found that the embryons formed by megalospheric forms give rise to individuals with a somewhat larger proloculus than the parents had. So, individuals with larger proloculus derive from megalospheric parents, while we know too, that the microspheric form derives from a megalospheric parent with very large proloculus. But the different circumstances, in which the three just-mentioned forms have arisen, may give rise to somewhat different characteristics.

In our case the individuals with the smaller megalospheric proloculus show the saddle-type or the lens-shape, bearing no knobs, due to the wider radiation of the dorsal lateral chambers. These individuals, which are in no other respect different from the other forms, but for the arrangement of those radiating rows of the dorsal chambers, and therefore in the forming of chalk-substance between these radiations, and who may also have had sowewhat different life, for instance in respect to another osmotic relation with the outer world, cannot be separated from the other forms, as they do not show characteristics, differing enough from them, to base on them specifical difference, as I showed statistically.

The individuals with a somewhat larger megalospheric proloculus are those with a knob and a more or less conical habitus. They can be separated into two sets of forms, the one with a flat ventral side, the other with a somewhat bulky one. But this difference is no specific one, as it merely is due to the somewhat more bulky outgrowth of the lateral chambers and a somewhat more thickening of the layers of chalk between. These characteristics may be due to a somewhat altered osmotic behavior of the protoplasm, due to the fact, that those forms always generate from megalospheric parents, and in that case may the different relation between the protoplasms and the nucleal substance throw some weight in the scales.

To these considerations we may add the occurrence of only one microspheric form. This form too shows the characteristics of the species.

Description of the species of *Orbitoides* from the chalk of Maestricht :

Microspheric form (B-form). Shells are very flattened, discoidal, with a distinct central knob on the dorsal side, which is more or less star-shaped. Fine pustules of protruding chalk are visible on the dorsal side. The mostly flattened ventral side shows very fine granulations and in most cases shows a slight umbilicus in the centre. Individuals with a diameter up to 15 mm. Proluculus small, followed by a spiral of equatorial chambers; afterwards the chambers are growing losenge-shaped. The central equatorial chambers narrow, becoming gradually higher towards the periphery and becoming very irregular towards the circumference. Here they form mostly two layers but they are not subdivided into chamberlets, as some authors suggest. Most of the equatorial chambers in the peripherical zone are connected with one another by means of six and even more foramina. The circumferantial chambers often lack the outer wall, due to sporulation. Ventral chambers differing from the dorsal ones in breadth, height and in situation, the dorsal chambers always lying in rows radiating tot he dorsal side of the shell, the ventral ones situated more irregularly.

Megalospheric form with somewhat smaller proloculus. Shells lacking central knob, being lens-shaped or saddle-shaped. The surface is covered with fine pustules of chalk, the protruding pillars which never are so strongly built as to form a central knob. Proloculus situated more nearly to the dorsal side of the shell in most cases. The layer of equatorial chambers in this way is more or less roof-formed. The embryonic apparatus consists of four chambers, the proloculus, which is relatively small, followed by three other chambers, surrounded together by a thick wall. These four chambers are connected with the outer world by means of two kinds of openings in the thick walls : the first chamber only by means of pores, the other three also by means of numerous foramina, by which they are connected with the equatorial chambers, which radiate from them. These first rows of equatorial chambers are somewhat raisin-shaped, the further rows show the losenge arrangement. Towards the periphery the equatorial chambers increase in height, but they never become irregularly shaped, as in the B-form. The higher height is due to the giving rise to embryons of the following form. All transitorial forms between this A_1-form and the A_2-form may be traced in the material. Diameter of the shells from 2 to 11 mm.

Megalospheric form with somewhat larger proloculus. Shells mostly with a protruding central knob on the dorsal side which in many cases is not due to a very great development of chalk-pillars, but to the fact, that the large embryonic apparatus is situated under the dorsal surface. In some shells the ventral side is flat or even umbilical, in other cases the ventral side is somewhat bulky. This variation shows all transitorial characteristics. The large proloculus, which in many cases is flattened, is surrounded by a sausage-shaped second chamber which surrounds the first chamber nearly totally. This second chamber shows in its wall the many foramina giving rise to the first row of equatorial chambers. These chambers show the lozenge arrangement, but they do not very much increase in height towards the periphery. This fact is due to the other kind of generation in this form, by means of smal spores which copulate afterwards and give rise to the microspheric proloculus. In both A_1 and A_2-forms the lateral chambers of the dorsal side differ in size and in arrangement from those in the ventral side, as has been described already in the B-form. Diameter of the shells from 3 till 11 mm., larger ones, having the same outer characteristics, being always microspheric.

NOMENCLATURE :

In his dissertation SCHIJFSMA fulminates against my views on the nomenclature of the Maestrichtian species in the following words :

« In his « Die Foraminiferen aus dem Senon Limburgens », part 5, a description of new forms of *Amphistegina fleuriausi*, HOFKER (1926, pp. 79, 80) gave a remark by way of an « erratum » which can be considered as a supplement of his part 3, in which he studied *Orbitoides faujasi* DEFRANCE of the Senonian of Limburg. The way in which he comdemned the study of SCHLUMBERGER at least astonished me. He tried to apply his ideas about trimorphism of the Foraminifera also to the Limburgian *Orbitoides*. So it could happen that he united 3 distinct species to *Orbitoides faujasi* DEFRANCE. He considered *Lepidorbitoides minor* (SCHLUMBERGER) as an *Orbitoides faujasi* DEFRANCE, *forma* B, that is the « smaller » megalospheric generation. *Orbitoides apiculata* SCHLUMBERGER he subdivided in *forma* A (the « larger » megalospheric form) and forma C (the microspheric generation) of *Orbitoides faujasi*. In his synonymy for *Orbitoides faujasi* DEFRANCE, page 30), HOFKER mentions *Orbitoides minor* (D'ARCHIAC).

» Although SCHLUMBERGER (1901) described circumstantially in pp. 460-462, 464 that the species-name « *faujasi* » had to be abandoned, HOFKER however ignored this conclusion for in his above-mentioned « erratum » he still used the wrong name of *Orbitoides faujasi* DEFRANCE. Instead of contributing a study, having in view the elimination of the entanglement in the extensive literature concerning the Orbitoids, he just contributed to a still greater confusion, as is testified recently by VAN RAADSHOVEN (1940). »

I have stated in this paper, that in the chalk of Maestricht only a single species can be found, and that the confusion lays on the side of those authors, who consider forms which cannot, statistically nor characteristically, be separated from each other as different species.

Schlumberger, Douvillé and even other authors have very accurately described species from different localities, and the only mistake some of them have made is, that, apparently basing their knowledge of the Maestrichtian form on poor material, they concluded that this Maestrichtian species was the same, as that which they just had described. But even the fact, that Douvillé described a species with a diameter up to 50 mm. (!) as *O. media*, makes it obvious, that our species from Limburg is no *O. media*.

The same can be said of the descriptions by Schlumberger. I mentioned the fact already, that in his figures on *L. apiculata* he entangled himself in the nomenclature of the figure. Then, the type-description of *O. media* does not refer to any *Orbitoides*, but to *Sporadotrema*.

So in 1926 I came to the conclusion, that the different authors, who described the species of Maestricht, did not describe this species at all, but several different ones. Only one author, d'Orbigny, may have dealt with the real *Orbitoides* from Maestricht without knowledge of other species and entangling them with our species. So I mentioned his *O. media* in the synonymy of the species in 1926.

The species-name *Lycophris faujasi* by Defrance however, altered in *Orbitoides faujasi* Defrance, was used by all older authors who described or labelled the material in our musea. So I chose this name, as no certainty whatever can be obtained, whether D'Archiac or d'Orbigny dealt with the right species from Maestricht. Reuss certainly dealt with it, and he too used the name of *Orbitoides faujasi* (Defrance). As I did not intend to enlarge the nomenclature of the Foraminifera by a trivial name, I used the name, which was most used by other authors.

So I may conclude this part of my investigations with the wish, that as only one simple species has been traced notwithstanding the contradictional views of other authors, this name *Orbitoides faujasi* (Defrance) may be used further on in literature, as rules of nomenclature cannot be applied in this case.

But is it a real *Orbitoides* ? Cushman (*Foraminifera*, 1928, p. 337) describes the genus as follows :

« Test lenticular, more or less compressed, surface ornamented with vermicular pillars or radiating costae. Embryonic chamber enveloped in a thick shell, at first quadrilocular, later becoming 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 diameter. Communication between the chambers by a few round lateral apertures. Upper cretaceous. »

The genus *Simplorbites* is nothing else as a polyembryonic, abnormal *Orbitoides*, as already is pointed out by several authors, and as it occurs also in the material from Maestricht.

The genus *Lepidorbitoides* has been described as follows :

« Test lenticular, surface papillate. Embryonic chambers bilocular, one much larger than the other and partly embracing it. Equatorial chambers somewhat elongate radially, outer wall curved, in the adult their sides touch and they become hexagonal in form. The communication between the chambers is by cribriform perforations, about 1,5 μ in diameter, over the entire anterior chamberwall, similar to the perforations of the chamber roofs. Pillars between the lateral chambers of pyramidal or conical form, terminating on the surface in granules or rounded pustules. »

The difference between *Orbitoides* and *Lepidorbitoides* seems to be the communication of the chambers. In *Orbitoides* it is by means of foramina, in *Lepidorbitoides* only by means of cribriform pores. Now we know that our form shows in all the forms (or in the so-called species) chambers, which communicate by means of foramina, and that only their roofs show the pores, mentioned in Cushman's description. Neither the shape of pillars, nor that of the embryonic apparatus in the megalospheric form can be used as a generic characteristic, as these different shapes may be found even in a single species, as is proved throughout by several authors.

So it is made clear at once, that the form, occurring in the chalk of Maestricht, cannot belong to any species of the genus *Lepidorbitoides*, so that the species *L. minor* and *L. socialis* cannot be applied to this species of Maestricht, as has been done by several authors.

Conclusion :

In the chalk of Maestricht a single species of *Orbitoides* occurs, named *Orbitoides faujasi* (Defrance). This species is a real *Orbitoides*, showing the characteristics of the genus. It shows three kinds of embryonic apparatus, microspheric, and two megalospheric ones, one with four chambers, the second, with larger proloculus, with only two. This characteristic, otherwise shown to be one of only later occurring *Orbitoids*, here is shown to occur in a single species from the Upper Senonian.

The most remarkable feature of the species, occurring in all three forms, is the difference between the dorsal and the ventral lateral chambers, the dorsal ones situated in rows, te ventral ones situated more irregularly. The ventral ones communicate not only by means of cribriform pores with those in former and higher layers, but also by means of larger tubes.

In his statistic study on the embryonic apparatus of some Foraminifera Cosijn gives some data about *Lepidorbitoides minor* from Maestricht (Leidsche geol. Meded., Vol. XII, 1942, p. 162). He obviously dealt with forma A_2 of *Orbitoides faujasi*, as the proloculus shows a diameter of about 100-113 μ. As I showed in my paper on the species in 1926 that the proloculus varies in diameter as to the generation to which it belongs, it is very probable, that Cosijn met in the different samples with different generations, which is always the case when one gathers specimens in different localities, and therefore came to the conclusion, that the diameter in these samples was not quite the same. The conclusion he takes from his data is not absolutely irrefutable.

Omphalocyclus macroporus (Lamarck).

I described this remarkable species in the year 1926 (Natuurhist. Maandblad, Jg. 15, n° 6, pp. 62-65). I gave further short notes on it my Siboga-report, nr 1, 1927, pages 20-26, in which notes I corrected the name, I first gave to the species, viz. *Sporadotrema errantium*, in *Sporadotrema macroporum* (Lamarck). Lamarck described, when he mentioned *Orbitoides* from Maestricht, in reallity this species, thus giving rise to some entanglement. For the vermiform ridges on the surface belong to this species, not to *Orbitoides*, and it was Bronn, who discovered this error, giving a new name to the species, *Omphalocylus macroporus*. But, as I shall demonstrate again now, dealing with the large material from the « Musée d'Histoire naturelle de Belgique », the species belongs to the same group, in which *Sporadotrema cylindricum* and other species found a place, and so we must consider the species from Maestricht as allied to *Sporadotrema*.

Firstly I will give a statistic outline of the numerous specimens, I was able to study again.

When considering a large material of this species from Maestricht and other localities of the same level (Upper Senonian), an author, eager to fabricate « species » would certainly erect three of them. Most of the individuals show a rounded shell, as is described in my former paper, covered with lozenge-ridges on both sides, thin in the centre, but growing rapidly thicker unto the periphery. The margin of the shell in those specimens is somewhat rounded. At this margin one may find two lines of large openings in the wall, separated by a row of round pustules, while at the dorsal and ventral side of those openings also a row of pustules is found up. In the rounding dorsal and ventral side of the margin a row of smaller pores is found, intermitting with those on the margin itself.

A second form shows much stouter shells, larger and thicker, with a margin abruptly ending, so that the total of the shell may be compared with a draught-stone. Four rows of large pores are found in this margin, two of them on the dorsal side, and two on the ventral, and these two rows are alternating with those on the dorsal side. Between the two sets of rows of openings thickenings of the wall are visible, thus forming a kind of wicker-work. I was inclined first, to consider these forms to be the microspheric generation, as I mentioned it in my paper in 1927. But in this paper I mentioned too, that the proloculus showed a diameter of about 60 μ, which is too large for a microspheric proloculus.

The third form shows much smaller shells than those of the two beforementioned ones. They are thin discs, not growing thicker towards the pery-phery and showing only slightly raised ridges on the surface of the shell. At the margin one may find only one row of large openings in the midst of the margin, bordered by two rows of pustules. Alternating with these large openings two rows of smaller openings are found at the dorsal and ventral side of the margin.

Among hundreds of specimens five or six individuals were found with irregularly built shells, forming partial discs from the centre of the shell, and projecting from it with a mostly sharp angle. These individuals showed to be polyembryonic, as they are found too in the genus *Orbitoides* and in other disc-building Foraminifera.

In a total number of 652 individuals I found :

thin form :

Diameter in mm :	1-2	2-3	3-4	4-5	5-6	6-7	
Individuals :	1	16	73	68	35	8	total : 201; average diam. : 4,2±0,9 mm.

stout form with rounded margin :

Diameter in mm :	2-3	3-4	4-5	5-6	6-7	7-8	
Individuals :	5	36	78	81	37	5	total : 220; average diam. : 5,01±1,14 mm.

stout form with abrupt margin :

Diameter in mm :	3-4	4-5	5-6	6-7	7-8	
Individuals	3	25	39	31	15	total : 113; average diam. : 5,83±1,95 mm.

In this way one discovers, that the thin form shows a top somewhat at 4, the two stout ones at about 5,5 mm. So the thin and the stout forms may be distinct from each other, the two stout forms not.

This fact gives some reason to consider the two stout forms as only a single form, which was proved on sections, made with my new method. They are one and the same in structure, only those with blunt margin are outgrown specimens of the other form.

The curve, made of all 652 individuals however shows only a single top :

Diameter in mm :	1-2	2-3	3-4	4-5	5-6	6-7	7-8	
Individuals :	1	21	109	271	155	76	20	total : 652; average diam. : 4,8±1,95 mm.

So here we deal with a species, in which the two forms of megalospheric generation show a curve with only a single top. In this way we are authorized to call those three groups, showing only slight differences in outer features, only a single species. As will be shown afterwards, the inner structure leads to the same conclusion.

I studied more than 1.000 individuals, bearing the characteristics of the species called by older authors *Orbitolites macroporus*, but I never met with a single microspheric individual, those mentioned in my paper from 1926 being nothing else than the megalospheric form with small proloculus.

So I came to the conclusion, that this microspheric form must be of a total different character, thus escaping those people, who selected the species from the rough material or would be absent.

This, yet hypothetical microspheric form could not be found up in the material of the « Musée d'Histoire naturelle de Belgique ».

Yet it is a remarkable fact, that in *Orbitolites vertebralis* (Quoy et Gaimard) the proloculus of the microspheric form, which shows the general characteristics of *Orbitolites* and not of *Sporadotrema*, possesses a diameter of only 15 μ. So it is quite probable, that *Orbitolites macroporus* too has a disc-like microspheric form, which, however, must be very rare, if at all existing.

Description of the form with small megalospheric proloculus :

As I mentioned already in my paper dealing with the subject in 1926, the shell begins with a relatively small proloculus, described then as a microspheric one, which, however cannot be the case. I measured the proloculi of 9 shells, belonging to the two types, with rounded or with blunt margin. They showed the following measures :

the larger shells showing the smaller proloculus, with an average of 61 μ. This is the same diameter, I quoted in my paper in 1926 (about 60 μ).

This proloculus is followed by a clew of chambers, showing no pores except towards the sidewalls of the shell, and communicating only with the former and with the following chamber by a single foramen. I will call these chambers « chambers of first order ». They are followed by chambers, situated in narrow coils, and in a single row in transverse section; they form only few rows, and are connected each with the two adjacent chambers of the former and those of the following coil. They thus give rise to a situation, which is found throughout the whole shell in *Planorbulina larvata*, as I have described it in my Siboga-report (1927). I will call them « planorbuline »

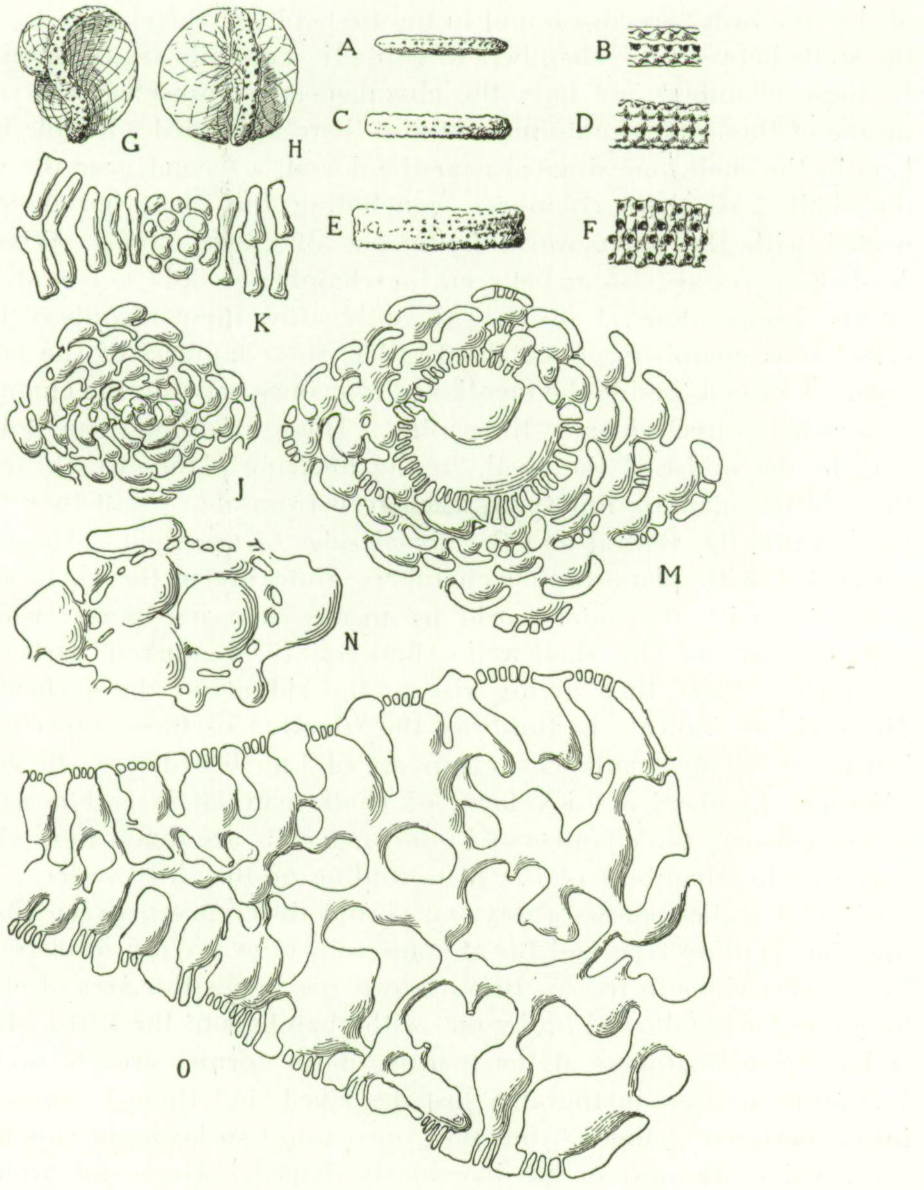


FIG. 23. — *Omphalocyclus macroporus* (LAMARCK).

A, B: A_2-form, with large proloculus; A: whole shell. ×5; B: margin. ×10. — C, D: A_1-form, young small proloculus; C: whole shell. ×5; D: margin. ×10. — E, F: A_1-form, fullgrown; E: whole shell. ×5; F: margin. ×10. — G, H: polynuclear specimens. ×5. — J: A_1-centre, decalcified, horizontal section; K: A_1-centre, decalcified, transverse section; M: A_2-centre, decalcified, horizontal section; N: A_2-centre, decalcified, transverse section. ×40. — O: section through a fullgrown A_1 individual, showing the pores of superficial chambers, the stoloniferous chambers, at the margin with two layers of them, foramina and openings of stolons at the margin of the shell. ×40.

chambers. In *Planorbulina*, especially in the microspheric form, the chambers of the first order are also found in the first coils of the chambers. In later coils the walls between the chambers of two adjacent coils are thickening somewhat. In these chambers not only the chambers are connected with each other by means of these four foramina, but also there is formed a double layer of chambers in the shell, one situated near the dorsal, a second near the ventral side of the shell. All these chambers, concluding the planorbuline ones, are connected with the outer world by means of coarse pores. Whether in these A_1-shells pores also occur between the chambers, could not be distinguished in all the preparations, I made. Abruptly after these chambers in two layers, called now chambers of the third order, the chambers of the last-formed coil form a foramen (beside the mentioned four ones between the chambers) growing in a radiate direction from the centre. These foramina form stolon-like chambers in the midst of the shell, in the mediane plane, which are formed like those of the planorbuline type, when seen from above; but they form foramina too towards the ventral and the dorsal sides of the shell. Those foramina are connected with planorbuline chambers quite under the surface of the shell, connected with the outer world by means of coarse pores, which open into sunken parts of the shell-wall. Between these sunken parts are ridges of secundary chalk, thus giving rise to the ridges on the surface of the shell. Those ridges indicate in this way the situation of those superficial chambers. I will call those chambers « chambers of fourth order ». Between the stoloniferous chambers a thick layer of chalk-material is laid down, so that the spaces between the chambers of following coils are much more developed than between the chambers of the planorbuline or the third order. In this way a horizontal section shows always an abrupt difference between the chambers of the planorbuline type and the stoloniferous ones, giving an aspect as is caused by the year-rings in trees. In outgrown specimens this area of chambers of the fourth order is followed up by one with chambers of the fifth. In this area the stoloniferous chambers at the margin of the former area form two foramina, just as is the case in the area just described, but these foramina do not open into superficial chambers, but they open into two layers of stoloniferous chambers, which are more or less irregularly shaped. These stoloniferous chambers are connected in their turn with the superficial ones.

At the margin of fullgrown specimens the chambers of the fifth order may give rise to superficial chambers with inflated sutures. They form the socalled brood-chambers which have been found in many other Foraminifera. Often these chambers are broken open in the fossil shells, and I am inclined to believe, that those broken chamberwalls indicate the creaping-out of the young shells.

In some of the shells examined very large and irregularly shaped superficial chambers were discovered, in which invariably were found up shells of other species of small Foraminifera. This fact of inclosing foreign shells in the outgrowing chambers (the shells were too large as to enter the foramina of *Orbitolites*) suggests the peculiarity, that the shells of *Orbitolites* were attached to some other body, on which these Foraminifera were creeping, when they formed their new chambers. All Foraminifera found in this way belonged to attached, arenaceous species. The walls of the chambers show some other particularities too; firstly they show granular outgrowths into the inner contents of the shell, but it is very probable, that those little outgrowths are nothing than fine cristals of chalk, being the first indications of fossilisation. A second peculiarity is the existence of fine granules of yellow or red material in the chalk in the inner walls of the chambers. These granules may be the remains of a colouring of the shell, as is always the case in recent *Sporadotrema*. These granules are not found up in the shells of other species of Foraminifera from the same localities.

RECAPITULATING WE FIND :

A small megalospheric proloculus of about 60 μ diameter, followed by a clew of chambers from the normal rotaline type. This clew is followed by some coils of *planorbuline chambers*, then afterwards the chambers form two layers of planorbuline chambers, then these chamber-layers are separated by stoloniferous chambers, first forming a single layer, afterwards a double one. All these layers are arranged in lozenge-rows. Pores are only formed by those chambers which strike the surface of the shell. They are coarse. The typical characteristic of all chambers, except those of the clew, and those of the first order, is the possession of four foramina, thus indicating the planorbuline type.

Considering the margin of a shell from without, very young shells may open with only two rows of foramina (the small openings on the dorsal and ventral sides). But when the shell has formed the single layer of stoloniferous chambers, a third row of openings is intercalated. This row is that wich we found in the stout shells with rounded margin. When two rows of stoloniferous chambers are formed, even two rows of large openings are shown at the margin. In reality one may easily observe on a transverse section with the paraffine-method, that the foramina between the stoloniferous chambers in horizontal direction are much larger than those between the superficial chambers. The small openings at the margin are the foramina of the superficial chambers, the large ones between are those of the stolons. Pores never have been observed at the marginal walls of the chambers.

The stout form with blunt margin.

This form is shaped quite like those described above. But it always shows the four layers of chambers near to the margin. The larger the shell is, the smaller is the proloculus. But always the shell begins with the clew of chambers, followed by the chambers of first order, etc.

The thin form.

Some of these showed to be young shells of the forms already described. But most of them, especially the thin and small forms (diameter about 4 mm) showed to be of quite a different type in respect to the first chambers. They are described in my paper (1926) as the Forms A and B. B, however, shows to be nothing but a variety, with more or less large shells (with smaller proloculus). All transitorial forms between them could be observed.

The proloculus is very large, five of them measured showed the diameter, in μ :

250, 200, 250, 187, 185. Average 219 μ.

The proloculus is followed and partly surrounded (forming thus the so-called raspberry-shape of embryonic apparatus) by three or four chambers, very large too, and surrounded with this proloculus by a thick wall. This wall is perforated by coarse pores, which open into the surrounding chambers. The four first chambers are separated by only thin walls, which, so far as I could see, never show perforation, except by the foramina. The dorsal and ventral pores of the wall of the embryon reach the surface of the shell, the other ones open into irregularly heaped chambers round the embryon. They form narrow chambers, but show directly the planorbuline type in the following coils. In such way the chambers of first order are not at all developed, and the planorbuline type follows directly on the clew-chambers. These planorbuline chambers are of the typical type, forming only comparatively thin walls between the rows. They form two layers, and stretch out towards the margin, thus the animal obliterates the stoloniferous chambers throughout. Here and there only a trace of stolons could be found up. In this way two rows of relatively small openings are found on the margin. The chambers of the first coils of planorbuline type often show not only their four foramina, but form pores too in their marginal walls, communicating with the chambers of the next coil of chambers. Mostly however these pores are obliterated. The amount of secundary chalk material is much smaller than in the A_1-form. I must call this form A_2. The chambers of the two layers are also connected by foramina, which form in some cases tubes between the two layers, running from the dorsal to the ventral side, but never horizontally, as do the stoloniferous chambers of the A_1form.

Systematic considerations :

In my first paper on this subject I mentioned the fact, that the species of Maestricht shows striking similarities in its inner structure with *Sporadotrema cylindricum,* and so I called this species *Sporadotrema errantium mihi.* When dealing with the genus *Sporadotrema* in the first part of my Siboga-report I reestablished the second name *macroporum,* thus calling the species *Sporadotrema macroporum.* In the second part of my Siboga-report I came to the conclusion, that *Marginopora vertebralis* Quoy et Gaimard shows nearly identical inner and outer structure with the fossil species *Omphalocyclus macropora* of Maestricht, and so I was inclined to call our species *Marginopora macropora*. But later investigations at the fossil species *Orbitolites complanata* of Lamarck from the Paris-basin showed without doubt, that this *Orbitolites* is nearly identical with *Marginopora vertebralis*, and shows no coarse pores.

This new research showed me further data about the inner structure, and in my report on the oriental expedition of His Majesty the King of Belgium (Résultats scientifiques du voyage aux Indes Orientales Néerlandaises, vol. II, p. I, 1930, pp. 9-12) I gave a more extensive account upon my views of the relationships between the genera, now coming to the conclusion, that three different species of *Orbitolites* can be distinguished, viz.

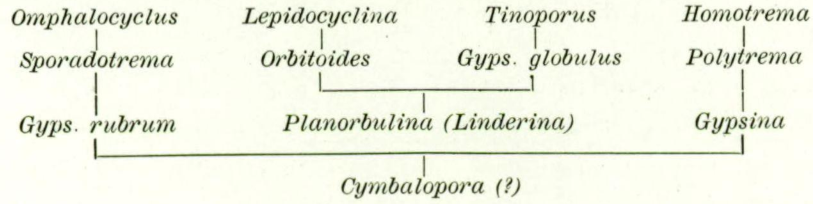
Orbitolites macropora Lamarck, from the chalk of Maestricht;
Orbitolites complanata Lamarck, from the Eocene of Paris;
Orbitolites vertebralis Quoy and Gaimard, which is a recent species.

The fact however, that this « *Orbitolites* » *macropora* Lamarck, as is shown in this paper, possesses real coarse pores in the outer walls (and does not show any traces of the fine pores found in the initial part of all *Peneroplidæ*) leads to the supposition, that we deal here with a remarkable instance of parallelism, and that a species, closely allied to *Sporadotrema*, shows an inner structure which is nearly identical with that of *Orbitolites vertebralis* Quoy et Gaimard.

Omphalocyclus is closely allied to the genus *Sporadotrema*, and this genus on its part is a real *Planorbuline* descendant, as I proved in the first part of my Siboga-investigations.

The genus *Omphalocyclus* has nothing whatever to do with the *Peneroplidæ*, and shows only outer resemblance with the genus *Orbitolites*.

The name of the Maestrichtian species thus must be *Omphalocyclus macroporus*, as the generic name *Orbitolites* created by Lamarck in 1801, cannot be applied here. The generic name of *Sporadotrema* was first mentioned in 1911 by Hickson. All these species may be gathered in the Family of the *Tinoporidæ*, thus giving rise to the following relationships :



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Depuis 1923, les Mémoires du Musée royal d'Histoire naturelle de Belgique ne sont plus réunis en Tomes. Chaque travail, ou partie de travail, a reçu un numéro d'ordre. La numérotation prend pour point de départ le premier fascicule du Tome I.

A partir de 1935, une deuxième série de Mémoires a été constituée, les fascicules en possèdent une numérotation indépendante de celle des Mémoires publiés jusqu'alors par le Musée. Cette deuxième série est plus particulièrement consacrée à des sujets ne présentant pas un intérêt immédiat pour l'exploration de la Belgique.

Sedert 1923 worden de Verhandelingen van het Koninklijk Natuurhistorisch Museum van België niet meer in Banden verenigd. Ieder werk, of gedeelte van een werk, heeft een volgnummer gekregen. De nummering begint met de eerste aflevering van Deel I.

In 1935 werd een tweede reeks Verhandelingen begonnen. De nummering der afleveringen hiervan is onafhankelijk van de tot dat tijdstip door het Museum gepubliceerde Verhandelingen. Deze tweede reeks is meer in het bijzonder gewijd aan werken, die niet van onmiddellijk belang zijn voor het onderzoek van België.

MÉMOIRES DU MUSÉE ROYAL D'HISTOIRE NATURELLE DE BELGIQUE.
VERHANDELINGEN VAN HET KONINKLIJK NATUURHISTORISCH MUSEUM VAN BELGIË.

PREMIÈRE SÉRIE. — EERSTE REEKS (1900-1948).

TOME I. — DEEL I.

1. — A. C. SEWARD. *La Flore wealdienne de Bernissart* ... 1900
2. — G. GILSON. *Exploration de la Mer sur les côtes de la Belgique* ... 1900
3. — O. ABEL. *Les Dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers.* I ... 1901
4. — C. E. BERTRAND. *Les Coprolithes de Bernissart.* I. *Les Coprolithes attribués aux Iguanodons* ... 1903

TOME II. — DEEL II.

5. — M. LERICHE. *Les Poissons paléocènes de la Belgique* ... 1902
6. — O. ABEL. *Les Dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers.* II ... 1902
7. — A. C. SEWARD et ARBER. *Les Nipadites des couches éocènes de la Belgique* ... 1903
8. — J. LAMBERT. *Description des Echinides crétacés de la Belgique.* I. *Étude monographique sur le genre Echinocorys* ... 1903

TOME III. — DEEL III.

9. — A. HANDLIRSCH. *Les Insectes houillers de la Belgique* ... 1904
10. — O. ABEL. *Les Odontocètes du Boldérien (Miocène supérieur) d'Anvers* ... 1905
11. — M. LERICHE. *Les Poissons éocènes de la Belgique* ... 1905
12. — G. GÜRICH. *Les Spongiostromides du Viséen de la Province de Namur* ... 1906

TOME IV. — DEEL IV.

13. — G. GILSON. *Exploration de la Mer sur les côtes de la Belgique. Variations horaires, physiques et biologiques de la Mer.* 1907
14. — A. DE GROSSOUVRE. *Description des Ammonitides du Crétacé supérieur du Limbourg belge et hollandais et du Hainaut.* 1908
15. — R. KIDSTON. *Les Végétaux houillers du Hainaut* ... 1909
16. — J. LAMBERT. *Description des Echinides crétacés de la Belgique.* II. *Echinides de l'Étage sénonien* ... 1911

TOME V. — DEEL V.

17. — P. MARTY. *Étude sur les Végétaux fossiles du Trieu de Leval (Hainaut)* ... 1907
18. — H. JOLY. *Les Fossiles du Jurassique de la Belgique* ... 1907
19. — M. COSSMANN. *Les Pélécypodes du Montien de la Belgique* ... 1908
20. — M. LERICHE. *Les Poissons oligocènes de la Belgique* ... 1910

TOME VI. — DEEL VI.

21. — R. H. TRAQUAIR. *Les Poissons wealdiens de Bernissart* ... 1911
22. — W. HIND. *Les Faunes conchyliologiques du terrain houiller de la Belgique* ... 1912
23. — M. LERICHE. *La Faune du Gedinnien inférieur de l'Ardenne* ... 1912
24. — M. COSSMANN. *Scaphopodes, Gastropodes et Céphalopodes du Montien de Belgique* ... 1913

TOME VII. — DEEL VII.

25. — G. GILSON. *Le Musée d'Histoire Naturelle Moderne, sa Mission, son Organisation, ses Droits* ... 1914
26. — A. MEUNIER. *Microplankton de la Mer Flamande.* I. *Les Diatomacées : le genre Chaetoceros* ... 1913
27. — A. MEUNIER. *Microplankton de la Mer Flamande.* II. *Les Diatomacées, le genre Chaetoceros excepté* ... 1915

TOME VIII. — DEEL VIII.

28. — A. MEUNIER. *Microplankton de la Mer Flamande.* III. *Les Péridiniens* ... 1919
29. — A. MEUNIER. *Microplankton de la Mer Flamande.* IV. *Les Tintinnides et Cætera* ... 1919
30. — M. GOETGHEBUER. *Ceratopogoninae de Belgique* ... 1920
31. — M. GOETGHEBUER. *Chironomides de Belgique et spécialement de la zone des Flandres* ... 1921
32. — M. LERICHE. *Les Poissons néogènes de la Belgique* ... 1926
33. — E. ASSELBERGHS. *La Faune de la Grauwacke de Rouillon (base du Dévonien moyen)* ... 1923
34. — M. COSSMANN. *Scaphopodes, Gastropodes et Céphalopodes du Montien de Belgique.* II ... 1924
35. — G. GILSON. *Exploration de la mer sur les côtes de la Belgique. Recherche sur la dérive dans la mer du Nord* ... 1924
36. — P. TEILHARD DE CHARDIN. *Les Mammifères de l'Éocène inférieur de la Belgique* ... 1927
37. — G. DELÉPINE. *Les Brachiopodes du Marbre noir de Dinant (Viséen inférieur)* ... 1928
38. — R. T. JACKSON. *Paleozoïc Echini of Belgium* ... 1929
39. — F. CANU et R. S. BASSLER. *Bryozoaires éocènes de la Belgique* ... 1929
40. — F. DEMANET. *Les Lamellibranches du Marbre noir de Dinant (Viséen inférieur)* ... 1929
41. — E. ASSELBERGHS. *Description des Faunes marines du Gedinnien de l'Ardenne* ... 1930
42. — G. STIASNY. *Die Scyphomedusen-Sammlung des « Musée royal d'Histoire naturelle de Belgique »* ... 1930
43. — E. VINCENT. *Mollusques des couches à Cyrènes (Paléocène du Limbourg)* ... 1930
44. — A. RENIER. *Considérations sur la stratigraphie du Terrain houiller de la Belgique* ... 1930
P. PRUVOST. *La Faune continentale du Terrain houiller de la Belgique.*
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46. — E. VINCENT. *Études sur les Mollusques montiens du Poudingue et du Tuffeau de Ciply* ... 1930
47. — W. CONRAD. *Recherches sur les Flagellates de Belgique* ... 1931
48. — O. ABEL. *Das Skelett der Eurhinodelphiden aus dem oberen Miozän von Antwerpen* ... 1931
49. — J. H. SCHUURMANS-STEKHOVEN Jr. and W. ADAM. *The Freeliving Marine Nemas of the Belgian Coast* ... 1931

50. — F. CANU et R. S. BASSLER. *Bryozoaires oligocènes de la Belgique* … 1931
51. — EUG. MAILLIEUX. *La Faune des Grès et Schistes de Solières (Siegenien moyen)* … 1931
52. — EUG. MAILLIEUX. *La Faune de l'Assise de Winenne (Emsien moyen)* … 1932
53. — M. GLIBERT. *Monographie de la Faune malacologique du Bruxellien des environs de Bruxelles* … 1933
54. — A. ROUSSEAU. *Étude de la variation dans la composition de la florule du toit des veines de l'Olive et du Parc des Charbonnages de Mariemont-Bascoup* … 1933
55. — M. LECOMPTE. *Le genre Alveolites Lamarck dans le Dévonien moyen et supérieur de l'Ardenne* … 1933
56. — W. CONRAD. *Revision du Genre Mallomonas Perty (1851) incl. Pseudo-Mallomonas Chodat (1920)* … 1933
57. — F. STOCKMANS. *Les Neuroptéridées des Bassins houillers belges.* I … 1933
58. — L. A. DECONINCK and J. H. SCHUURMANS-STEKHOVEN Jr. *The Freeliving Marine Nemas of the Belgian Coast.* II … 1933
59. — A. ROUSSEAU. *Contribution à l'étude de Pinakodendron Ohmanni Weiss* … 1933
60. — H. DE SAEDELEER. *Beitrag zur Kenntnis der Rhizopoden* … 1934
61. — F. DEMANET. *Les Brachiopodes du Dinantien de la Belgique.* I … 1934
62. — W. ADAM et E. LELOUP. *Recherches sur les Parasites des Mollusques terrestres* … 1934
63. — O. SICKENBERG. *Beiträge zur Kenntnis Tertiärer Sirenen* … 1934
64. — K. EHRENBERG. *Die Plistozaenen Baeren Belgiens.* I. Teil : *Die Baeren von Hastière* … 1935
65. — EUG. MAILLEUX. *Contribution à l'étude des Echinoïdes du Frasnien de la Belgique* … 1935
66. — M. LECOMPTE. *L'Aérolithe du Hainaut* … 1935
67. — J. S. SMISER. *A Revision of the Echinoid Genus Echinocorys in the Senonian of Belgium* … 1935
68. — J. S. SMISER. *A Monograph of the Belgian Cretaceous Echinoids* … 1935
69. — R. BRECKPOT et M. LECOMPTE. *L'Aérolithe du Hainaut. Étude spectrographique* … 1935
70. — EUG. MAILLIEUX. *Contribution à la Connaissance de quelques Brachiopodes et Pélécypodes Dévoniens* … 1935
71. — K. EHRENBERG. *Die Plistozaenen Baeren Belgiens.* Teil II : *Die Baeren von Trou du Sureau (Montaigle)* … 1935
72. — J. H. SCHUURMANS-STEKHOVEN Jr. *Additional Notes to my monographs on the Freeliving Marine Nemas of the Belgian Coast.* I and II … 1935
73. — EUG. MAILLIEUX. *La Faune et l'Age des quartzophyllades siegeniens de Longlier* … 1936
74. — J. H. SCHUURMANS-STEKHOVEN Jr. *Copepoda parasitica from the Belgian Coast.* II. (*Included some habitats in the North-Sea.*) … 1936
75. — M. LECOMPTE. *Revision des Tabulés dévoniens décrits par Goldfuss* … 1936
76. — F. STOCKMANS. *Végétaux éocènes des environs de Bruxelles* … 1936
77. — EUG. MAILLIEUX. *La Faune des Schistes de Matagne (Frasnien supérieur)* … 1936
78. — M. GLIBERT. *Faune malacologique des Sables de Wemmel* I. *Pélécypodes* … 1936
79. — H. JOLY. *Les fossiles du Jurassique de la Belgique.* II. *Lias inférieur* … 1936
80. — W. E. SWINTON. *The Crocodile of Maransart (Dollosuchus Dixoni* [Owen]) … 1937
81. — EUG. MAILLIEUX. *Les Lamellibranches du Dévonien inférieur de l'Ardenne* … 1937
82. — M. HUET. *Hydrobiologie piscicole du Bassin moyen de la Lesse* … 1938
83. — EUG. MAILLIEUX. *Le Couvinien de l'Ardenne et ses Faunes* … 1938
84. — F. DEMANET. *La Faune des Couches de passage du Dinantien au Namurien dans le synclinorium de Dinant* … 1938
85. — M. GLIBERT. *Faune malacologique des Sables de Wemmel* II. *Gastropodes, Scaphopodes, Céphalopodes* … 1938
86. — EUG. MAILLIEUX. *L'Ordovicien de Sart-Bernard* … 1939
87. — R. LERUTH. *La biologie du domaine souterrain et la faune cavernicole de la Belgique* … 1939
88. — C. R. BOETTGER. *Die subterrane Molluskenfauna Belgiens* … 1939
89. — R. MARLIÈRE. *La Transgression albienne et cénomanienne dans le Hainaut (Études paléontologiques et stratigraphiques)*. 1939
90. — M. LECOMPTE. *Les Tabulés du Dévonien moyen et supérieur du Bord Sud du Bassin de Dinant* … 1939
91. — G. DELÉPINE. *Les Goniatites du Dinantien de la Belgique* … 1940
92. — EUG. MAILLIEUX. *Les Echinodermes du Frasnien de la Belgique* … 1940
93. — F. STOCKMANS. *Végétaux éodévoniens de la Belgique* … 1940
94. — E. LELOUP, avec la collaboration de O. MILLER. *La flore et la faune du bassin de chasse d'Ostende (1937-1938)* … 1940
95. — W. CONRAD. *Recherches sur les eaux saumâtres des environs de Lilloo.* I. *Étude des milieux* … 1941
96. — EUG. MAILLIEUX. *Les Brachiopodes de l'Emsien de l'Ardenne* … 1941
97. — F. DEMANET. *Faune et Stratigraphie de l'Étage Namurien de la Belgique* … 1941
98. — A. PUNT. *Recherches sur quelques Nématodes parasites de poissons de la mer du Nord* … 1941
99. — W. CONRAD. *Sur la faune et la flore d'un ruisseau de l'Ardenne belge* … 1942
100. — F. STOCKMANS et Y. WILLIÈRE. *Palmoxylons paniséliens de la Belgique* … 1943
101. — F. DEMANET. *Les Horizons marins du Westphalien de la Belgique et leurs faunes* … 1943
102. — E. LELOUP. *Recherches sur les Triclades dulcicoles épigés de la forêt de Soignes* … 1944
103. — M. GLIBERT. *Faune malacologique du Miocène de la Belgique* … 1945
104. — E. CASIER. *La Faune ichthyologique de l'Yprésien de la Belgique* … 1946
105. — F. STOCKMANS. *Végétaux de l'Assise des sables d'Aix-la-Chapelle récoltés en Belgique (Sénonien inférieur)* … 1946
106. — W. ADAM. *Revision des Mollusques de la Belgique.* I. *Mollusques Terrestres et Dulcicoles* … 1947
107. — E. LELOUP. *Les Cœlentérés de la faune belge. Leur bibliographie et leur distribution* … 1947
108. — H. R. DEBAUCHE. *Étude sur les Mymarommidae et les Mymaridae de la Belgique (Hymenoptera chalcidoidea)* … 1948
109. — A. PASTIELS. *Contribution à l'étude des Microfossiles de l'Éocène belge* … 1948
110. — F. STOCKMANS. *Végétaux du Dévonien supérieur de la Belgique* … 1948

DEUXIÈME SÉRIE. — TWEEDE REEKS (1935-1948).

1. — W. CONRAD. *Étude systématique du genre Lepocinclis Perty* … 1935
2. — E. LELOUP. *Hydraires calyptoblastiques des Indes occidentales* … 1935
3. — « MÉLANGES PAUL PELSENEER » … 1936
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5. — M. YOUNG. *The Katanga Skull* … 1936
6. — A. D'ORCHYMONT. *Les Hydraena de la Péninsule Ibérique* (en annexe synonymie de deux formes méditerranéennes) … 1936
7. — A. D'ORCHYMONT. *Revision des « Coelostoma » (s. str.) non américains* … 1936
8. — C. DECHASEAUX. *Limidés jurassiques de l'Est du Bassin de Paris* … 1936
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10. — H. HEATH. *The Anatomy of some Protobranch Mollusks* … 1937
11. — A. JANSSENS. *Revision des Onitides* … 1937
12. — E. LELOUP. *Hydropolypes et Scyphopolypes recueillis par C. Dawydoff sur les côtes de l'Indochine française* … 1937
13. — H. I. TUCKER-ROWLAND, PH. D. *The Atlantic and gulf coast tertiary Pectinidae of the United States* … 1938
14. — H. G. SCHENCK and PH. W. REINHART. *Oligocène arcid Pelecypods of the genus Anadara* … 1938
15. — *Résultats scientifiques des croisières du navire-école belge « Mercator »*. II … 1939
16. — A. JANSSENS. *Monographie des « Scarabaeus » et genres voisins* … 1940
17. — E. LELOUP. *Caractères anatomiques de certains Chitons de la côte californienne* … 1940
18. — A. JANSSENS. *Monographie des Gymnopleurides (Coleoptera Lamellicornia)* … 1940
19. — A. D'ORCHYMONT. *Palpicornia de Chypre* … 1940
20. — A. D'ORCHYMONT. *Les Palpicornia des Iles Atlantiques* … 1940
21. — *Résultats scientifiques des croisières du navire-école belge « Mercator »*. III … 1941
22. — H. DEBAUCHE. *Geometridae de Célèbes* … 1941
23. — CH. DUPOND. *Contribution à l'étude de la faune ornithologique des Iles Philippines et des Indes orientales néerlandaises.* 1942
24. — A. D'ORCHYMONT. *Contribution à l'étude de la tribu Hydrobiini* BEDEL, *spécialement de sa sous-tribu Hydrobiae (Palpicornia-Hydrophilidae)* … 1942
25. — E. LELOUP. *Contribution à la connaissance des polyplacophores.* I. *Fam. Mopaliidae* PILSBRY, 1892 … 1942
26. — G. F. DE WITTE et R. LAURENT. *Contribution à la systématique des formes dégradées de la famille des « Scincidae » apparentées au genre « Scelotes »* FITZINGER … 1943
27. — F. TWIESSELMANN. *Contribution à l'étude anthropologique des Pygmées de l'Afrique occidentale* … 1942
28. — A. D'ORCHYMONT. *Faune du Nord-Est brésilien* (récoltes du Dr O. Schubart). — *Palpicornia* … 1944
29. — G. F. DE WITTE et R. LAURENT. *Revision d'un groupe de Colubridae africains* … 1947

HORS SÉRIE. — BUITEN REEKS.

Résultats scientifiques du Voyage aux Indes orientales néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique, publiés par V. Van Straelen.

Vol. I. — Vol. II. — Vol. III, fasc. 1 à 19. — Vol. IV. — Vol. V. — Vol. VI, fasc. 1.

BULLETIN DU MUSÉE ROYAL D'HISTOIRE NATURELLE DE BELGIQUE.
MEDEDELINGEN VAN HET KONINKLIJK NATUURHISTORISCH MUSEUM VAN BELGIË.

TOMES I à XXIV (1882-1948).

DELEN I tot XXIV (1882-1948).

Un arrêté du Régent du 3 septembre 1948 a substitué à la dénomination du Musée royal d'Histoire naturelle de Belgique celle d'Institut royal des Sciences naturelles de Belgique.

Bij besluit van de Regent dd. 3 September 1948 werd de benaming van het Koninklijk Natuurhistorisch Museum van België gewijzigd. Deze instelling heet nu Koninklijk Belgisch Instituut voor Natuurwetenschappen.

MÉMOIRES DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE.
VERHANDELINGEN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN.

PREMIERE SÉRIE. — EERSTE REEKS.

111. — J. A. CUSHMAN. *Recent Belgian Foraminifera* ... 1949

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30. — M. GLIBERT. *Gastropodes du Miocène moyen du Bassin de la Loire.* (Première partie.) ... 1949

31. — G. GERKENS. *Les Batutsi et les Bahutu. (Contribution à l'anthropologie du Ruanda et de l'Urundi, d'après les mensurations recueillies par la Mission G. Smets.)* ... 1949

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MEDEDELINGEN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN.

TOME XXV (1949) en cours de publication.

DEEL XXV (1949) ter pers.

TABLES.

1. — M. GLIBERT. *Table analytique des tomes I à XV du Bulletin du Musée royal d'Histoire naturelle de Belgique, 1882-1888 et 1930-1939* ... 1943

2. — M. GLIBERT. *Table analytique des Mémoires 1 à 100 du Musée royal d'Histoire naturelle de Belgique (1900-1943)* ... 1944

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