STUDIES ON THE FAUNA OF CURACAO AND OTHER CARIBBEAN ISLANDS: No. 115.

RECENT FORAMINIFERA FROM BARBADOS

by

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Euuvigerina flintii (Cushman)	61	161–164		×
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Planulina foveolata (Brady)	62	170–173	×	×
Carpenteria Gray	63			
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Carpenteria monticularis Carter	68	182–190	×	
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Mississippina concentrica (Parker&Jones)	72	212–214	×	×
Hoeglundina elegans (d'Orbigny)	74	215–223		×
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Amphistegina d'Orbigny	80			
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Rotorbinella barbadosensis nov. spec.	83	243–246	×	
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Globigerina conglobata Brady	115	326–337, 342	×	×
Globigerina rubra d'Orbigny	117	267, 341, 343–363	×	×
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Orbulina universa d'Orbigny	125	381–397	×	×
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Eponides repandus (Fichtel & Moll)	139	452–461	×	×
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INTRODUCTION

While visiting the Bellairs Research Institute at Barbados during one of his collecting trips to the West Indies, Dr. P. WAGENAAR HUMMELINCK took two large samples of surfacial floor sediments of the sea west of Barbados. These samples have been trusted to the author for foraminiferal research. The excursion on which the material has been collected, aboard the research vessel "Diadema", had been organised by the Director of the Bellairs Institute, Dr. JOHN B. LEWIS.

The results add to our knowledge of the benthonic communities of Barbados' west coast (see also LEWIS, 1965, and MACINTYRE, 1967).

The samples are from habitats, bearing HUMMELINCK'S station numbers:

Sta. 1442 BARBADOS, west coast ½ mile W. of Holetown, depth 100 m; 19.II.1964
Sta. 1443 BARBADOS, west coast 1 mile W of Holetown, depth 200 m; 19.II.1964.

The material from both stations consisted of shells, sponges, Foraminifera, Bryozoa, etc. – loosely cemented together – on which many Recent species were attached. Between these clumps a large quantity of Recent free living Foraminifera were found. A multitude of planktonic Foraminifera occurred too, especially in Sta. 1443.

LEWIS (1965, p. 1052) mentions hermatypic corals and many species of sponges in a depth of about 100 m; sponges were much rarer at the depth of 200 m, where the hermatypic corals failed (p. 1054). This difference in the communities may have a bearing on the difference in foraminiferal faunae.

Remarkable was the enormous quantity of attached forms living on the clumps of loosely cemented shells etc., with several species hitherto unknown from the Caribbean Sea; as well as the large amount of Lagenidae and arenaceous Foraminifera. In sample 1442 *Amphistegina* dominated, whereas in sample 1443 it was nearly absent. In sample 1442 *Textulariella* was very rare, whereas in sample 1443 it was extremely common. In sample 1442 *Cribrogenerina* and *Liebusella* were abundant, whereas in sample 1443 they were rare. *Sporadotrema* occurred in many attached specimens in sample 1442, whereas in sample 1443 it was nearly absent. All these facts point to a strong dependence of Foraminiferal species on the depth of the sea.

Very few of the species described by the author (1964) from the tidal zone of the Caribbean Islands could be refound in the samples from Barbados (only *Quinqueloculina polygona*, *Amphistegina globosa* and *Rotorbinella rosea*); this once again points to a strong dependence of Foraminifera on the environment. Two species, lacking in sample 1442, were abundant in sample 1443: *Pseudonodosaria comatula* (Cushman) and *Euuvigerina flintii* (Cushman). Of the Foraminifera, described by the author (1956) from a sample, taken by MORTENSEN off St. Croix (= Santa Cruz), depth about 800 m, only a small number occurred in the samples 1442 and 1443; in 1956 only part of this extremely rich fauna was described. Most of the arenaceous species found in the sample taken off St. Croix, not yet described, are absent in the samples from Barbados; they form a typical deep-sea fauna, which cannot be said about the samples from Barbados. Depth must be one of the factors, which have the biggest influence on the occurrence of whole groups of Foraminifera.

Species found in the St. Croix sample, and not in the samples from Barbados are:

Sorites orbitolitoides Hofker
Rhabdammina abyssorum Sars
Rhabdammina linearis (Brady)
Saccorhiza ramosa (Brady)
Topylammina vagans (Brady)
Bathysiphon filiformis Sars
Reophax difflugiformis Brady
Reophax scorpiurus Montfort
Reophax nodulosus Brady
Alveophragmium subglobosum (Sars)
Ammoglobigerina globigeriniformis (Parker & Jones)
Cyclammina cancellata Brady
Cyclammina pusilla Brady
Involutina anguillae (Höglund)
Trochammina squamata Jones & Parker
Ammolagena clavata (Parker & Jones)
Tritaxis fusca (Williamson)
Clavulina tricarinata d'Orbigny
Clavulina nodosaria d'Orbigny
Listerella nodulosa (Cushman)
Valvopavonina atlantica (Cushman)
Virgulinopsis cubana (Bermúdez)
Virgulinopsis translucens (Phleger & Parker)
Bitubulogenerina pulchella (d'Orbigny)
Globobulimina caribbea Cushman & Bermúdez
Globobulimina aperta Hofker
Bolivina tortuosa Brady
Bolivina vadescens Cushman
Bolivina (Loxostoma) barbata Phleger & Parker
Bolivina (Loxostoma) lanceolata Parker
Bolivina spatuloides Hofker
Bolivina subexcavata Cushman & Wickenden
Bolivina lowmanni Phleger & Parker
Bolivina subaenariensis Cushman
Bolivina striatula Cushman
Bolivina (Rectobolivina) reticulosa (Cushman)
Bolivina (Rectobolivina) advena (Cushman)
Bulimina spicata Parker
Bulimina alazanensis Cushman
Angulogerina occidentalis Cushman
Euuvigerina parvula (Cushman)
Euuvigerina peregrina (Cushman)
Siphogenerina costata Schlumberger
Virgulina compressa (Bailey)
Cassidulina scabra Brady
Cassidulinoides mexicana Cushman
Ehrenbergina spinea Cushman
Ehrenbergina trigona Goës
Pseudoparrella hyalina Hofker
Rotorbinella rosea (d'Orbigny)
Planulina ariminensis d'Orbigny
Robertinoides bradyi (Cushman & Parker)
Nonionella atlantica (Cushman)
Elphidiononion articulatum (d'Orbigny)
Elphidiononion poeyanum (d'Orbigny)
Cushmanella browni (d'Orbigny)
Discobolivina corrugata (Williamson)
Neoconorbina orbicularis (Terquem)
Discopulvinulina crassipora Hofker
Discopulvinulina subaraucana Cushman
Discopulvinulina bertheloti (d'Orbigny)
Cymbaloporetta bulloides (d'Orbigny)
Cancris auriculata (Monftort)
Cancris sagra (d'Orbigny)
Valvulineria mexicana Parker
Valvulineria floridensis Cushman
Gavelinopsis atlantica Hofker
Asterigerina carinata d'Orbigny

This shows that the foraminiferal fauna from off Barbados, though also rich in species, is quite different from that found in the much deeper sample off St. Croix.

Species from off Barbados, also found in the fauna off St. Croix (= Santa Cruz) are:

Bigenerina irregularis Phleger & Parker
Liebusella soldanii (Jones & Parker)
Septigenerina floridana (Cushman)
Textulariella barrettii Cushman
Robulus calcar (Linné)
Robulus iotus (Cushman)
Frondicularia sagittula van den Broeck
Lingulina carinata d'Orbigny
Eponides repandus (Fichtel & Moll)
Neoeponides antillarum (d'Orbigny)
Hoeglundina elegans (d'Orbigny)
Karreriella bradyi (Cushman)
Mississippina concentrica (Parker & Jones)
Lamarckina atlantica Cushman
Siphonina primitiva Hofker
Siphonina pulchra (Cushman)
Euuvigerina flintii (Cushman)
Several planktonic Foraminifera

In total 83 species are described from Barbados; one new genus and 3 new species were found. Moreover, 6 species are new for the Caribbean area. Of many species the inner structure, the microstructures of the walls and other data were studied.

The species described are deposited in the foraminiferal collection of the Geological Survey of the Netherlands, Haarlem.

LAMELLAR, BILAMELLAR AND MONOLAMELLAR FORAMINIFERAL TESTS

Since the studies by Smout (1954), Reiss (1958, 1963) and others, these terms were used in so many totally different ways, that it will be opportune to define them again. This has already been done in a global way by Loeblich & Tappan (1964, p. 99–100).

When we observe sections through tests, many groups of Foraminifera form their walls from one layer of material which may be granular or agglutinated, calcareous or radial crystalline, or aragonitic; the test wall also forms the septa between the chambers which consequently are also monolamellar.

Other groups or species of groups may add material, mostly crystalline, to the outer wall, but not over the septa; or, in case where for a long time these septa formed the outer wall of a chamber before a new chamber was added, even the septa may be covered by an outer secondary layer of material. So we have to consider septa, walls of chambers not forming the outer wall, which may be thickened at the outside secondarily; this may occur in inflated and overlapping chambers especially, e.g. in planktonic species. True septa of planktonic species, however, mostly do not show pores and they are always simple, so that most planktonic species – observed with the foregoing remarks in mind – are monolamellar, as true septa are monolamellar; lamellation in planktonic forms always takes place only at the outer surface of the tests. This can be ascertained when considering the meeting points of adjacent chambers in horizontal sections and when studying the walls of newly formed last chambers, as these walls are always primarily simple.

The author was able to demonstrate (several papers, 1967, 1968), in many instances where former authors described species as bilamellar, that during geologic times, the genus to which they belong began with monolamellar species with granular wall structure and that in the course of that time a secondary thickening of the granular wall appeared. In some instances this secondary thickening occurred on the outside, in others on the inside; again in other instances even on both sides, though seldom simultaneously. This process often includes even the septa, which were once outer walls.

Remarkable is that in these cases the primary wall remains granular even in the most advanced stages of the process. Under low magnification such walls with secondary thickening seem to be bilamellar, but in reality they consist of a granular primary wall and one or two crystalline secondary thickenings. Such forms of "bilamellarity" cannot be considered as a suprageneric characteristic, as ontologically and phylogenetically the wall structure is primarily monolamellar, with a later secondary (extra) lamellation.

A so-called septal flap, being a large thin flange of a toothplate, may also cause lamellation of the septa; this structure may be found in aragonitic tests such as *Lamarckina* and the Epistomariidae, but also in a large group of species which may be gathered around *Rotalia* and *Streblus*. To this group furthermore belong those species which have a planospiral test, such as *Elphidium*. In most cases observed, the primary wall is hyaline, radial crystalline, whereas the toothplate and the septal flap are granular in structure.

In planktonic species the primary wall is not granular, as in reality the granulation is due to exogene material laid down by the protoplasm; in some groups such as in *Mississippina* and in later forms of *Cibicides* and *Gyroidina*, the foreign nature of the granulations can easily be recognized as small parts of shells of Foraminifera and Coccolites are rather common in this material. Exogene material is difficult to obtain in case of Planktonic Foraminifera, and as a result the primary wall is hyaline, radial crystalline calcareous.

Many groups of Foraminifera, such as *Orbitoides* and *Miniacina* have "bilamellar" or "trilamellar" structures in the chambers which are formed later; however, the first chambers formed – the embryonic apparatus and the post-embryonic chambers – distinctly show that at least the inner walls, the septa, are monolamellar. Here too the group has to be described as monolamellar, and the lamellae of later chambers must be products of secondary thickening to strengthen the test walls.

Furthermore there are those groups of Foraminifera which I wrote about having double walls and septa (HOFKER, 1957, p. 281–282). Actually this is not true. *Gavelinella*, *Gavelinopsis* and *Stensiöina* have septa and walls which all show granular primary walls; the oldest known species only have these walls; the septa always end at the apertures with lips which are mainly formed by granular wall-parts. Each next chamber wall adheres to the former one in an indentation of the latter, thus clearly showing that the outer hyaline layer of the outer wall and septum is a secondary thickening. This indentation is not found in those species in which the granular primary wall lies on the outer side of the wall (*Gavelinella danica*), but is always distinct in the case where the granular primary wall is situated on the inner side (Fig. 1a–g). In the septa the granular lamella is often found in the middle, and inwardly and outwardly covered by more hyaline layers. In older forms these layers are fibrous-calcareous or even micro-granular; they often become radial calcareous in later forms. When the granular primary wall is situated in the middle of the septum (which – seen in low magnification – looks like a double walled septum), the inner hyaline thickening is mostly restricted to the septum, so that the granular primary wall forms the inner lamella of the outer chamber wall.

Only in *Gavelinella danica* from the Paleocene, the inner wall is the hyaline part (with the sigmoidal lip at the aperture), whereas the outer lamella is distinctly granular. Here is, as already mentioned, no indentation on which the wall of a next chamber attaches itself, indicating that here too the hyaline part is the secondary one.

Obviously, even in these cases with so-called double septa, we cannot speak of true "bilamellar" septa or walls in the sense of SMOUT (1954) and REISS (1958, 1963), as such walls ought to have two simultaneously formed lamellae.

Very remarkable are the walls of *Mississippina*; here an inner, totally granular, wall exists which may be even better indicated as agglutinated, and at the sutures and the margin of the test a secondary hyaline fibrous calcareous layer partly covers the granular wall, thus leaving the granular wall free in the middle of the chamber walls, dorsally as well as ventrally (Fig. 213, 214).

MCGOWRAN (1966) found that many genera with aragonitic tests are "bilamellar". However, in the two species *Hoeglundina elegans* and *Lamarckina atlantica* – found in this material – the doubling of the walls apparently occurs mainly by means of the septal flaps of the toothplates, and consequently these species do not belong to the bilamellar Foraminifera. MCGOWRAN also mentions doubling by a septal flap in some aragonitic species (Fig. 220–230).

Planktonic Foraminifera are said to be bilamellar; however, true (poreless) septa of many species studied here, are invariably monolamellar, and the outer walls consist of the lamella which continues into the septum, and a secondary outer lamella which thickens the outer walls; young specimens seldom show these outer thickenings (Fig. 238–242).

The inner layer of planktonic tests – which is often the only layer in young specimens or of surface-plankton – is evidently the primary wall (Fig. 268, 276, 299, 388, 406). This wall can only be of hyaline calcite, since no material can be incorporated which is of foreign origin (agglutination, granulation); the outer wall of a just-formed chamber always consists of one single layer, the primary wall. Older walls may obtain secondary thickening layers on the outside – especially in specimens from bottom-samples – but the septa themselves remain monolamellar (Fig. 284, 297, 309, 314, 315, 393, 415). This observation is in striking contradiction to the views of many other investigators.

The genus *Carpenteria* was described as being bilamellar. Loeblich & Tappan (1964, p. 707) placed this genus in the Subfamily Victoriellinae, about which they say (p. 705) that the genera are bilamellar. Yet a close investigation of several species, among which the genotype, showed that they are monolamellar (Fig. 180, 187, 199, 202).

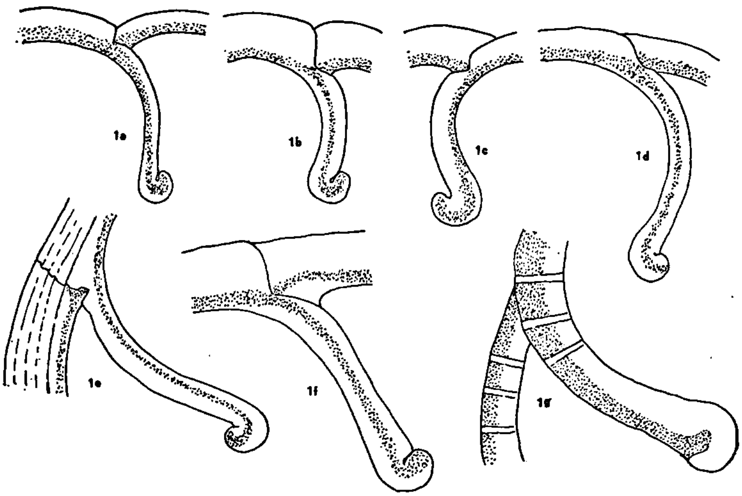


Fig. 1. Horizontal sections of septa and walls of the genera *Gavelinella*, *Gavelinopsis*, *Stensiöina*, all believed formerly to be "bilamellar", but having a primary granular wall, secondarily thickened by hyaline calcitic substance at the outside, or at the inside, or at both sides of walls and of septa (× 180).

- a. *Stensiöina exsculpta*, Austermann, N. W. Germany, Santonian.
- b. *Stensiöina pommerana*, Lüneburg-Zeltberg, N. W. Germany, Lower Maestrichtian.
- c. *Stensiöina pommerana*, Aix-la-Chapelle, N.W. Germany, Lower Maestrichtian.
- d. *Gavelinella tumida*, Folx-les-Caves, Belgium, Santonian.
- e. *Gavelinopsis involuta*, near Maastricht, Netherlands, Uppermost type-Maestrichtian.
- f. *Gavelinopsis voltziana*, Bovenste Bos, South Limburg, Netherlands, Lower Maestrichtian.
- g. *Gavellinella danica*, mineshaft Maurits III, South Limburg, Netherl., Paleocene.

Typically bilamellar, at least in the adult part of the tests, may be *Sporadotrema* and *Biarritzina*, as this paper proves (Fig. 474, 482). However, since the initial chambers have distinctly monolamellar walls and septa, it is questionable whether these genera are bilamellar.

DIRECTION OF COILING IN TROCHOID TESTS

The direction of coiling has been one of the main objects investigated by many students, especially in respect to planktonic species. A good synopsis was given by LOEBLICH & TAPPAN in 1964 (p. 113–119). Bearing in mind that VASIČEK (1953) showed that the coiling ratio might differ in different generations of Foraminifera, and that the direction of coiling in *Globigerina pachyderma* changes with temperature, the present author studied several species, planktonic and benthonic in this respect (BANDY, 1960).

In other papers (in press) the author will demonstrate that the direction of coiling depends on the generation analyzed (*Asterorotalia papillosa, A. dentata, A. concinna, A. annectens, Pseudorotalia schroeteriana, Planulina wuellerstorfi, Caucasina lappa*); here the B-generation coils to the right, the A-generation coils to the left. The same is stated here for *Eponides repandus, Globigerina rubra* in the Caribbean sea, *Globorotalia menardii, S. truncatulinoides,* in such a way, that all microspheric specimens coil to the right and where temperature influences the direction of coiling this influence is only expressed in the A-generation.

Moreover, the direction of coiling is studied in planktonic species in respect to the distance of occurrence to the equator (temperature). *Globigerina eggeri* and *G. triloba-sacculifera* show right coiling near the equator and left coiling in more arctic waters, with ratios between these two extremes. This proves an evident dependance upon temperature.

The same, but not so regular, was found for *Globorotalia truncatulinoides*. If we suppose that *Globigerina inflata* and *Pulleniatina obliqueloculata* form one single biologic unit – for which supposition morphologic proofs are given here – *Pulleniatina* is the tropical form with coiling direction to the right, whereas *Globigerina inflata* is the cold-water form with coiling direction to the left.

However, *Globigerina rubra* and *Globorotalia menardii* near the equator show a direction of coiling to the left, whereas more northern samples show directions which were more to the right. So we must conclude that species which are right-coiling near the equator, coil even more to the right when they are farther removed from the equator; whereas species which near the equator are coiling to the left, may coil more to the right, when being farther removed from the equator.

This implies that the rule given by BANDY for *Globigerina pachyderma* is not pertinent for all species of planktonic Foraminifera. Remarkable is the change in direction of coiling in *Globigerina daubjergensis* studied by the author; during the Danian this direction changed from left to right, whereas during the same period *G. pseudobulloides* did not change its direction of coiling at all (HOFKER 1962). But during the Danian a gradual increase of the percentage of individuals with very small proloculus was stated in *G. daubjergensis*, which could not be stated in *G. pseudobulloides*. Here, obviously, the change in life-cycle prevaled in *G. daubjergensis*; the increase in number of microspheric specimens during the Danian, with their coiling direction to the right, caused the coiling direction to change in the populations while a change in temperature during that period did not influence the direction of coiling. In *Eponides antillarum* the author proves that microspheric specimens are left-coiling and megalospheric specimens coil to the right.

SYSTEMATIC PART

Technitella atlantica Cushman Fig. 2–3

Technitella atlantica CUSHMAN, 1947, p. 87, pl. 18 fig. 17. "Test composed of a single chamber, somewhat compressed, the sides nearly parallel, base truncated, apertural end contracted to a cylindrical neck; wall composed of sponge spicules generally arranged lengthwise to the test and usually with one or more elongate ones extending beyond the base of the test; aperture rounded, at the end of the apertural neck. Length 1.15–1.30 mm; breadth 0.50–0.55 mm."

Whether the species belongs to *Technitella* is not certain; *Technitella legumen* Norman is much larger, and shows two layers of sponge spicules arranged perpendicularly. Remarkable is that the neck of the aperture consists not of sponge spicules but of chitinous material.

This species was rarily found by CUSHMAN off Canaveral, Florida. Two specimens found in St. 1443, depth 200 m, are identical but for a somewhat smaller size (about 0.9 mm in length).

Reophax Montfort, 1808 Figs. 4–9

The genotype of *Reophax* is *R. scorpiurus* Montfort, 1808. This species was found abundantly in samples from the Bay of Naples and in a sample off Frederiksted, Santa Cruz (= St. Croix), Caribbean Sea, depth 800 m. It has been well-figured by LOEBLICH & TAPPAN (1964, fig. 128, 1). The most recent description, also by LOEBLICH & TAPPAN (1964, p. 216), runs as follows: "Test free, elongate, nearly straight or arcuate; chambers few, increasing in size as added, sutures nearly horizontal, obscure to moderately constricted; wall agglutinated, with comparatively little cement, surface rough; aperture terminal, rounded, at the end of a distinct tubular neck."

However, very typical characteristics were not mentioned by LOEBLICH & TAPPAN, viz. that the agglutination in the genotype consists of only one layer of sand grains and that the somewhat brownish cement is only found between these grains, never forming a coating. So it is obvious that only those species, fulfilling the above-mentioned conditions have to be gathered in the genus *Reophax*.

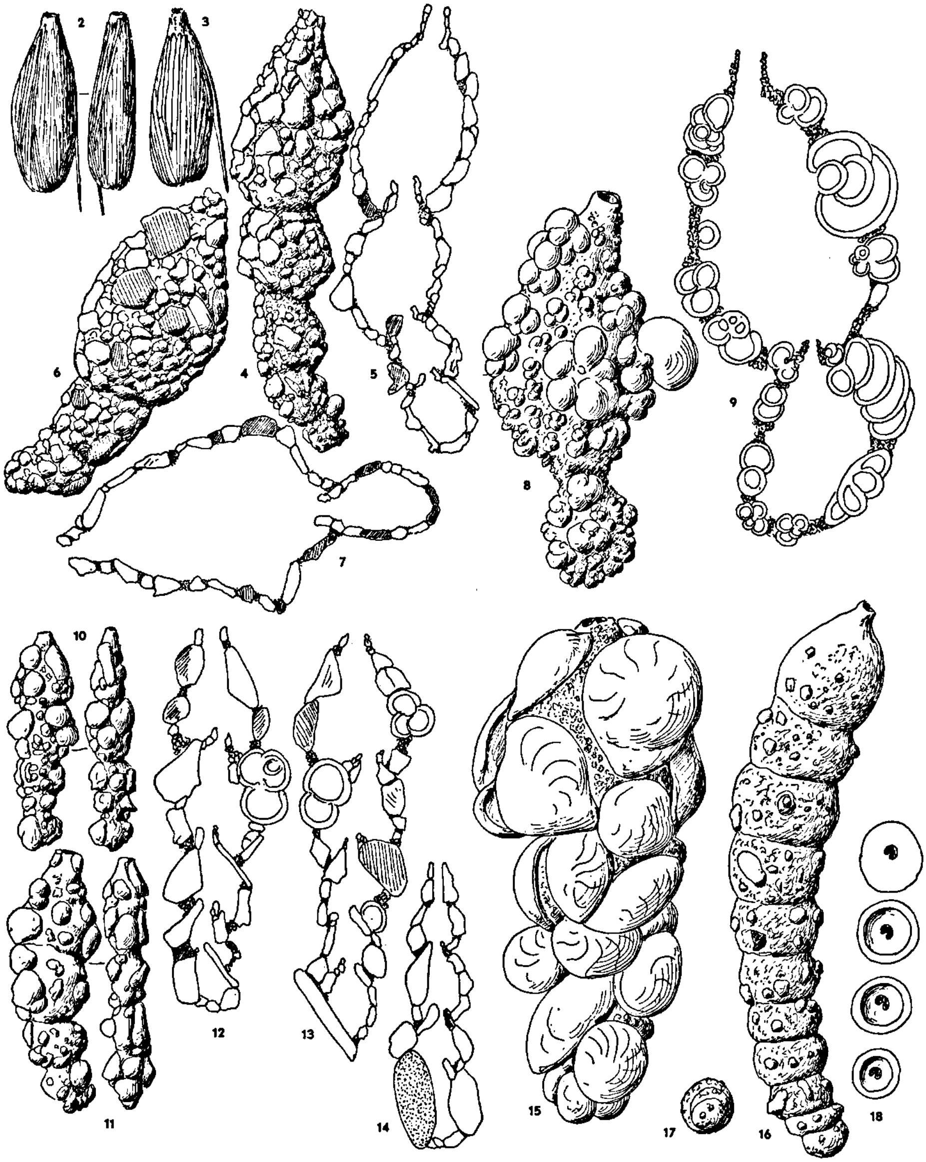
The single layer of grains, or foraminiferal tests, or sponge needles, is found in many species with an uniserial test; only these species have to be named *Reophax*. All species which have a thick wall consisting of several layers of grains cannot belong to this genus. This was already stated by the author (1930) in the case of *Nodosinum* Hofker, in which genus the wall shows several layers of grains. The same can be said of several other forms named *Reophax*, such as *R. procerus* Goës, renamed by BERMÚDEZ

Dusenburyina, *R. sabulosus* Brady and *R. cylindricus* Brady which show simple apertures, a straight row of chambers, but a wall which is composed of more than a single layer of sand grains. The latter two species, moreover, show a distinct inner pseudochitinous lining which is never found in *Reophax*. I had to establish a new genus for such species (*Loeblichella*).

There seems to be an error in the description given by CUSHMAN for this genus *Reophax*: he states that the wall is "typically with a chitinous base and an outer wall of agglutinated material" (1950, p. 90). This chitinous base could not be established in the genotype as well as in many other species dissected; it was always ascertained that fine cement is only found between two adjacent grains of the agglutination, and that any trace of a pseudochitinous "base" is totally missing.

It seems that the various species of *Reophax* are very specific in the choice of the material they use for their agglutination. The species described by HÖGLUND as *R. scotti* Chaster, *R. gracilis* (Kiaer), *R. catenata* Höglund, and *R. catenella* Höglund are a peculiar group which form their tests by means of minute flat grains; this may also be said about *R. nana* Rhumbler (HÖGLUND, 1947), but not so clearly. *Reophax scorpiurus* Montfort invariably forms its test of coarse, irregular grains; in *R. subfusiformis* Earland the grains always consist of very coarse material with many very large grains of a very dark substance; in *R. bilocularis* Flint the material consists only of tests of rounded Foraminifera, mostly *Globigerina*, but also *Planulina* and globular agglutinated species; in the very large species *R. bermudezi* nov. spec., the agglutination consists of large tests of *Amphistegina* and *Archaias*; in the species attributed by BRADY (1884, pl. 30 fig. 14) to *P. scorpiurus* the test is invariably composed of fine sponge needles (*R. spiculifera* Brady), etc.; in *R. bermudezi* the cement contains globular fine sand grains.

It will be obvious that the different species may be distinguished not only by their different forms, but also by their different kinds of agglutination. In environments where the material for such an agglutination fails, the species is not found.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The author gave descriptions and figures of *Reophax guttifer* Brady (1932, p. 77–82), *R. dentaliniformis* Brady, *R. scorpiurus* Montfort, *R. spirulifera* Brady, and *R. pilulifer* Brady (1930, p. 120–121); they all had a single-layered agglutinated wall without any trace of an inner pseudochitinous layer.

Reophax compressus Goës Fig. 10-14

Reophax compressus Goës, 1894, p. 27, pl. 6 fig. 203–210.

This small species resembles an *Ammobaculites* in which the coiled part is missing. One might suggest that it is an *Ammobaculites* with such a large proloculus, that the coiled part is suppressed. However, the inner structure reveals that there is no inner pseudochitinous lining, whereas the wall consists of only one layer of agglutinated grains – foraminifera and other mostly calcareous particles – cemented together only between the grains and at the base of the wall of a next chamber, where it adheres to the former chamber wall.

These are characteristics of *Reophax*, not of *Ammobaculites*. The whole test is distinctly compressed and consists of three to five chambers, more or less pyriform in longitudinal section. The agglutination is very coarse and at the end of the last formed chamber the round aperture protrudes on a short neck. Most specimens observed do not exceed 1.5 m.

Common in Sta. 1442, 100 m, also in Sta. 1443, 200 m.

Fig. 2–3. *Technitella atlantica* Cushman. – Barbados, sta. 1443: one specimen from two sides, and another specimen (× 27).

Fig. 4–5. *Reophax scorpiurus* Montfort. – Santa Cruz (= St. Croix), off Frederiksted, 800 m; × 5, longitudinal section (× 60).

Fig. 6–7. *Reophax subfusiformis* Earland. – 65°24′ N, 29°00′ W, Ingolf-Exp., 735 Dan. fath.; 7, longitudinal section (× 26).

Fig. 8–9. *Reophax bilocularis* Flint. – Santa Cruz, off Frederiksted, 800 m; 8 (× 85); 9, longitudinal section (× 30).

Fig. 10–14. *Reophax compressus* Goës. – Barbados, sta. 1442: 10–11, specimens from two sides (× 20); 12–13, longitudinal sections through the broad side; 14, through the compressed side (× 30).

Fig. 15. *Reophax bermudezi* nov. spec. – Barbados, sta. 1442 (× 15).

Fig. 16–18. *Dusenburyiana procera* (Goës). – Barbados, sta. 1442: 16, total test; 17, apical end; 18, tranverse sections through successive chambers (all × 6).

Reophax bermudezi nov. spec. Fig. 15, 19

Reophax bilocularis (not Flint), BERMÚDEZ, 1935, p. 140, pl. 10, fig. 6.

BERMÚDEZ did not describe this large species, but he gave a good longitudinal section which reveals the characteristics. His specimen had a length of 2.3 mm, which is much larger than *R. bilocularis* Flint; moreover, it is covered by large foraminiferal tests.

Test large, up to 4 mm, elongate, straight or arcuate, consisting of 2, 3 or 4 chambers, with open aperture at the end of the last formed chamber on a not very conspicuous neck. Chambers somewhat elongate, overlapping. Sutures nearly invisible, due to the coarse agglutination which consists of large tests of *Amphistegina* which cover the animal like scales. Foraminiferal tests cemented together by cement in which rounded finer sand grains are imbedded. No pseudochitinous basal layer could be observed. In the specimen figured by BERMÚDEZ the agglutination also contains *Archaias*. So we have to describe the agglutination as consisting of lenticular larger Foraminifera.

The species is rare in St. 1442, only 5 specimens could be observed in the material.

Dusenburyina procera (Goës) Fig. 16–18, 20

Reophax procerus GOËS, 1894, p. 27, pl. 8 fig. 413–417; BERMÚDEZ, 1935, p. 149, pl. 10 fig. 3–5
Dusenburyina procera (Goës), BERMÚDEZ & KEY, 1952, p. 73; LOEBLICH & TAPPAN, 1964, p. 281, fig. 188, 6–7.

No microspheric specimens as figured by GOËS, could be observed. The tests are always bent to one side, as in *Dentalina*. It is uniserial and circular in section throughout. The wall consists of grains, tests of Foraminifera etc., with a considerable amount of cement. The chambers are pyriform, but overlapping, so that older chambers are often twice broader than long. Aperture terminal, with short neck and elongate, with distinct simple dent. Dent always situated at the bent side of the test. Proloculus in the megalospheric specimens distinct from the outside, nearly globular in longitudinal section.

LOEBLICH & TAPPAN placed this species in the Valvulinidae; however, in *Clavulina* as well as in *Valvulina* the test wall is porous, whereas in *Dusenburyina* no pores could be observed. Moreover, in *Clavulina*, also with an uniserial part of the test, the toothplates, forming the dents at the apertures, are always situated in such a way that they form in successive chambers angles of 120° with one another, thus following the pattern of the chambers in the triangular part.

In case that *Dusenburyina* developed from a Valvuline ancestor, the dents in the chambers should have followed the pattern of the triangular part; this is not so and we must conclude that this species and genus does not belong in the Valvulinidae. It might have derived from some sessile, coiled form.

The species is rather common in sample 1442, off Barbados, 100 m.

Loeblichopsis nov. gen.

Tests elongate, consisting of a single row of chambers which overlap each other so that sutures are nearly invisible from the outside. Test agglutinated, consisting of walls which are formed by more than one single layer of grains and with an inner pseudochitinous lining. Chambers more or less pyriform with single foramina and apertures which are situated in the axis of the test. Each chamber rests on the former one with a broad base which conceals the suture. In this way the test becomes cylindrical.

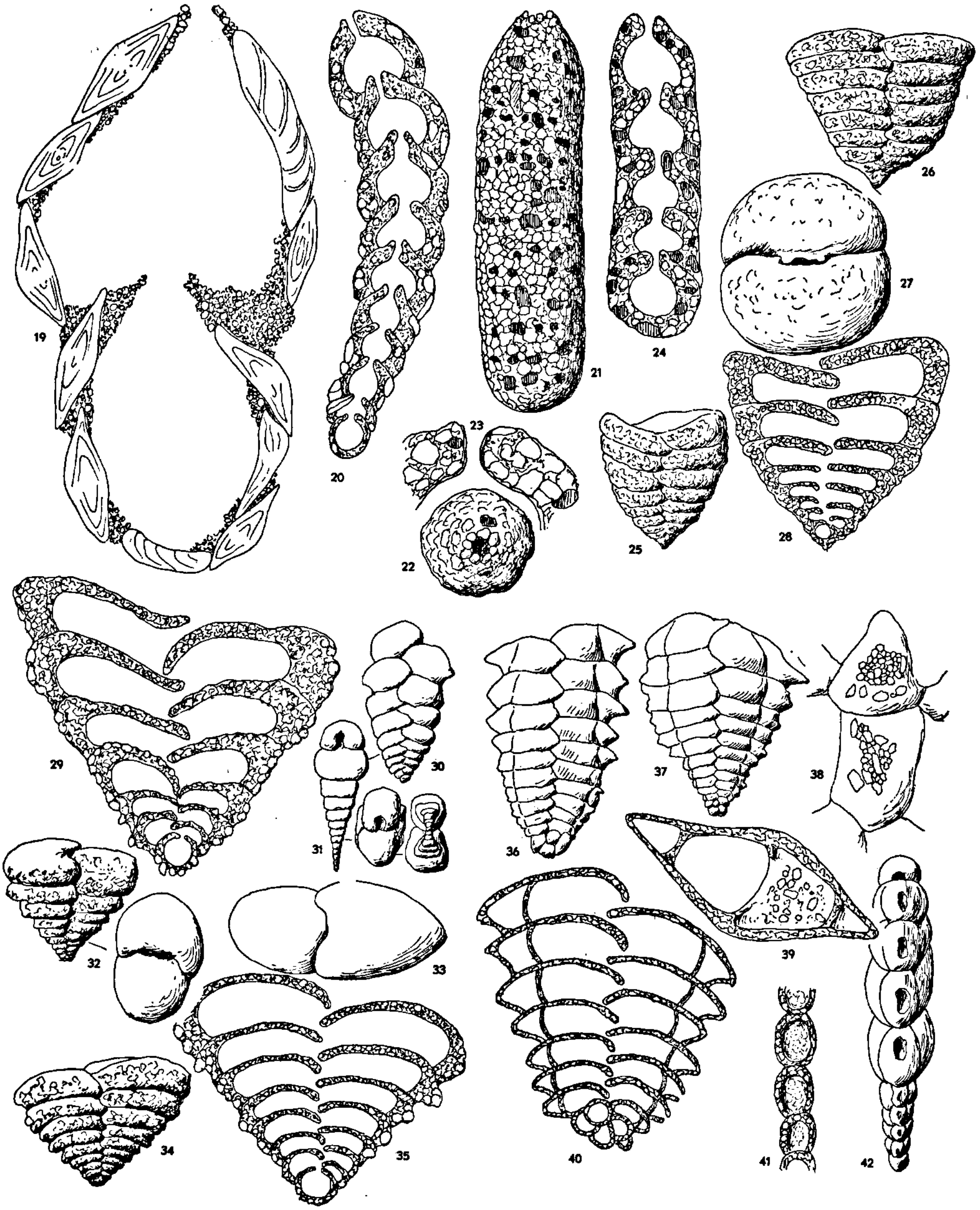
Genotype: *Reophax cylindricus* Brady.

There are at least two species which belong to this genus: the genotype and *Reophax sabulosus* Brady.

Loeblichopsis cylindrica (Brady) Fig. 21–24

Reophax cylindricus BRADY, 1884, p. 299, pl. 32 fig. 7–9; FLINT, 1897, p. 274, pl. 18 fig. 6; CUSHMAN, 1910, p. 91, fig. 129–131; CUSHMAN, 1920, p. 24, pl. 5 fig. 8.

Test cylindrical, rounded at the apical, slightly more tapering at the oral end. Aperture rounded with a border of distinct sand grains. Wall consisting of finer and coarser sand grains, neatly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cemented with very little cement. Wall brownish or greyish in colour, slightly banded since at the sutures more and darker grains are used. Sutures flush nearly with the surface, as each next chamber rides with a thickened base on the tapering end of the former one. Inner chamber-lumina pyriform. Inner walls of chambers and, especially, their apertural necks, coated by a brown pseudochitinous layer. Grains of agglutination consisting always of siliceous sand only.

This species was found in several stations from the North Atlantic, in very deep water; it is remarkable that it also occured (7 specimens) in Sta 1442, West off Barbados, depth 100 m. The specimens are very typical. The length here was up to 6 mm, breadth about 1 mm.

Textularia pseudotrochus Cushman Fig. 25–29

Textularia pseudotrochus CUSHMAN, 1922a, p. 21, pl. 5 fig. 1–3.

Between *Textularia barrettii* of megalospheric generation which always has a truncate top of the conus and nearly straight sides, specimens occur which show a pointed apex and distinctly convex

Fig. 19. *Reophax bermudezi* nov. spec. – Barbados, sta. 1442: transverse section through bilocular specimen (× 26).

Fig. 20. *Dusenburyiana procera* (Goës). – Barbados, sta. 1442: longitudinal section (× 11).

Fig. 21–24. *Loeblichopsis cylindrica* (Brady). – Barbados, sta. 1442: 21, total test; 22, apertural face; 23, longitudinal section through apertural face, showing the pseudochitinous lining (× 60); 24, longitudinal section (× 12).

Fig. 25–29. *Textularia pseudotrochus* Cushman. – Barbados, sta. 1442: 25–26, two specimens in sideview (× 12); 27, apertural face of specimen of fig. 26 (× 12); 28, longitudinal section (× 15). – Barbados, sta. 1443: 29, longitudinal section (× 60).

Fig. 30–31. *Textularia subplana* Cushman. – Barbados, sta. 1442: test from four sides (× 20).

Fig. 32–35. *Textularia conica* d'Orbigny. – Barbados, sta. 1443: 32–34, several specimens, sideviews and apertural faces (× 36); 35, longitudinal section (× 150).

Fig. 36–42. *Septigerina floridana* (Cushman). – Barbados, sta. 1442: 36–37, two specimens (× 36); 38, one chamber and its marginal part, surface (× 150); 39, transverse section through end-chambers (× 150); 40, longitudinal section, showing the spiral initial part and the secondary septa in the chambers (× 60); 41, tangential transverse section, showing the finely agglutinated secondary septa (× 60); 42, total test, from the narrow side, points of chambers slightly abrased (× 60).

sides. The apertural face is nearly circular. The outer surface is often very smooth, so that the sutures are scarcely visible, but other specimens have the surface somewhat roughened and the sutures are depressed. The slightly concave apertural face has a slit-like aperture and is always smooth.

On section the chambers are low, with mostly slightly rounded septa, the test is entirely biserial with globular proloculus at the pointed apex, the agglutination consists of grains cemented together with much cement.

The species is not common in sample 1442, and much more common in 1443.

Textularia subplana Cushman Fig. 30–31

Textularia concava FLINT (not Karrer), 1897, p. 283, pl. 28 fig. 5.
Textularia subplana CUSHMAN, 1922a, p. 15, pl. 2 fig. 10.

Test in the oldest part much compressed, later chambers (in outgrown specimens) may become more inflated. In the flattened part the periphery is levelled at right angles to the sides. Chambers somewhat rectangular, with not much depressed, but distinct slightly oblique sutures. Wall smooth with much cement and later chambers somewhat pointed at the periphery. Aperture sutural, a high and narrow slit.

CUSHMAN believed that only part of the specimens figured in the photograph given by FLINT belongs to this species; obviously CUSHMAN did not have fully outgrown specimens. All specimens figured by FLINT belong to this species, but it is not KARRER'S species. It is remarkable that FLINT mentions this species in a depth of about 100 m, and CUSHMAN does the same.

Two specimens in St. 1442, also at a depth of 100 m.

Textularia conica d'Orbigny Fig. 32–35

Textularia conica D'ORBIGNY, 1839, p. 143, pl. 1 fig. 19–20.

Test triangular in side view, oval in end view. Margin distinctly lobulate, sutures nearly horizontal and depressed, slightly curved. Agglutination smoothly finished, often with coarser grains at the margin. Septa and apertural end slightly convex, very smooth. Aperture a narrow slit in the middle of the axial suture.

Specimens beginning with a small proloculus have a more rounded end view than those with a larger proloculus; proloculus at the end of the apical point.

This species occurs in both stations off Barbados and also in the sample off Santa Cruz, depth 800 m, where it is common.

Septigerina floridana (Cushman) Fig. 36–42

Textularia pseudocarinata CUSHMAN, 1921, p. 121, pl. 22 fig. 5.
Textularia floridana CUSHMAN, 1922a, p. 18, pl. 2 fig. 11–12.

Test beginning with a short spiral with its axis perpendicular to the axis of the main test; test later elongate triangular, each chamber ending at the margin in a distinct spine which is often partly broken. Test very compressed, with sharp periphery and thickened axial part, especially in the middle of the test. Sutures of the biserial part distinct, slightly depressed, nearly horizontal. Chambers at the apertural face slightly convex, apertural face lozenge-shaped; aperture a small opening at the suture. Agglutination fine, wall smooth.

Length about 1 mm, never more.

Longitudinal sections reveal that each septum runs from the aperture towards the top of the marginal spine and that then the wall sharply bends towards the axis, adhering to the wall of the former chamber. But each hollow spine is separated from the main chamber lumen by a thin septum, beginning in the third Chamber of the spiral. This septum shows no opening whatever toward the main chamber and is distinctly secondarily formed, as it consists of much finer agglutinated material than that of the septa themselves.

The genus *Septigerina* Keijzer from the Eocene also begins with a spiral and also shows these septa near the margin, though here in the genotype, the secondary septa mostly show openings between the main chamber and the marginal part. Yet it is evident, especially as in the genotype the septa become larger and more closed towards the end of the test, that this recent species *floridana* is a later direct offspring of this genotype. So it seems best to name this remarkable species *Septigerina.*

This species was also found by the author in many samples from the Siboga-Expedition, especially from deeper water. These Pacific specimens do not differ in any characteristic from the Caribbean ones as found in Barbados (Sta. 1442) and St. Croix (800 m deep). It is certain that the Pacific species was called *Textularia pseudocarinata* by CUSHMAN. I maintain the name *floridana*, since CUSHMAN did not describe the inner structure of his *T. pseudocarinata*. The specimens figured by BRADY (1884, pl. 42 fig. 15–16) are very typical.

Septigerina must be closely related to *Spiroplectammina*; in the latter genus the tests begin with a spiral and the transverse section is also lozenge-like.

Very common in Sta. 1442 and 1443, off Barbados; also occurring off St. Croix, depth 800 m.

Bigenerina irregularis Phleger & Parker Fig. 43–50

Bigenerina nodosaria d'Orbigny, var. *textularioides* (Goës), BERMÚDEZ, 1935, p. 153.
Bigenerina irregularis PHLEGER & PARKER, 1951, p. 4, pl. 1 fig. 16–21.

From the description given by FLINT (1897, p. 289, pl. 35 fig. 3) of *Clavulina parisiensis* d'Orbigny, var. from coarse coral sand, and from the description given by CUSHMAN (1922a, p. 25, pl. 5 fig. 8–9) of *Bigenerina nodosaria* d'Orbigny, var. *textularioidea* (Goës), both stating that the species has a length of about 4–5 mm, can be concluded that the species mentioned by BERMÚDEZ in 1935 (length 1.5 mm, abundant in all localities around Cuba) cannot be the species described by these two authors. Moreover, BERMÚDEZ sent me some specimens from his Cuba-collection, showing the identity with the species here described. It is obvious that the large species described by FLINT and CUSHMAN belongs to *Cribogenerina parkerae* (ANDERSEN) (1961, p. 26). The species differs from *Bigenerina nodosaria* d'Orbigny by the much coarser agglutination, the more depressed sutures and the biserial part, which is easier to distinguish. All specimens described here have a rounded or slightly ellyptical aperture and not a cribate one.

Tests consist of the flat biserial part followed by an uniserial row of chambers with distinctly compressed sutures, whereas the last formed chamber is pyriform with protruding part with axial rounded aperture. The test shows a coarse agglutination, mainly of calcitic grains, seldom also of foraminiferal tests. In longitudinal section the walls of the biserial chambers are thin, those of the uniserial part much thicker, whereas the lumen of the uniserial chambers is distinctly pyriform.

There are three generations: one is a robust form with very large triangular flat biserial part, the B-generation; a second generation has a slightly more slender form, also with a prominent flat triangular biserial part, but smaller and with less chambers, the A_1-generation; the third form is very slender with the largest set of uniserial chambers and a very small biserial part, consisting of few chambers, the A_2-generation. The B-generation is rare in the material.

Measurements: length of test 0.25–2.80 mm; breadth endchamber 0.25–0.75 mm; number of biserial chambers 3–17; number of uniserial chambers 3–9; diameter proloculus 12.5–100 μ.

It could be stated that the total number of biserial chambers and the length of the individuals decrease with the increase of the diameter of the proloculus.

The breadth of the endchamber decreases slightly with the increase of the proloculus. The number of uniserial chambers does not show a distinct relation to the diameter of the proloculus.

Most of the specimens observed (149 individuals) belong to the A_1-form, with an average proloculus-diameter of 50 μ; some specimens clearly had a larger proloculus, with an average of 75 μ, the A_2-form; the B-generation was rare in the material; 4 specimens had a proloculus-diameter from 12.5–18 μ.

Some specimens with large proloculus and small number of biserial chambers believed to belong to the A_2-generation, had a very long test due to the large number of uniserial chambers; most of them, however, had a small test with only few uniserial chambers. The B-individuals invariably had a large test with 7–9 uniserial chambers.

The species strongly resembles *Cribrogenerina parkerae*; in Sta. 1442 the two species occur together; but in the sample off Frederiksted (St. Croix), 800 m deep, only the smaller species occurs.

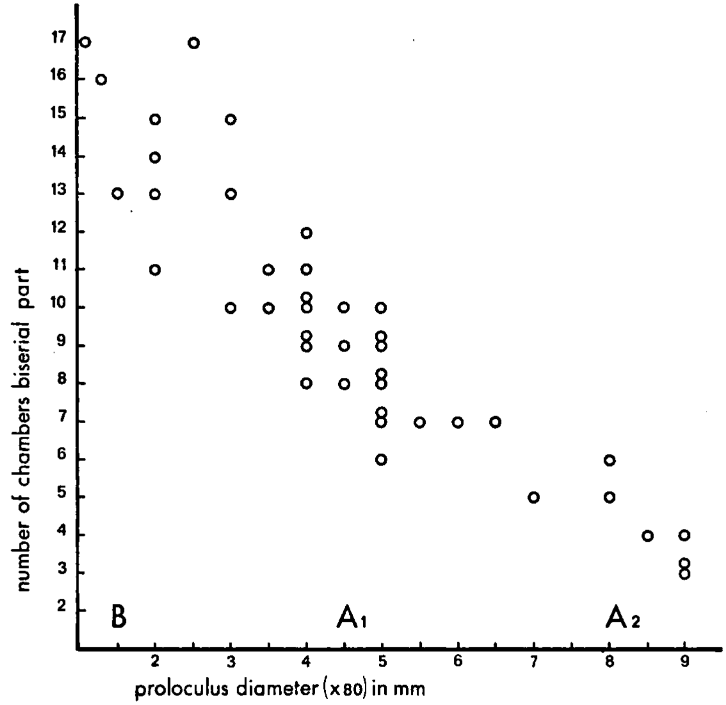


Fig. 43. *Bigenerina irregularis* Phleger & Parker. – Diagram showing the diameter of the proloculus and the number of chambers in the biserial parts of the tests. The correlation is typically negative, as it is in so many other Foraminifera.

Cribrogenerina parkerae Andersen Fig. 51–56

Cribrogenerina parkerae ANDERSEN, 1961, p. 26; LOEBLICH & TAPPAN, 1964, p. 254, fig. 166, 1–2.

This species is much larger than *Bigenerina nodosaria* d'Orbigny, as most specimens reach a length of about 4.5 mm. Most specimens show a tiny biserial part which forms an angle with the later axis of the test and is very thin. The main test consists of a series of pyriform chambers which overlap, whereas the very rough agglutination consisting of calcitic grains and Foraminifera, obscures the sutures which are depressed. The slender test gradually increases in breadth towards the last formed chamber. The aperture is distinctly cribrate in the later chambers, but consists of a triangular opening in the more initial ones, as described by the author for *Bigenerina nodosaria* from the Key-Islands, Pacific (1933, p. 86, fig. 9). It may be that here also three generations occur as some small specimens showed a very short biserial part with large proloculus (A_2-generation).

Whether it is necessary to have a distinct genus for this species is not certain; it could be that the cribrate aperture of *Cribrogenerina* is formed by sand grains irregularly covering the normal triangular aperture. The size of the test may be due to circumstances.

The genus *Cribrogenerina* was created for Carbonian and Permian bigenerids with a cribrate aperture; yet they show general characteristics which strongly differ from those of *C. parkerae.* It is certain that FLINT'S *Clavulina parisiensis,* var. from coral sand, is this species. Moreover, CUSHMAN'S species *Bigenerina nodosaria* d'Orbigny var. *textularioides* (Goës) with its length of 5–7 mm is not the small species mentioned by BERMÚDEZ as such (1935, p. 153), but the species described here. So it is not at all sure that this large species should be named *Cribrogenerina*; it may be a *Bigenerina* in which the last formed chambers developed a cribrate aperture, not comparable with the large rounded aperture found in true paleozoic *Cribrogenerina.* Moreover, in paleozoic *Cribrogenerina* the later chambers seem to be more or less labyrinthic and are very broad and low, whereas the species described here has the pyriform chambers typical of *Bigenerina.*

The species is common in sample 1442, off Barbados, 100 m; rare in 1443.

Valvotextularia oceanica (Cushman) Fig. 57–62

Textularia folicacea Heron-Allen & Earland, var. *oceanica* CUSHMAN, 1932, p. 8, pl. 1 fig. 11–12.

The test begins relatively flat, mostly somewhat pointed at the apical end, with slightly oblique sutures between the chambers which are a little broader than high. Typical is that the chamber walls at the margin of the test often show a proximal dent due to a large grain in the agglutination; this agglutination is rather coarse, consisting of very irregularly placed sand grains and, at the distal part, often includes tests of Foraminifera and parts of shells. The distal part has a more rounded transverse section than the proximal part of the test.

In longitudinal sections the proloculus is not located at the apical end, but always somewhat to one side, so that the first chambers form a short spiral; this spiral is strongly developed in the microspheric form (which was not found in the material off Barbados, but could be described by the author in the Bay of Jakarta (1968).

The test wall shows distinct pores between the sand grains. These two characteristics point to the genus *Valvotextularia.*

This species, known till now only from the Indian and Pacific Oceans, occurs in Sta. 1443, 200 m. It does not differ in characteristics from that found in the Pacific, but is very typical.

Gaudryina convexa (Karrer) Fig. 63–64

Textilaria convexa KARRER, 1865, p. 78, pl. 16 fig. 8.
Gaudryina rugosa d'Orbigny, BRADY, 1884, p. 381, pl. 46 fig. 14–16.
Gaudryina hastata PARR, 1932, p. 219, pl. 22 fig. 40.
Gaudryina quadrangularis Bagg var. *antillana* BERMÚDEZ & ACOSTA, 1940, p. 55, pl. 9 fig. 4–5.
Gaudryina stavensis Bandy, BANDY, 1956, p. 194, pl. 30 fig. 1.
Gaudryina convexa (Karrer), BURDETT, c.s., 1963, p. 513.

There are two forms, possibly two generations. One form is small, triangular in side view, with only one or two biserial rows of chambers and it is somewhat triangular in apertural view; the other form is much longer, with the triangular part nearly as long as the biserial part, the latter consisting of about 4 rows of biserial chambers, and it is nearly rounded in apertural view. In both forms the apertural side is very smooth, slightly truncate, with a small crescent-formed aperture in the middle of the suture, whereas the sides of the chambers are roughly agglutinated in the biserial part and slightly smoother in the triangular part.

The species differs little from *G. quadrangularis* Bagg from the Pacific; CUSHMAN described a species as *Gaudryina convexa* (1911, p. 66, fig. 105; 1922, p. 71, pl. 8 fig. 5); whether this species is the same as that described by KARRER in 1865 is not certain, though the figures by CUSHMAN do not differ much from the figures given by BURDETT, c.s., 1963, in their monograph on *Gaudryina convexa* (Karrer). In any case, CUSHMAN refers under this name a species found by him in the Pacific as well as in the West Indian seas. It is possible that CUSHMAN knew the name given by KARRER, though not mentioning its author.

The species found (not commonly) in sample 1443, 200 m, certainly belongs within the variation as described by BURDETT c.s. (1963).

Pseudoclavulina mexicana Cushman Fig. 65–66

Clavulina parisiensis Brady, Parker & Jones, GOËS, 1894, p. 41, pl. 8 fig. 378–383.
Clavulina parisiensis d'Orbigny, var. *humilis* FLINT (not Brady), 1897, p. 289, pl. 36 fig. 1.
Clavulina humilis Brady, var. *mexicana* CUSHMAN, 1922, p. 83, pl. 16 fig. 1–3.
Pseudoclavulina mexicana CUSHMAN, 1937, p. 117, pl. 16 fig. 5–11.

The triangular part is more or less distinct, short; then follows an uniserial part which consists of 5–8 chambers with clearly depressed sutures. The wall is distinctly agglutinated, rough. The aperture is a rounded opening on a short neck.

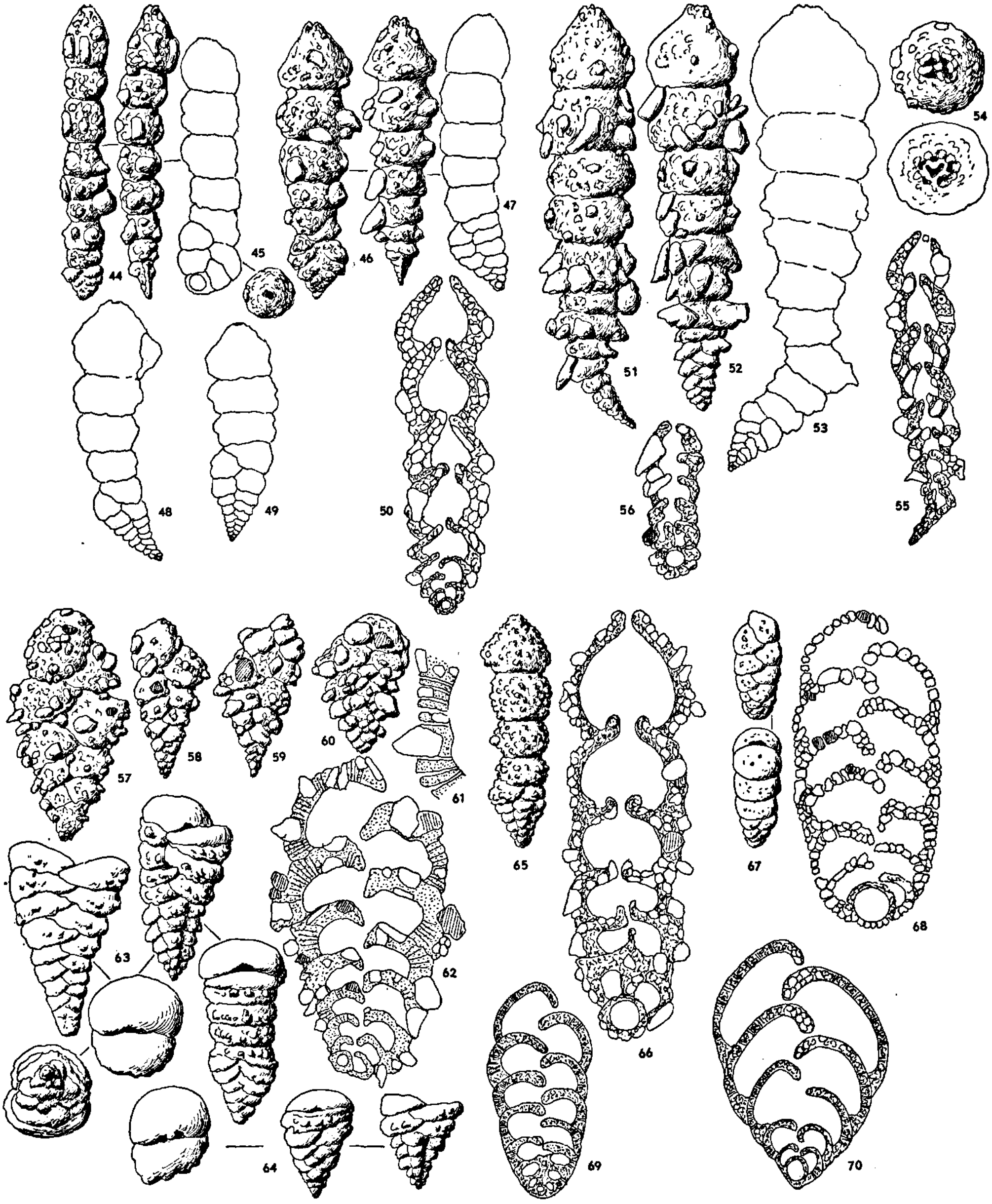
Longitudinal sectioning shows that the test is thin, consisting of irregular sand grains, mostly of calcitic nature. There seems to be a thin pseudochitinous inner layer. The necks of the apertures possess no traces whatever of a toothplate and the chamber walls do not show pores.

The tests found only in Sta. 1443, where the species is not uncommon, do not exceed 1 mm in length and are smaller than those described by CUSHMAN from Florida, and by PHLEGER & PARKER (1951) from the Mexican Gulf.

Dorothia caribaea Cushman Fig. 67–68

Dorothia caribaea CUSHMAN, 1936, p. 31, pl. 5 fig. 3; 1937, p. 99, pl. 11 fig. 5.

Test short and stout, initial end broadly rounded, sides nearly parallel, first whorls polyserial, forming a small part of the test, later chambers biserial, about 3–4 series. Sutures distinct, slightly oblique. Test wall clearly agglutinated, but smooth. Aperture sutural, in the middle of the last formed chamber suture, slit like.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Wall consisting of one layer of sand grains, strongly cemented, with some pores between the grains, only visible in sections.

Typical for this species is the rather coarse agglutination which is uncommon in *Dorothia.* The genotype, *D. bulletta* (Plummer) has a very fine agglutination in which the pores in the wall are very distinct. Pores also were observed in *D. pupoides* (Reuss) from the Santonian (see Hofker, 1964b, p. 8–11, fig. 3 & 7) *D. gibbosa* (d'Orbigny) from the Pliocene of Italy has a somewhat coarser agglutination of the test wall, especially in the region of the apertural side, and has also very distinct pores in the outer walls. In *D. caribaea,* however, the test wall is coarsely agglutinated all over and hence the pores between these sand grains are rather inconspicuous (cf. Fig. 69–70).

Since in all species studied the walls show pores, it is obivous that this characteristic is of generic value. This is the more so, since in *Valvulina* as well as in *Martinottiella* pores are found in the outer walls (Hofker, 1956, p. 36, *Listerella*); *Clavulina* shows these pores also (Hofker, 1956, p. 26; 1964b, fig. 5). It is remarkable

Fig. 44–50. *Bigenerina irregularis* Phleger & Parker. – Barbados, sta. 1442: 44–45, specimens of the A_2-generation; 46–47, A_1-generation; 48–49, B-generation (all × 20); 50, longitudinal section (× 24).

Fig. 51–56. *Cribrogenerina parkerae* Andersen. – Barbados, sta. 1442: 51–52, megalospheric test from two sides; 53, microspheric test (both × 20); 54, two apertural faces with the "cribrate" aperture; 55, longitudinal section through microspheric specimen (× 15); 56, longitudinal section through probable A_2-specimen with only two biserial chambers (× 12).

Fig. 57–62. *Valvotextularia oceanica* (Cushman). – Barbados, sta. 1443: 57–60, four specimens (× 20); 61, part of test wall with the pores in the agglutinated wall (× 60); 62, longitudinal section, showing the excentric proloculus (× 27).

Fig. 63–64. *Gaudryina convexa* (Karrer). – Barbados, sta. 1443: two specimens from different sides (× 20).

Fig. 65–66. *Pseudoclavulina mexicana* Cushman. – Barbados, sta. 1443: 65, total test (× 27); 66, longitudinal section (× 60).

Fig. 67–68. *Dorothia caribaea* Cushman. – Barbados, sta. 1443: 67, total test from two sides (× 20); 68, longitudinal section, showing pores in the coarsely agglutinated walls (× 45).

Fig. 69· *Dorothia bulletta* (Plummer). – Navarro Formation: longitudinal section (× 45).

Fig. 70. *Dorothia gibbosa* (d'Orbigny). – Pliocene of Castell' Arquato, Italy: longitudinal section (× 45).

that LOEBLICH & TAPPAN placed all these genera together in the Valvulinidae (1964, p. 279); they omitted, however, *Dorothia* and *Marssonella* which also have these pores in the walls as well as the general chamber arrangement.

The species is not very common in Sta. 1443, and is missing in Sta. 1442. Only megalospheric specimens were observed.

Karreriella bradyi (Cushman) Fig. 71–74

Gaudryina pupoides d'Orbigny, BRADY, 1884, p. 378, pl. 46 fig. 1–4.
Gaudryina bradyi CUSHMAN, 1911, p. 67, textfig. 107; 1922a, p. 74, pl. 12 fig. 8.
Cribrogoësella bradyi CUSHMAN, 1935, p. 4, pl. 1 fig. 10–11; 1937a, p. 120, pl. 14 fig. 4–5.
Karreriella bradyi (Cushman), CUSHMAN, 1937a, p. 135, pl. 16 fig. 6–11.

Test in the microspheric generation with 9–11 polyserial chamber-rows, followed by about 6 biserial rows in the adult; chambers in the polyserial part scarcely visible, in the biserial part with distinctly depressed, more or less horizontal sutures, in the last formed chambers inflated.

Test in the initial part circular in transverse section, later slightly quadrangular. In the last formed chambers the aperture – which is slightly areal, transverse and narrow – is doubled by an axial lip which, however, seems to be formed to strenghten its border. Aperture with clearly protruding lip. Test tapering towards the end; length up to 2 mm.

In the megalospheric generation the test consists of a small polyserial part, forming only the conical initial end, followed by a series of 5 rows of biserial chambers. The aperture is a somewhat areal slit, with protruding lip.

It is not very clear why CUSHMAN puts the microspheric form into *Cribrogoësella*, since the aperture does not have the typical form as found in the genotype. The wall is very smooth and its surface even shining. Sections show that it is built of very fine agglutinated material, closely cemented. Fine pores occur in the outer walls, so that this species is allied to *Dorothia* which also shows pores in the test walls.

In the microspheric form the proloculus is very small, in the megalospheric form much larger. Since the initial wall in the microspheric form is very thick, the initial part of this generation is not so pointed as in many other microspheric Foraminifera.

The species occurs in both stations, 1442 and 1443.

Tritaxilina yasicaensis Bermúdez Fig. 75–79

Tritaxilina yasicaensis BERMÚDEZ, 1949, p. 96, pl. 5 fig. 55–56.

This species, originally described from the Miocene, obviously continues into the Recent, just as is the case with *T. atlantica* Cushman.

Test conical to fusiform, tapering towards the initial end which is bluntly pointed. Apertural end strongly truncate, totally flat or mostly a little lobulate, due to the substratum. Chambers difficult to distinguish, often with raised distal wall part. Wall agglutinated with much cement. Aperture a very small arcuate slit in the centre of the apertural side, often with a slight lip.

Sections show that the walls of the later biserially arranged chambers form a divisional mural in the middle of the chamber running towards the axial part. Thus, as in other species of *Tritaxilina*, the wall may be described as pseudo-labyrinthic. Such outgrowths are not found in the chambers in the initial part, where the test begins with coils of 5 chambers, rapidly attaining the biserial stage.

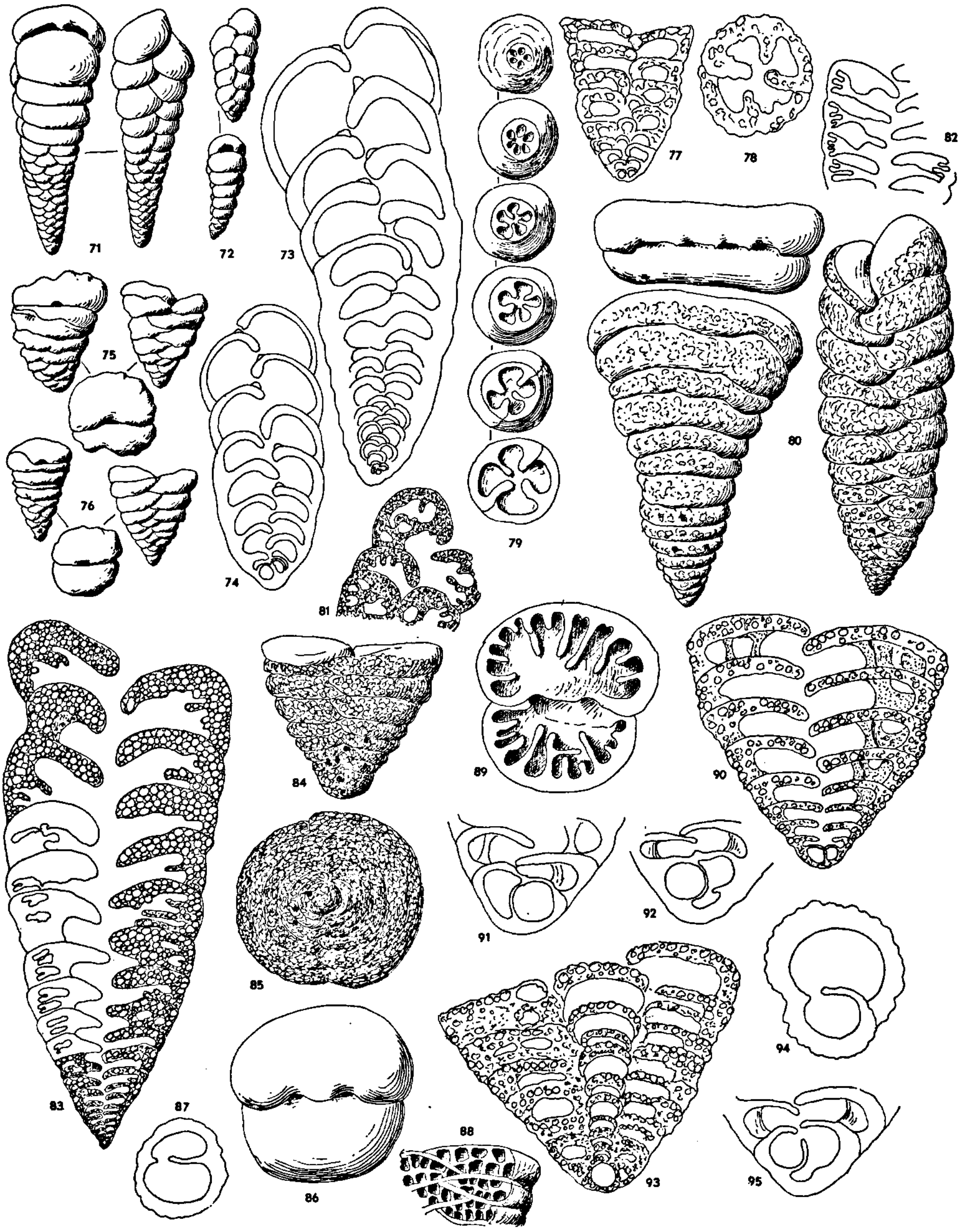
The specimens found in Sta. 1443, where the species is not uncommon, are small, not exceeding 1 mm.

Textulariella barrettii (Jones & Parker) Fig. 80–95

Textularia barrettii JONES & PARKER, 1863, p. 80, 105; 1876, p. 99, fig.; BRADY, 1884, p. 367, pl. 44 fig. 6–8; CUSHMAN, 1919, p. 31, pl. 6 fig. 5–7; 1922a, p. 20, pl. 3 fig. 3–6.

Textulariella barrettii CUSHMAN, 1935, p. 11, pl. 2 fig. 2; 1937a, p. 66, pl. 1 fig. 14–30; HOFKER, 1956, p. 30, pl. 1 fig. 14–30; GROENHAGEN & LUTERBACHER, 1966, p. 235–246.

It is remarkable that in Lower Cretaceous as well as in Tertiary and Recent samples in which *Textulariella* is found, specimens also occur which are known under the genus-name of *Cuneolina*. CUSHMAN already mentioned this in 1937 (under *Cuneolina*) and pointed out that the inner structure of both genera is identical.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In 1956 the present author showed that *Cuneolina angusta* Cushman is the microspheric form of *Textulariella barrettii* (Jones & Parker).

The test is conical with a circular apertural and a slightly concave side. The top of the conus is not pointed but bluntly rounded; the sides are straight, smooth or with somewhat depressed sutures. On horizontal section the chambers show the strong labyrinthic structure, formed by divisions running from the outer wall, but leaving the central part of the chambers free; these divisions are complicated by horizontal secondary divisions which are irregularly placed. The top of the conus is formed by two chambers: the more globular proloculus which is, in all cases observed, situated excentrally and a second chamber, partly enveloping the proloculus ventrally as well as dorsally.

This second chamber, which may be indicated as a deuteroconch, does not show traces of divisions. Above it the biserially arranged chambers begin. Specimens broken at their top often still show a part of the third chamber, the first one of the biserial series. This may have led to the conclusion, as given by CUSHMAN, that the test of this species begins with a short triserial part. This is not so. The fact that the deuteroconch is found slightly above the proloculus may indicate that, if there may be spoken

Fig. 71–74. *Karreriella bradyi* (Cushman). – Barbados, sta. 1443: 71, microspheric individual, known as *Cribrogoësella*; 72, megalospheric specimen (× 20); 73, longitudinal section through microspheric specimen; 74, idem, megalospheric (× 30).

Fig. 75–79. *Tritaxilina yasicaensis* Bermúdez. – Barbados, sta. 1443: 75–76, two specimens (× 20); 77–78, longitudinal and transverse sections showing polyserial initial end and slightly labyrithic chambers (× 30); 79, successive transverse sections (× 20).

Fig. 80–95. *Textulariella barrettii* (Jones & Parker). – Barbados, sta. 1443: 80, B-form from three sides, known as *Cuneolina angusta* Cushman (× 11); 81, longitudinal somewhat tangential section through forma B, showing labyrinthic walls (× 11); 82, same specimen, axial longitudinal section of end chambers (× 11); 83, longitudinal axial section through B-form (× 15); 84–86, test of A-form (× 12); 87, transverse section through initial top of A-form (× 30); 88, tangential section through end chambers of A-form, showing the labyrinthic structure (× 12); 89, transverse section through A-form (× 12); 90, axial section through A-form (× 30); 91–92, 95 initial parts of axial sections (× 60); 93, axial section, perpendicular to section of fig. 90; 94, transverse section through top of A-from, showing the two initial chambers (× 60).

of a spiral, this spiral has its axis perpendicularly to the axis of the main test. It is evident that the structure of a proloculus and a deuteroconch points in some way to *Dictyoconus.*

Both megalospheric and microspheric forms begin with one proloculus, followed by a second non-alveolar chamber, and then the normal alveolated chambers in a biserial series start. In the large microspheric form the first ten rows of chambers have thin walls and the secondary septa very much resemble those found in *Pseudotextulariella* from the Lower Cretaceous; later chambers have much thicker walls and the septa become more irregular. Very large specimens of the *Cuneolina*-like generation in the end show much inflated smooth apertural sides; the aperture, in the megalospheric form small and narrow, becomes an elongated slit in the B-generation which, in some places, often forms a crenulate margin. These crenulations may reach the wall of the former chamber, thus forming a row of openings; it is this form which may have led to the creation of the genus *Cuneolinella* Cushman & Bermúdez.

In any case, it is evident that *Textulariella barrettii, Cuneolina angusta* and *Cuneolina lewesi* form one single species, as GROENHAGEN & LUTERBACHER have concluded. It remains remarkable that *Pseudotextulariella* and *Cuneolina pavonia* d'Orbigny occur together in the same Lower Cretaceous beds, and that their inner structures indicate that they also belong together. Moreover it is here stated that in the microspheric form of *Textulariella barrettii* the first sets of chambers strongly show the inner structure of *Pseudotextulariella.*

Both *Textulariella* and *Pseudotextulariella* have no initial spiral in the sense of the Valvulinidae, as described by CUSHMAN; obviously he mistook the first alveoles of the initial biserial chambers for the initial spiral. I agree with GROENHAGEN & LUTERBACHER that *Textulariella* cannot be placed together with *Kilianina* and *Pfenderina* in one subfamily, nor can it be placed in the Family of the Pavonitinidae as done by LOEBLICH & TAPPAN (1964, p. 299). GROENHAGEN & LUTERBACHER created for *Textulariella, Guppiella, Alveovalvulina* and *Alveovalvulinella* a new Family, Textulariellidae. It is not certain that these genera belong together and it may be that, in spite of the large geologic gap between Lower Cretaceous *Pseudotextulariella* and Miocene-Recent *Textulariella,* these two genera belong together (see also Lower Cretaceous and Tertiary *Cuneolina* and *Dictyoconus*). It is possible that the extreme habitat of these forms is the reason why in Upper Cretaceous and Lowest Tertiary, no forms have yet come to our knowledge.

In sample 1443 the species is very abundant, as in the sample off Santa Cruz (HOFKER, 1956). It is evident that *Textulariella* is a species adapted to deeper water. In 1443 also the microspheric form, *Cuneolina angusta* Cushman, is common. In sample 1442 only four megalosphaeric specimens were found.

Liebusella soldanii (Jones & Parker) Fig. 96–107

Lituola soldanii JONES & PARKER, 1860, p. 307, No. 184; CARPENTER, PARKER & JONES, 1862, pl. 6 fig. 42–43.

Lituola soldanii Jones & Parker, var. *intermedia* VAN DEN BROECK, 1876, p. 74, pl. 2 fig. 1, 3, 4, 6.

Valvulina triangularis d'Orbigny, var. *polyphragma* GOËS, 1882, p. 87, pl. 11 fig. 390–400.

Haplostiche soldanii BRADY, 1884, p. 318, pl. 32 fig. 13–18 (not 12); FLINT, 1897, p. 277, pl. 21 fig. 3.

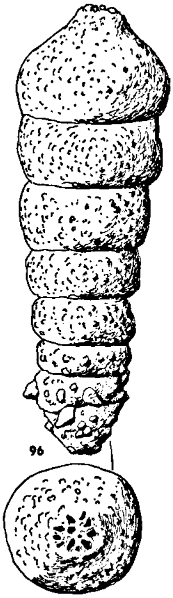
Haplostiche dubia CUSHMAN (not d'Orbigny), 1920, p. 34,, pl. 7 fig. 2–3.

Liebusella soldanii (Jones & Parker), CUSHMAN, 1937a, p. 166, pl. 20 fig. 1–11; HOFKER, 1956, p. 39, pl. 3 fig. 8–31.

This species is very variable; the microspheric form is even known as *Liebusella soldanii* var. *intermedia* (Van den Broeck) as the present author stated in 1956.

The test of the megalospheric form consists of 2–4 whorls of three, sometimes four chambers following the proloculus; they have axially placed apertures, and only the first whorl has simple chambers, all later ones being more or less labyrinthical. This closely coiled set of chambers is abruptly followed by uniserial ones, which more or less overlap former chambers, with fairly distinct depressed sutures.

The thick wall consists of grains of calcite, intermingled with tests of Foraminifera, parts of shells, grains of calcified algae, etc. Especially the triserial part in the megalospheric generations, but also the proximal parts of later chambers, show coarse particles on the outside.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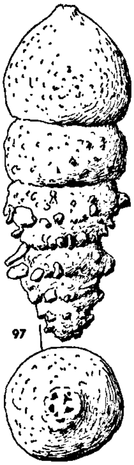
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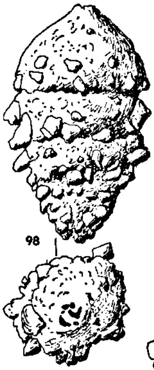
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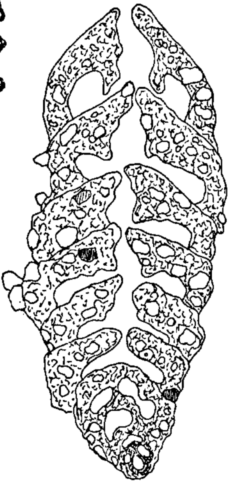
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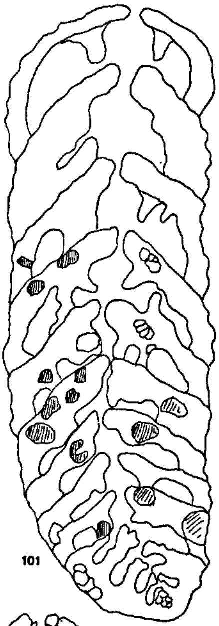
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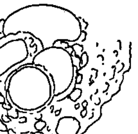
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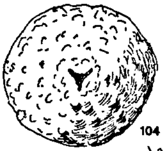
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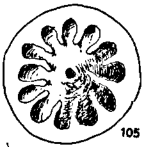
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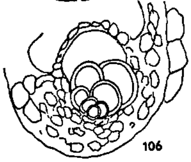
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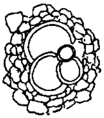
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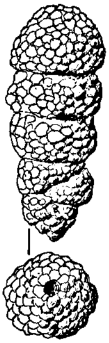
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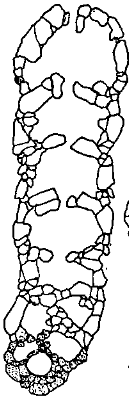
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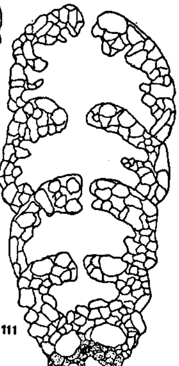
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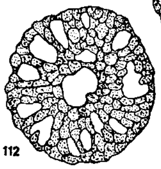
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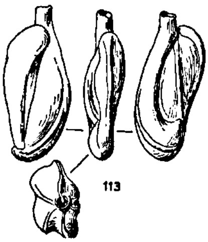
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The microspheric, much larger generation mostly shows a smooth surface and only the initial part may have coarser grains on the outside; in this generation the sutures of the uniserial chambers may often be invisible.

As I described in 1956, there are three generations, B, A_1 and A_2. The aperture is a central areal opening, which may have one dent, or is obscured by small particles of calcitic material and a crenulated outer surrounding circle, giving rise to the complicated aperture mentioned by me in 1933 and 1956 and by many other authors.

In 1949 the author analysed *Hagenowella paleocenica* HOFKER (1949, p. 431–434, textfig. 1–3) in both microspheric and megalospheric generations. When we compare the transverse sections as shown in that paper with those found in the initial part of *Liebusella*, the resemblance is striking. Here too, the initial part is triserial after the proloculus and the later chambers become labyrinthic. The present author is convinced that *Hagenowella* and *Liebusella* belong to the same group. However, *Hagenowella* was suppressed by LOEBLICH & TAPPAN (1961, p. 241–244) on valid grounds and a new genus proposed for European Upper Cretaceous (Lower Maestrichtian) specimens found in Rügen which specimens, how-

Fig. 96–107. *Liebusella soldanii* (Jones & Parker). – Barbados, sta. 1442: 96, total test of B-generation, known as var. *intermedia* Van den Broeck, sideview and apertural face (× 10); 97, A_1-form, from two sides (× 10); 98, A_2-form, from two sides (× 10); 99, young specimen (× 10); 100, longitudinal section through A_1-form (× 15); 101, longitudinal section through B-form (× 15); 102, successive transverse sections through A-individual, the upper 5 sections × 6, the lowest one × 20, showing the triserial initial spiral; 103, longitudinal section through initial part of A-specimen (A_1) (× 60); 104, apertural face of microspheric specimen (× 10); 105, last formed chamber in transverse section of B-form (× 6); 106, longitudinal section of B-specimen of fig. 101 (× 60); 107, transverse section through microspheric specimen, initial spiral, showing a triserial arrangement of the initial chambers (× 60).

Fig. 108–112. *Liebusella flintiana* Cushman. – Barbados, sta. 1443: 108, total test from two sides, megalospheric (× 11); 109, microspheric test from two sides (× 11); 110, longitudinal section through megalospheric test (× 30); 111, longitudinal section through microspheric test (× 30); 112, transverse section showing the labyrinthic inner structure (× 30).

Fig. 113. *Quinqueloculina polygona* d'Orbigny. – Barbados, sta. 1443: test from four sides (× 11).

ever, are identical with *Ataxogyroidina* Marie. MARIE (1941, p. 53) states that this genus is typical for "une série d'arcs-boutants, plus ou moins développés, localisés au contact de la suture inférieure".

This also is the case in the Eocene species hitherto described as *Hagenowella* but for the fact that in these more developed species the last part of the test may become more or less biserial. LOEBLICH & TAPPAN (1961, p. 242) established a new genus for those Cretaceous forms with labyrinthic inner structure, *Hagenowina* Loeblich & Tappan; they do not differ from the initial parts of Eocene "*Hagenowella*" and *Liebusella*.

LOEBLICH & TAPPAN (1964, p. 283) gave *Ataxogyroidina* Marie as synonym with *Ataxophragmium* Reuss which is stated by them to have inner partitions too. Though neither *Ataxophragmium* nor *Ataxogyroidina* were mentioned by LOEBLICH & TAPPAN in 1961, *Hagenowina* is evidently a younger synonym of one or both of them. Although not mentioned, *Remesella* Vasiček with genotype *R. mariae* Vasiček – as described by LOEBLICH & TAPPAN (1964, p. 290) – is possibly synonym with those forms, which GLAESSNER (1937, p. 366–367, pl. 2 fig. 15) put down as *Textulariella? varians*. The latter species is identical with VASIČEK's and comes very close to *Hagenowella paleocenica* Hofker. In RAUZER & FURSENKO (1959, p. 225) the species of GLAESSNER is called *Textulariella*, though the latter doubted its generic status. It is impossible that the species belongs to *Textulariella*, since the triserial initial part is not like that of this genus.

But it seems likely that from *Ataxogyroidina* (*Hagenowina*) over *Hagenowella* (*Remesella*) the phylogeny runs towards *Liebusella*. In the latter genus the biserial part as found in *Hagenowella* may be totally suppressed, but all three groups have the identical part which in *Ataxogyroidina* forms the whole test.

The geographic form, described by the author in 1956, from 800 m off Santa Cruz (St. Croix), only differs from the form found abundantly in sample 1442, off Barbados, 100 m, in the more rough surface of the latter and a more yellowish colour. The inner structure is the same.

Liebusella flintiana (Cushman) Fig. 108–112

Valvulina triangularis d'Orbigny, var. *eocaena* GOËS, 1882, p. 88, pl. 11 fig. 401–403.
Clavulina eocaena GOËS (not Gümbel), 1894, p. 41, pl. 8 fig. 368–377; 1897, p. 35, fig. 1.
Clavulina flintiana CUSHMAN, 1922a, p. 86, pl. 15 fig. 7–9.
Goësella flintiana CUSHMAN, 1937a, p. 116, pl. 13 fig. 13–16.

The species is characterized by the red-brown colour of the tests of all individuals. There are two forms. One form is relatively small, slender, with rounded initial end which is as broad as the uniserial part. It has one series of 3–4 chambers above the proloculus which is relatively large, followed by one set of two chambers in biserial arrangement, and then 3–4 uniserial chambers. Aperture simple, rounded, median on the apertural side, small. Outer surface of the test consisting of large, irregular, often angular sand grains, quartz.

A longitudinal section shows that the walls of the chambers are thin, mostly consisting of one layer of grains, especially when the latter are large. Grains agglutinated by fine brown material. There are nearly no indications of labyrinthic structure.

The second form is larger, more robust, beginning with a pointed initial part with several coils of 4–5 chambers after the small proloculus. This part is followed by two chambers arranged biserially and there are 3–4 uniserial chambers. In the uniserial part the chamber sutures are clearly depressed. The outer wall consists, as in the first mentioned form, of irregular and angular quartz grains. The aperture is situated as in the first form, but is mostly larger, rounded.

In longitudinal sections the chamber walls are much thicker than in the first form and consist mostly of 2–3 layers of sand grains. Moreover, in several of the chambers there are septa forming sacs in the walls, so that the chamber becomes labyrinthic.

This phenomenon can also be seen on transverse section, and has been figured and described by FLINT as "chambers partially divided by a network of incomplete septa springing from the outer wall"; CUSHMAN misinterpretes this structure as "wall vacuolar, thick".

It is clear that the two forms, both with outerly the same structure and the peculiar brown colour, also mentioned by both FLINT & CUSHMAN, are only megalospheric and microspheric generations of one and the same species which in the megalospheric form has the characteristics of *Goësella*, but in the microspheric form those of *Liebusella*. So it is more correct to place this species in the genus *Liebusella*.

Liebusella soldanii, though not so common as in Sta. 1443, also occurs in Sta. 1442. But this species has a test wall consisting solely of calcitic grains. This may be one of the typical examples of specific specialisation in the choice of the material in agglutinated species. Quarz grains are not common in the samples.

In Sta. 1443, West of Barbados, at 200 m, *L. flintiana* is not uncommon.

Quinqueloculina polygona d'Orbigny Fig. 113

Quinqueloculina polygona D'ORBIGNY, 1839, p. 98, pl. 12 fig. 21–23; HOFKER, 1964, p. 22, fig. 13.

This species was already described by the present author in 1964 from the tidal zones. The specimens in Sta. 1442 and 1443 do not differ from the specimens found in shallow water, nor do they differ from those, found in the sample off Santa Cruz, depth 800 m. A slightly less elongate variety was found by GRAHAM & MILITANTE in the Philippines (1959, p. 46, pl. 6 fig. 1.), where it is abundant too. So it is one of the very few species of *Quinqueloculina* which are found all over the world and in tropical areas; moreover, it lives not only in shallow water, but also in deep.

Pyrgo subsphaerica (d'Orbigny) Fig. 114–121

Biloculina subsphaerica D'ORBIGNY, 1839, p. 162, pl. 8 fig. 25–27.
Pyrgo subsphaerica (d'Orbigny), CUSHMAN, 1929, p. 68, pl. 18 fig. 1–2.

The tests of the megalospheric generation are small, rounded, slightly longer than broad; the periphery of the chambers is rounded, but the last formed chamber bends clearly inwards to meet the former. The sutures are depressed, but always with an area which is slightly bending outwards over the next chamber. The aperture is situated on the oblique apertural side, broadly oval with a distinct tooth with two lateral extensions. Testwall smooth, polished.

The initial part of these specimens begins with a rounded thin-walled proloculus with a diameter of about 80 μ, followed by a long neck chamber which is loop-formed, thus being twice transsected. Then some irregular chambers follow, also with very thin walls, with more or less triloculine arrangement. Then the biloculine arrangement starts with about five chambers with relatively thick walls.

The tests of the microspheric generation are larger, the general form is the same, but at the periphery the chambers show a subacute to rounded edge before the wall bends towards the former chamber. The flange at the suture is somewhat more pronounced. The aperture is slightly more elongate and the tooth is broader with distinct lateral extensions.

This generation starts with a proloculus with a diameter of about 25 μ, followed by a quinqueloculine arrangement of two sets of thin-walled chambers. Then one set of chambers follows in a triloculine arrangement. After this coil the biloculine arrangement starts with about 4 chambers with extremely thick walls.

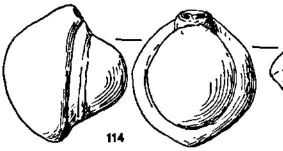
As in Sta. 1443 no other species of *Pyrgo* is found, and as in the sample off Santa Cruz the two described forms also occur, it is evident that both forms belong to one single species with two distinct generations. Remarkable is that the B-generation differs in some minor features from the A-generation.

This is, according to CUSHMAN, the most common species in the West Indian region. It is the only species of the genus *Pyrgo* found in sample 1443, off Barbados. In sample 1442 no specimens occur, while in the deeper sample from Santa Cruz (800 m) at least 4 species were found, but here also this species is the most common one.

The length of the megalospheric generation is about 0.8 mm, often smaller. The length of the microspheric generation is larger, about 1.2 mm.

LAGENIDAE

The number of species belonging to the Lagenidae is relatively large in the studied samples. This shows that these samples are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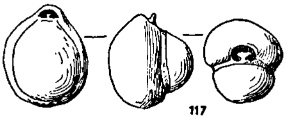
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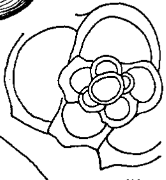
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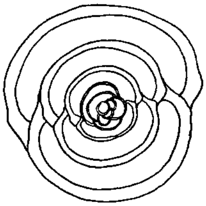
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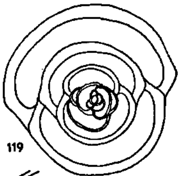
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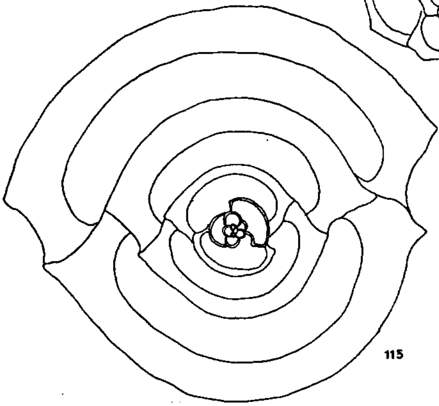
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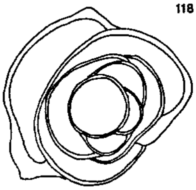
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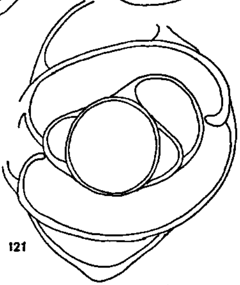
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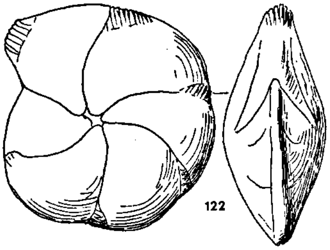
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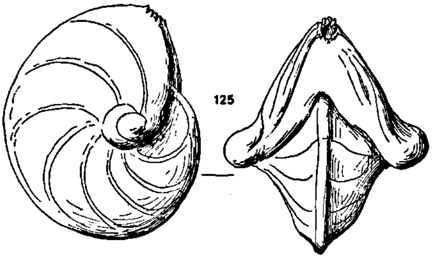
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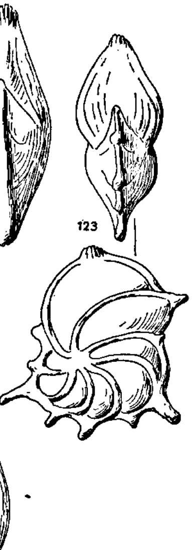
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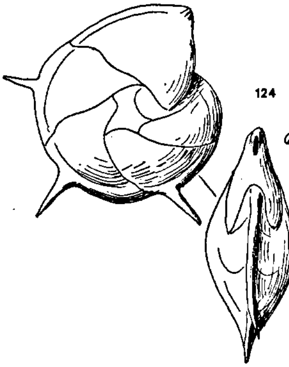
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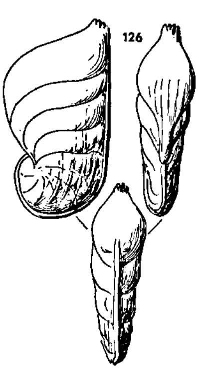
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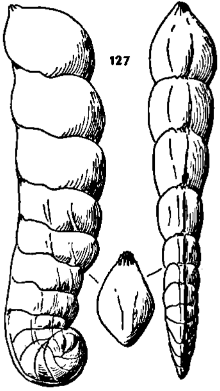
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autochthonous, since Lagenidae are nearly unknown from beach or coral-reef samples.

Remarkable is that few of the coiled species had the large apertural opening, characteristic for *Robulus*, though it is often believed that *Robulus* is a modern genus in respect to forms with a typically radiate aperture; most species which are coiled thus belong to *Lenticulina.*

Difficult is the taxonomic status of species which have a more or less distinct coiled first part, whereas the later part is uncoiled. It is believed that such species with rounded or oval transverse sections of the uncoiled part belong to *Marginulina* or *Marginulinopsis*; whereas those with distinctly compressed uniserial part, especially when they show a clear carina, are mostly classed in the genera *Vaginulina* and *Vaginulinopsis.*

The difference between *Marginulina* and *Marginulinopsis* is believed to be found in the larger coiled part of the latter, and the same can be said about the difference between *Vaginulina* and *Vaginulinopsis.* However, we know already that in such species the amount of coiling is a function of the size of the proloculus and in specimens with very large proloculus, the coiling part may be suppressed totally (see also *Lingulina* and *Lingulinopsis*).

Specimens of all genera mentioned above have somewhat oblique sutures, with their most proximal part at the ventral side, opposite

Fig. 114–121. *Pyrgo subsphaerica* (d'Orbigny). – Barbados, sta. 1443: 114, microspheric generation from three sides (× 15); 115, transverse section of microspheric specimen (× 45); 116, initial part of this section (× 113); 117, megalospheric specimen (× 15); 118–119, two transverse sections of megalospheric specimens (× 30); 120–121, initial parts of the sections of 118–119 (× 113).

Fig. 122. *Lenticulina atlantica* (Barker). – Barbados, sta. 1442: from two sides (× 12).

Fig. 123. *Lenticulina antillea* (Cushman). – Barbados, sta. 1442: from two sides (× 12).

Fig. 124. *Lenticulina* (*Robulus*) *calcar* (Linnaeus). – Barbados, sta. 1443: from two sides (× 21).

Fig. 125. *Lenticulina* (*Robulus?*) *submamilligera* (Cushman). – Barbados, sta. 1442 (× 12).

Fig. 126. *Marginulina costata* Batsch. – Barbados, sta. 1442: from three sides (× 12).

Fig. 127. *Marginulina bachei* Bailey. – Barbados, sta. 1442: from three sides (× 12).

to the aperture, as well as to the side where the uncoiling begins.

Those species which are totally uncoiled, with a radiate aperture and sutures which are not oblique, are classed in the genera *Dentalina* or *Nodosaria*. *Dentalina* (with the genotype *D. cuvieri* d'Orbigny) has straight sutures perpendicular to both sides of the test. *D. trujilloi* Loeblich & Tappan (1964, fig. 403–404) however, shows distinctly oblique sutures and thus belongs to *Marginulina* with large proloculus.

Nodosaria was believed to differ from *Dentalina* in its showing a totally straight test. But there are so many variations between quite straight and distinctly arcuate (*Dentalina*), that a differentiation between the two genera is extremely difficult. In both genera the microspheric forms are completely uncoiled. Both have apertures which are found just on top of the last formed chamber, whereas in *Marginulina* and *Vaginulina* the apertures are clearly excentric. I believe it more adequate to name all uncoiled species with straight sutures and central (axial) aperture *Nodosaria*, since this name has priority.

The genus *Lingulina* is characterised by the slit-like aperture which shows no radiate structure. It is obvious that specimens with large proloculus show a straight uniserial test, whereas specimens with small proloculus show the initial part coiling. This cannot be a characteristic which is of generic importance, and the name *Lingulinopsis* has to be suppressed. The slit-like aperture suggests that it is a primitive genus, since in all Lagenidae known, the simple aperture was the first one geologically, whereas only in later time the radial aperture developed.

Lingulina carinata d'Orbigny Fig. 140–143

Lingulina carinata D'ORBIGNY, 1826, p. 257, No. 1; Modèles, No. 26; 1839a, p. 124, pl. 1 fig. 5–6; GOËS, 1896, p. 65; CUSHMAN, 1923, p. 95, pl. 19 fig. 1–2.

Test elongate, tapering, depressed, with slightly carinate sides. The megalospheric form with nearly horizontal sutures which are somewhat curving backwards towards the sides; the microspheric form with coiled first part and slightly oblique sutures. Sutures depressed, sides distinctly lobulate (this is more a characteristic of

L. seminuda, but the striae at the periphery are missing totally in the specimens studied). Wall smooth. Aperture an elongate slit in the axis of the last formed chamber.

Two well-preserved specimens in sample 1442; one of them is microspheric; several specimens in 1443.

Nodosaria flintii Cushman Fig. 134

Nodosaria obliqua FLINT (not Linné), 1897, p. 311, pl. 57 fig. 5.
Nodosaria flintii CUSHMAN, 1923, p. 85, pl. 14 fig. 1.

Test elongate, initial part pointed, tapering gradually towards the middle of the test, last formed chambers not so broad. Sutures indistinct in the larger part of the test, only the last formed three or four chambers with clearly depressed transverse sutures. Whole test ornamented by longitudinal costae, which are spirally twisted on the initial part of the test. The aperture – situated on a neck – is a rounded opening surrounded by 9–10 small knobs, the remains of a radiate aperture. Most tests are distinctly arcuate.

The species is common in sample 1442.

Vaginulina filiformis nov. spec. Fig. 139

Nodosaria filiformis (not d'Orbigny), CUSHMAN, 1923, p. 76, pl. 12 fig. 1–2.

Test elongate, slightly arcuate at the side of the apertures which can be seen at the concave side through the wall which is smooth. Chambers in the initial part with smooth sutures, later chambers with depressed sutures and especially at the convex side somewhat inflated. Sutures distincly oblique. Aperture clearly excentric, radiate.

The initial end proves that the species belongs to *Vaginulina*; it is not the species described by d'Orbigny. Though there is but a very small difference between the side-view of the test and the concave side – the tranverse section being nearly circular – the fact that at the concave side all former apertures can be seen and that the sutures become gradually more oblique towards the initial end, indicates that this species belongs to the genus *Vaginulina*.

Some specimens in Sta. 1442, and some in 1443. Length maximum 10 mm.

Vaginulina bermudensis Cushman Fig. 138

Vaginulina bermudensis Cushman, 1923, p. 136, pl. 38 fig. 2.

Test elongate, arcuate (especially near the initial end), circular or slightly oval in transverse section. Sutures clearly oblique, especially towards the initial end. Aperture radiate, excentric, at the concave side of the test. All rudimentary apertures visible at the sutures at the concave side. Only the last formed chambers with lightly depressed sutures, mostly at the convex side. Ornamented by very fine costae which continue across the chambers, and are directed to the median line of the concave side, near the initial end.

Length maximum 7 mm. This species originally was described from the Bermudas; it is common in Sta. 1442.

Vaginulina americana Cushman Fig. 136

Vaginulina linearis Brady Flint, 1897, p. 314, pl. 61 fig. 1(?).
Vaginulina americana Cushman, 1923, p. 135, pl. 38 fig. 3–4.

Test elongate. Concave side nearly straight; with distinctly oblique sutures and radiate aperture. Other side clearly convex, with depressed sutures. In the later chambers former apertures are visible; these are covered by the ornamentation nearer to the initial part.

Test ornamented by coarse, slightly oblique costae, interrupted at the sutures. At the concave side they bend towards the median line, thus forming a kind of blunt carina in the more initial part. Last chamber always without ornamentation.

The length of the species in the sample studied was not exceeding 2 mm. The species is not common in the material.

Vaginulina advena Cushman Fig. 137

Nodosaria (Dentalina) roemeri Brady, 1884, p. 505, pl. 63 fig. 5; Flint, 1897, p. 310, pl. 56 fig. 5.
Nodosaria advena Cushman, 1923, p. 79, pl. 14 fig. 12.

Test relatively short, arcuate, slightly compressed, consisting of 5–7 chambers. Later chambers with depressed sutures which are highly oblique. Aperture radiate at the concave side; former apertures still partly visible at the sutures.

Test towards the initial part with slightly indicated carina at the concave side. Tests slightly compressed, if at all. Wall smooth.

Length in the material maximum 2 mm. Some specimens in Sta. 1442.

Marginulina costata (Batsch) Fig. 126

Nautilus (Orthoceras) costatus BATSCH, 1791, p. 2, pl. 1 fig. 1.
Marginulina costata (Batsch), BRADY, 1884, p. 528, pl. 65 fig. 10–13; CUSHMAN, 1923, p. 132, pl. 37 fig. 2.

Initial part of test strongly coiled, with distinct carina which continues at the straight side of the test. Later uncoiled chambers rapidly gaining in breadth, with plainly rounded apertural face and sigmoid sutures which are slightly depressed. Aperture at straight side (concave side). Especially the initial part of the test is ornamented by somewhat irregular coarse costae, also present on the apertural face. Test compressed.

This species might be the microspheric form of *Vaginulina americana* Cushman.

Rare in the Barbados material.

Marginulina bachei Bailey Fig. 127

Marginulina bachei BAILEY, 1851, p. 10, fig. 2–6.
Marginulina ensis FLINT (not Reuss), 1897, p. 314, pl. 59 fig. 3.
Marginulina bachei Bailey, CUSHMAN, 1923, p. 129, pl. 36 fig. 7–9.

Test elongate, consisting of a close-coiled initial part which is very compressed, and an uncoiled part where the chambers gradually inflate towards the end. One side of the uncoiled part is slightly concave and the chambers here are only very slightly inflated; the convex side shows strongly depressed sutures.

Sutures sigmoidal in the uncoiled part, aperture at the concave side, older apertures are partly visible. Initial coiled part of the test with distinct carina which shortly continues at the concave side of the uncoiled part. In the last formed chambers the carina

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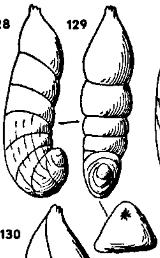

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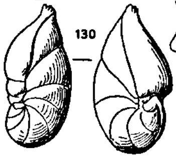

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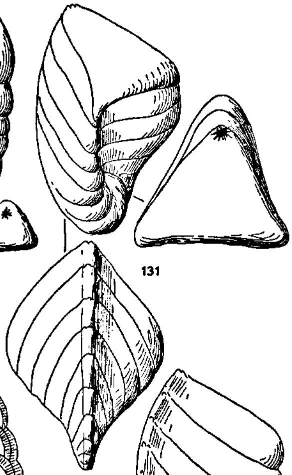

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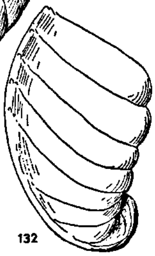

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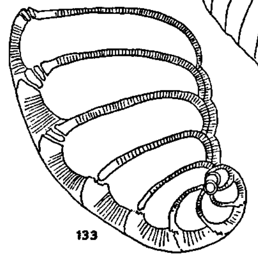

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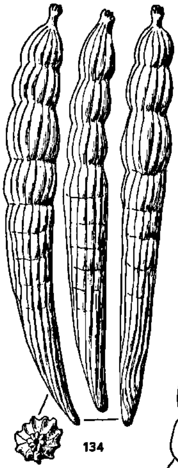

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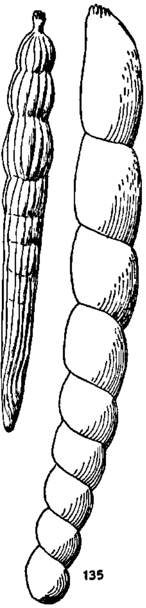

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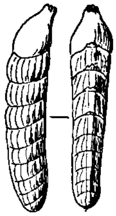

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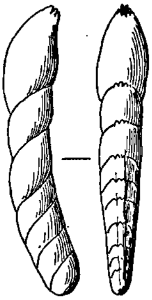

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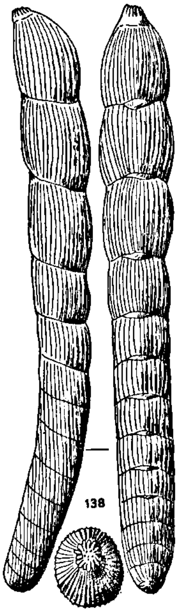

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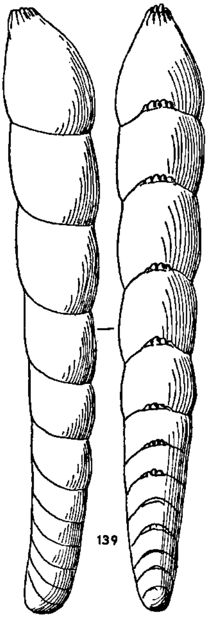

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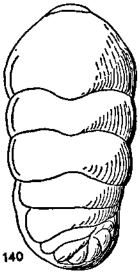

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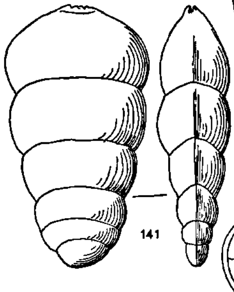

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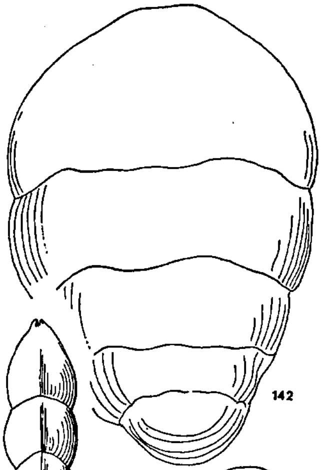

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becomes obscure, due to the inflation of the chambers. This species might be the microspheric form of *Vaginulina filiformis.*

Length in the material maximum 3 mm. Not common.

Lenticulina submamilligera (Cushman) Fig. 125

Cristellaria submamilligera CUSHMAN, 1917, p. 657; 1923, p. 109, pl. 28 fig. 3.

Test biconvex, with a thin keel. Chambers with curved sutures which are raised, hyaline, distinct, slightly bossed. Chambers ending centrally in a plainly calcitic boss, resulting in a lozenge-shaped test in apertural view. Apertural side bordered by two clearly protruding edges, inflated. Aperture a central opening surrounded by many small protuberances, radiate, at the periphery of the test (*Robulus*-type?).

Some specimens attain a diameter of 2 mm or even more. Common in the material.

Lenticulina vortex (Fichtel & Moll) Fig. 146

Nautilus vortex FICHTEL & MOLL, 1803, p. 33, pl. 2 fig. d–i.
Robulina vortex (Fichtel & Moll), D'ORBIGNY, 1826, p. 288, No. 4.
Cristellaria vortex (Fichtel & Moll), PARKER, JONES & BRADY, 1871, p. 240, pl. 10 fig. 82; BRADY, 1884, p. 548, pl. 69 fig. 14–16; FLINT, 1897, p. 317, pl. 65 fig. 1; CUSHMAN, 1923, p. 108.

Test very smoothly lenticular, with slight keel and numerous very regular chambers with curved sutures reaching the centre,

Fig. 128–130. *Saracenaria acutauricularis* (Fichtel & Moll). – Barbados, sta. 1443 (× 21).
Fig. 131–133. *Saracenaria italica* (Defrance). – Barbados, sta. 1443; from several sides and longitudinal section (× 21).
Fig. 134. *Nodosaria flintii* Cushman. – Barbados, sta. 1442 (× 12).
Fig. 135. *Dentalina* cf. *filiformis* d'Orbigny. – Barbados, sta. 1443 (× 21).
Fig. 136. *Vaginulina americana* Cushman. – Barbados, sta. 1442 (× 12).
Fig. 137. *Vaginulina advena* (Cushman). – Barbados, sta. 1442 (× 12).
Fig. 138. *Vaginulina bermudensis* Cushman. – Barbados, sta. 1442 (× 12).
Fig. 139. *Vaginulina filiformis* nov. spec. – Barbados, sta. 1442 (× 12).
Fig. 140–143. *Lingulina carinata* d'Orbigny. – Barbados, sta. 1442, 1443: 140, 143, microspheric form, known as *Lingulinopsis*; 140 (× 24); 143 (× 12); 141–142, megalospheric forms (× 12).

without umbo. Surface smooth, even at the sutures. Apertural side narrow; aperture at the periphery of the test, radial, often with slightly prolonged ventral (or axial) larger opening (*Robulus*-type).

Diameter of test about 1 mm or slightly more. Common in the material.

Lenticulina atlantica (Barker) Fig. 122

Cristellaria articulata BRADY (not Reuss), 1884, p. 547, pl. 69 fig. 10, 12; FLINT, 1897, p. 317, pl. 64 fig. 2 (partly).
Cristellaria lucida CUSHMAN, 1923, p. 111, pl. 30 fig. 2.
Cristellaria atlantica BARKER, 1960, p. 144.

Test lenticular, with about 6 chambers in the last formed whorl. Chambers broad, slightly inflated, with narrow sutures and umbo which are both somewhat depressed. Sutures curved, ending in remnants of former apertures. Aperture large, somewhat protruding in the middle of the last formed chamber, consisting of numerous canals, radiate. Periphery bluntly keeled or without keel, slightly lobulate.

Common in the material of Sta. 1442.

Lenticulina antillea (Cushman) Fig. 123

Nodosarina crepidula (Fichtel & Moll), var. *cassis* GOËS, 1882, p. 49, pl. 3 fig. 50–51.
Cristellaria echinata FLINT (not d'Orbigny), 1897, p. 318, pl. 66 fig. 2.
Cristellaria antillea CUSHMAN, 1923, p. 116, pl. 31 fig. 1, pl. 32 fig. 1, pl. 34 fig. 1.

Test lenticular, compressed, chambers rapidly increasing in breadth; each chamber with a distinct rim at both sides of the apertural side which is strongly inflated. These rims form the very much inflated, often beaded sutures. They also form the plain carina which is heavily built, blunt and provided with irregular spines, which are bluntly finished.

Length about 1 mm. Only one specimen in the material of Sta. 1442.

Lenticulina calcar (Linné) Fig. 124

Nautilus calcar LINNÉ, 1767, p. 1162, No. 272.
Cristellaria calcar BRADY, 1884, p. 55, pl. 70 fig. 9–12.

Test close-coiled, lenticular, with triangular broad and long chambers. The slightly curved sutures do not reach the middle and are not radial but oblique to radial, so that each suture of a former chamber reaches the next one at about ⅔ of the length. Margin slightly keeled with one spine on each chamber, except for the last formed chamber. Surface smooth and shining. Aperture mostly with one middle larger opening (*Robulus*-type).

The species was not found in sample 1442 (100 m), but in several specimens in 1443; it was extremely common in the sample off Santa Cruz (St. Croix), 800 m deep.

Lenticulina iota (Cushman) Fig. 144

Cristellaria iota CUSHMAN, 1923, p. 111, pl. 29 fig. 2; pl. 30 fig. 1.

Test close-coiled, compressed, with distinct calcareous umbo which is flush with the surface. Typical is the broad keel at the carina which is transparent. Sutures slightly curved, nearly radial, not raised. Aperture radiate, in some specimens with a slightly larger opening in the middle of the apertural face (*Robulus*-type?).

Several specimens in Sta. 1443, 200 m.

Lenticulina echinata (d'Orbigny)? Fig. 145

Robulina echinata D'ORBIGNY, 1846, p. 100, pl. 4 fig. 21–22.

One single specimen was found in Sta. 1443 which may belong in the variation-breadth of this species. It differs from the type of D'ORBIGNY only in having no spines at the margin. Even the longitudinal striae at the surface of the last formed chambers are visible, whereas in older chambers the raised, slightly bossed sutures and the pustules on the chamber walls are very distinct. Aperture of *Robulus*-type.

CUSHMAN (1921, p. 233) mentions the species living in the Philippines. Thus the species would not be restricted to the Miocene.

Saracenaria acutauricularis (Fichtel & Moll) Fig. 128–130

Nautilus acutauricularis FICHTEL & MOLL, 1798, p. 102, pl. 18 fig. g–i.

Test in the megalospheric form beginning with a short spiral, which is followed by about 6 uncoiling chambers. In the microspheric tests the spiral is somewhat larger, and only very few uncoiling chambers follow, so that the whole test becomes more compact. In the uncoiled chambers the inner side is flattened, typical for *Saracenaria*, thus showing triangular chambers in transverse section.

The test wall is smooth or (in the coiled part) ornamented by very shallow striae. The outer periphery is more or less sub-acute, in the coiled part slightly keeled. The aperture is close to the outer "keel" and distinctly radiate. The megalospheric tests have a length of maximum 1.5 mm.

This species is known from the Oligo-Miocene and Pliocene of the Caribbean region and was first described by FICHTEL & MOLL from Recent shore sands in the Mediterranean; it occurs also in the shore sands at Rimini, Italy. It was abundant in Sta. 1443. The tests are well-preserved so that the species seems to be still living in the Caribbean area, from which it is also mentioned by CUSHMAN from 102–165 m (1923, p. 124, pl. 35 fig. 1). FLINT (1897, p. 316, pl. 63 fig. 3) recorded it from off Florida and off the coast of Carolina.

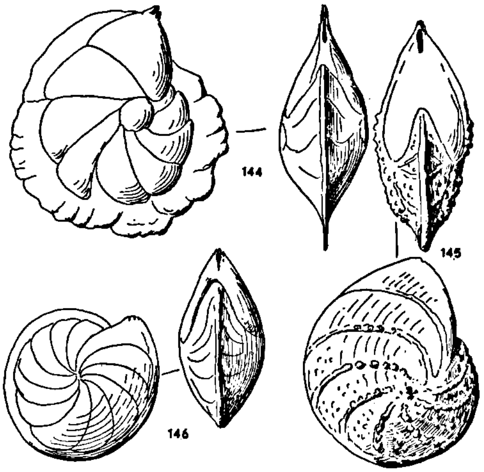


Fig. 144. ***Lenticulina*** **(*Robulus*)** ***iota*** (Cushman). – Barbados, sta. 1443; from two sides (× 20).

Fig. 145. ***Lenticulina*** **(*Robulus*)** ***echinata*** (d'Orbigny)?. – Barbados, sta. 1443; from two sides (× 20).

Fig. 146. ***Lenticulina*** **(*Robulus*)** ***vortex*** (Fichtel & Moll). – Barbados, sta. 1442; from two sides (× 11).

Saracenaria italica Defrance Fig. 131–133

Saracenaria italica DEFRANCE, 1824, p. 177; 1827, p. 344; Atlas Conch., pl. 13 fig. 6.
Saracenaria italica (Defrance), BERMÚDEZ, 1949, p. 153, pl. 8 fig. 53–54.
Cristellaria italica (Defrance), FLINT, 1897, p. 316, pl. 63 fig. 6.

Test stout, consisting of a coiled, keeled, initial part, followed by a more uncoiled one, of about 3–5 chambers which are triangular in section. Angles sub-angular. Surface smooth; aperture radiate, at the dorsal angle.

FLINT and CUSHMAN (1923, p. 125–126) found the species in the Gulf of Mexico and the Caribbean in deeper water; it is also known from the Miocene of the same region.

The species was not uncommon in Sta. 1443.

Dentalina cf. **filiformis** d'Orbigny Fig. 139

Dentalina (*Nodosaria*) *filiformis* D'ORBIGNY, 1826, p. 253, No. 14.
Nodosaria filiformis d'Orbigny, BRADY, 1884, p. 500, pl. 63 fig. 4 only; CUSHMAN, 1921, p. 194, pl. 34 fig. 9; 1923, p. 76, pl. 12 fig. 1 (not 2).

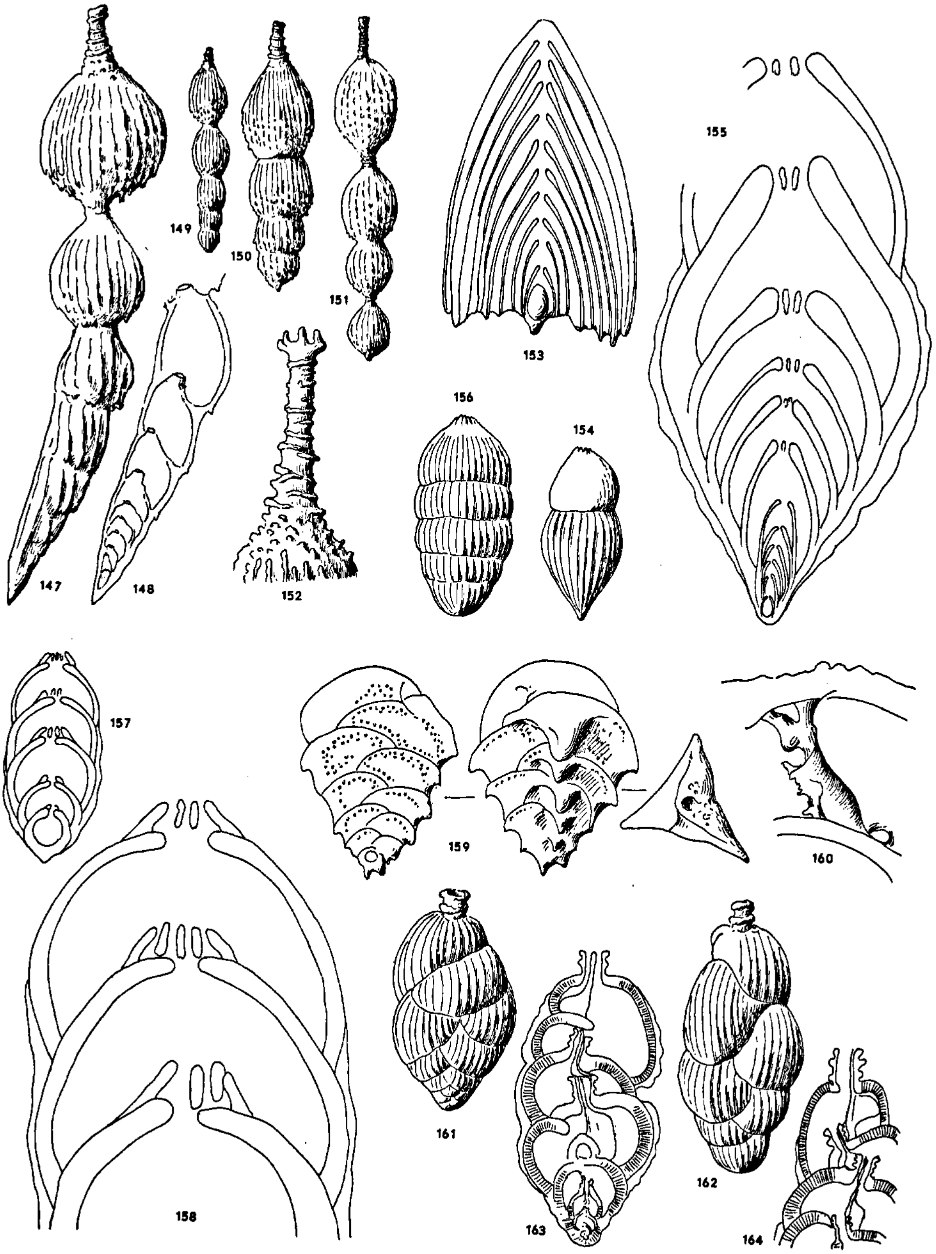
There are some specimens in Sta. 1443 which may belong to D'ORBIGNY's species; however, BRADY gave several figures on his pl. 63, which show horizontal sutures and a central aperture; only his fig. 4 has the oblique sutures and excentric aperture. This can also be said about the figure given by CUSHMAN (1921). We do not know exactly what is meant by *Nodosaria filiformis* of D'ORBIGNY and it certainly is a fossil form.

CUSHMAN (1923) mentioned *N. filiformis* from the West Indies, but believed that it is uncertain whether the West-Indian species belongs to D'ORBIGNY's species.

Amphicoryna intercellularis (Brady) Fig. 147–152

Nodosaria radicula Linné var. *scalaris* GOËS (not Batsch), 1882, p. 21, pl. 1 fig. 8.
Nodosaria scalaris GOËS (not Batsch), 1894, p. 73, pl. 13 fig. 718.
Nodosaria intercellularis BRADY, 1881, p. 63; 1884, p. 515, pl. 65 fig. 1–4; CUSHMAN, 1923, p. 89, pl. 14 fig. 2–4, pl. 17 fig. 3.
Amphicorina intercellularis (Brady), HOFKER, 1957, p. 102, fig. 104.
Amphicorina (?) *intercellularis* (Brady), BARKER, 1960, p. 136, pl. 65 fig. 1–4.

The present author showed that in the Bay of Naples several forms occur of a species which are known under the name of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Nodosaria scalaris (Batsch) of which the microspheric generation is known as *Amphicoryna* (*Marginulina*) *falx* (Jones & Parker) (HOFKER, 1932, p. 110–115, fig. 27–29).

In 1940 BUCHNER confirmed this view (p. 404–405, pl. 1). The present author came to the conclusion (1932, 1957) that as the microspheric form is the fundamental form of a species, this species ought to be named *Amphicoryna* Brady. Later (1964, p. 513–514, fig. 401, 1–2) LOEBLICH & TAPPAN joined this view.

At least three recent species are known: *A. scalaris* (Batsch) from the Mediterranean, *A. separans* (Brady) from the Pacific and *A. intercellularis* from the Caribbean. *Lagenonodosaria* Silvestri is found in many publications, but must be considered as a younger synonym of *Amphicoryna* Schlumberger.

The three Recent species, mentioned above, differ from each other mainly in the structure of the neck of the aperture and the ornamentation of the wall. In *Amphicoryna scalaris* (Batsch), the neck is ornamented by distinct and narrow transverse rings, and the ornamentation of the walls consists of smooth elongate costae.

In *A. separans* (Brady) the ornamentation of the neck shows

Fig. 147–152. ***Amphicoryna intercellularis*** **Brady. – Santa Cruz (= St. Croix), depth 800 m; 147, microspheric specimen (× 150); 148, the same in a clarifier (× 150); 149–150, megalospheric specimens (× 60); 152, apertural part of a megalospheric specimen (× 150). – Barbados, sta. 1443; 151, megalospheric specimen (× 60).**

Fig. 153. ***Frondicularia sagittula*** **van den Broeck. – Barbados, sta. 1443; megalospheric specimen (× 11).**

Fig. 154–158. ***Pseudonodosaria comatula*** **(Cushman). – Barbados, sta. 1443: 154, microspheric individual (× 30); 155, longitudinal section through microspheric specimen (× 113); 156, megalospheric specimen (× 30); 157, longitudinal section (× 30); 158, same section, oral part, showing the chamberlets of the apertures (× 113).**

Fig. 159–160. ***Reussella mortenseni*** **Hofker. – Barbados, sta. 1443: 159, total test from three sides (× 50); 160, toothplate (× 150).**

Fig. 161–164. ***Euuvigerina flintii*** **(Cushman). – Barbados, sta. 1443: 161 microspheric individual (× 45); 162, megalospheric specimen (× 45); 163, longitudinal section through microspheric specimen, with the typical flaps of the toothplates; 164, oral part of longitudinal section through megalospheric specimen, with the toothplates (both × 60).**

distinct transverse rings and that of the chamberwalls consists of longitudinal costae which mostly are distinctly spinose.

In *A. intercellularis* (Brady) the rings around the neck are irregular, whereas the ornamentation on the walls consists of costae which at the proximal side of the chambers change in short spines.

Remarkable is the aperture of *A. intercellularis* in some megalospheric specimens, as its rim is distinctly dentated. The microspheric form begins with an elongate small proloculus and the first 9 chambers have the aperture directed to the concave side as in *Marginulina* (*Amphicoryna*); the end-chambers have end-standing areal apertures.

In some tests, microspheric as well as megalospheric, the last formed chambers are connected with former chambers by the neck, and do not overlap these chambers. This may lead to easy rupture of these chambers, and it is remarkable that Lagenae with costate ornamentation often show a secondarily closed opening at their apical ends; they may be ruptured end-chambers of *Amphicoryna.*

Some specimens were found in Sta. 1443.

Frondicularia sagittula van den Broeck Fig. 153

Frondicularia alata d'Orbigny, var. *sagittula* VAN DEN BROECK, 1876, p. 113, pl. 2 fig. 12, 14.
Frondicularia sagittula van den Broeck, CUSHMAN, 1923, p. 143, pl. 21 fig. 1–2; 1943, p. 25–26, pl. 5, 6 fig. 1–3.

Test flat, compressed, triangular or lozenge-shaped, depending on the generation found. The riding chambers form at the base more or less developed spines. The megalospheric proloculus is somewhat protruding, with initial spine. The aperture forms a slit at the end of the large test.

The species is typical for deeper water, was common in a sample from St. Croix, and was found in one well-preserved specimen in Sta. 1443.

Pseudonodosaria comatula (Cushman) Fig. 154–158

Nodosaria comata BRADY, 1884, p. 509, pl. 64 fig. 1–5.
Nodosaria comatula CUSHMAN, 1923, p. 83, pl. 14 fig. 5.

Pseudoglandulina comatula (Cushman), PHLEGER & PARKER, 1951, p. 10, pl. 5 fig. 7–9.

The test of the microspheric generation begins with a sharp point, without distinct sutures in the strongly tapering initial part and has a last formed chamber which is divided from the first part by a depressed suture. This last chamber does not have the typical longitudinal costae which are found on the wall of the larger part of the test.

This generation is small. On longitudinal section there are a set of 5 chambers following the proloculus, which chambers, though slightly overlapping each other, are elongate and narrow. After this set the strongly overlapping chambers begin, the first three with relatively thin chamber walls, the later three with much thicker walls. The last formed chamber is smaller and not so overlapping. It appeared to the author that the first five chambers are farther overlapping at one side than at the opposite one.

The megalospheric generation is larger, stouter, beginning with a blunt initial part, followed by about 4 chambers with distinct depressed sutures. All chambers show the outer longitudinal costae but the last formed chamber is smooth in the distal part.

Both generations have a radiate aperture at the outside, but the megalospheric specimens show in longitudinal section a distinct apertural "chamber" placed over the simple rounded apertural opening of each of the later chambers. Such an additional apertural "chamber" is also found in some species of *Lenticulina.*

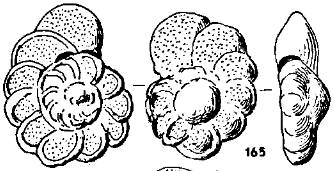
It is remarkable that this species is common in Sta. 1443 (200 m), but is missing in Sta. 1442 (100 m), and that several authors describe it from deeper water.

Reusella mortenseni Hofker Fig. 159–160

Reusella mortenseni HOFKER, 1956, p. 51–55, pl. 5 fig. 1, 4–7.

The toothplate is a complicated structure and typical for late Tertiary and Recent species.

This species was described in 1956 from a sample off Santa Cruz, about 250 m deep. Two small specimens were found in sample 1443, 200 m. It seems to be restricted to the Caribbean region and to a depth of about 200 m or more.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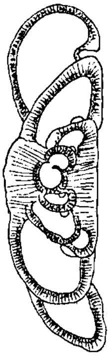
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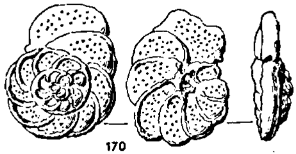
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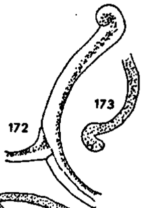
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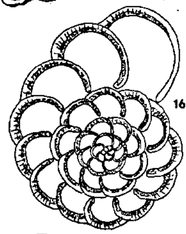
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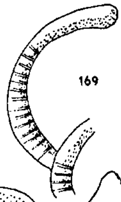
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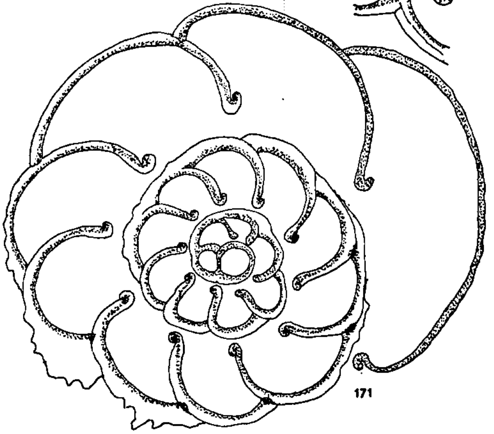
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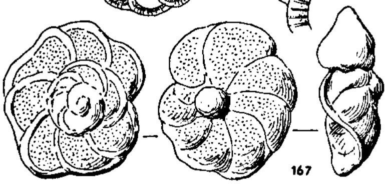
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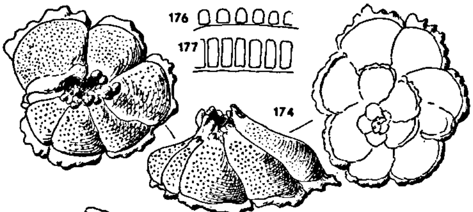
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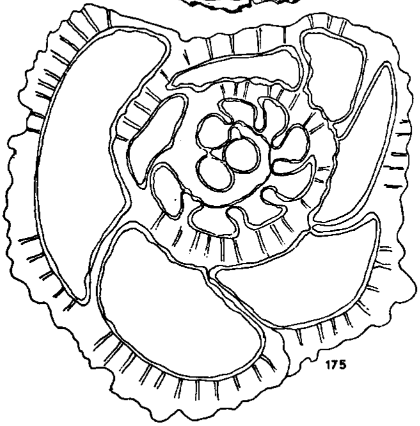
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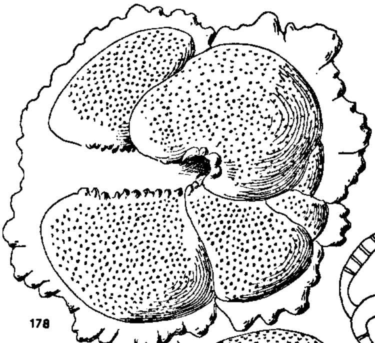
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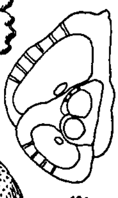
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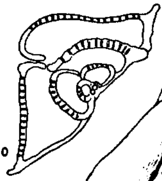
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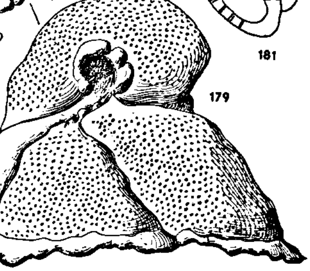
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Euuvigerina flintii (Cushman) Fig. 161–164

Uvigerina tenuistriata Flint (not Reuss), 1897, p. 320, pl. 68 fig. 1.
Uvigerina flintii Cushman, 1923, p. 165, pl. 42 fig. 13.
Euuvigerina flintii (Cushman), Hofker, 1956, p. 80, pl. 9 fig. 4–9.

Typical are the somewhat thick-set form of the megalospheric generation, the fine numerous rounded ribs, the irregular transverse thickenings on the neck of the aperture which mostly show a hyaline lip at the end. The walls have very fine pores and are rather thick. Peculiar is the toothplate which shows the elongate form typical for *Euuvigerina* but often has a broader base.

This species was fully analysed by the author in 1956. Phleger & Parker (1951, p. 53, fig. 25) showed that it occurs in depths from 100 to 1000 m, and is never common. It was not present in Sta. 1442, but was very common in Sta. 1443. Cushman (1923) found it most common in about 100 m.

Cibicides antilleanus Drooger Fig. 165–169

Cibicides pseudoungerianus (Cushman) var. *antilleana* Drooger, 1953, p. 146, pl. 23 fig. 4–5.
Cibicides protuberans Parker, 1954, p. 542, pl. 12, fig. 13–14, 16.

Test relatively large, largest diameter observed 1.4 mm, plano-convex, lobulate in the adult, often irregular in outline and – due to substratum – often contorted. In juvenile and in microspheric

Fig. 165–169. *Cibicides antilleanus* Drooger. – Barbados, sta. 1443: 165, microspheric specimen from three sides (× 20); 166, transverse section through megalospheric individual, showing the granular primary walls; 167, megalospheric specimen (× 30); 168, horizontal section (× 30); 169, wall and septum of chamber (× 150).

Fig. 170–173. *Planulina foveolata* (Brady). – Barbados, sta. 1443: 170, specimen from three sides (× 27); 171, horizontal section, showing the granular primary walls and the simple walls and septa of the last formed chambers (× 113); 172, wall, septum and insertion of wall of next chamber (× 150); 173, part of wall and apertural lip of the last formed chamber (× 150).

Fig. 174–181. *Carpenteria balaniformis* Gray. – Barbados, sta. 1443: 174, specimen from three sides (× 20); 175, transverse section through the base of the test of 174 (× 113), in each of the chambers the pseudochitinous layer can be seen; 176–177, sections through walls (× 113);
178–179, another somewhat more bulky specimen and older than that of 174 (× 20); 180, transverse section through test, showing simple walls and septa (× 24); 181, initial part of section of 180 (× 113).

specimens regular. Periphery slightly keeled, but in later chambers more narrowly rounded.

The earlier whorls are concealed by a thickened wall at the flat side; the later formed chambers strongly overlapping at the dorsal side till they reach a clear and distinct calcitic knob in the centre – being the most conspicuous feature. Chambers about 12 in the last formed whorl in microspheric, about 8 in megalospheric specimens. Sutures at the flat side curved and somewhat limbated, later depressed. At the convex side all sutures slightly curved and distinctly depressed. Wall in last formed chambers thin, but in the more initial chambers secondarily thickened at both sides. Pores fine for the genus. Aperture near the margin, bending over in a sutural slit at the spiral side.

The test wall is simple in the initial chambers, especially in the microspheric form; in later chambers walls and septa seem to be double, as the granular primary wall is thickened at its outside by hyaline material, especially in the centre at both sides of the test. The granular primary wall forms the larger part of the whole test wall in the later chambers.

Longitudinal and transverse sections reveal that this species must be closely allied to *Cibicides lobatulus*; *C. antilleanus* differs from the latter species by its hyaline thickenings of the centre.

The species was mentioned by DROOGER from the Miocene of Aruba; it was found by PARKER & PHLEGER in the Gulf of Mexico, from 42–1,829 m, but with a maximum of 21% in depths shallower than 200 m. In Sta. 1443, depth 200 m, the species was not uncommon; several specimens were found attached with their flat side to shells.

Planulina foveolata (Brady) Fig. 170–173

Anomalina foveolata BRADY, 1884, p. 674, pl. 94 fig. 1.
Anomalina ariminensis BRADY, PARKER & JONES (not d'Orbigny), 1888, p. 228, pl. 45 fig. 21 a–b.
Discorbina biconcava FLINT (not Jones & Parker), 1897, p. 327, pl. 72 fig. 5.
Planulina foveolata (Brady), CUSHMAN, 1931, p. 111, pl. 20 fig. 3–4.
Cibicides (*Planulina*) *foveolatus* (Brady), HOFKER, 1956, p. 114, pl. 14 fig. 18–22.

The present author already analysed this species in 1956. The ventral side shows strongly overlapping chambers, leaving only the central part free. Chambers of the last formed whorl with curved smooth sutures. Distinct coarse pores all over the wall. The margin is somewhat truncate, as in *Planulina ariminensis*, mostly due to the marginal side of the last formed chambers on the dorsal side, where all chambers are visible and the spiral sutures of the chambers form a distinct rim at the margin. At the dorsal side the sutures are distinctly curved backwards and those of older chambers are very inflated, forming marked ribs over the sutural borders, as can be seen on the transverse section (1956, pl. 14 fig. 21).

Horizontal sections show that the wall of the last formed chamber is entirely granular, monolamellar; at the marginal aperture it forms a sigmoid rim. In older chambers the septa also show the granular primary wall, but here it is thickened by fibrous calcitic material, so that – especially at the sigmoid rim – the primary wall is situated between an outer and an inner layer of more hyaline material. From the center of the spire to the last formed chambers, the inner hyaline lining gradually becomes thinner and it is absent at the outer wall.

The proloculus shows the inner granular primary wall and the outer secondary hyaline thickening too, but the septum between proloculus and second chamber consists only of the granular primary wall. It is obvious that *Planulina foveolata* is monolamellar with secondary hyaline thickenings at walls and septa.

The species was found not uncommonly in Sta. 1443.

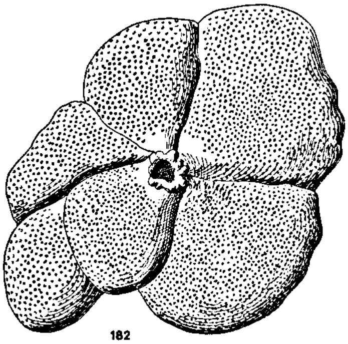
Genus **Carpenteria** Gray, 1858

Loeblich & Tappan (1964, p. 707) believe that only those species which show a somewhat conical test with flattened spiral side showing all chambers, belong to this genus; but they also class in this genus species which have no aperture at the top of the conus but at the periphery of its base. This cannot be maintained. For the most typical characteristic of all species in reality belonging to *Carpenteria* is, that each of the chambers has its aperture, at least in adult specimens, in the center of the ventral (conical) side; each next chamber is connected with the former by the sutural part of that aperture, though it may be situated on a neck. Each next chamber has its aperture over the former one, mostly enveloping it entirely.

"The sub-cylindrical species previously placed in *Carpenteria* should be referred to *Biarritzina*" (l.c. p. 628); this may be right for "*Carpenteria*" *proteiformis* Goës, but certainly not for many other species which in the adult form builds elongate tests on the originally coniform young part. Since *C. proteiformis* shows "bilamellar" walls and pores fusing into larger canals, this species may belong to a different group than all the other species hitherto gathered in the genus *Carpenteria* and so the present author will in respect to this species, follow the advise given by LOEBLICH & TAPPAN.

CUSHMAN (1931, p. 141) described "*Carpenteria*" *proteiformis* Goës from the Caribbean, from fairly deep water; GOËS described it in 1882 from that region for the first time. BRADY (1884, p. 677) mentions *C. monticularis* Carter from Bermuda, from 435 fathoms. CARTER (1876, p. 211) described *C. utricularis* (Carter) as abundant in the Caribbean. CUSHMAN (1931), however, could not find *C. monticularis* and *C. utricularis* in his material from the Caribbean, though he describes another species, *C. hassleri* Cushman (1931, p. 141, pl. 26 fig. 2–5) from 100 fathoms off Barbados, obviously about the same locality from which it is here redescribed, but now with all three other species mentioned above.

HOFKER (1930, p. 127) found in the East Indies *C. utricularis* from 11–94 m depth; *C. montricularis* from 11–304 m; *C. proteiformis* from 36–90 m; and moreover, *C. raphidodendron* Möbius from shore and reef, but also from 694 m. This would mean that *Carpenteria* is not at all a genus typical for reefs, as DROOGER & KAASSCHIETER (1958, p. 35) believed. Living specimens of "*Carpenteria*" *proteiformis* and several other species were found abundantly by the present author off Barbados in 100–200 m depth; they were mostly attached there. The species are: *Carpenteria balaniformis*, *C. utricularis*, *C. monticularis*, *C. hassleri* (close to *C. hermanni* Dakin) and *Biarritzina proteiformis*. It is very remarkable that this biocoenosis of *Carpenteria* in so many respects is identical with that, found in deeper water in the Pacific; GRAHAM & MILITANTE (1959) found none of these species in the shallow waters they investigated in the Philippines, though many stations consisted of coralline sands. Remarkable also is that in these samples off Barbados, two other typical species occur abundantly which are also found in the tropical Pacific: *Sporadotrema rubrum* (d'Orbigny) and *Miniacina miniacea* (Pallas); together with the genus *Carpenteria* they form the sessile fauna on the "coralline" boulders found in these stations. They are living there. Beautiful specimens of *S. rubrum* were found on coral from off the Isle of Edam (Bay of Batavia), in shallow water; CUSHMAN, TODD & POST (1954, p. 373) described specimens under the name of *Carpenteria proteiformis* Goës?, with dark red or orange colour, which obviously belong to *Sporadotrema*, from Bikini and nearby atolls (Marshall Islands), from beach and reef samples. In the Barbados sample 1442 well-preserved and obviously living specimens occur, but they never form the large branched individuals as figured on pl. 8 and 9 by the present author in 1930; obviously the circumstances at Barbados were less favorable for this species. Several authors (e.g. CUSHMAN, 1931, p. 143) deny the occurrence of *Sporadotrema* in the Caribbean; so the species is new for this region. The present author stated that *Homotrema rubrum* (Lamarck) is the only sessile species of the Homotremidae found in the tidal zone of the Caribbean Islands (1964, p. 85–86); EMILIANI (1951) found *Homotrema* off Bermuda; *Miniacina*, however, well-known from the tropical Pacific Islands, was hitherto not mentioned from the Caribbean; CUSHMAN (1931) says that the genus is unknown from the Atlantic. It is, however, very abundant in Sta. 1442 and 1443 and once again is new for the region. The present author described *M. miniacea* (*Polytrema*) from many stations of considerable depths of the Siboga Exp. (1927, p. 28). So it is evident that *Homotrema rubrum* is a shallow-water form, whereas *Miniacina miniacea* is more common in deeper water, at least in the Caribbean region. We may conclude that a very remarkable sessile fauna occurs West of Barbados, typical for deeper water (100–200 m), connected with such a fauna from the Pacific.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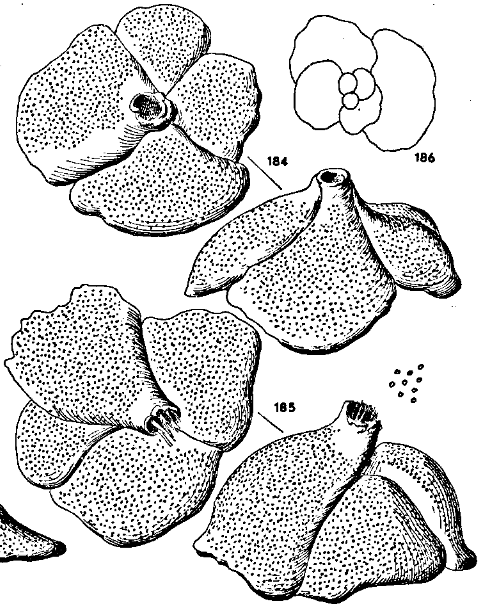

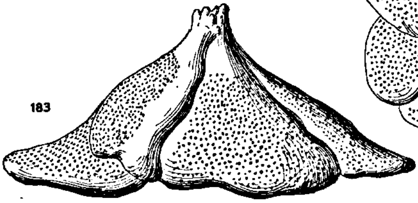
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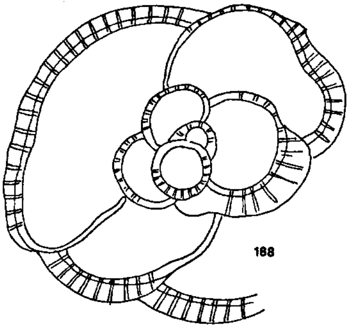
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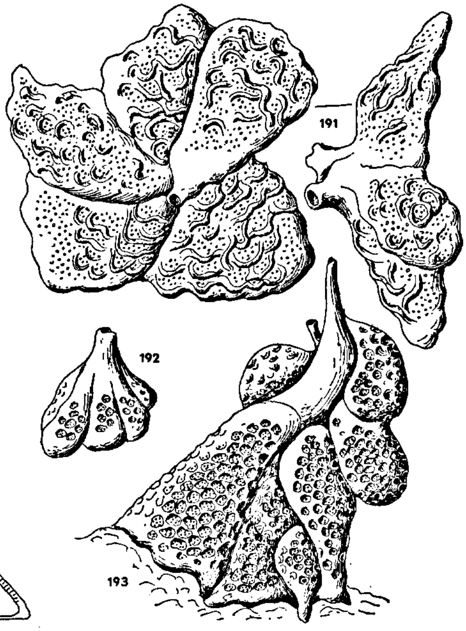

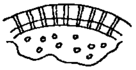
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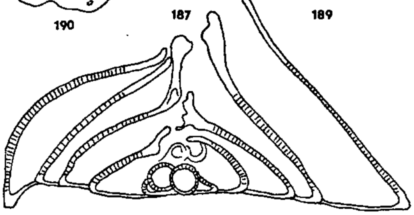
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Carpenteria balaniformis Gray Fig. 174–181

Carpenteria balaniformis Gray, 1858, p. 269–270; Loeblich & Tappan, 1964, p. 707, fig. 580, 1.

The most typical features of this species are: test originally attached, plano-convex, plano-spiral at the attached side, but chambers rapidly involute at the free side. The last whorl which is visible on the convex side is made up of about 5–6 chambers. A peripheral keel which is poreless and crenulate spreads slightly over the substrate. Wall calcareous, distinctly perforate at the conical surface of the chambers, but non-porous at the truncate apertural face and in the irregular prolifications around the "umbilical" apertures. Aperture in the first whorls of chambers small, sutural, in the middle of the suture of the conical side; in later chambers more slit-like and reaching up to a central opening on top of the conus.

Vertical sections reveal that only in the later chambers the central parts of apertures formed by parts of test walls bend inward and upward. Some of the wall parts, especially the outer walls, may seem double through overlapping of next chamber walls and show a basal pseudochitinous inner lining. Horizontal sections show the typical spiral arrangement of the chambers and simple septa between them; in case the outer walls seem double, only the inner layer continues in the septum, so that the outer layer must be secondarily formed.

These characteristics show that *Carpenteria balaniformis* Gray cannot belong to the group in which Loeblich & Tappan placed it. As is the case in *C. hassleri* Cushman, *C. monticularis* Gray and *C. utricularis* Gray the walls and septa prove to be monolamellar,

Fig. 182–190. *Carpenteria monticularis* Carter. – Barbados, sta. 1443: 182–183, specimen from two sides (× 20); 184–185, two other specimens from two sides (× 40); 186, initial part of specimen seen from the base (× 60); in 185 some pores are designed (× 60); 187, transverse section (× 18); 188, horizontal section through the base (× 60); 189, wall of initial chamber (× 60); 190, wall of later chamber, showing secondary thickening (× 60).

Fig. 191–193. *Carpenteria utricularis* (Carter). – Barbados, Sta. 1443: 191, specimen from two sides (× 12); 192, young specimen (× 6); 193, outgrown specimen (× 6).

as is typical in this genus, of which *C. balaniformis* is the genotype. However, LOEBLICH & TAPPAN placed *Carpenteria* in the Subfamily Victoriellidae, of which they say that its genera are bilamellar.

BELFORD (1960, p. 112, pl. 35, fig. 11–12) described a genus *Haerella*, with the genotype *H. conica* Belford. The horizontal section clearly shows that here too we have to do with a monolamellar genus, and that conditions are quite similar to those found in *Carpenteria*. Possibly LOEBLICH & TAPPAN were right in their belief that *Haerella* Belford and *Carpenteria* Gray are synonyms; why LOEBLICH & TAPPAN placed *Haerella* in the bilamellid Victoriellidae, is not quite clear.

As the three other species described here sub *Carpenteria* also have simple septa and eventually secondarily thickened outer walls, the genus *Carpenteria* should be considered as a monolamellar genus. Maybe that *Haerella* belongs to the Rupertidae as BELFORD believed; *Rupertia stabilis* Wallich is the genoholotype of Rupertia and also has simple septa and simple outer walls, though they may be thickened secondarily, and not double septa as in the Rotaliidae, as LOEBLICH & TAPPAN (1964, p. 627) believed. In that case *Carpenteria* also may belong here. *Carpenteria raphidodendron* Moebius, analysed by the present author in 1930 (p. 131, pl. 51 fig. 6, 8–11, pl. 52 fig. 7, 11–14) also has simple walls and simple septa and may be near *C. hassleri* Cushman. Thus all known species of *Carpenteria* (*Haerella* also conceived as *Carpenteria*) are monolamellar species closely allied to *Rupertia*. It is a remarkable fact that many of these species strengthen their pseudopodia by means of sponge-needles.

This species, first described from the Philippines, was found in several typical specimens off Barbados, Sta. 1443 (200 m).

Carpenteria monticularis Carter Fig. 182–190

Carpenteria monticularis CARTER, 1877, p. 211, pl. 13 fig. 9–12; BRADY, 1884, p. 677, pl. 99 fig. 1–5; CUSHMAN, 1915, p. 48, pl. 20 fig. 3; 1921, p. 362; HOFKER, 1930, p. 126, pl. 50 fig. 3–4, 8, 10, 12, pl. 52 fig. 4.

In 1930 the author believed that *C. monticularis* is the A_1-

generation of *C. utricularis*; but the large material now at hand from off Barbados shows that this is a valid species, though some young forms of *C. utricularis* may have the smooth surface, characteristic for *C. monticularis*.

The test in adult specimens has the form of a volcano with smooth magma-streams at its sides. The last-formed chamber encloses the former apertures with its apertural neck. The chamber walls are entirely smooth and relatively thin. The pores in the walls are distinct and densely placed, leaving the distal sutural part of a chamber free. Sponge spicules may protrude from the aperture. The walls are mostly simple but overgrowing walls of next chambers may simulate double walls. The initial chambers in the A-generation may form a distinct spiral but in specimens with large proloculus, they may form a cluster (raspberry-type), as figured by the author in 1930, pl. 50 fig. 10.

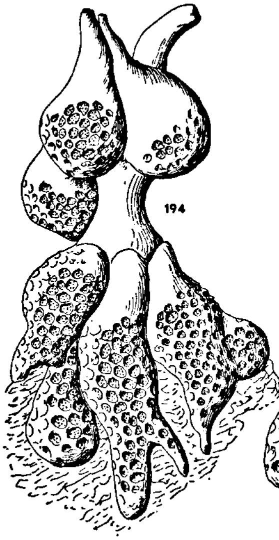
The species is rather common in Sta. 1442; in the Pacific it occurs mostly in depths from 90–300 m (Siboga) or 12–220 m (CUSHMAN, Philippines); so it seems to be a species typical for deeper water, so that the occurrence in Sta. 1442 and Sta. 1443 is not astonishing.

Carpenteria utricularis (Carter) Fig. 191–201

Polytrema utriculare CARTER, 1876, p. 211, pl. 13 fig. 11–17.
Carpenteria utricularis CARTER, 1877, p. 176; BRADY, 1884, p. 678, pl. 99 fig. 6–7, pl. 100 fig. 1–4; CUSHMAN, 1921, p. 360, pl. 73 fig. 4–5; HOFKER, 1930, p. 126, pl. 50, pl. 52 fig. 1–5, 8–9.

This species is always recognizable by the typical honeycomb structure of the test wall. Young or small specimens form a volcano-like test with the last formed chamber opening as its crater; in some of such specimens the aperture is situated on a more or less elongated neck; outgrown specimens form chambers on or around this neck too, so that very variable and grotesque tests may be met with.

The first part of the test is formed by a large proloculus followed by a set of spiral chambers if the megalospheric proloculus is not very large, and by a cluster of chambers if the proloculus is larger (raspberry-type). Later chambers may become very elongate, creeping along the substrate, whereas those chambers which attach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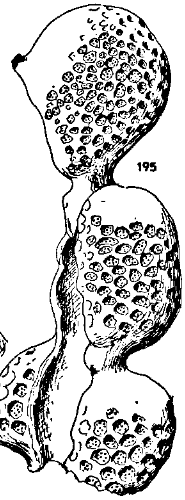
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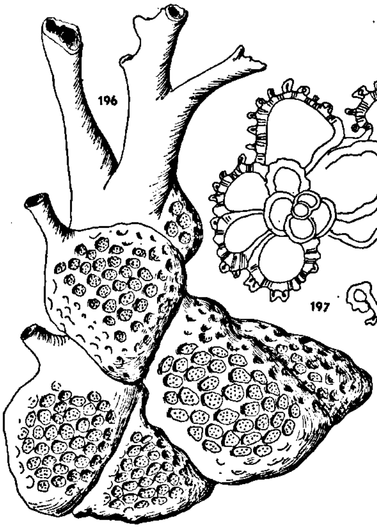
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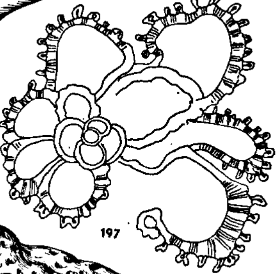
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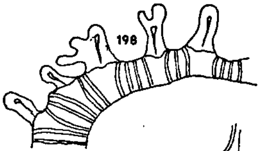
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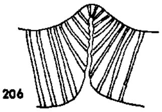
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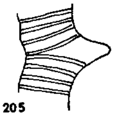
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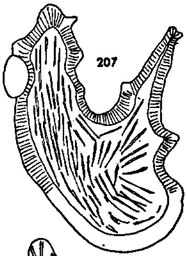
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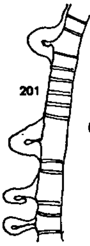
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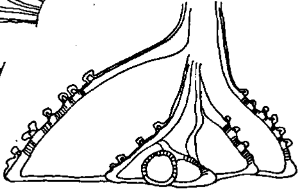
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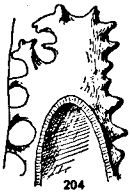
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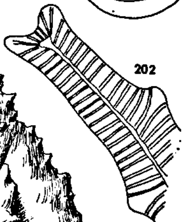
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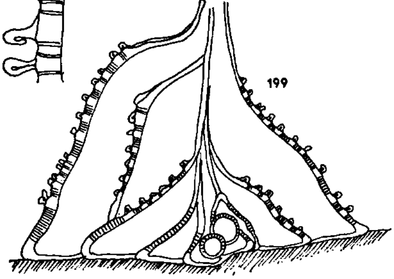
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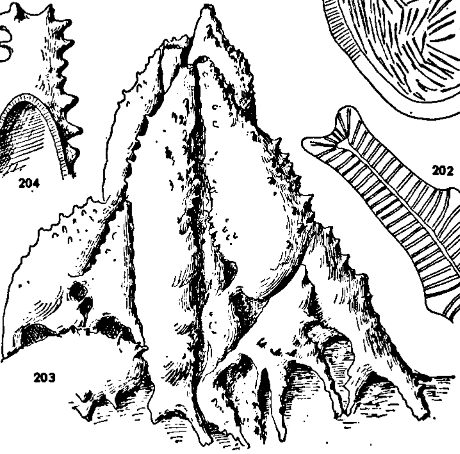
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the elongate neck of a later chamber, may be more globular or drop-like. The first chambers show relatively smooth chamber walls, whereas the later chambers get the honeycomb structure.

The wall is always a simple one, pierced by not very coarse but distinct pores. The honeycomb structure is formed by a network of poreless calcite forming a kind of layer over the porous wall and folded where the raised walls of the honeycomb are formed. This interrupted poreless layer is a continuation of the poreless neck on which the aperture is situated. Transverse sections through tests make it probable that each new chamber is formed by protoplasm which streamed out from the aperture of the former chamber and not from a sutural aperture, as found in trochoidal species of Foraminifera. In the septa between chambers, which may be partly poreless, no traces of apertures could be found. In the honeycombs several pores can be seen.

Carpenteria utricularis is common in both localities.

Carpenteria hassleri Cushman Fig. 202–211

Carpenteria hassleri CUSHMAN, 1931, p. 141, pl. 26 fig. 2–5.

Tests very variable in form, but in principle as usual in *Carpenteria*. In the megalospheric form at least the variability is due to the enormous size of the embryonic apparatus, consisting of a very large globular proloculus, followed by a cluster of chambers rapidly increasing in size, mostly half-globular and about 6 in number. Afterwards more elongate chambers are added with many

Fig. 194–201. *Carpenteria utricularis* (Carter). 194, outgrown specimen (× 6); 195, three last formed chambers of outgrown specimen, obviously formerly attached to some branch (× 12); 196, outgrown specimen with large apertural necks (× 12); 197, transverse section through base (× 12); 198, chamber wall of specimen of 197 (× 30); 199–200, axial sections throughyoung specimens (× 18); 201, part of wall of specimen of 199 (× 60).

Fig. 202–207. *Carpenteria hassleri* Cushman. – Barbados, sta. 1442: the pustulate form; 202, part of testwall, section, rootlike outgrowth at the base (× 30); 203, total specimen, from the side (× 6); 204, rootlike chamber of the base, with pustulate outgrowths (× 6); 205, part of section through chamber wall with pustule (× 30); 206, part of wall, section, near a rootlike outgrowth (× 30); 207, basal chamber, the protoplasm of which filled with sponge spicules (× 6).

protuberances in sample 1442, with smooth walls in sample 1443. With their elongate and often tubular apertural part they strive upwards, whereas with their lower ends they form root-like outgrowths which are always closed at the ends and which fasten on the irregular shaped substratum. These root-like ends in Sta. 1442 very much resemble those found in *Carpenteria herdmanni* Dakin from the Pacific, so that it may be that this species is only a regional variety of the latter species.

Over the walls of the very large chambers – placed very irregularly around the initial part and curved in several directions – small pustules are found which are similar protuberances as the "roots". All these protuberances and roots are formed as the tubular projections of the walls found in species of *Pararotalia*. The pores in the thick, but entirely simple walls are distinct and closely set; the tubular ends of the chambers on which the apertures are situated are poreless. Remarkable is, that in several outgrown specimens the last formed enormous chambers (they reach a length of 10 mm and more) each have an aperture, and consequently more than one aperture is formed at the end of the crater.

The specimens found in Sta. 1442 show the protuberances on the test walls; moreover, these specimens are relatively low, forming tests like volcanoes; in Sta. 1443, the specimens match more those described by CUSHMAN, with smooth outer test walls, whereas many specimens form slender elongate tests with the later chambers not reaching the substratum, spiralling along the axis of the stem. The last formed chamber in these individuals has a protruding apertural neck, without pores; along this neck later chambers creep up. It may be that these specimens are found in an environment more favorable to the species. The inner structure is the same, with the earlier chambers having a thick brown inner pseudochitinous lining and a very large proloculus.

Mississippina concentrica (Parker & Jones) Fig. 212–214

Pulvinulina concentrica Parker & Jones, in BRADY, 1884, p. 470, pl. 48 fig. 14; PARKER & JONES, 1865, p. 393; BRADY, 1884, p. 686, pl. 105 fig. 1; CUSHMAN, 1931, p. 43, pl. 9 fig. 4–5 (as *Eponides concentrica*).

Discopulvinulina (Mississippina) concentrica (Parker & Jones), HOFKER, 1956, p. 180, pl. 27 fig. 1–8.
Mississippina concentrica (Parker & Jones), HOFKER, 1963a, p. 157–160, fig. 6.
Stomatorbina concentrica (Parker & Jones), McGOWRAN, 1966, p. 482–488, pl. 4 fig. 1–7.

This species was already described by the author from Santa Cruz; its finer wall structure was analyzed by the author (1963) and by McGOWRAN (1966).

There is a primary wall which covers each chamber on all sides and forms simple septa. The primary wall is distinctly agglutinated. At the sutures, at the margin and also over the ventral tena the primary wall is covered by hyaline radial calcareous material which consists of very fine crystals perpendicular to the surface. Smaller or larger parts of the tests are thus covered by the granular (agglutinated) primary wall only. In 1956 I thought that at least the hyaline parts were pierced by very fine pores; now I believe that in reality these so-called pores are these crystals, for these "pores" were never observed filled with air, as is always the case in real fine pores, as in the Lagenidae. McGOWRAN believes the walls to be porous.

Sections reveal that beneath the tenon of each chamber a toothplate is connected with the septal foramen, in the same way as was stated for *Discorbis vesicularis* Lamarck (HOFKER, 1963, p. 146–149, fig. 1–6). The tenon at the ventral side separates a protoforamen from the deuteroforamen.

Studies on topotypes of *Stomatorbina* Dorreen and *Schlosserina* Hagn proved that these two genera must be younger synonyms of *Mississippina*. *Schlosserina* has no extra areal apertures on the apertural face, as these rounded openings end in small sacs in the wall and are no openings; otherwise the structure of this Eocene species is that of *Mississippina*. The description of *Mississippina* given by LOEBLICH & TAPPAN (1964, p. 776) is entirely wrong; no supplementary apertures exist near the peripheral keel; they are mistaken for the coverless parts of the primary wall. Moreover, *Stomatorbina* differs not from *Mississippina*, only in minor, specific characteristics; the name *Mississippina* Howe was first used in 1930, whereas the name *Stomatorbina* Dorreen was used for the first time in 1948; *Stomatorbina* is a later synonym of *Mississippina* also (see Uchio, 1952, p. 195–200).

Mississippina is already found in the Lower Campanian (Hofker, 1959a, p. 290, fig. 97–99 on p. 335); the oldest known forms and the Recent forms differ only in the thickness of the primary wall, whereas all other characteristics are identical. It seems that the genus has affinities with agglutinated forms and has not changed much during time. No affinities exist with the Epistomariidae, as Loeblich & Tappan (1964) believed.

Hoeglundina elegans (d'Orbigny) Fig. 215–223

Rotalia (*Turbinulina*) *elegans* d'Orbigny, 1826, p. 276, No. 54.
Pulvinulina elegans (d'Orbigny), Brady, 1884, p. 699, pl. 105 fig. 4–6.
Epistomina elegans (d'Orbigny), Martinotti, 1926, p. 3; Cushman, 1931, p. 65, pl. 13 fig. 6; Hofker, 1951, p. 375–379, fig. 254–257.
Hoeglundina elegans (d'Orbigny), Brotzen, 1948, p. Hofker, 1954, p. 201, fig. 49–50.

Hoeglundina (or *Höglundina*) *elegans* was found in several relatively small specimens in Sta. 1443; it is more common in the sample off St. Croix (800 m), together with another species, *H. hyalina* Hofker; in the latter sample the specimens reach a much larger diameter, nearing 2 mm. In the sample Sta. 1443 (200 m), the well-preserved specimens never exceed 0.7 mm in diameter. This species was analyzed by the author in 1951 and 1954.

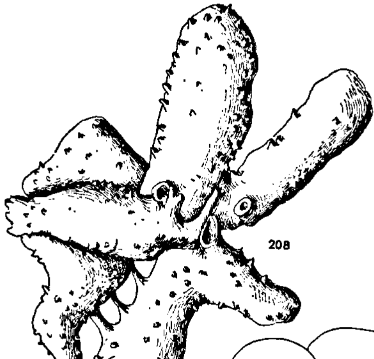
In the sample Sta. 1443 the tests are lenticular with sharp margin. Undamaged tests show about 9 chambers at the ventral side in the megalospheric form, with radial flush sutures ending in the central calcitic mass which is level with the surface. Especially at the ventral side bosses of pores form a typical pattern of irregular whitish spots in the darker and more hyaline test wall. At the dorsal side the sutures of the last formed whorl of chambers are distinct and strongly oblique, whereas the more initial whorls are obscured by the very strong thickening of the dorsal walls, especially in microspheric specimens. The species as described here from Sta. 1443, is identical with that found in samples around the Baleares in the Western Mediterranean.

Whereas in Jurassic and Lower Cretaceous genera (viz. *Brotzenia* Hofker) the toothplates remain in all chambers of a test, they are resorbed in all chambers except in the last formed one in *Hoeglundina*. Each toothplate in the geologically later forms adheres to the septum with the foregoing chamber and may even cover this septum for some part at its ventral and dorsal sides.

It is obvious that in this way this toothplate may be best compared with the toothplate of *Rotalia* (septal flap).

Hoeglundina and all other genera belonging to the same group have aragonitic walls. The author called their Family Epistomariidae in 1954, but this name has been erroneously used by LOEBLICH & TAPPAN (1964, p. 592) for genera with a calcareous wall. Some modern authors (MCGOWRAN, 1966, p. 477–488; BELFORD, 1966, p. 190) believe that *Hoeglundina* and other aragonitic genera are bilamellar. This statement is in contradiction to the many thousands of sections the present author made when studying aragonitic species, recent and fossil. It is certain that some groups of aragonitic species show secondary thickening of outer walls. But this feature is no characteristic of bilamellation. Moreover, BELFORD (1966, p. 12) believed that what was called toothplate by the author, is a fold of the chamber wall and not a toothplate, and consequently is bilamellar. New thin sections through the toothplate of *Hoeglundina* show that it is simple, not double, and that it has a granular microstructure – as is the case in all such structures – not formed by the later ectoplasm, but within the protoplasm which forms the first wall (primary wall) in many calcareous forms too. Moreover, where the toothplate adheres to the former foramen in *Hoeglundina*, it distinctly shows a suture with the septal wall, so that it cannot be a fold of that wall. Bilamellation cannot be traced by means of transverse sections, as MCGOWRAN did (1966, pl. 3 fig. 4), but has to be traced in the septa on horizontal sections. On transverse sections, the secondary thickenings of the outer walls of *Hoeglundina* resemble very much those of *Rotalia trochidiformis* Lamarck. Yet *Rotalia* and *Hoeglundina* have been described by REISS (1963, p. 16, 59), as lamellar and not as bilamellar, as MCGOWRAN and BELFORD did. For bilamellation can only be seen in the septa, and in *Rotalia* the septa have been described as simple, but secondarily double, due to the septal flap of the toothplate.

Therefore it was opportune to study once again the inner structure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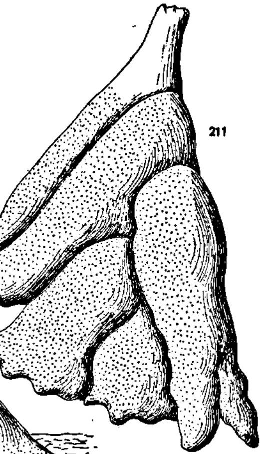
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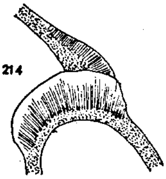
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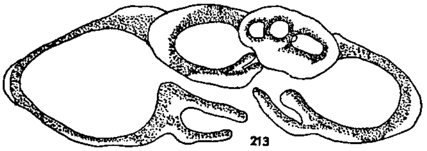
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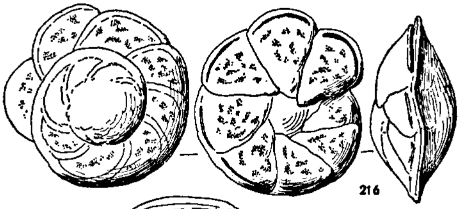
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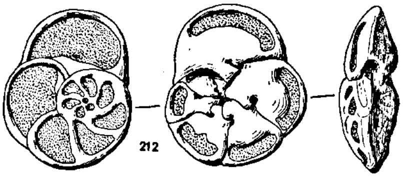
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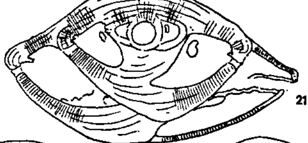
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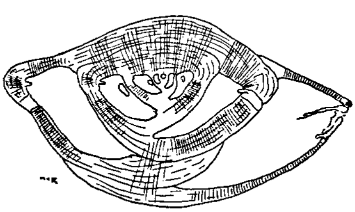
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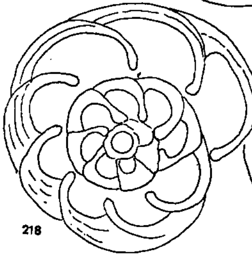
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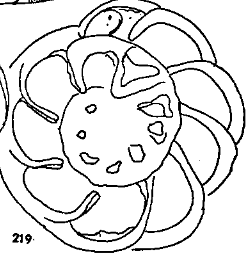
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of *Hoeglundina*, genotype *H. elegans* (d'Orbigny). This study shows that, though in older chambers the larger part of the toothplate is absorbed, part of it remains: a crista dorsally from the toothplate foramen at the ventral side of the margin and, moreover, a more or less large part of the "septal flap" of the toothplate adhering to the septum with the former chamber. Since the latter mentioned part of the toothplate is found at the ventral side, near the foramen, horizontal ventral sections through tests show septa which are apparently double; yet a close examination of very thin sections reveals that the proximal part of this "double" septum consists of clear, even partly porous, substance and can be followed towards the periphery into the peripheral chamber wall. The distal part, however, never shows pores, and is more opaque, very finely granular; this is the remaining part of the septal flap of the toothplate. Transverse tangential sections clarify this phenomenon: only at the ventral side of the septum this "doubling" is found. In this way, horizontal sections taken more towards the dorsal side of the test never show "double" septa. And as a species is only bilamellar, when the whole septum consists of two lamellae, it is obvious that *Hoeglundina* is not a bilamellar genus. As soon as the last formed chamber is older, its wall thickens secondarily in all parts which are porous, not in the poreless part of the apertural

Fig. 208–209. ***Carpenteria hassleri*** Cushman. – Barbados, sta. 1442: pustulate variety. 208, young specimen, from above (× 6); 209, attached side of another young specimen, showing the very large proloculus and some more initial chambers (× 12).

Fig. 210–211. ***Carpenteria hassleri*** Cushman. – Barbados, sta. 1443: smooth variety (both × 11).

Fig. 212–214. ***Mississippina concentrica*** (Parker & Jones). – Barbados, sta. 1443: 212, specimen from three sides (× 20); 213 transverse section (× 60); 214, part of transverse section, showing granular primary walls and hyaline thickenings consisting of fine radially placed crystals (× 150).

Fig. 215–219. ***Hoeglundina elegans*** (d'Orbigny). – Barbados, sta. 1443: 215, transverse section of microspheric specimen (× 30); 216, specimen from three sides (× 20); 217, transverse section through megalospheric specimen (× 30); 218, horizontal section near the dorsal side (× 30); 219 horizontal section taken more through the ventral side of the test (× 30), showing the so-called double septa, a doubling formed by septal flaps of the tootplates (30).

face; that part forms, when a next chamber is added, the septum with the former chamber.

So, *Hoeglundina* has quite the same inner structure as *Rotalia trochidiformis* Lamarck, viz. outer, secondary lamination of the walls, per instar, and simple septa which may be secondarily doubled by the septal flap of the toothplate at their ventral sides.

Conclusions:

1. *Hoeglundina* has an aragonitic test.
2. It shows lamination of the outer test walls per instar.
3. It shows a real toothplate in the last formed chamber, forming a broad toothplate foramen just ventrally to the margin.
4. The toothplates in other chambers than the last formed one, are resorbed by the protoplasm except for two parts, adhering to the border of the toothplate foramen and to the inner septum respectively.
5. The septa of *Hoeglundina* are monolamellar, and are only at their ventral side "double" by means of the adhering part of the toothplate, a kind of "septal flap".

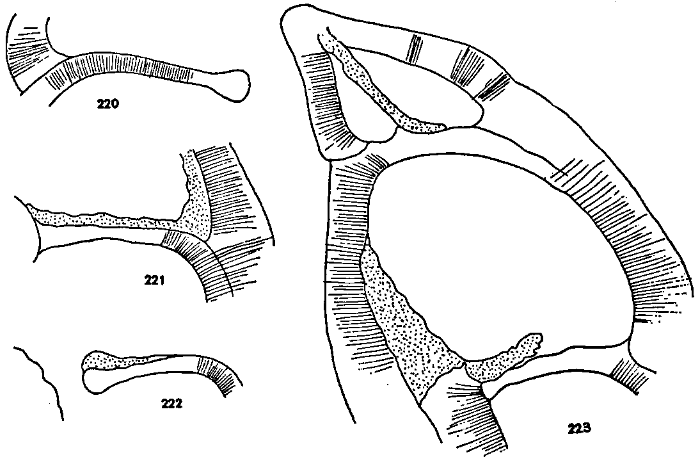


Fig. 220–223. ***Hoeglundina elegans*** (d'Orbigny). – 220, horizontal section through a septum, taken near the dorsal side, the septum is simple (× 113); 221, horizontal section through a septum, taken more to the ventral side, showing the septal flap of the toothplate which consists of granular matter (× 113); 222, septum with granular matter (× 113); 223, part of a tangential section, transverse, showing rests of the toothplate with a septal flap at the septum at the ventral side (× 113).

Lamarckina atlantica Cushman Fig. 224–230

Lamarckina atlantica CUSHMAN, 1931, p. 35, pl. 7 fig. 7; HOFKER, 1956, p. 105–108, pl. 13 fig. 5–15, textfig. 6.

In 1956 the author already described the variable ornamentation on the dorsal side and the three generations, A_1, A_2 and B. The toothplate is found in the axial part of each chamber and forms a dentated plate over part of the umbilical hollow. From that plate, whose axial part is connected with the loop-shaped protoforamen of the former septum and chamber, thin plates creep up along the dorsal and ventral walls; the ventral one even reaches the marginal carina. Parts of the septa are also covered by these plates which are homologous to septal flaps. The septa are simple in a horizontal tangential ventral section; if in a deeper section the foramen is reached, the septum remains simple, but the dorsal thickening of the border of the foramen is doubled by the toothplate. When the section reaches the carinate margin, the septa are more or less covered at their outer sides by the somewhat undulating septal flap which may even partly form the marginal wall. At the axial part of the toothplate this flap emerges from a peculiar hook.

MCGOWRAN (1966, p. 478) believed that *Lamarckina* is bilamellar; however, he described that "the inner lining continues over the distal septal face", which is just the case when there is a septal flap. Moreover, he states that it is not always continuous.

The outer walls, especially at the dorsal side of the test, may be thickened by secondary layers of aragonite. As we found similar septal flaps in *Hoeglundina*, obviously the aragonitic genera do not belong to the bilamellate Foraminifera, but the toothplates may form septal flaps, covering parts of the septa as well as parts of the chamber outer walls. This was stated by the author for many of the genera mentioned by MCGOWRAN, as well as for *Cushmanella*.

Genus **Amphistegina** d'Orbigny, 1826

Two species of this genus occur in the Caribbean area: *Amphistegina radiata* (Fichtel & Moll) and *A. gibbosa* d'Orbigny, also in Miocene layers. In the Pacific three species are known, *A. radiata* (Fichtel & Moll), *A. madagascarensis* d'Orbigny and *A. lessonii* d'Orbigny, all three described by TODD (1965, p. 33–35, pl. 11 fig. 3–4, pl. 12–14). *A. radiata* was originally described from the Red Sea. So it has a striking circumequatorial appearance.

The inner structure of *Amphistegina* will be described in another paper; this genus is very close to *Asterigerina*; the difference being that in *Amphistegina* the main chambers are overlapping at the ventral side. The toothplate between main and secondary chambers is of a granular structure, very much complicated and obliquely placed. The walls of the chambers are hyaline, calcareous radial and – as the septa – simple; this latter statement is in contradiction with the suggestion mentioned by REISS, that the genus is bilamellar; this suggestion has caused classification of *Asterigerina* and *Amphistegina* in two different families. In reality *Amphistegina, Asterigerina* and *Tremastegina* show so many characteristics in common, that they cannot be separated.

Asterigerina carinata d'Orbigny (the genotype of *Asterigerina*) is very common in the shallow water of the Caribbean; it was found in many samples from the tidal zone and abundantly in a sample off St. Croix (800 m), but is missing in the two samples off Barbados.

Amphistegina radiata (Fichtel & Moll) Fig. 231–233

Nautilus radiatus FICHTEL & MOLL, 1798, p. 58, pl. 8 fig. a–d.
Amphistegina radiata (Fichtel & Moll), CHAPMAN, 1895, p. 45, pl. 1 fig. 8–10, 12; SAID, 1949, p. 38, pl. 4 fig. 10; TODD, 1965, p. 34, pl. 13 fig. 1–3.

Many authors have confused this species with others, as *Amphistegina madagascarensis* d'Orbigny and *A. lessonii* d'Orbigny. However, comparison with the types found in the FICHTEL & MOLL collection in Vienna and with topotype material from the Red Sea shows that this species is very typical and cannot be confused with one of the two mentioned species. In *A. madagascarensis* the main chambers bend largely over the ventral side and the number of chambers is always much smaller; in *A. lessonii* the main chambers are scarcely overlapping at the margin, whereas the secondary sutures or ornamentation are not only found in the chamber walls of the numerous main chambers, but also in those of the secondary chambers; moreover, *A. lessonii* is much larger and not so sharply edged. This is the first time that the species is mentioned from the Caribbean region and it seems to be here a form from deeper water.

Test lenticular, with 11 to 14 chambers in the last formed whorl. At the dorsal side sutures with a sharp edge of about 90°, strongly bending backwards; the edge is situated in the middle of the suture and not, as in *A. lessonii*, near the periphery. Margin sharply edged. Chambers at the dorsal side not reaching the centre, where a relatively small hyaline knob is found. There is a crenulate suture in the middle of each chamber, in the narrow part pointing towards the centre; moreover, a short suture, just before the edge in each suture runs from the distal suture of each chamber towards the middle of it, ending blindly. This suture is not found in *A. lessonii*.

The margin is sharp, nearly keeled. At the ventral side the main chambers strongly overlap at the periphery to about the middle of the radius, ending in a rounded suture. The secondary chambers form a wedge between two main chambers; they are relatively broad and do not reach the centre. Their sutures are curved and twisted. Near the aperture – which is a narrow slit near the margin – an area with fine knobs is situated over the older chambers. This area is nearly invisible in *A. lessonii*.

A. radiata is a circumtropical species. It is not found in the shallow water of the West Indies but in deeper water only, together with *A. gibbosa* which occurs in both shallow and deeper water. In a sample off St. Croix (800 m) no specimens of *Amphistegina* were found. It is remarkable that TODD (1965), p. 34 speaks of *A. radiata* as "this is the deepwaterform of *Amphistegina*". HOFKER (1951, p. 444–448, fig. 304) identified it from Indonesia where it occurred abundantly in small specimens in a depth exceeding 800 m.

Amphistegina gibbosa d'Orbigny Fig. 235–237

Amphistegina gibbosa D'ORBIGNY, 1839, p. 120, pl. 8 fig. 1–3; HOFKER, 1964, p. 88–90, fig. 224–226.

Amphistegina lessonii CUSHMAN (not d'Orbigny), 1931, p. 79, pl. 16 fig. 1–3.

Test lenticular, one side more convex than the other, distinctly asymmetric in side view. At the dorsal side 12–15 chambers visible, sutures and chambers not reaching the centre which is formed by a hyaline knob; sutures near the centre radial, then suddenly bending distalwards and with an often sharp hook bending proximalwards and strongly curving towards the periphery. Margin sharp. At the ventral side the dorsal main chambers bend over from the margin to about ⅓ of the radius, with a rounded suture. Secondary chambers not reaching the centre, star-like, often with twisted sutures. Near the aperture a narrow region with small dents is situated. Aperture a narrow slit near the margin at the ventral side of the last main chamber. No secondary sutures or other ornamentations on the chamber walls. Surface smooth, sutures not raised.

The author already stated the difference between *A. lessonii* (Fig. 234), a Pacific species, and *A. gibbosa*. The latter also occurs in the Upper Miocene of Dominica, from where it was described as *A. lessonii* by BERMÚDEZ (1949, p. 263, pl. 19 fig. 1–3). Thus it is obvious that *A. gibbosa* is an endemic species typical for the Caribbean region. It is more primitive than any other Recent species of *Amphistegina*, as all other species show secondary sutures, at least on the main chamber walls. It seems to be closest related to *A. madagascarensis* d'Orbigny from the Pacific, as shown in Fig. 238.

A. gibbosa is the only species of this genus occuring in the shallow waters around the West Indian islands. It is also very abundant in moderate deep water, as stated by BERMÚDEZ and CUSHMAN. It is common in Sta. 1442.

Rosalina globularis d'Orbigny Fig. 239–242

Rosalina globularis D'ORBIGNY, 1826, p. 271, pl. 13 fig. 1–2.
Discorbina globularis d'Orbigny, BRADY, 1884, p. 643, pl. 86 fig. 13 (not fig. 8); FLINT, 1897, p. 327, pl. 72 fig. 2.
Rosalina globularis d'Orbigny, LOEBLICH & TAPPAN, 1964, p. 584, fig. 459, 1.
Not: CUSHMAN, 1931, p. 22, pl. 4 fig. 9.

This species is very closely related to *Discorbis floridensis* Cushman but differs from it in the much flatter test of the latter. Yet the author believes that CUSHMAN as well as PARKER may have had specimens of real *globularis* too, when describing them as *floridensis*; perhaps *floridensis* is the shallow-water-form of *globularis.*

Test circular or slightly oval; periphery scarcely lobulate. Dorsal side strongly convex, globular; ventral side flat or even slightly concave. At the dorsal side all chambers visible, with distinctly curved sutures which may be slightly depressed, especially in the later chambers. The walls at the dorsal side pierced entirely by small but distinct pores, densely placed. The sub-acute margin only with scattered pores or poreless. At the ventral side only the chambers of the last formed whorl visible. The distal deuteroforamen clearly visible as a crescent-shaped opening, separated from the proximal very small and slit-like protoforamen by a large, triangular tenon. This tenon shows a distinct pointed part towards the umbilical region and covers it entirely. Visible sutures of former chambers distinctly curved. The peripheral parts of the chamber walls show the same distinct pores as found at the dorsal side; the tena are entirely poreless. Transverse and horizontal sections reveal that the chamber walls and the septa are simple, hyaline, radial calcareous.

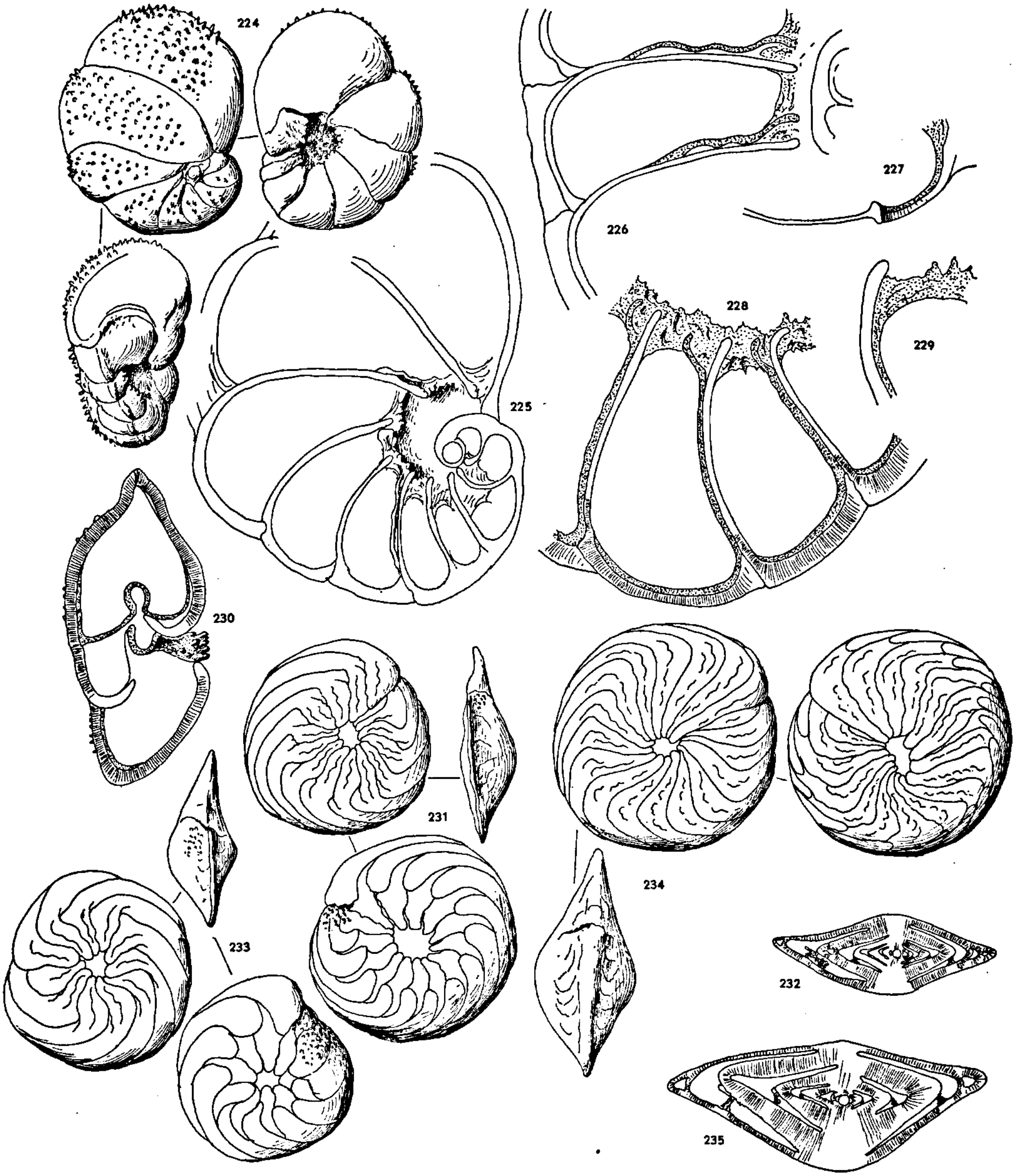
The animals live with their ventral sides attached to shells; around each test an irregular rim of white granular calcitic material is situated.

The species did not occur in Sta. 1442, but was very common in Sta. 1443; it was not found in the sample off St. Croix (800 m), where several other species of the same group were common (HOFKER, 1956, p. 178–186).

Rotorbinella barbadosensis nov. spec. Fig. 243–246

Test planoconvex, the dorsal side convex, hyaline secondary calcite forming a distinct knob in the centre; ventral side nearly flat; periphery rounded, margin sub-acute. At the dorsal side all chambers visible, except in the initial part which may be obscured by the central thickening; chamber sutures distinct, smooth, strongly curved backward; 8–9 chambers in the last formed whorl.

At the ventral side sutures slightly curved, distinct, slightly limbate, sinuous in the last formed chambers. The ventral suture of the last formed chamber shows a distinct indentation near the margin, where the small crescent shaped aperture lies. Chambers not reaching the distinct smooth calcitic knob in the centre. Walls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at dorsal and ventral sides pierced by very fine pores which are also found at the margin. Walls in the last formed chambers relatively thin, granular; in more initial chambers these walls are thickened secondarily by more hyaline material on transverse section, but here too the inner granular part of the walls can be seen. On horizontal section the septa are entirely granular, whereas at the margin the granular primary wall is covered by more hyaline material, not forming a distinct layer.

The test is slightly oval or entirely circular; the diameter is mostly 0.65 mm; the thickness of the test is about 0.20 mm.

The species was fairly common in Sta. 1442.

Rotorbinella rosea (d'Orbigny) Fig. 247–250

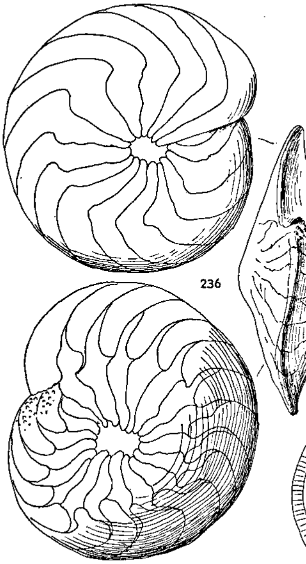
Rotalia rosea D'ORBIGNY, 1826, p. 272, No. 7; Modèles No. 36.
Rotalina rosea D'ORBIGNY, 1839, p. 72, pl. 3 fig. 9–11.
Truncatulina rosea (d'Orbigny), BRADY, 1884, p. 667, pl. 96 fig. 1.
Rotorbinella rosea (d'Orbigny), BERMÚDEZ, 1952, p. 75; HOFKER, 1964, p. 109, fig. 263–265.
Parella rosea (d'Orbigny), HOFKER, 1956, p. 112, pl. 14 fig. 5–9.

Fig. 224–230. *Lamarckina atlantica* Cushman. – Barbados, sta. 1443: 224, test from three sides (× 60); 225, horizontal section ,showing the toothplates and some septal flaps of these toothplates along the proximal septa (× 113); 226, part of a horizontal section, showing the primary walls continuing in the septa, and the septal flaps emerging from the axially situated toothplates (× 150); 227, axial part of septum with toothplate and septal flap, taken just at a foramen, the wall of the foramen is doubled by the septal flap, but the septum itself remains here simple (× 150); 228, primary walls with septa formed by continuation of the primary walls, outer secondary thickening of the walls, axial toothplates and septal flaps emerging from the toothplates; taken dorsally from the foramen (× 150); 229, toothplate septal flap, also covering axial part of septum at the distal side of a chamber, from horizontal section near through the vental wall (× 150); 230, transverse tangential section, showing foramina, toothplate and the septal flaps of the toothplate (× 60).

Fig. 231–233. *Amphistegina radiata* (Fichtel & Moll). – Barbados, sta. 1442: 231, from three sides (× 20); 232, transverse section (× 20); 233, from the type-region, Red Sea (× 20).

Fig. 234. *Amphistegina lessonii* d'Orbigny. from off Sorong, New Guinea, depth 4.5 m (× 11).

Fig. 235. *Amphistegina gibbosa* d'Orbigny. – Barbados, sta. 1442: transverse section (× 20).



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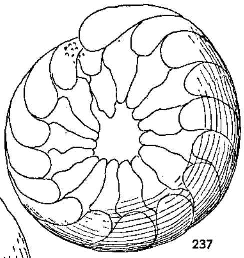

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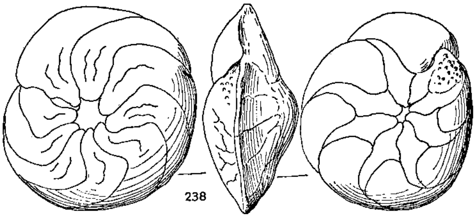

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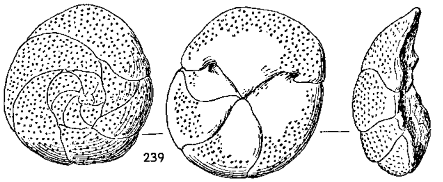

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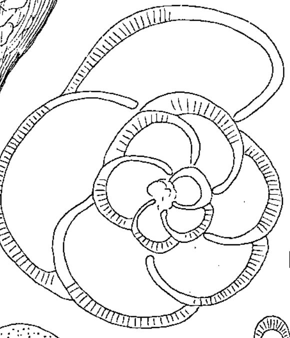

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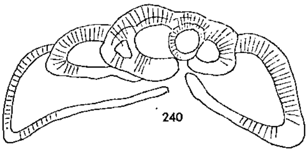

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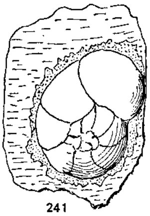

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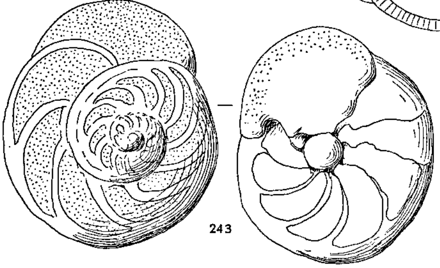

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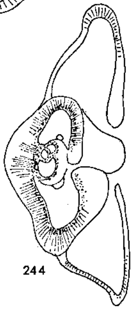

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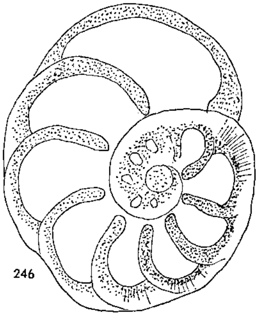

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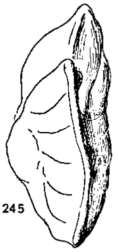

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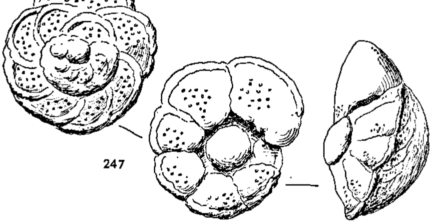

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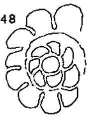

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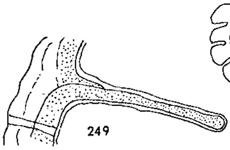

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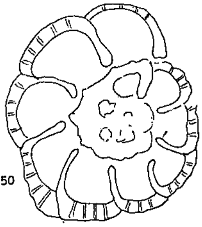

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In 1956 the present author believed that this species was related to *Osangularia*; but comparison with many species of *Rotorbinella* in 1964 showed that the species may be better placed in the genus *Rotorbinella*, as done by BERMÚDEZ (1952).

The inner structure shows that – as in most species of *Rotorbinella* – a distinct calcitic knob is found running from the initial part and filling up most of the umbilical cavity. In this feature and in the absence of toothplates, the genus *Rotorbinella* can be distinguished from *Discorbis*. Therefore the author does not agree with LOEBLICH & TAPPAN (1964, p. 572) who thought *Rotorbinella* to be synonymous with *Discorbis*. Typical of *Rotorbinella* is the bending ventralwards of the last formed chamber.

In 1956 and in 1964 the author gave transverse sections of *R. rosea*. Here special attention is given to the horizontal section. The outer walls, especially those of the dorsal sides, are thickened by secondary lamellae of calcite. But the septa between the chambers are simple and the whole test is distinctly granular. All chambers are lined on the inner side by brownish coloured pseudochitin. The initial chambers form a simple trochoidal spiral. A distinct sigmoidal border at the aperture is not found, as also was stated in

Fig. 236–237. *Amphistegina gibbosa* d'Orbigny. – Barbados, sta. 1442: 236, from three sides (× 20); 237, from the miocene of Dominica, ventral side (× 20).

Fig. 238. *Amphistegina madagascarensis* d'Orbigny. – off Sorong, New Guinea, 9 m depth (× 20).

Fig. 239–242. *Rosalina globularis* d'Orbigny. – Barbados, sta. 1443: 239, test from three sides (× 20); 240, transverse section (× 30); 241, specimen attached to part of shell, with the calcitic attaching matter surrounding it (× 20); 242, horizontal section, showing the simple septa (× 30).

Fig. 243–246. *Rotorbinella barbadosensis* nov. spec. – Barbados, sta. 1442: 243, dorsal and ventral sides (× 60); 244, transverse section, showing the granular primary walls (× 60); 245, specimen of 243, apertural face (× 60); 246, horizontal section, showing the granular septa, the wall of the last formed chamber simple and totally granular, walls of older chambers with the hyaline secondary thickening over the granular primary walls (× 60).

Fig. 247–250. *Rotorbinella rosea* (d'Orbigny). – Barbados, sta. 1443: 247, total test from three sides (× 60); 248, initial spiral of chambers, horizontal section (× 60); 249, part of wall with septum taken from a horizontal section, showing the granular primary wall continuing in the septum, the more hyaline outer secondary thickening of the wall and the inner pseudochitinous lining (× 150); 250, horizontal section (× 60).

Rotorbinella barbadosensis; this also might be a characteristic for the genus. The simple granular septa also occur in the genus *Osangularia*, thus it may be allied to that genus as well.

Siphonina primitiva Hofker Fig. 251–253

Siphonina primitiva HOFKER, 1956, p. 120, pl. 15 fig. 19–24.

As I described already in 1956, this species with very short apertural neck is primitive, as the whole test wall of each chamber is pierced by distinct, but narrow pores; the carina is nearly missing, though the wall is thicker at the margin and forms a narrow keel as is seen in transmitted light.

The distal parts of the apertural necks form structures which very much resemble those described by the author (also 1956) as toothplates of the genus *Parrella*. This could be ascertained in horizontal sections of material from Barbados. Just as in *S. pulchra*, the distal walls of the apertural necks run inward towards the marginal walls of the former whorl of chambers and show the structure as found in the toothplates of *Streblus* (Fig. 254). Moreover, the walls of the necks of the apertures are distinctly granular, just as in the toothplates of so many Foraminifera.

Remarkable is that in polarized light the tests are not crystalline but granular or, possibly, slightly fibrous radial at the margin, but not at all radial as described for *Siphonina* by LOEBLICH & TAPPAN (1964); this characteristic applies to the first known species of the group, *Pulsiphonina prima* too. Yet, this *S. primitiva* is a true *Siphonina*, as the aperture, situated ventrally from the margin, has a short but distinct neck.

The species very much resembles *Siphonina danvillensis* Howe & Wallace from the Eocene Cocoa-sands of Alabama, U.S.A.; the latter also shows the primitive characteristics of pores piercing the whole chamber wall and not restricted to special areas of the walls. In this Eocene species the walls are not radial crystalline, but granular too. In 1951 (p. 341) and 1956 the author suggested a relationship between *Osangularia* and *Siphonina*.

The species is small; diameter 0.25 mm.

Siphonia primitiva was first described from a depth of 200 m off St. Croix; it also occurred in a Barbados sample (1443) from about the same depth, whereas it was not found in samples from 100 m (Barbados, 1442) and 800 m (St. Croix). So the species seems to be restricted to a depth of about 200 m.

Siphonina pulchra Cushman Fig. 255–258

Siphonina pulchra CUSHMAN, 1919, p. 42, pl. 14 fig. 7; 1931, p. 69, pl. 14 fig. 2–3; HOFKER, 1956, p. 120–122, pl. 16 fig. 1–8.

The horizontal section shows that the chamber walls have an inner granular lining at the periphery which can be followed into the walls of the neck of the peculiar aperture; this lining may be the primary wall. Remarkable is the resemblance of the whole structure of the apertural neck adhering to the inner filling of the umbilical region and the toothplate of the genus *Streblus*; Fig. 254 shows a horizontal section through *Streblus tepidus* for comparison. So it is not so far fetched when I took the inner parts of the apertural structure in *Siphonina primitiva* HOFKER (1956, p. 120) for a toothplate-structure. The walls at the outside of the granular layer are distinctly crystalline and show in polarised light the structure of *Patellina* and *Spirillina vivipara* as figured by RHUMBLER (1911, pl. 5), indicating that the walls consist of large calcareous crystalls. Remarkable are the often flask-like pores which may bifurcate in the carina.

Pulsiphonina prima seems to have the primary granular wall only, so that the crystalline layer of the wall may be a later adaptation.

This species occurred only in Sta. 1442, where it was fairly abundant. It has been analyzed by the author (1956) from off Santa Cruz (St. Croix), depth 800 m.

Genus **Parrelloides** Hofker 1956

This genus was established by the author for species which have the characteristics of what has been called "*Cibicides*" with a lenticular test: all chambers visible at one side, only those of the last formed whorl on the other side; with pores in the walls of the spiral side, whereas the walls at the involute side are poreless or show pores in the last formed chambers only. The test wall in the species observed is granular, fibrous radial or radial, the septa in horizontal sections are simple, though later secondarily thickening lamellae may occur in the outer walls. The aperture in most species is a sutural slit at the involute side, often reaching the margin which in several species is poreless and acute.

The author mentioned *Parrelloides hyalina* Hofker (*P. bradyi* Trauth?) as the genotype; *Parrelloides cookei* (Cushman & Garret) was also placed in *Parrelloides* in 1956. BELFORD (1966, p. 99–103) showed that *P. robertsonianus* (Brady), *P. soendaensis* (Leroy) and *P. okinawensis* (Leroy) belong here as well.

The present author showed that the microstructure of the test wall is not an essential generic characteristic, as it may change within a genus during the course of geologic time; it is not necessary that all species belonging to *Parrelloides* have radial walls; they may be fibrous radial or even granular. I found that in many species of the genus *Parrelloides* there is an inner granular part of the septal wall and an outer more hyaline part which may be fibrous radial or entirely radial.

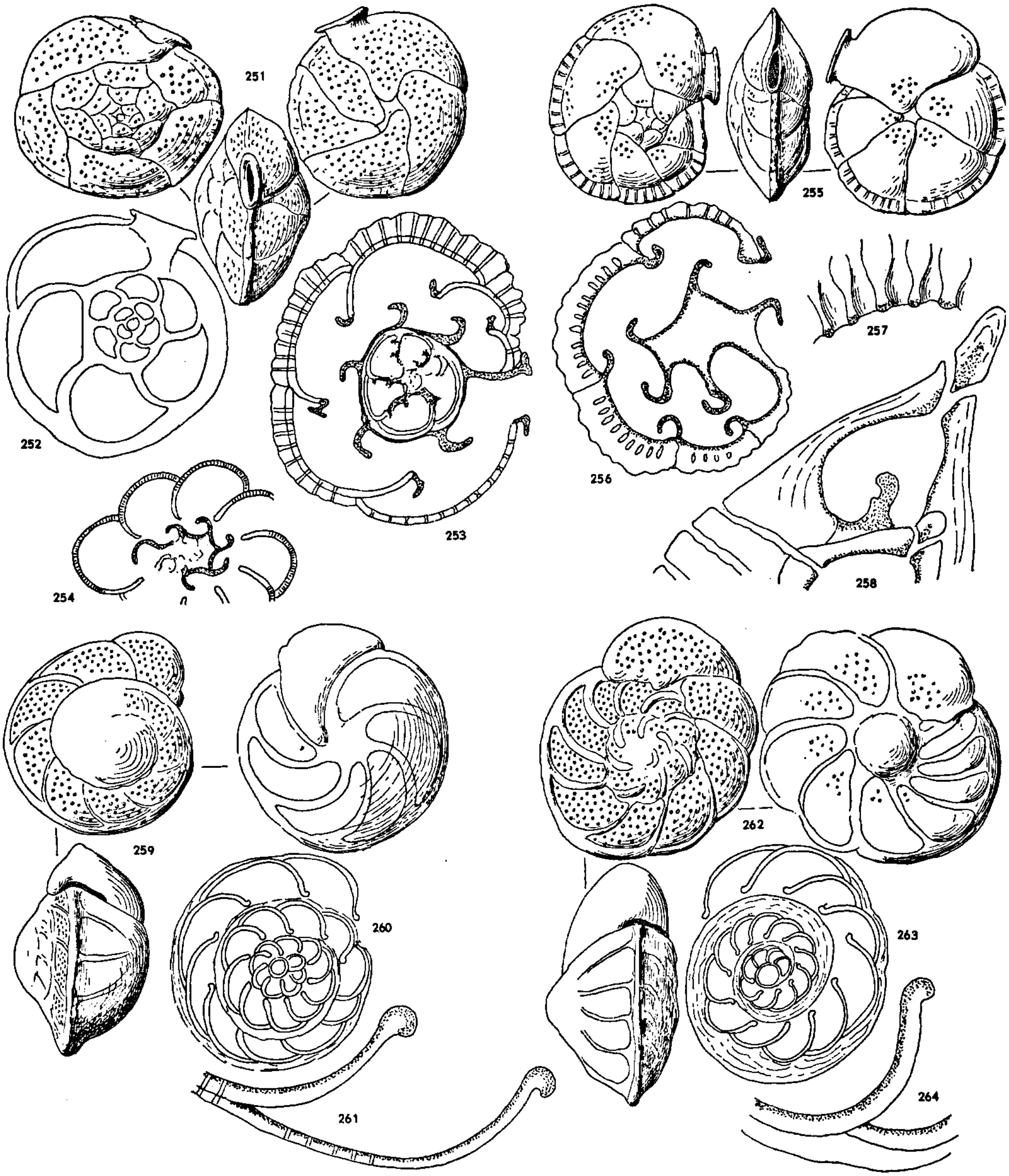
Species which showed to possess the typical characteristics of *Parrelloides* are *Truncatulina midwayensis* Plummer from the Midway Formation; *Truncatulina alleni* Plummer from the same locality; *Cibicides succedens* Brotzen from the Paleocene clays of Denmark; *Planulina* cf. *wuellerstorfi* Cushman & Stainforth from the Lower Oligocene of Ecuador; *Planulina mexicana* Nuttal from the Oligocene of Ecuador; *Cibicides detemplei* d'Orbigny from the Tegel of Baden (Miocene) in Austria; *Cibicides* (*Planulina*) *foveolata* Brady from St. Croix (800 m), Caribbean; *Cibicides pseudoungerianus* Cushman from Iceland (40 fathoms).

To this list we may now add two other species, viz. *Cibicides umbonatus* Phleger & Parker and *Cibicides mollis* Phleger & Parker.

LOEBLICH & TAPPAN (1964, p. 757) believe *Parrelloides* Hofker to be a synonym of *Cibicidoides* Thalmann 1939. They believe that *Cibicidoides* Brotzen is a nomen nudum; this, however, is not the case, for *Cibicidoides* Brotzen 1936 was a subgenus, with certainty given for those *Cibicides*-like species which show a convex spiral side so that they were not attached; this description is clear enough. As subgenotype was designated *Cibicides* (*Cibicidoides*) *eriksdalensis* Brotzen. Moreover, in 1942 BROTZEN once again described *Cibicidoides* Brotzen 1936, now given as genus, not as subgenus; once again, the genotype was designated as being *C. eriksdalensis* Brotzen 1936. Here the aperture was described by BROTZEN as "interio-marginal septal" with distinct umbilical opening at the spiral suture. As in the different species here described by the present author, the aperture cannot be followed in the spiral suture and is not found in the genotype *Parrelloides hyalina* Hofker, *Parrelloides* cannot be a synonym of *Cibicidoides*.

Later BROTZEN (1948) described another species as *Cibicidoides*, *C. proprius*, but it is not certain whether that species belongs to *Parrelloides* or *Cibicidoides*; *C. proprius* has a fibrous radial or even granular test. LOEBLICH & TAPPAN (1964, p. 757) speak of *Cibicidoides* Thalman 1939, but it is remarkable that THALMANN himself (1960) quotes *Cibicidoides* Brotzen 1936, but as a subgenus and gives as subgenotype *Truncatulina mundula* Brady, Parker & Jones, designated as such by THALMANN in 1939. As, however, BROTZEN in 1936 gave his new species the name of *Cibicides* (*Cibicidoides*) *eriksdalensis* and as he gave a good distinction for the subgenus *Cibicidoides* (p. 194) in that way that he said: "Da jedoch die gewölbte Nabelseite der neuen Art gegen solche Lebensweise spricht (die angeheftete Lebensweise), wäre eine Genustrennung angebracht", it is clear that BROTZEN meant to distinguish the forms with flat or concave spiral side (*Cibicides*) from those which have a convex spiral side: *Cibicides* (*Cibicidoides*), with the only type given in 1936, *C.* (*C.*)*eriksdalensis* Brotzen. In my opinion there was neither reason to change the genotype nor to quote THALMANN as the author of the name *Cibicidoides*.

In both species analyzed here from Barbados, the aperture cannot be followed at the spiral side. Since neither the septa nor the walls of last formed chambers are double, the two species have to be placed in the genus *Parrelloides*, just as BELFORD (1966) did for similar species from New Guinea.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Parrelloides mollis (Phleger & Parker) Fig. 259–261

Cibicides mollis PHLEGER & PARKER, 1951, p. 30, pl. 16 fig. 7–9.

Test small, mostly biconvex, 3 whorls in the megalospheric adult, of which at the dorsal (spiral) side only the last formed whorl is distinctly visible; the earlier whorls are confused by the thick central thickening with secondary calcitic material. Margin sub-acute, often with distinct blunt keel. At the ventral side only the 7–8 chambers of the last formed whorl visible. At the dorsal side chamber sutures distinctly oblique backward, at the ventral side the thick sutures strongly curved. In the walls of the last formed whorl at the dorsal side distinct but relatively small pores are visible; at the ventral side no pores visible; here the sutures of the last formed chambers slightly depressed, leaving a flush area in the middle. Aperture a narrow slit near the margin or even slightly marginal, but the larger part of it at the ventral (involute) side. Test always brownish.

Fig. 251–253. *Siphonina primitiva* Hofker. – Barbados, sta. 1443: 251, specimen from three sides (× 30); 252, horizontal section near the dorsal side, showing the chambers (× 30); 253, horizontal section taken nearer the ventral side, showing the granular parts forming the sipho-like apertural neck (in reality the toothplates), the primary walls continuing in the simple septa, the primary wall over the last formed chamber and the hyaline, fibrous radial thickening over the primary wall at the outer walls (× 60).

Fig. 254. *Streblus tepidus* Cushman. – Horizontal section, for comparison with the horizontal section of *Siphonina primitiva* (× 60).

Fig. 255–258. *Siphonina pulchra* Cushman. – Barbados, sta. 1442: 255, specimen from three sides (× 20); 256, horizontal section, showing the granular toothplates (× 30); 257, large pores in the carina (× 113); 258, part of transverse section, showing the granular primary walls, the granular toothplate and the bifurcating large pores in the marginal carina of the test (× 113).

Fig. 259–261. *Parrelloides mollis* (Phleger & Parker). – Barbados, sta. 1443: 259, test from three sides (× 60); 260, horizontal section (× 60); 261, two septa and the outer chamber wall, showing that the septa are simple with an inner granular primary which is thin; the outer wall of a chamber grows backward over the outer wall of the next chamber, strengthening it (× 150).

Fig. 262–264. *Parrelloides umbonatus* (Phleger & Parker). – Barbados, sta. 1443: 262, test from three sides (× 60); 263, horizontal section, showing secondary thickening of the outer walls which may be originated from the thickenings of later chambers also (× 60); 264, septum and outer wall, showing the simple septum consisting of an inner granular part and a hyaline outer part which do not form, however, distinct layers (× 150).

Horizontal sections reveal that the septa are simple with a granular part on their inner sides; they continue in the margin which may be secondarily thickened. The hyaline part of the walls is fibrous radial.

The species is common in Sta. 1443.

Parrelloides umbonatus (Phleger & Parker) Fig. 262–264

Cibicides umbonatus Phleger & Parker, 1951, p. 31, pl. 17 fig. 7–9.

Test biconvex, with about 3 whorls in the megalospheric tests. Spiral side less convex than the involute side. Margin sub-acute with slight keel. At the dorsal spiral side all chambers visible, chambers of the last formed whorl slightly overlapping the former whorl. Sutures distinct, often slightly limbate, strongly curved backwards. Walls pierced by distinct pores. At the ventral side sutures distinct, broad, strongly curved backward; last formed chamber walls also porous. Margin lobulate at the last formed chambers. Centre of involute side covered by a more or less hyaline calcitic knob.

Horizontal sections reveal that the septa are simple with granular inner part and more hyaline outer side. Outer walls thickened by overlapping walls of later chambers. Wall material distinctly brownish.

The species is common in Sta. 1443.

Cancris oblonga (Williamson) Fig. 265

Rotalina oblonga Williamson, 1858, p. 51, pl. 4 fig. 98–100.

Whereas off Santa Cruz (St. Croix), 800 m, *Cancris auriculata* (Montfort) and *Cancris sagra* (d'Orbigny) could be described and analyzed by the author (1956, p. 199–203), it was now possible to analyse specimens of *Cancris oblonga* (Williamson) occurring in less deep water.

The last formed chamber forms a lip over the ventral aperture; the whole form of the test strongly recalls *Lamarckina*, but also *Globorotalia*. The test is elongate, about twice as long as broad, compressed with poreless carina at the periphery, with about 9 chambers rapidly increasing in volume, following the proloculus.

At the dorsal side all chambers visible, at the ventral side the last formed chamber partly covering the former ones. Test wall very thin and shining, dorsal side with walls entirely pierced by very fine pores; at the ventral side the wall of the last formed chamber has a poreless central part.

Horizontal sections show that the septa are partly poreless and thickened at the foramina; septa and walls are monolamellar, just as in *Globorotalia* and *Globotruncana*, at least in specimens which are really planktonic. In 1956 the present author gathered these three genera into the family Marginolamellidae; this viewpoint can be maintained, as it is known now that all three genera have the following characteristics in common:

Walls primarily thin, with monolamellar septa throughout; pores fine but distinct; at the ventral side of the last formed chamber a poreless part of the chamber wall near the tectum plate and connected with the poreless marginal rim or keel; aperture at the ventral side, connected with the umbilicus, and covered by a tectum which may be a changed toothplate. The aperture is a foramen compositum.

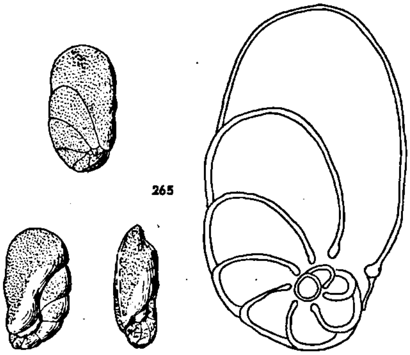


Fig. 265. *Cancris oblonga* (Williamson). – Barbados, sta. 1443: 265, test from three sides (× 20) and horizontal section through a test, showing the simple hyaline walls and septa (× 60).

PLANKTONIC SPECIES

In both stations, 1442 and 1443, planktonic species are common. Moreover, most species are the same in both stations.

The following species are found:
Globorotalia tumida (Brady)
Globorotalia menardii (d'Orbigny)
Globorotalia truncatulinoides (d'Orbigny)
Globigerina sacculifera Brady
Globigerina rubra d'Orbigny
Globigerina conglobata Brady
Globigerina eggeri Rhumbler
Pulleniatina obliqueloculata (Parker & Jones) [only Sta. 1442]
Orbulina universa d'Orbigny
Candeina nitida d'Orbigny
Sphaeroidinella dehiscens (Parker & Jones) [only Sta. 1443]

It is remarkable that the following species common at Santa Cruz (St. Croix) about 800 m deep (HOFKER, 1956), are *not* found at the sea-floor in the stations 1442 (100 m) and 1443 (200 m), though the total amount of planktonic specimens off Barbados was large:
Globigerina quinqueloba Natland
Globigerina aequilateralis Brady
Globorotalia fimbriata (Brady)

Perhaps these species occur alive only in deeper water, so that they are absent in the more shallow samples off Barbados. The data given by PHLEGER & PARKER (1950) about living specimens gathered in plankton nets in the North-west Gulf of Mexico point in that direction.

The following species have been described by the present author (1965) from off St. Croix.
Globorotalia tumida, G. menardii and *G. truncatulinoides,* p. 192–199, pl. 29 fig 15–33, pl. 30 fig. 1–14;
Globigerina sacculifera, G. rubra, G. conglobata, G. eggeri, p. 222, 230–231, 235, pl. 32 fig. 19–37, pl. 33 fig. 15–17, pl. 34 fig. 25–41, pl. 35 fig. 1–17, 22–27;
Orbulina universa, p. 236, pl. 35 fig. 28;
Pulleniatina obliqueloculata, p. 203–206, pl. 31 fig. 16–24;
Candeina nitida, p. 98–99, pl. 12 fig. 10–17.

The author believes that *Globigerina sacculifera* is the bullate form of *G. tribola* (Reuss) and it is thus not mentioned separately in this paper.

In this paper the author will describe some of the variants of these species found in the samples and some sections of the tests. These sections show clearly that all the species found off Barbados are monolamellar, having simple septa and simple inner walls of the more initial chambers; they form, however, a secondary thickening over their outer walls, over the primary layer. This is in contradiction with the observations of several other authors who believe the planktonic Foraminifera to belong to the bilamellar species.

BÉ & LOTT (1964, p. 823–824) stated that the primary wall is double, though all their figures, especially fig. 3, show that this wall is simple and forms the simple-walled septa. They emphasized the later addition of an outer thickening in deeper-living specimens, and not the thickening-per-instar, as emphasized by REISS. The inner layer of the primary wall, as believed by BÉ & LOTT, covering the whole inner surface of walls and septa, cannot be affirmed and is not in agreement with the ideas about bilamellarity given by SMOUT and REISS.

The monolamellar nature of the Globigerines could also be established in another way. Sample 1443 yielded in its finest fraction many very young specimens, with a diameter of about 0.030 mm; the results were as follows (Fig. 338–342).

Globigerina rubra; test walls of chambers simple, but dorsally over the first initial chambers a thin secondary layer could be traced.

Globigerina eggeri; all chambers show the primary wall only; no secondary thickenings could be found.

Globigerina sacculifera (= *G. triloba*); all chambers show the primary wall only with fine pustules at the surface.

Globigerina conglobata; in this individual the outer walls already show the secondary layer, but all the inner walls are simple; in this case it seems that the individual was already too much developed.

So it is obvious that the Globigerinae first have simple walls and that the second layer found in older specimens on the outer walls is secondarily formed. Globigerinae are monolamellar originally.

A similar result was obtained studying very young specimens of *Globorotalia menardii*. The entire ventral and dorsal walls of the whole last formed whorl are simple; only the dorsal wall of the most initial part shows a secondary thickening. The ventral walls of that part are simple. As I stated (1964, p. 453–456, pl. 1 fig. 4) that the septa of *Globorotalia menardii* and *G. tumida* are simple, and since living planktonic specimens of *G. menardii* show simple walls also (HOFKER, 1962, p. 110, fig. 44), it is obvious that the genus *Globorotalia* is also monolamellar of origin (see Fig. 420).

Globotruncana also has monolamellar septa (HOFKER, 1964). In an other paper (1968a) the author showed that many other species which are thought to be planktonic have monolamellar septa. HOFKER Jr. (1969) came to the same result. *Globorotalia menardii* and *G. tumida* gathered from bottom samples are not only much larger than the young and the planktonic specimens, but have added to their outer primary walls one or even more layers of secondary calcitic material, just as in *Globigerina*. The same phenomenon could be stated in *Orbulina universa*. This adding of calcitic layers over the primary walls may be the means to sink to the bottom, to resume a benthonic life, or at least live in deeper water. Benthonic life could be stated by CHRISTIANSEN (1965) for the microspheric generation of *Globigerina rubra*.

COILING DIRECTIONS Fig. 266

Globigerina eggeri forms a good instance for the dependence of direction of coiling on temperature (or possibly distance to the equator); near the equator nearly all specimens are coiling to the right; at about 40°N about 30% are coiling to the left and at about 65°N nearly 100% coil to the left, with all gradations between. The same phenomenon can be seen in *Globorotalia truncatulinoides* as in this species between 0°N and 18°N most specimens are coiling to the right, whereas in a latitude from 30°N to 40°N 55% to 95% are coiling to the left; no records are known to the author from more northerly latitudes.

In *Globigerina sacculifera* the coiling pattern is somewhat different. In stations from 0°N to 15°N about 55–60%, at 18°N 65%, at 38°N 75% are coiling to the left. No specimens are known to the author from more northerly latitudes; though the tendency to change the pattern of coiling from right to left exists, the scope of the change is much more limited (from 65–75% left) than in *G. eggeri* and *G. truncatulinoides*.

Another pattern is found in the *G. inflata-Pulleniatina obliqueloculata*-group. We may consider this group as a biologic unit, as the finer structure of the test is the same and as in samples taken from the boundary at about 30°N, the two forms called

G. inflata and *Pulleniatina* touch each other in the Pacific as well as in the Atlantic. At about 30°N *G. inflata* begins to become globular and the last formed chambers begin to overlap the ventral side of the test. At that border suddenly *Pulleniatina obliqueloculata,* which from 0° to about 20°N coils mostly to the right direction, changes into *G. inflata* (or is taken over by the latter), which from about 30° to 68°N coils nearly only in left direction. In case both forms occur together, there may be a mingling of directions too, but as a whole the change from right to left at about 30°N is a sudden one. So, in the Western Mediterranean all specimens of *G. inflata* coil to the left, but many specimens have the outer form of small specimens of *Pulleniatina.*

Quite different is the change of direction of coiling in *G. rubra* and in *G. menardii.* Both species have in the tropical region of the Western Atlantic left-coiling megalospheric tests, whereas the microspheric tests are right-coiling.

In the sub-tropical regions (Atlantic and Mediterranean) *G. rubra* has 45%, *G. menardii* 35% left-coiling specimens. In the tropical Pacific *G. rubra* seems to be replaced by *G. rubescens* Hofker with its red colour and small rounded aperture in the last formed chamber; it is remarkable that the latter species has 8% left-coiling individuals, so that it differs from *G. rubra* also in the coiling pattern.

This reverse pattern in coiling direction of *G. rubra* and *G. menardii* shows us, compared with that found in *G. eggeri*, *G. sacculifera* and *G. truncatulinoides* that obviously the change in coiling direction in regard to the distance with the equator is only found in the megalospheric generations and, moreover, that the percentages of coiling direction in those instances ought to be used only as an indicator of the temperature of the surrounding water, if the direction of change with the higher distance from the equator is known in any species concerned. Moreover, the study of the change in coiling direction may add to our knowledge of the connection of two forms believed to belong to different species (e.g. *G. inflata-Pulleniatina*) or the difference between such forms (*G. rubra* and *G. rubescens*).

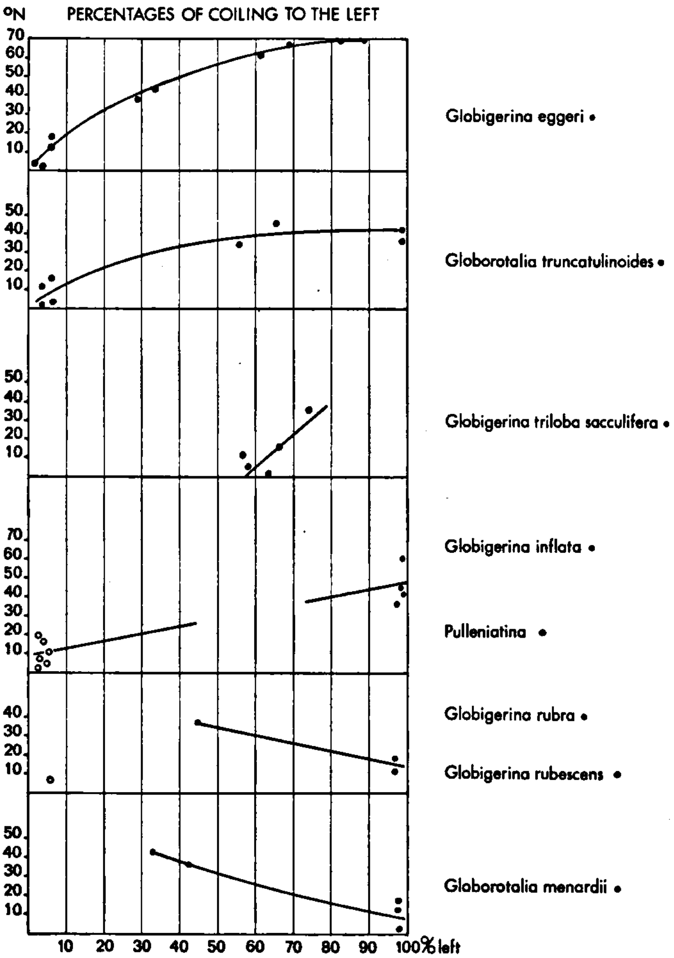


Fig. 266. Percentages of left coiling of some planktonic Foraminifera, in consideration to the length in °N. *G. eggeri*, *G. truncatulinoides* and *G. sacculifera* show a distinct tendency to change the direction of coiling from right to left when the samples in which they were found withdraw from the equator. *G. inflata* and *Pulleniatina obliqueloculata* do the same, when we consider them to belong to one biologic unit, though the change from right to left is an abrupt one. However, *G. rubra* and *G. menardii* show the reverse change of direction, from left to right. It is obvious from the analysis, that *G. rubescens*, found in the Pacific, is a species which is quite different from *G. rubra*.

The samples studied were:

Ingolf Exp. St. 119	67°N	Mar de Alboran, Mediterr.	39°N
Ingolf Exp. St. 105	65°N	Santa Cruz, Caribbean	18°N
Ingolf Exp. St. 91	64°N	Barbados 1443	13°N
Cirrus Exp.	62°N	Snellius Exp. St. 85	4°N
Cirrus Exp. off Finisterre	44°N	Siboga Exp. Nias Deep	0°N

Benthonic origin of planktonic Foraminifera

The study of planktonic Foraminifera was enormously stimulated by the publication of a short paper by Grimsdale (1951, p. 463–475). Since that time many investigators specialised in planktonic Foraminifera and tried to establish phylogenetic lines of evolution. However, do planktonic Foraminifera form a special, homogenous group?

It is certain, that originally Foraminifera were benthonic animals. Christiansen (1965) found that *Globigerina rubra* has a benthonic microspheric generation. Many planktonic species are known now to sink down in the sea after a typically planktonic stage, forming thicker and thicker tests. We know of many planktonic animals, not Foraminifera, that either have a benthonic life-part too, or belong to typically benthonic groups in which some of the species obtained the means to lead a planktonic life. Obviously the main source of planktonic life is to be found at the bottom of the sea, though not of the deep sea, for peculiar adaptations are necessary to conquer the planktonic environment.

It will be obvious that long-range phylogenetic trends in planktonic Foraminifera are not very likely to occur. Moreover, we should bear in mind that at several geologic times benthonic forms may have changed their way of living to planktonic. Quite different groups may have succeeded in this change, most of them may have had one or two planktonic species and then given up the attempt.

The author (1956, p. 312–340) stated that the group around *Globotruncana* which is believed to have been planktonic, might have had forefathers which were benthonic and possessed a proto- and a deutero-foramen in the beginning as found in *Conorboides*. The fact is that all planktonic Foraminifera investigated by my son, Hofker Jr. (1969) and by myself in this paper, proved to be monolamellar, as also is *Conorboides*. The sudden appearance of such forms as *Candeina, Cassigerinella, Globigerinatella,* all with a very short geologic life-span and with degenerated toothplates indicating benthonic forefathers, points in this direction. Many groups, common in Recent seas, have certainly appeared on the theatre of planktonic life in the late Tertiary or even later; this implicates that the planktonic life is difficult to manage.

From where did they come? The present author showed that *Candeina* and *Globigerinatella* came from such forms as *Virgulinella*; *Cassigerinella* may have derived from *Globocassidulina*; they had benthonic forefathers (see *Stichocassidulina*). Another typical instance for a short-living planktonic form is *Globigerina* (*Globocanusa*) *daubjergensis,* which began in the uppermost Cretaceous, developed during the Danian and ended in the form of *G. kozlowskii* in the Paleocene. There are many examples in which planktonic forms begin with a trochoidal stage and end in a planospiral stage; the first named stages resemble benthonic forms of the *Rosalina*-group very much.

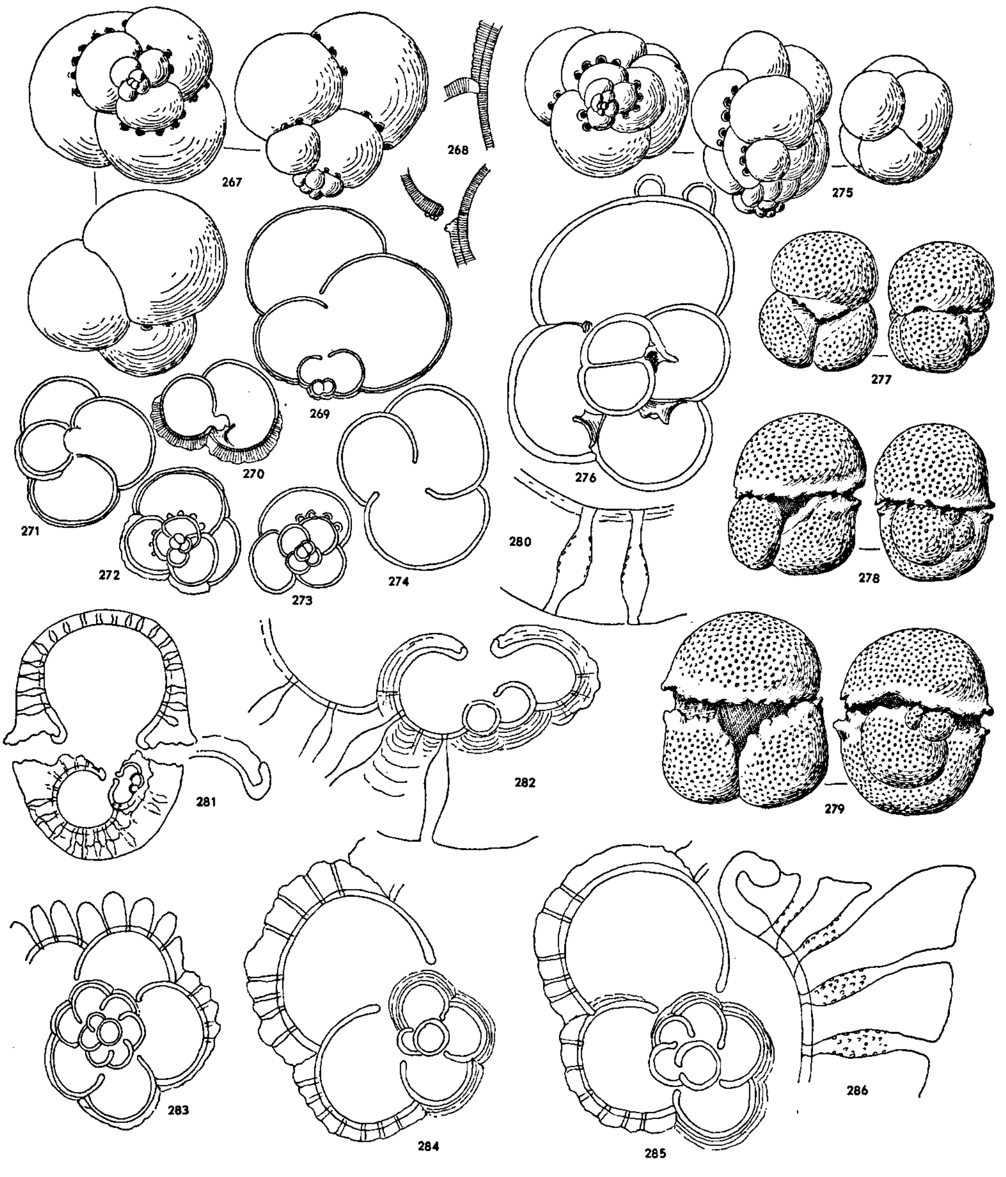
The author (1957, p. 414–418) showed that the *Globigerina aspera* group of the Upper Cretaceous began as a trochoid form and ended with a planospiral form. In the uppermost Cretaceous *G. pseudobulloides* suddenly appears, a short-living form not transgressing the Paleocene-Eocene boundary. BYKOWA (1960, p. 309–327), however, tried to prove that *G. pseudobulloides* derived from late *G. aspera,* once again obtaining the trochoidal form, surpassing into forms as *G. eocaenica,* to end once more in a planospiral group, *G. micra* (see also BERGGREN, 1966); such a change in the pattern, repeated more than once, is not very likely. BANDY (1967, p. 1–31) believed that the *G. daubjergensis*-group derived from a "reservoir" of microforaminifera in the Upper Cretaceous which might have developed from the *washitensis-portsdownensis*-group, a far-fetched hypothesis; the *Globigerinelloides*-group should have ended in the Upper Maestrichtian (BYKOWA's paper was not mentioned), and *G. pseudobulloides* should have derived from a *Hedbergella*-complex, once again a hypothesis. All such lineages postulate that planktonic species should have a long-living evolutionary development as such and do not take into account the possibility that each new group of planktonic Foraminifera may evolve from a benthonic group as well. Especially at larger faunal breaks new starts of planktonic groups seem likely and probably we should not seek forefathers of newly developing planktonic groups in older planktonic ones, but in benthonic groups. For planktonic animals are always extremely specialized creatures. There we find many examples of larvae of benthonic organisms which lead a planktonic life; in larvae with less differentiated cells adaptation to planktonic life may be easier; groups which may be planktonic in the adult stage, such as Rotifera, ought to be considered as larvae which became sexual (retardation). Therefore it may be that all the planktonic Foraminifera have a benthonic part in their life-cycle, and that the planktonic species in reality form parts of life-cycles and thus are no species at all.

Moreover, it may be that planktonic species as such are belonging to primitive groups of Foraminifera, apt to adaptation to the planktonic life. In this respect it is remarkable, that I found that all species described in this paper show a monolamellar structure of the walls. Later stages of development of planktonic Foraminifera show a secondary thickening of the outer walls in many cases, which may be the indication that they are sinking down in the sea to attain the benthonic habitat. In accordance to what was found by CHRISTIANSEN (1965), we should look for possibly short benthonic stages of planktonic species. The microspheric generation in Foraminifera has the more primitive characteristics of the species. Since CHRISTIANSEN found the microspheric form of *Globigerina rubra* to be benthonic, this may also point to a benthonic origin of the planktonic Foraminifera. For in many Foraminifera the most archaic forms are the microspheric ones.

Candeina nitida d'Orbigny Fig. 267–276

Candeina nitida D'ORBIGNY, 1839, p. 108, pl. 2 fig. 27–28; CUSHMAN, 1924, p. 36, pl. 5 fig. 1; HOFKER, 1956, p. 98–99, pl. 12 fig. 10–17.

This species was analysed by the present author in 1956; the first chambers show small reduced toothplates at the simple round apertures of the first embryonic chambers; the microspheric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generation starts with a spiral of about 6 chambers before the triserial arrangement begins; the megalospheric generation is triserial from the beginning. All chamber walls show an inner primary part which also forms the septa, whereas at the outside a secondary thickening may be formed, especially at the dorsal side of the test; the last-formed chamber has a wall consisting only of the primary wall. Thus the species is monolamellar. Whereas the inner chambers have only one sutural ventral aperture which shows a slight dentation in the middle, the later chambers form secondary rounded openings at their sutures with the former chambers too. The pores are densely placed and extremely fine. Not the slightest connection seems to exist with the Globigerines and the species appearing for the first time in the Miocene, must have connections with *Virgulinella pertusa* (Reuss) which shows these secondary openings at the sutures as well; also with *Globigerinatella insueta* Cushman & Stainforth, which similarly has the fine pores, the secondary sutural openings (though they occur

Fig. 267–276. *Candeina nitida* d'Orbigny. – Barbados, sta. 1443: 267, total test, from three sides (× 60); 268, test wall with insertion of next chamber wall, simple septum and secondary thickening of outer wall, and similar section taken just through one of the sutural openings, showing that such such openings must have been formed secondarily (× 150); 269, longitudinal section through a test, showing the secondary outer thickenings on older chambers, but septa and wall of last formed chamber being simple (× 60); 270, the two initial chambers of 269, enlarged, showing the simple septa and the primary walls and the outer thickening; moreover, a distinct toothplate is seen at the foramen between the two chambers (× 150); 271–274, several transverse sections, some with secondary thickening, others without this tickening (× 60); 275, an elongate test from three sides (× 60); 276, horizontal section through the two initial chambers and four more chambers, showing the simple septa and three distinct toothplates at the foramina (× 150).
Fig. 277–286. *Sphaeroidinella dehiscens* (Parker & Jones). – Barbados, sta. 1443: 277–278, two specimens seen from two sides each (× 30); 279, very large, microspheric specimen from Santa Cruz, depth 800 m (× 30); 280, wall with inner primary wall and strong secondary thickening outside and two flask-like pores with fine dentation at their inner side (× 150); 281, longitudinal section going through the proloculus (× 60); 282, initial part of 281, showing strong multilamellar secondary thickenings of the walls, but inner wall and septum of the first formed chambers simple (× 150); 283, horizontal section of *Globigerina sacculifera*, to show the difference between the initial spiral and that of *Sphaeroidinella* in 284–285 (× 150); 286, part of the wall of 281, showing the primary wall forming the loop at the aperture and the secondary thickening, with the pores and their inner dents on the surface (× 150).

here also as areal openings in the later chambers) and the reduced toothplates in the embryonic chambers (see HOFKER, 1959, p. 3, fig. 4–6). Both species are also found in the Miocene. The secondary thickening of the outer walls is also found in several species of *Bulimina*, *Virgulina*, etc; this does not mean that the species is bilamellar. Most specimens are coiling to the right.

Several specimens of this species were found in Sta. 1443.

Sphaeroidinella dehiscens (Parker & Jones) Fig. 277–286

Sphaeroidina dehiscens PARKER & JONES, 1865, p. 369, pl. 19 fig. 5.
Sphaeroidinella dehiscens (Parker & Jones), CUSHMAN, 1927, p. 90; HOFKER, 1956, p. 207, pl. 31 fig. 25–37; BÉ, 1965, p. 81–97, pl. 1–2.

The present author stated in 1956 that the species must have some relation to *Pulleniatina*; not only the polished surface and the very hyaline material of the walls, but also the overlapping structure at the ventral sides of the last formed chambers are similar in both species. It is remarkable that the inner surface of the pores of *Sphaeroidinella* is grooved, often with small retrograde spines, a characteristic also found in some forms of *Orbulina*. I stated in 1956 that the proloculus is very small, with a diameter of 2–5 μ; this is not always the case, so that the occurrence of two generations may be proved herewith. The megalospheric generation consists of relatively small specimens, whereas the microspheric form is the larger one. In the megalospheric form the initial spiral consists of about 4–5 chambers following the proloculus in which the outer wall is strongly thickened secondarily by several lamellae; the septa consist only of the primary wall, so that the species is monolamellar. In the later chambers the pores are very typical, beginning at the inside (in the primary wall) with a relatively narrow part, then widening flask-like, whereas at the outer surface they are narrowing again. The secondary thickening of the outer walls in adult specimens is enormous. The primary wall at the apertures ends loop-shaped in transverse section, as in so many other Globigerines; but just here the secondary thickening is so large, that thick crenulated lips appear at the outside.

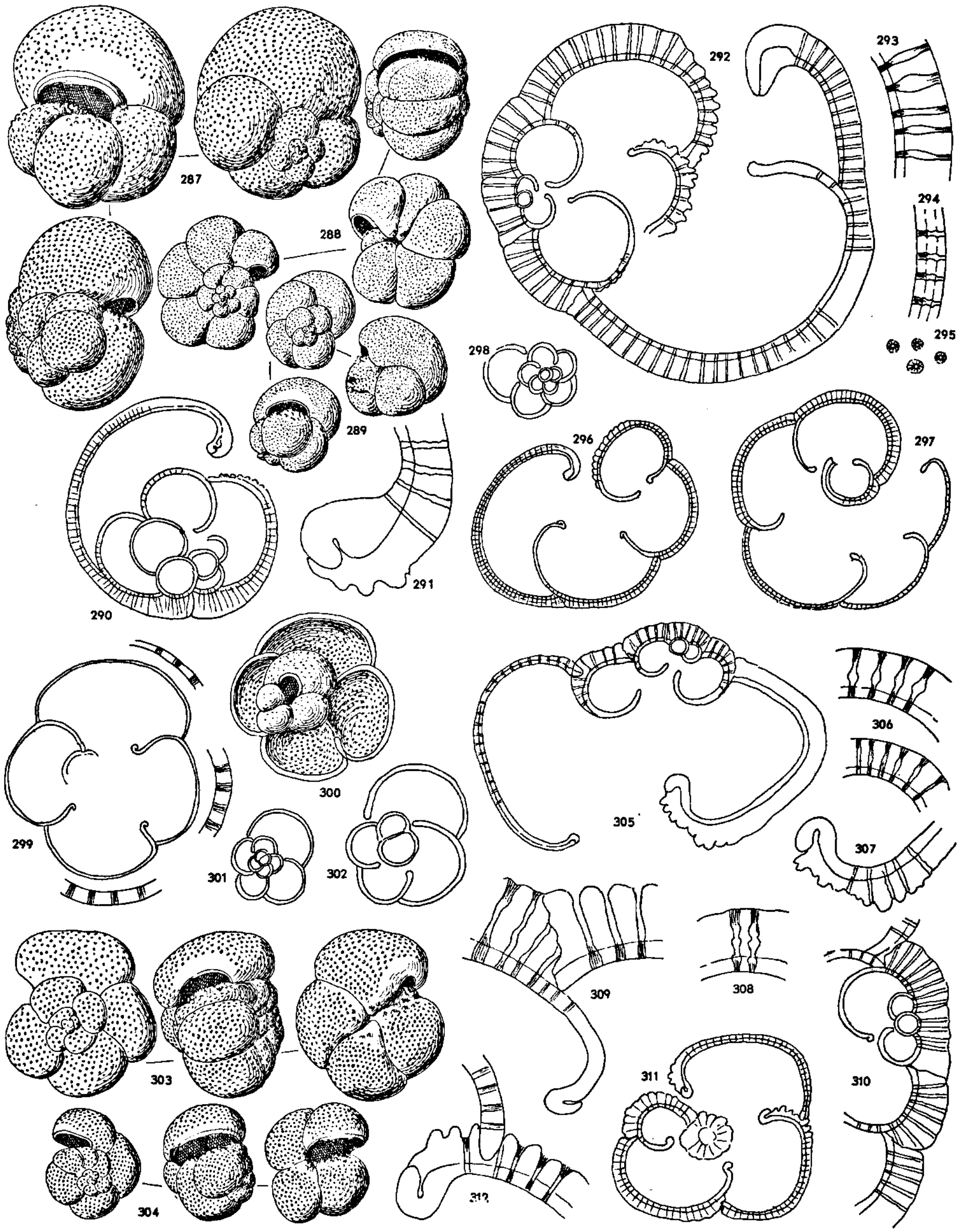
BÉ believed that *Sphaeroidinella* might be a developmental stage of *Globigerina sacculifera*; but in young chambers the pores of *G. sacculifera* are much more densely placed than in young chambers of *Sphaeroidinella*; moreover, the embryonic spiral of *G. sacculifera* differs largely from that of *Sphaeroidinella* in horizontal sections, though BÉ mentions that the young specimens of the two cannot be distinguished. Transverse sections through both species reveal that the chambers in *Sphaeroidinella* overlap much more at the ventral side – even in the embryonic part – than they do in *G. sacculifera*. I absolutely believe both species are so different in the structure of walls and tests that they cannot belong together; moreover, in *G. sacculifera* as well as in *Sphaeroidinella dehiscens* both microspheric and megalospheric generations are found. But several characteristics of *Sphaeroidinella* indicate an affinity to *Pulleniatina*.

Sphaeroidinella dehiscens occurs in some specimens in Sta. 1443; it was more common in the sample off Santa Cruz (St. Croix), depth 800 m (HOFKER, 1956).

Pulleniatina obliqueloculata (Parker & Jones) Fig. 287–302

Pullenia obliqueloculata PARKER & JONES, 1865, p. 368, pl. 19 fig. 4.
Pulleniatina obliquiloculata (Parker & Jones), CUSHMAN, 1927, p. 90; HOFKER, 1956, p. 203–206, pl. 31 fig. 16–24.

Pulleniatina was found in several specimens in Sta. 1443. It was analysed by the present author in 1956, and he stated that the chambers are built in a trochospiral, with the last formed chambers so much inflated at the ventral side that they seem to overlap the former chambers. LOEBLICH & TAPPAN (1964, p. 671) describe this as somewhat streptospiral. Remarkable are the smoothly finished and shining walls with pustules near the aperture. The walls of the initial chambers are thin at their ventral sides and are distinctly monolamellar. At the outside they are heavily thickened secondarily. The later chambers show outer walls which consist of two lamellae, but only the inner one continues in the septum which is for its larger part poreless. The septum ends with a folded rim forming the border of the aperture; in chambers with a secondarily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thickened septum, especially where pustules are formed, the folded rim is nevertheless formed by the inner primary wall only. So, in reality, *Pulleniatina* is monolamellar with outer secondary thickening forming a lamella or even lamellae. The pores are remarkable; in 1956 the present author described them as consisting

Fig. 287–302. *Pulleniatina obliqueloculata* (Parker & Jones). – Barbados, sta. 1443: 287, total test from three sides, megalospheric specimen (× 60); 288, total test of microspheric specimen, Van Gogh sta. 1° 51'S, 99° 36'E, depth 683 fath (× 30); 289, total test, megalospheric, from three sides (× 20); 290, section through initial part, showing the inner chambers with only primary walls and the outer walls secondarily thickened, specimen of fig. 289 (× 60); 291, enlarged end of outer wall of section of 290, showing that the primary wall forms the typical sigmoid lip of the aperture, and the secondary thickening forming the outer lamellum, so that the aperture seems to have a double walled lip (see 287) (× 150); 292, section through proloculus and initial worls, showing the primary walls and the secondary thickenings (× 100); 293, wall part of this section with the complex pores (× 150); 294, pores widening at the junctions of thickening layers, with the grooves in their inner walls (× 150); 295, pores seen from within, with the peculiar grooves in their inner walls (× 150); 296, "horizontal" section through the specimen of 287, the septa consist of the primary walls only (× 60); 297, horizontal section of specimen of 288, showing the two last formed chambers with primary simple walls only and the simple septa (× 60); 298, initial part of the specimen of 288 with the microspheric proloculus (× 150); 299–302, successive sections through a specimen taken with plankton-towl, Siboga sta. 185, Pacific: 299, horizontal section, showing the simple walls and septa (× 60) and parts of the outer walls enlarged, showing the bushes of complex pores (× 150); 300, section more to the dorsal side, showing more initial chambers and the aperture which is typically umbilical (× 60); 301, initial spiral, showing a bilocular embryon (× 60); 302, central part of this section (× 150).

Fig. 303–312. *Globigerina inflata* d'Orbigny. – From several sources, not found in Barbados: 303, from Rimini, one of the localities of D'ORBIGNY, test from three sides (× 60); 304, from Mar de Alboran, Mallorca, Mediterranean, test from three sides, showing last formed chambers tending to those found in *Pulleniatina* (× 30); 305, transverse section through specimen of 303 (× 113); 306, two wall sections showing the complex pores as found in *Pulleniatina* (× 150); 307, part of section 305, showing the same apertural end as designed in 291 for *Pulleniatina* (× 150); 308, pores with broader parts as seen in those of *Pulleniatina* of 294 (× 150); 309, part of section of 305 with the septum consisting only of the primary wall, also found in the outer wall, see 292 (× 150); 310, part of another section, through specimen off Mallorca, showing the simple septa of the initial chambers continuing in the primary walls of the secondary thickened outer walls (× 113); 311, horizontal section, which may be compared with 296 (× 60); 312, part of section of 311, with insertion of a chamber wall in that of an older chamber, and the construction of the apertural lip, see also the complex pores (× 150).

of bundles of fine protopores; I now believe that these "protopores" remain as fine longitudinal ridges on the inner walls in older pores. Often the pores begin relatively wide at the inner side of the wall, whereas they end at the surface with a finer opening.

Small specimens of *Pulleniatina obliqueloculata* resemble *Globigerina inflata* d'Orbigny from Rimini and the Western Mediterranean, but also from the North Atlantic very much. It is quite possible that *G. inflata* and *P. obliqueloculata* are very close and that the former species is nothing but the temperate and cold water form of tropical *Pulleniatina*; if this is the case, the name *obliqueloculata* ought to be replaced by the older name, *inflata*. The whole form of *inflata* is that of young *obliqueloculata*, the apertures are quite identical in form, both have the pustules at the base of the apertures and the test walls are identical in finer structure, as will be seen from the figures. Even the typical pores with their protopores or inner ridges are found in *G. inflata* as well. Typical *G. inflata* was not found off Barbados or off St. Croix. PHLEGER & PARKER (1951, p. 34, pl. 19 fig. 10–11) mention *G. inflata* from the Mexican Gulf; but the figure they give shows a young specimen of *Pulleniatina*. In this tropical region only the tropical form exists, having the bulbous end-chambers in the adult specimens.

Pulleniatina obliqueloculata is coiling to the right, whereas most specimens of *Globigerina inflata* coil to the left; this would also be the case, when the two forms belonged to one single species for in most species of *Globigerina* and other Foraminifera right coiling is found in warm, and left coiling in cold water. Large specimens of *G. inflata* in the Mediterranean already show the tendency to have the last formed chambers overlapping the former ones at the ventral side. A microspheric specimen of *Pulleniatina* showed not the slightly oblique and overlapping chambers at the ventral side, but the chambers arranged as in typical *G. inflata*. A microspheric specimen of *G. inflata* from the North Atlantic near Iceland showed right coiling and could not be distinguished from the microspheric specimen of *P. obliqueloculata* found near Nias, South of Sumatra, Pacific.

BANNER & BLOW (1967, p. 133–162) believed that *Pulleniatina* derived from *Turborotalia acostaensis* Blow via *Pulleniatina primalis* Banner & Blow. These species from the Tertiary often coil to the left, as *G. inflata*. Moreover, these fossil species do not show the strongly overlapping last formed chambers of *P. obliqueloculata*, but show the typical structure of *G. inflata* and microspheric *P. obliqueloculata*. As we know that microspheric forms show more primitive characteristics than megalospheric forms as a rule, the concept of the evolution of BANNER & BLOW (1967) seems to be the right one, if it can be found that the typical structure of the pores found in *G. inflata* and in *P. obliqueloculata* is the same or similar in *T. acostaensis*. BANNER & BLOW describe the chamber structure of *Pulleniatina* as "streptospiral"; but this term was used from the beginning for those forms which show a change in the direction of the axis of coiling within the test; this is not so in *Pulleniatina*, in which only the latest chambers show a slight tordation, but in which the axis of coiling remains a straight one. Therefore the term "streptospiral" cannot be used.

P. obliqueloculata from a planktonic sample, Siboga-Exp. St. 185, protoplasma-filled, was sectioned from ventral to dorsal side. The latest whorl consisted of four chambers, just as the former whorl, with a high nearly umbilical aperture, whereas the first whorl consisted of five chambers with a bilocular embryonic apparatus. The specimen was megalospheric, with a prolucolus diameter of 30 μ. The microspheric specimen sectioned from bottom sample Nias, 683 fathoms, mentioned above, had a proloculus diameter of 8 μ; the embryonic apparatus consisted of the proloculus only.

In bottom samples the chamber walls are thickened at the outer side by one or two secondary layers. Only the primary wall continues in the septa on horizontal sections; this means that the species is monolamellar. In the microspheric specimen the two last formed chambers have the primary wall only. Mostly in bottom-samples the last formed wall too is thickened secondarily on the outside; this means that at the bottom or in deeper water no further chambers are added and thus the last formed chamber is thickened. The specimen sectioned from the plankton sample Siboga-Exp. St. 185, showed in all outer walls and in the septa only the primary wall. It is obvious that thickening of outer walls takes place in deeper water or near to the bottom of the sea, just as is found in many other planktonic Foraminifera. Remarkable was in this planktonic specimen that the primary pores all consisted of a bundle of fine pores (HOFKER, 1956). This means that the hollow pores with fine costae in the inner walls found in thickened test walls, evolve from these bundles by dissolving the inner fine pores.

These primary protopores as found in *Pulleniatina* and in *G. inflata* form an important generic feature, separating the two species from *Turborotalia*, as they do not exist in the genotype of the latter. They may be comparable with the sieve-plates found in the pores of many other Foraminifera.

Globigerina eggeri Rhumbler Fig. 313–325, 338

Globigerina dubia BRADY (not Egger), 1879, p. 71; 1884, p. 595, pl. 79 fig. 17.
Globigerina eggeri RHUMBLER, 1900, p. 19, fig. 20.

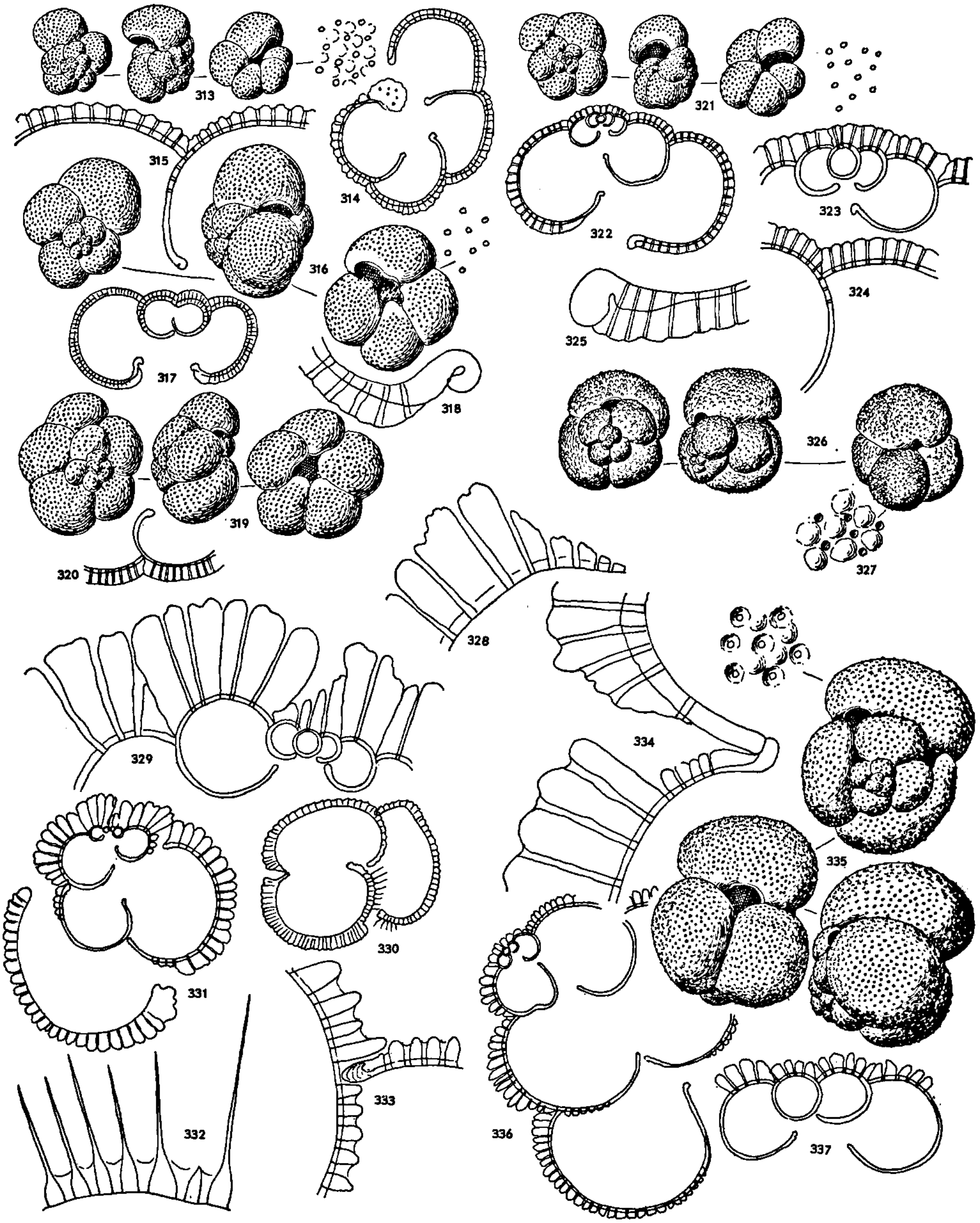
Test at the dorsal side somewhat flattened; margin strongly rounded, chambers at the ventral side strongly inflated, especially the last formed chambers. At the dorsal side the initial spiral always consisting of five chambers, the last formed whorl consisting of four to five chambers (in some cases, when a small last one is formed, of six chambers). Dorsal chamber sutures somewhat depressed, distinct, slightly curved backwards. At the ventral side the umbilicus remains open and is often rather large. The last formed chamber shows a crescent-shaped aperture directed to the umbilical hollow but often elongate towards the periphery, with a more or less distinct raised smooth and strengthened border or lip; in the older chambers this border may be seen partly or is covered by the inflated ventral side of the chamber. Surface smooth but never shining, with small rounded pores which are distinct and often with rounded pustules between; the pustules, however, do not give the surface a rough structure. Diameter of test in Sta. 1443 about 0.6 mm; in the North Atlantic Northwest of Iceland (Ingolf-Exp.) always smaller, with diameter 0.4–0.5 mm. In the sample off Santa Cruz (St. Croix) specimens may reach 0.8 mm, but mostly are 0.6 mm in diameter.

Sections reveal that the real poreless septa are completely simple, and that only the outer walls, those of the initial spiral as well as those of the later chambers are thickened secondarily, so that they always seem to be double. The lip-like border of the aperture is formed by the inner primary layer which here forms a kind of loop directed outward. This loop is strengthened by the second layer at its outer side.

It is remarkable that the outer walls of the specimens found in the Caribbean Sea are distinctly thicker than those found in the Arctic Ocean; however, the primary wall in both regions has the same thickness. The statement that the outer layer of the walls is secondary can be proved at the junctions of the walls of two chambers: the inner primary layers of these walls – which continue in the septal walls – always touch each other at the junctions; the secondary outer layers wedge into each other. In very thin last chambers the wall consists only of the inner primary wall. However, it seems that the outer secondary layer is laid down very soon after the forming of the primary wall, at least in more adult chambers; this is an adaptation to planktonic life, as the very inflated nearly globular walls need strengthening on the outside; this is also the reason why the inner septa do not show this strengthening.

BANDY (1960, p. 671–681) showed that the direction of coiling in *Globigerina pachyderma* (Ehrenberg) is a function of the environmental temperature. He concludes (p. 680): "Apparent temperature control of coiling ratios in some planktonic Foraminifera suggests that the biochemistry of the gene is affected by temperature. Low temperatures favour mutations towards the sinistral dominance in some species; high temperatures appear to favour mutation towards dextral dominance". This phenomenon could be affirmed in *Globigerina eggeri* (see Fig. 266).

BANDY believes that the genes are affected by the temperature and that accordingly mutations are formed; this, however, is not necessary; it is more probable that the Foraminifera as such (at least the species involved), possess a gene which enables them to change their direction of coiling with temperature; otherwise it would be impossible that in the course of time, with the change from cold to warm, and afterwards once again to cold, this change from left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to right and once again to left could be produced; for a change in the genotype, starting a mutation, cannot be reversed.

Globigerina conglobata Brady Fig. 326–337, 342

Globigerina conglobata Brady, 1879, p. 72; 1884, p. 603, pl. 80 fig. 1–5, pl. 82 fig. 5; Fornasini, 1899, p. 582, pl. 2 fig. 12–15, pl. 3 fig. 1–5, pl. 4 fig. 6; Hofker, 1956, p. 235, pl. 35 fig. 22–27, textfig. 21; 1961, textfig. 6–9 on p. 66.

Characteristic are the low end-chambers and the lack of a real umbilicus due to the inflation of the last formed chambers at the ventral side. Some specimens have relatively thin walls, but bottom specimens have extremely thickened walls, especially at the dorsal side. These walls are characterised by many rounded pustules over the entire surface between which the relatively small pores are

Fig. 313–325. *Globigerina eggeri* Rhumbler. – Barbados, sta. 1443: 313, specimen from three sides (× 30) and surface of test (× 150); 314, horizontal section, showing the simple septa of older chambers and the last formed chamber totally covered by a secondary thickening as in all the outer walls (× 60); 315 part of section of 314 (× 150); 316, specimen from three sides (× 30) and wall surface (× 150); 317, tangential transverse section (× 30); 318, part of section of 317, showing that the lip at the aperture is formed only by the inner primary wall (× 150); 319, specimen (× 30); 320, part of horizontal section through specimen of 319, with the septum formed by the primary wall only (× 60); 321, specimen from three sides (× 30), and surface (× 150); 322, transverse section through this specimen, showing the simple inner walls, but the last formed chambers covered totally by the secondary thickening (× 113); 323, part of section of 322, with the simple septa of the initial chambers (× 150); 324, part of section of 314, showing the septum formed by the primary wall only (× 150); 325, part of section of 322, with the apertural lip, formed by the primary wall (× 150).

Fig. 326–337. *Globigerina conglobata* Brady. – Santa Cruz (= St. Croix), depth 800 m: 326, specimen from three sides (× 23) and 327, surface of wall (× 150); 328, part of section of wall of 331 where the outer wall changes into the septum (× 150); 329, initial part of section of 331, showing the septal walls consisting of the primary walls only (× 150); 330, horizontal section, with some of the spines (× 30); 331, transverse section through the proloculus, with the simple septa, consisting of the primary walls only (× 45); 332, primary part of wall with the spines (× 150); 333, insertion of chamber wall into an older chamber wall (× 150); 334, part of section 336, showing that only the primary walls form the connection between two walls, and the secondary thickening of outer walls (× 150); – Barbados, sta. 1443: 335, large specimen from three sides (× 23) and the outer surface (× 150); 336, transverse section through specimen of 335, showing the simple septa (× 45); 337, initial part of section of 336 (× 150).

found. The main aperture is always situated at the place where the umbilicus of the ventral side should be; it is small, semicircular and provided with a slightly thickened rim which is often faintly crenulate. The few secondary apertures at the dorsal side, always situated where three sutures meet, are small and do not show a distinct rim. In one specimen the surfacial spines were found on the surface of the chamber overlapped by the last formed one; they are the continuation of the pustules between the pores. The insertion of a next chamber in the wall of a former one shows that a large

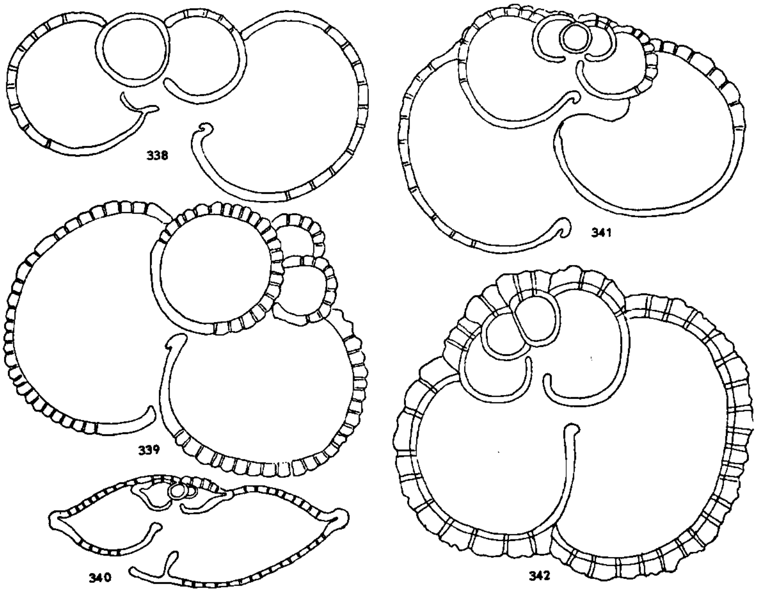


Fig. 338–342. Barbados, sta. 1443: Young specimens of planktonic Foraminifera. The figure shows transverse sections through *Globigerina eggeri* Rhumbler (338); *Globigerina sacculifera* Brady (339); *Globorotalia menardii* (d'Orbigny) (340); *Globigerina rubra* d'Orbigny (341); *Globigerina conglobata* Brady (342). The first mentioned five tests do not show any secondary thickening of the test walls, but for that of *G. rubra*, which shows a slight secondary thickening at the dorsal initial side; that of *G. conglobata* already shows secondary thickening at the outside, whereas the inner septa remain simple. All other specimens show simple walls and septa, a good proof that they all belong to the monolamellid Foraminifera. For it is impossible that young specimens are monolamellid whereas, when becoming adult, they might be bilamellid, see p. 97. (× 150).

part of the outer wall consists of a secondary thickening; the primary wall is thin and forms the inner walls of the initial chambers. The septa are built only by the primary wall.

In a sample off Santa Cruz left and right coiling was random. Yet it seems that specimens which are coiled to the right have a smaller proloculus than those coiled to the left. Small specimens show four chambers in the last formed coil, whereas very large ones have three chambers in the last formed whorl.

The finer structure of the test is very similar to that found in *Globigerina pachyderma* (Ehrenberg); it may be that the latter species is the coldwater form of *G. conglobata*. Young specimens of *G. conglobata* very much resemble those of *G. pachyderma*; they do not yet possess the dorsal secondary apertures.

Some specimens have a bulla over the main aperture of the last formed chamber; this feature is a rare one in the samples observed in the Caribbean but more common in deep samples from the Pacific (see HOFKER, 1961).

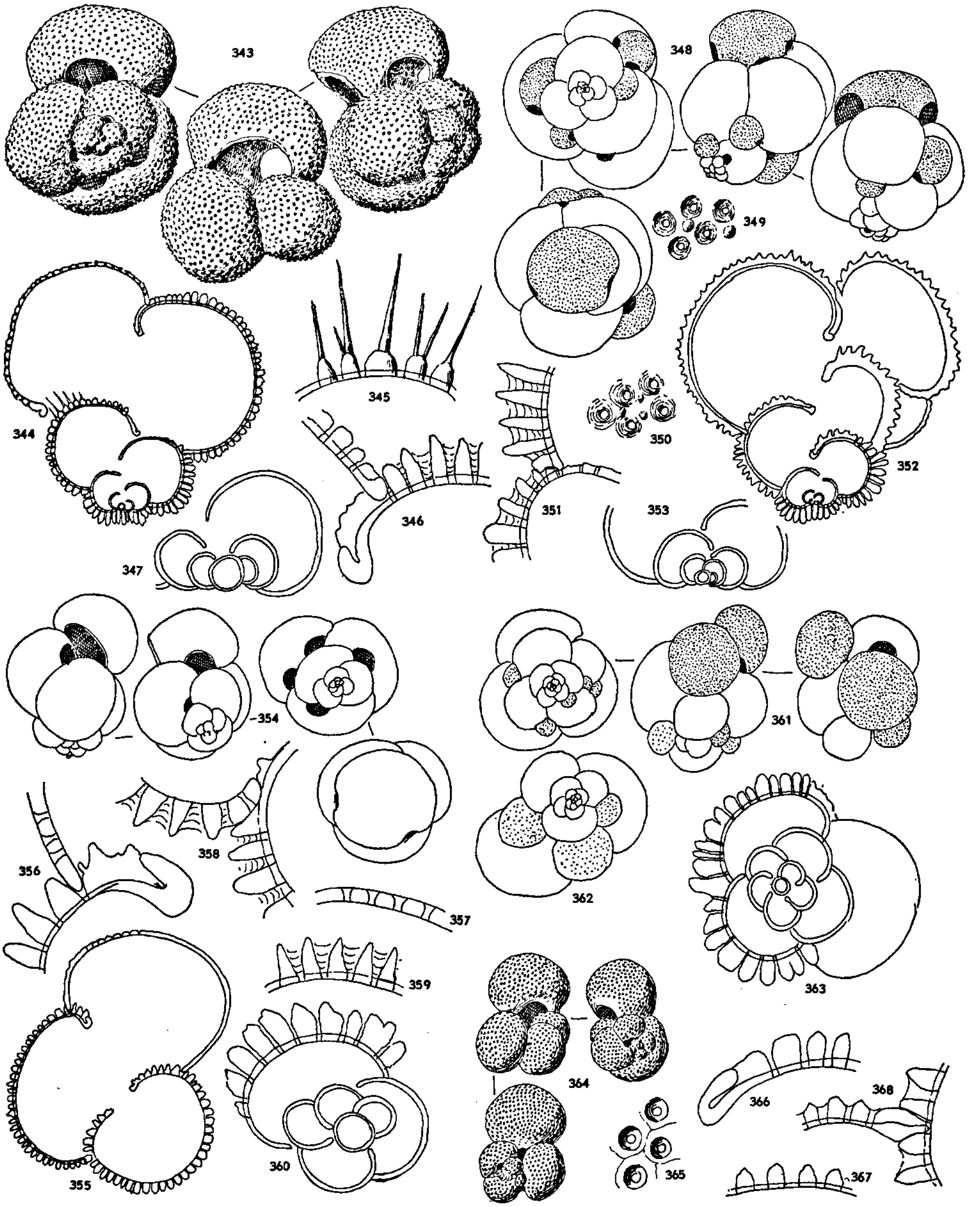
The author studied specimens of *G. conglobata* described by FORNASINI (1899) from the coast of Rimini too. These very small specimens surely belong to *conglobata* and strongly resemble young ones from the Caribbean. Among them were also found foraminifera described by D'ORBIGNY (1826) from Rimini as *G. elongata*; they are the microspheric form of *G. conglobata*, and are comparable to the elongate microspheric specimens of *G. rubra*, called var. *pyramidalis* by VAN DEN BROECK (1876).

***Globigerina conglobata* is frequent, especially in sample 1443.**

Globigerina rubra d'Orbigny Fig. 341, 343–363

Globigerina rubra D'ORBIGNY, 1839, p. 82, pl. 4 fig. 12–14; HOFKER, 1956, p. 231–234, pl. 35 fig. 1–17, textfig. 20; HOFKER, 1959, p. 3–4, textfig. 7–9.
Globigerinoides rubra (d'Orbigny), CUSHMAN, 1927, p. 87; CHRISTIANSEN, 1965, p. 197–202, textfig. 1–3.

The test wall is somewhat spinous; between the relatively large and distinct pores, which end into pits at the surface, pustules are found which are rounded in the last formed chambers and have more pointed tops in older ones with thicker walls. These "spines"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may be seen on transverse sections through the walls. In many walls a thin inner primary wall may be detected which may form the wall of just-formed later chambers; the tests shows secondary thickening in the outer surface walls. Near the border of a foramen the primary wall folds outwards, forming the thick rim of the foramen; the secondary thickening encloses the rim also. When two chamber walls meet, the later formed wall is embedded in the older wall, showing that the thickening of the older wall is secondary. Remarkable is that this thickening of the outer wall has been a periodical one, since fine transverse striae can be observed on the inner walls of the pores. The inner walls of the initial chambers consist solely of the primary wall; in later formed chambers these inner walls were mostly thickened before a next chamber was added, but real poreless septa are always monolamellar; *Globigerina rubra* belongs to the monolamellar Foraminifera.

Fig. 343–363. *Globigerina rubra* d'Orbigny. – Santa Cruz (= St. Croix), depth 800 m: 343, individual from three sides (× 60); 344, longitudinal section through specimen of 343 (× 60); 345, part of section 344 with spines (× 150); 346, another part of section 344, showing insertion of chamber wall, apertural lip formed by primary wall only and growth lines in the inner walls of the pores (× 150); 347, initial chambers of section 344, showing that the specimen was megalospheric (× 150); 348, microspheric specimen from four sides, with bullae over the openings of the test (× 30) and with 349, outer surface with growth lines within the pores (× 150); 350, the same, from a megalospheric specimen (× 150); 351, insertion of chamber wall and septum consisting of primary wall only (× 150); 352, transverse section through specimen of 348 with secondary thickenings over some of the septa and bulla consisting of primary wall only (× 60); 353, part of section 352, through the initial part, showing that the specimen was microspheric (× 150); – Barbados, sta. 1443: 354, specimen from four sides (× 30); 355, horizontal section through this specimen, the wall of the last bulla-like chamber consists of the primary wall only (× 60); 356, part of section 355, showing the simple wall of the last formed chamber and the primary wall of the former chamber forming the border of the aperture (× 150); 357–359, walls of last formed chamber and of later chambers (× 150); 360, horizontal section of the initial whorl of specimen 354, showing the megalospheric proloculus (× 150); 361, microspheric specimen, coiling to the right and bullae (× 30); 362, same specimen, initial spiral with bullae (× 60); 363, section of initial spiral, showing microspheric proloculus (× 150).

Fig. 364–368. *Globigerina triloba* Reuss. – Barbados, sta. 1443: 364, total specimen (× 20); 365, surface of test wall (× 150); 366–368, parts of sections through walls, with primary walls and secondary thickenings and the insertion of a wall (× 150).

It is remarkable that the specimens of *G. rubra* in the Mediterranean as a whole have higher domed tests than in the Caribbean. The author believes that there is no reason to establish a special genus for those Globigerinae which show dorsal openings at the sutures, as even the genotype of *Globigerinoides*, *Globigerina rubra* d'Orbigny, has an ontogenetic stage in which these openings are absent. Moreover, the author showed in *G. daubjergensis* Brönnimann and in *G. triloba-sacculifera* that these species form orthogenetic and phylogenetic gentes in which the first ontogenetic and phylogenetic stages have no dorsal openings; thus the boundary between *Globigerina* and *Globigerinoides* cannot be clearly established either (HOFKER, 1961, p. 64–68, textfig. 1–5).

HOFKER (1956) observed that the more elongate forms of *G. rubra* are microspheric; they were called *helicina*-form by him, a name which would be better given as *pyramidalis*, as CHRISTIANSEN proved. Moreover, HOFKER showed that the proloculi of *G. rubra* in the microspheric form have a diameter of about 5μ, whereas those of the megalospheric, normal form have a diameter of about 10 μ or more. The author found a similar phenomenon in *G. daubjergensis*, where the specimens with larger proloculus have a test with a rounded initial top, whereas those with small proloculus have a much more pointed initial top, just as in *G. rubra* (HOFKER, 1962, p. 122–123; 1966, p. 314–317, fig. 173–174). This observation was sustained by CHRISTIANSEN, who found bottom-dwelling forms of the *pyramidalis*-type, living in mud-houses, which showed a proloculus diameter of about 5 μ and a multiple nucleus, proving them to be the microspheric generation. CHRISTIANSEN, moreover, showed that the planktonically living stages are small and that – when nearing the bottom of deeper sea – they add the bulla-like chambers with multiple sutural openings which are so characteristic for the megalospheric specimens of *G. rubra* with more rounded initial top. This was confirmed by my samples from Barbados and St. Croix (HOFKER, 1956). In the sea near Barbados, in depths of 100 and 200 m, only the very small specimens of the planktonic form are found; in the much deeper sample off St. Croix (about 800 m), the considerably larger specimens with white-coloured voluminous last formed chambers occur, together with the B-form. This elongate B-form, figured by BRADY (1884, pl. 79 fig. 14–15), is not *G. elongata* D'ORBIGNY from Rimini, but the B-form of *Globigerina conglobata* Brady (compare also FORNASINI, 1899, p. 11, pl. 3 fig. 8–10).

In 1959 (p. 5, fig. 8) the author stated that at least in the Caribbean the B-individuals of *G. rubra*, when adult, close all their sutural and apertural openings by bullae; this fact was not stated by CHRISTIANSEN for the mediterranean form. I found now that in the Caribbean all B-individuals have these extra bullae.

In *G. daubjergensis*, during the Danian period, the elongate form with small proloculus became more and more abundant (HOFKER, 1966, p. 321, fig. 175); it was also shown that during that period the direction of coiling changed more and more from left to right. It was found now that the B-specimens of *G. rubra* in the Caribbean are all coiled to the right, all those with a large proloculus, however, to the left. A similar statement was given by VASIČEK (1953); he found that in *Globorotalia scitula* (Brady) the two generations show a different coiling-direction. It is remarkable that CHRISTIANSEN figured a microspheric specimen which is coiled to the left; this may be an error, since it is very difficult to trace the direction of coiling in the B-generation without making sections. The figures given by the author in 1959 show a left-coiling A-specimen and a right-coiling B-specimen; six B-specimens studied from off St. Croix were right-coiling; 105 specimens belonging to the A-generation showed left-coiling.

Globigerina triloba Reuss Fig. 364–380

Globigerina triloba REUSS, 1850, p. 374, pl. 47 fig. 11.

Globigerina sacculifera BRADY, 1877, p. 535; 1884, p. 604, pl. 80 fig. 11–17, pl. 82 fig. 4.

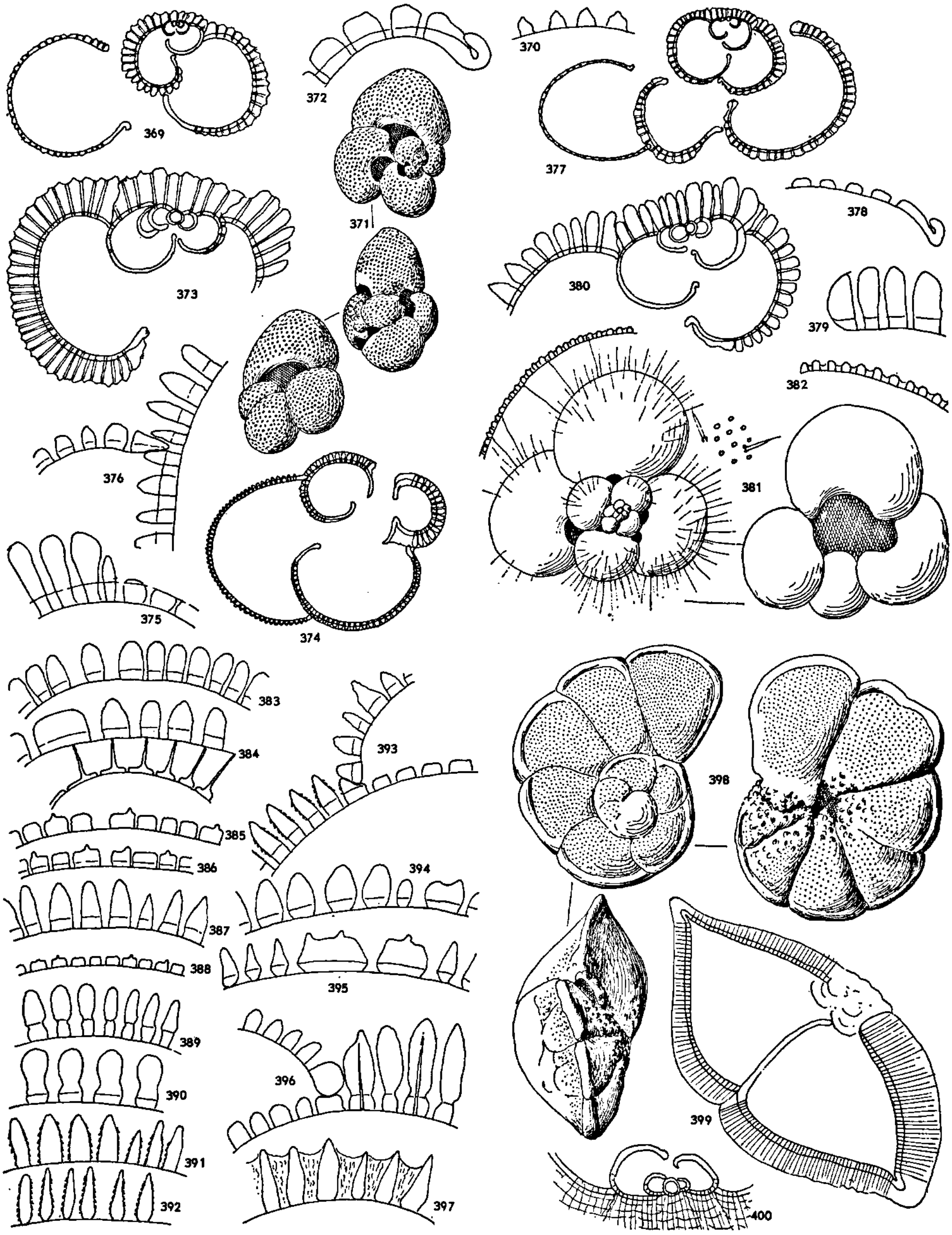
Globigerinoides sacculiferus (Brady) var. *immatura* LE ROY, 1939, p. 263, pl. 3 fig. 19–21.

Globigerinoides triloba triloba (Reuss), BOLLI, 1957, p. 112, pl. 25 fig. 2, textfig. 21 No. 1.

Globigerinoides triloba immatura Le Roy, BOLLI, 1957, p. 113, pl. 25 fig. 3–4, textfig. 21 No. 3.

Globigerinoides triloba sacculifera (Brady), BOLLI, 1957, p. 113, pl. 25 fig. 5–6, textfig. 2 No. 4.

Globigerinoides triloba (Reuss), COLOM, 1964, p. 54–55, textfig. 18 No. 1–35.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Test beginning with a small proloculus surrounded by a spiral of five small chambers; the next whorl has three or four chambers which rapidly increase their size. In the *triloba*-form which is ontogenetically and phylogenetically the oldest, dorsal apertures are not visible; here the end-stage has three chambers in the final whorl. A next whorl is also formed by three chambers, which are more voluminous and have at the dorsal side distinctly visible dorsal apertures at the junction of three chamber walls. This stage seems to be the end-stage of the *triloba*-form, as it is found in the Miocene and commonly as young or badly developed specimens in the Recent too. Then a large chamber may be added, giving rise to the *immatura*-form. This voluminous chamber is built over the ventral centre of the former triserial whorl, and its wall is

Fig. 369–380. *Globigerina triloba* Reuss. – Barbados, sta. 1443: 369, section through specimen of the *triloba*-type, the last formed chamber with the dorsal "aperture" (× 45); 370, the wall of the last formed chamber, consisting of the primary wall only (× 150); 371, specimen of the *sacculifera*-type (× 20); 373, initial part of section 369, showing that the septa of the initial chambers are simple (× 113); 375, 376, parts of walls of section 374, showing that only the primary wall forms the apertural lip, that a septum consists in the primary wall and that the chamber wall inserts an older wall at its primary wall (× 150); 374, horizontal section (× 30); 377, transverse section through *sacculifera*-type (× 45); 378, wall of last formed chamber (bulla), consisting of the primary wall only (× 150); 379, section through outer wall of older chamber, with primary wall and secondary thickening (× 150); 380, section of the initial part of 377, showing that the inner walls of the initial chambers consist of the primary walls only (× 180).

Fig. 381–397. *Orbulina universa* d'Orbigny. – From several sources: 381, living specimen from sta. 185, Siboga Exp., Pacific, initial chambers from dorsal and ventral sides, with part of the enveloping globular bulla and part of surface of this initial test (× 60 and 150); 382, wall of the bulla of 381, consisting of the primary wall only (× 150). – All following figures from sections of bullae and inner tests (× 150); 383, Barbados, sta. 1443: 384, Barbados, sta. 1443, with testwall and spines of inner initial stage, showing primary wall only; 385, from Finisterre; 386, from Santa Cruz; 387, from Rimini; 388, from Pacific, Siboga sta. 185; 389, from Rimini; 390, from Nias deep, 683 fath., Pacific; 391–392, from Santa Cruz, depth 800 m; 393 "*Biorbulina*", from off Finisterre, the septum consisting of primary wall only; 394–395, from Pacific, Telegraaf sta. 47; 396, "*Biorbulina*" from Barbados, sta. 1443; 397, from Santa Cruz, depth 800 m.

Fig. 398–400. *Globorotalia tumida* (Brady). – Santa Cruz (= St. Croix), depth 800 m: 398, microspheric specimen, coiling to the right (× 30); 399, tangential transverse section, the septum is formed by the simple primary wall only (× 60); 400, section of the same individual through the initial part (× 150).

mostly thinner than those of the foregoing chambers, so that it may be compared with a bulla. A next chamber may be added (in some cases even two), which is different, being more elongate, often pointed at the margin, in some cases even lobulate and ending in several points. This chamber once again is situated over the centre of the ventral side and its chamber wall remains thin. The ventral larger apertures invariably have a thickened rim. Marginally from this rim the chamber wall may be poreless. The dorsal apertures do not have rims and here the surrounding wall shows pores. The pores, at least in the more adult chambers, are distinct and large, opening into pits of the surface; this surface has rounded knobs between the pits or may be more or less smooth. Sections show that there may be a basal primary wall layer which is always thin, whereupon thickening may take place; in many instances this primary layer cannot be discerned with certainty. The rim of an aperture is formed only by the primary wall which is folded outward here, often with a narrow canal in the fold. Where a real septum is sectioned, it consists only of the primary wall, like the thin wall of the "bulla" of the *sacculifera*-form. That the thickening of the outer walls is secondary, can be seen where the wall of a later chamber is wedged in the wall of a former one; the inner part of the wall of the former chamber is also thinner than that continuing as outer wall of the test. When a dorsal aperture is sectioned, the folding of the primary wall is not seen. The wall of the chamber concerned may be strengthened by secondary material which closes the pores; it seems as if the wall is dissolved here to form the dorsal apertures.

We must therefore conclude that *Globigerina triloba* and its forms do not belong to the bilamellar Foraminifera, but is monolamellar with simple septa. The primary wall which surrounds the initial chambers also forms the inner walls or septa, but outer walls may be strengthened very soon after being formed by a secondary thickening which especially on the dorsal side may be very thick. The pores in such walls are large, running as tubes in these walls and opening like a funnel or crater. A real honeycomb structure was never present in recent specimens.

The direction of coiling always seems more to the left than to the right in tropical surroundings. This may be concluded from Fig. 266.

This species was described from Santa Cruz (≡ St. Croix) by HOFKER 1956 (p. 229, *G. triloba* Reuss; p. 230, *G. sacculifera* Brady; pl. 34 fig. 25–32, 38–41). The two given diagrams in the 1956 paper show that *G. triloba* is a younger stage, whereas *G. sacculifera* is the most adult stage, the former having its maximum size at 0.87 mm, the latter at 1.00 mm.

It was COLOM who pertinently proved that *G. triloba* Reuss, *G. immatura* le Roy and *G. sacculifera* Brady are one and the same species; *G. triloba* must be the primitive form, *G. immatura* and *G. sacculifera* cannot be other than more developed forms due to optimum environment. It is certain that in Recent gatherings one may find all three forms together; it may be that two of them, *G. immatura* and *G. sacculifera* are generations. Since ontogenetically the three forms clearly show that they are only stages of one species and as the finer structure of the test in all three, living as well as fossil, is identical, one cannot but conclude that they are forms of the same species. This may be indicated by using three names, as BOLLI did, but it seems better to drop these names altogether and to call them by the first mentioned name, *G. triloba* Reuss.

Orbulina universa d'Orbigny Fig. 381–397

Orbulina universa D'ORBIGNY, 1839, p. 3, pl. 1 fig. 1.
Biorbulina bilobata (d'Orbigny), BLOW, 1956, p. 69, fig. 2 no. 16.

Orbulina bilobata d'Orbigny is nothing but an *Orbulina* which has formed a second chamber. The present author (1954, p. 38) believed that there must be at least two different species of *Orbulina* in recent seas. BANDY (1966, p. 79–86) came to the conclusion that different species of *Globigerina* seem to form an *Orbulina*-stage. ADSGEAD (1967, pl. 1) proved that *Globigerina bulloides* d'Orbigny (a species without dorsal extra foramina) formed an *Orbulina*-stage in culture; the present author found in plankton-hauls from the Pacific living specimens of *Orbulina* in which the trochoid inner individual had secondary dorsal openings, thus belonging to

"*Globigerinoides*". So at least two quite different species of *Globigerina* are found forming *Orbulina*; this means that the genus *Orbulina* cannot have a real generic status, but is only a stage of several, not even close planktonic Foraminifera.

When a second chamber is added ("*Biorbulina*"), the wall between the two chambers remains thin, though the first chamber may have a secondarily thickened wall; in reality the inner primary wall continues as the only layer in the wall between the two chambers; this means that the septum, where it exists in the two-chambered form, is simple. In most cases the wall of the second chamber is much thinner than that of the first chamber; moreover, it wedges in the wall of the first chamber reaching the primary wall of the latter. This shows that the outer layer of older chambers of individuals is a secondary one. Specimens of *Orbulina* hatched from surface water always show an extremely thin wall, only consisting of the primary layer; individuals obtained from bottom-samples often show the secondary thickening. So it may be that when sinking down and living, the outer wall is gradually thickened. Le Calvez (1936, p. 125–133) found that the deeper a living specimen is found, the more the chamber walls of the initial coiled individual are absorbed. May be this absorption contributes to the secondary thickening of the outer layer. Bé & Hamlin (1967, p. 102) found in the Northern Atlantic near the surface thin-shelled juvenile forms in the trochospiral stage; thick-shelled spherical individuals were present in vertical tows; this observation agrees with the views mentioned above.

Sections reveal that there are quite different structures of the walls. One group of specimens has very narrow normal pores, with a diameter of 2–4 μ, measured in longitudinal section at the primary wall; a second group shows pores which have a broader part in longitudinal section just outward of the primary wall, with a diameter of about 8–10 μ at the primary wall; a third group has pores which widen funnel-shaped towards the surface of the wall and mostly show fine dents or crenulations at their inner surface, and an inner diameter of 8–14 μ at the primary wall. One might suppose that the larger pores were widened secondarily; but specimens with only the primary wall also show these differences in width of the pores.

In "*Biorbulina*" mostly a larger opening exists in the primary wall dividing the two chambers. Most recent specimens of "*Biorbulina*" do not show larger openings at the sutures between the two chambers. Most specimens of *Orbulina* show several larger rounded openings between the pores; they are not apertures in the normal sense but seem to have been formed to issue flagellospores. Sections prove that these openings are preformed and not secondarily formed by absorption, since the testwall surrounding these openings is just as broad as between the normal pores.

Remarkable is the difference in size of the individuals found in one locality; yet it seems that this difference is of no specific interest, as all the different structures mentioned can be found in larger and in smaller specimens. Specimens with a thin wall consisting only of the primary wall, which are much more transparent than those with a thicker wall, occur also in bottom-samples; they may have been dead before they sank.

It is obvious that the *Orbulina*-stage of planktonic Foraminifera shows the same characteristics of microstructure of the test as found in so many other species: the wall is primary monolamellar; when septa occur ("*Biorbulina*") they are monolamellar. In older specimens, more to the bottom of the sea, the walls may be double due to secondary thickening.

Globorotalia tumida (Brady) Fig. 398–406

Pulvinulina menardii var. *tumida* Brady, 1877, p. 535; 1884, p. 692, pl. 103 fig. 4–6.

Globorotalia tumida (Brady) Cushman, 1927, p. 91; Hofker, 1956, p. 194–199, pl. 29 fig. 27–33; 1964a, p. 454, pl. 1 fig. 4.

In 1956 the present author gave the characteristics of this species: an elongate test, with convex dorsal side and much inflated later chambers ventrally. A large and often thick lip covers the aperture which may be a foramen compositum; proto- and deuteroforamen separated by the lip, which may be a reduced toothplate. The chambers on the ventral side show distinct pustules at the aperture; dorsally the sutures are rounded, ventrally they are compressed and straight. A distinct and thick carina separates dorsal and ventral sides.

The author stated that the septa are simple and poreless (HOFKER, 1964a); this could be ascertained in the present study: the septa are the continuation of the inner primary wall. Planktonic living specimens could not be studied; but a young specimen from St. Croix showed that the last formed chamber had only the primary wall, whereas the more initial chambers showed a thin secondary thickening over the primary wall at the dorsal side. The carina is formed by a marginal folding of the primary wall, often forming a kind of canal; this fold is also covered by the secondary thickening. All specimens from Sta. 1443 showed a thin secondary thickening only, whereas most specimens found off St. Croix showed a much heavier thickening. So it seems that the planktonic specimens only have slight thickening, which increases with depth; may be the bottom-living specimens came down by means of this heavy thickening of the test.

Nearly all specimens found are coiled to the left; but always rare specimens are found as well, which are coiled to the right. Sections revealed that those right-coiling specimens are always microspheric, with an inner proloculus-diameter of about 10 μ; all left-coiling specimens have a larger proloculus, with a diameter of about 16–20 μ. They form the megalsopheric generation; this is in agreement with the outcome in several species of *Globigerina*.

Globorotalia tumida is not uncommon in Sta. 1443, though occurring in relatively small specimens; in the sample off Santa Cruz (St. Croix, 800 m) it is far more common and here the specimens are often larger.

Globorotalia menardii (d'Orbigny) Fig. 340, 413–420

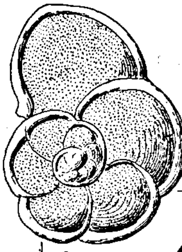
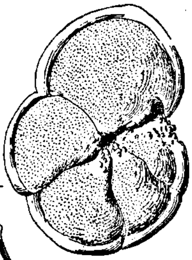
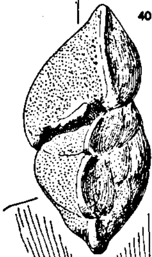
Rotalia menardii D'ORBIGNY, 1826, p. 273, No. 26; Modèles, No. 10.
Pulvinulina repanda var. *menardii* PARKER & JONES, 1863, p. 394, pl. 16 fig. 35-37.
Pulvinulina menardii (d'Orbigny), GOËS, 1882, p. 112, pl. 8 fig. 289–295; BRADY, 1884, p. 690, pl. 103 fig. 1–2.
Globorotalia menardii (d'Orbigny), CUSHMAN, 1931, p. 91–94, pl. 17 fig. 1; HOFKER, 1956, p. 194–199, pl. 30 fig. 1–6.

In 1956 the present author gave an analysis of this species from off Santa Cruz (St. Croix), depth 800 m. The species is very common, especially in Sta. 1443 (200 m). It can be distinguished from *G. tumida* by the more rounded and much more compressed form.

Most specimens found in a plankton sample, Sta. 185, Siboga-Expedition, Pacific, only show the primary wall over all the chambers; there may be a very thin secondary thickening over the primary wall of the dorsal side of the initial chambers. The lip, also thin, over the ventral aperture passes inwardly into the thickened border of the septal part of the foramen, thus having similarity with the situation which is found in *Discorbis* (Fig. 420). It may be a kind of toothplate, according to its situation. The primary wall also forms the fold at the margin, building a narrow canal more or less connected with the chamber lumen forming the marginal poreless carina. A young specimen found in Sta. 1443 shows the same structure as found in Siboga-Sta. 185, with only the primary wall forming the test wall (see Fig. 340). The specimens of larger size found at Sta. 1443 possess in the last formed chambers the primary wall only, but in older chambers a secondary thickening is found over the primary wall, so that the outer walls seem to be double (Fig. 418); this doubling not only occurs at the dorsal side, but also at the ventral sides of former chambers; however, not ventrally at more initial chambers which consist of the primary walls only.

Horizontal sections through the margin show, that only the primary wall of the outer margin continues as the septum; this can also be seen in transverse tangential sections. Thus the septa are simple, only in a section near the dorsal wall of the test, they may seem to be double as the chamber walls bend slightly inward. This proves that *Globorotalia menardii*, just as *G. tumida*, is monolamellar, with secondary thickenings over the outer walls in specimens which are living nearer or at the bottom of the sea.

Most specimens studied coiled to the left; between this multitude some rare specimens were found which are right-coiling. Left-coiling specimens invariably have a proloculus, followed by a second mostly smaller chamber; these two chambers may form the megalospheric embryon. The inner diameters of these proloculi vary between 16 and 24 μ. The rare right-coiling specimens always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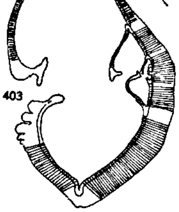
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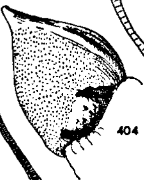
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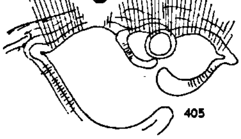
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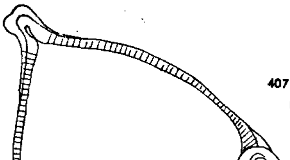
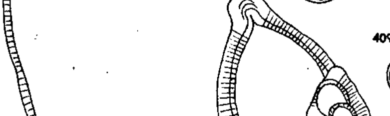




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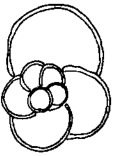
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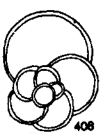
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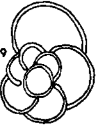
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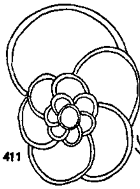
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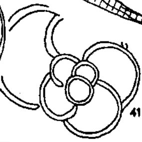
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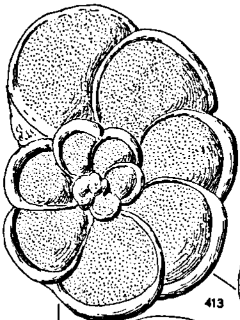
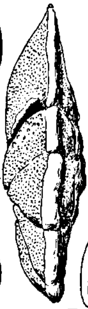
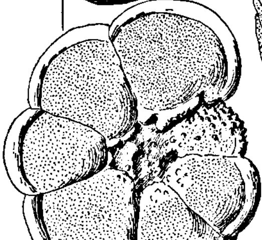
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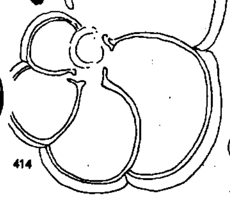
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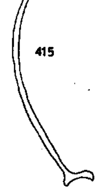
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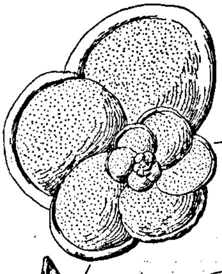
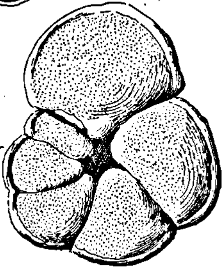
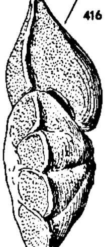
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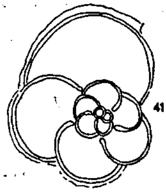
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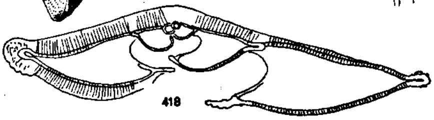
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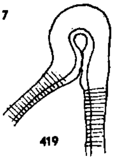
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have a much smaller proloculus and the second chamber is slightly larger than the proloculus; here the inner diameter of the proloculus is 8–11 μ; they must be microspheric. So, just as is the case in tropical *G. tumida* and in the tropical specimens of several *Globigerinae* described here, the difference between the two generations is not only found in the size of the proloculus, but also in the direction of coiling. This phenomenon is not restricted to planktonic Foraminifera.

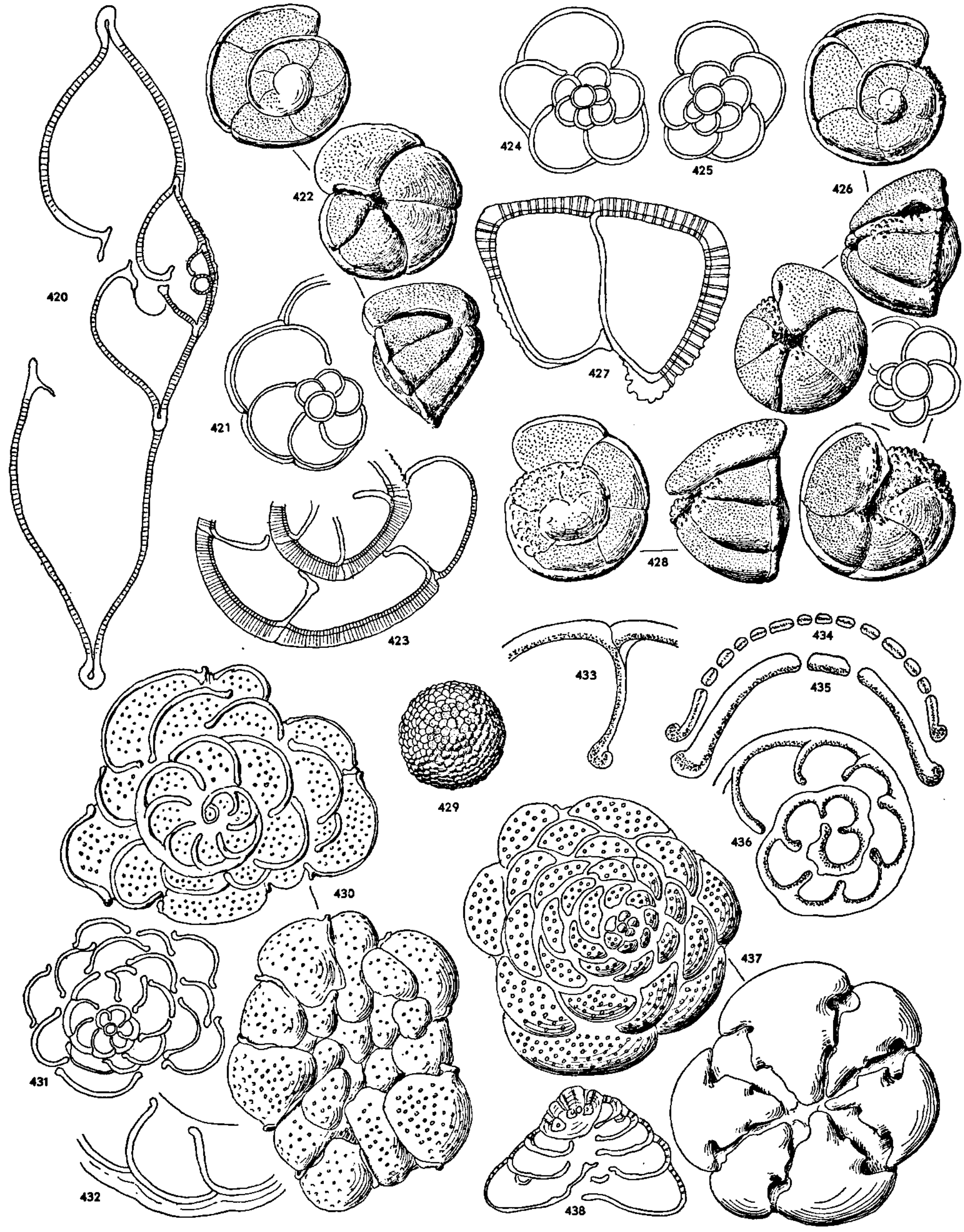
One specimen of the microspheric generation was found in the plankton sample mentioned above; its protoplasm, coloured with Heidenhain-tincture, showed a multitude of small nuclei which are absent in the planktonic megalopsheric specimens.

Globorotalia truncatulinoides (d'Orbigny) Fig. 421–428

Rotalia truncatulinoides D'ORBIGNY, 1839a, p. 132, pl. 2 fig. 25–27.
Pulvinulina truncatulinoides PARKER & JONES, 1865, p. 398, pl. 16 fig. 41–43.
Globorotalia truncatulinoides (d'Orbigny), CUSHMAN, 1927, p. 176; 1931, p. 97, pl. 17 fig. 4.
Globorotalia (Truncarotalia)truncatulinoides (d'Orbigny), CUSHMAN & BERMÚDEZ, 1949, p. 35.

Fig. 401–406. *Globorotalia tumida* (Brady). – Barbados, sta. 1443: 401, megalospheric test, coiling to the left (× 20); 402, transverse section through 401 (× 100); – Santa Cruz, depth 800 m: 403, transverse section, the thickening of the test is much heavier than in the specimen from Barbados, depth 200 m (× 100); 404, aperture and lip (× 30); 405 section through the initial part of 403, proloculus megalospheric (× 113); 406, young specimen, the thickening of the outer walls is much less pronounced and in the last formed chamber only the carina is thickened, whereas the rest of its wall consists only of the primary wall (× 113).

Fig. 407–412. *Globorotalia menardii* (d'Orbigny). – Siboga exp. sta. 185, Pacific: 407–409, 412, optical sections of the megalospheric initial parts of five specimens in canada-balsam, from plankton (× 150); – Barbados, sta. 1443: 410–411, sections through microspheric initial part, seen from the ventral side (the coiling is to the right) (× 150); – Barbados, sta. 1443: 413, megalospheric, from three sides (× 30); 414, horizontal section, showing the simple septa (× 30); 415 part of section 414, showing the septum formed by the primary wall only (× 150); – Siboga exp. sta. 185, Pacific: 416, living specimen from plankton sample, from three sides, microspheric, the coiling is to the right; 417, optical section of the initial part of 416 (× 150); – Barbados, sta. 1443: 418, transverse section (× 30); 419, part of this section, showing the carina (× 113).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The present author has described and analysed this species several times: HOFKER, 1932, p. 129–131, textfig. 39a-f; 1956, p. 193–194, pl. 19 fig. 15–26; 1956a, p. 371–373, textfig. 4; 1960, p. 111–115, text figs. 1–10.

There are but few data which have to be mentioned here. Transverse sections taken in the middle reveal that the outer walls, except for the last chamber when newly formed, consists of two layers, an inner primary one and a thicker, secondary outer layer. The inner primary wall continues into the simple, poreless septum. This may also be stated of oblique transverse sections through two of the last formed chambers. So the species is monolamellar, and not bilamellar as supposed by many modern writers.

Horizontal sections through specimens just below the dorsal surface reveal that the test begins with a spiral of chambers around the proloculus consisting only of the simple primary walls, and that after the forming of at least 6 chambers the outer walls receive their secondary thickening.

Fig. 420. *Globorotalia menardii* (d'Orbigny). – Siboga exp. 185, Pacific: section through microspheric specimen from plankton sample. Only at the dorsal side of the initial part there is a slight secondary thickening; all other walls consist of the primary walls only (× 113).

Fig. 421–428. *Globorotalia truncatulinoides* (d'Orbigny). – Barbados, sta. 1443: 422, from three sides (× 20); 421, section near the dorsal side, seen from within (× 150); 423, section taken more to the ventral side, proving that the septa are simple and that they continue in the primary wall of the outer wall which is thickened secondarily (× 60); 424–425, initial parts of a sinistral and dextral specimen from off Finisterre, showing the difference in size of the proloculi (× 150); 426, Barbados, sta. 1443, specimen coiling to the right (× 20); 427, tangential transverse section showing the simple septum continuing in the primary wall (× 60); 428, Santa Cruz, depth 800 m, specimen coiling to the left (× 20) and horizontal section of the initial chambers (× 150).

Fig. 429. *Sphaerogypsina globulus* (Reuss). – Barbados, sta. 1443 (× 20).

Fig. 430–436. *Planorbulina mediterranensis* d'Orbigny. – 430, ventral and dorsal (attached) sides (× 60); 431, horizontal section (× 45); 432, some chambers of the initial spiral, showing that the septa are simple and consist of the primary walls only (× 113); 433, septum and wall of initial spiral, showing an inner granular part (× 150); 434; outer wall of one of the last formed chambers, with the granular part in the middle (× 150); 435, outer wall of one of the chambers, just following the initial spiral, showing the granular part at the inner side (× 150); 436, horizontal section of initial part (× 150).

Fig. 437–438. *Cymbaloporetta squammosa* (d'Orbigny). – Barbados, sta. 1443: 437, dorsal and ventral side (× 60); 438, transverse section (× 30).

Parker (1957) showed that in cores of the Eastern Mediterranean coiling of the tests may be in left or right direction, and that this direction in percents changes with the depth of the sample in the core. In many samples from off Mallorca, Western Mediterranean, the present author found nearly all specimens coiled to the left. In St. Croix and Barbados, nearly all specimens were right-coiling; left-coiling specimens and most right-coiling specimens proved to be megalospheric; very large specimens were already described in 1956 by the author as belonging to the microspheric generation; they are all right-coiling.

A study of the direction of coiling of *G. truncatulinoides* showed following results (Fig. 421–428):
Santa Cruz, Caribbean, depth 800 m: mostly right, some left.
Barbados Sta. 1443: in 12 specimens 11 were right, one left.
Snellius Exp., Sta. 44, E. of N. Borneo: mostly right, few left.
Snellius Exp., Sta. 92, off Ceram: all right.
300 miles E. of Finisterre, Atlantic: about an equal number right and left.
Mediterranean, off Majorca: all specimens left.
Mediterranean, Gulf of Naples: all left.
Canary Islands, depth 300 m, Atlantic: all left.
East Africa, near coast, depth 200 m: all left.
Snellius Exp., Sta. 85, W. of Misool: mostly left, but some right.

One would be inclined to believe that temperature has to do with the direction of coiling; tropical temperature would be indicated by right-coiling, temperate temperature would induce a coiling more to the left (see Finisterre); but then one is at a loss about the sample taken off Misool (Indonesian Archipelago) where coiling is mostly to the left.

The possibility remains that the direction of coiling is a function of the proloculus-diameter and that the latter is a function of temperature.

The species is found rarely in Sta. 1442, somewhat more common in Sta. 1443.

Sphaerogypsina globulus (Reuss) Fig. 429

Ceriopora globulus Reuss, 1848, p. 33, pl. 5 fig. 7.
Gypsina globulus (Reuss), Brady, 1884, p. 717, pl. 101 fig. 8.
Sphaerogypsina globulus (Reuss), Galloway, 1933, p. 309.

This species is rather rare in Sta. 1443 (one specimen only). It is cosmopolitic in tropical and sub-tropical seas.

The inner structure of the test will be described in an other paper (in press). The chamber walls are monolamellar with an inner granular primary part. The test consists of many layers of small chambers which mostly are not arranged radially.

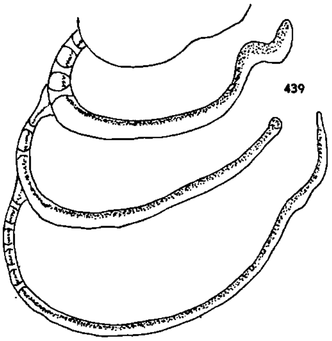
Planorbulina mediterranensis d'Orbigny Fig. 430–436

Planorbulina mediterranensis d'Orbigny, 1826, p. 280, No. 2, pl. 14 fig. 4–6; Modèles, No. 79.

The specimens found in Sta. 1443 often attain a diameter of more than one mm; they differ, however, from *P. acervalis* Brady (Hofker, 1964, p. 85, fig. 217–219) from the tidal zones of the Caribbean Islands as they do not show apertures in the marginal chambers. These apertures are situated areally and not suturally and consequently the chambers do not extend outward. Yet it is not certain whether the specimens found off Barbados do not belong to *P. acervalis*.

The test walls are much thicker than in typical mediterranean specimens; the marginal walls of the spiral chambers are thickened by several lamellae. The walls and septa in the initial part consist of an inner granular, and an outer hyaline lamellum; this is also the case in the more central annularly placed chambers, following the spiral ones. In the later more marginal chambers, however, the primary wall (consisting of the granular lamellum), is situated in the middle of the wall, whereas two hyaline, radial crystalline lamellae have been added at the inside as well as at the outside of it. This structure was also found in typical *P. mediterranensis* from the Bay of Naples.

The flat spiral side is the attached one; at the other side the outer chambers partly overlap the former ones, a feature also known from typical *P. mediterranensis*.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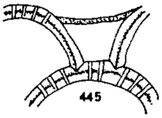
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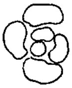
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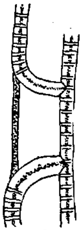
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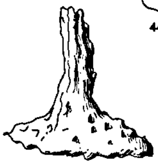
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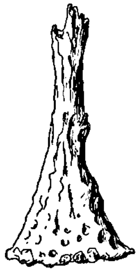
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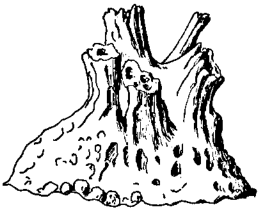
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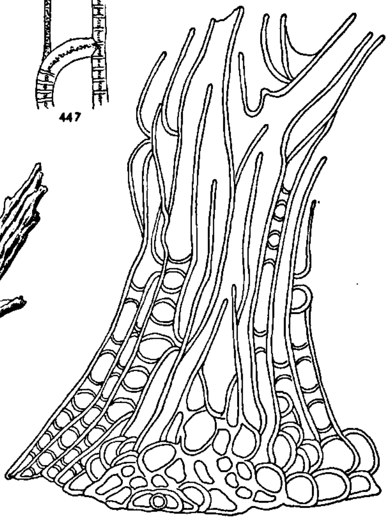
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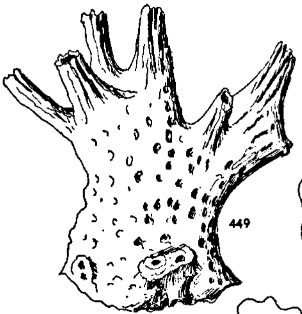
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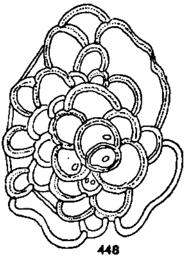
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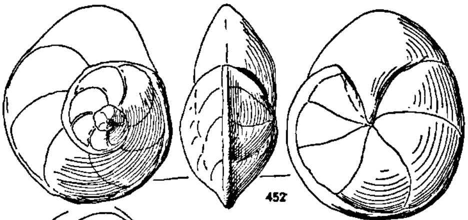
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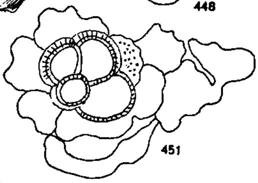
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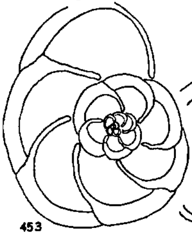
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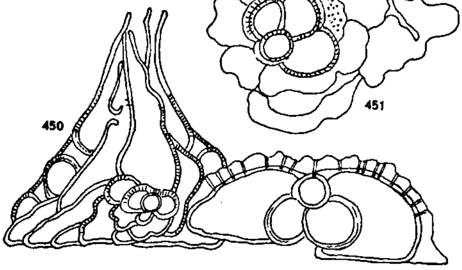
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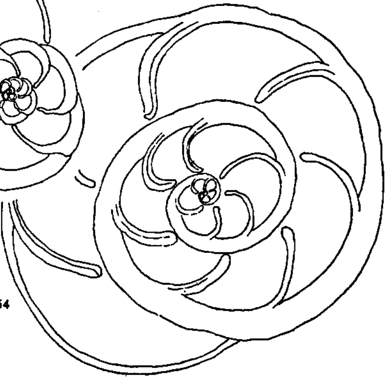
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Cymbaloporetta squammosa (d'Orbigny) Fig. 437–439

Rotalia squammosa D'ORBIGNY, 1826, p. 272, No. 8.
Rosalina squammosa D'ORBIGNY, 1939, p. 91, pl. 3 fig. 12–14.
Rosalina poeyi D'ORBIGNY, 1839, p. 62, pl. 3 fig. 18–20.
Cymbalopora poeyi (d'Orbigny), CARPENTIER, PARKER & JONES, 1862, p. 215, pl. 13 fig. 10–12.
Cymbalopora squammosa (d'Orbigny), CUSHMAN, 1922, p. 41, pl. 6 fig. 4–6.
Cymbaloporetta squammosa (d'Orbigny), CUSHMAN, 1928, p. 7; 1931, p. 83, pl. 16 fig. 4; HOFKER, 1951, p. 477–484; 1956, p. 188–189, pl. 28 fig. 11–20; 1964, p. 64, fig. 215.

In the samples 1442 and 1443 mostly the flat form of this species was found; only in much deeper water the high-conical form appears, as in the samples described by the author in 1956. In 1956 and 1964 the author also gave transverse sections and in 1956 the description of the two forms. Horizontal sections are given here.

An horizontal section of the initial part of the test shows the megalospheric proloculus followed by at least 10 normal trochoidally arranged chambers; the first of these show simple septa, the later ones have a granular inner primary wall which continues as inner lamellum of the marginal wall, whereas an outer secondary thickening consists of fibrous radial hyaline material. Ventrally the typical poreless outgrowths of the later chambers, overlapping

Fig. 439. *Cymbaloporetta squammosa* (d'Orbigny). – Barbados, sta. 1443: part of section of 438, the ventral walls have the granular parts at the inner side, whereas it changes its place to the middle of the wall in the outer walls (× 150).

Fig. 440–451. *Miniacina miniacea* (Pallas). – Barbados, sta. 1442: 440–443, specimens (× 12); 444, initial spiral of 443 (× 30); 445, part of the outer walls of section 448, showing that the closing wall is formed by the granular primary wall only, whereas in the walls of the chambers this wall is found in the middle of the walls (× 150); 446, longitudinal section (× 30); 447, part of the outer walls of section 446 (× 150); 448, transverse section of a stem (× 30); 449, Barbados, sta. 1443: (× 12); 450, longitudinal section of a young specimen adherent to a specimen of *Carpenteria utricularis* (× 30); 451, basal transverse section through young specimen; the septa of the initial part are simple (× 100).

Fig. 452–454. *Eponides repandus* (Fichtel & Moll). – Barbados, sta. 1442: 452, microspheric individual, coiling to the right (× 30); 453, initial spiral of this specimen (× 60); 454, another microshperic specimen, section, seen from within (in reality it is coiling to the right), septa which are sectioned more dorsally seem to be double; but sectioned more in the middle, they are simple (× 60).

former whorls, are shown. The chambers reach the ventral centre of the test, with two ventral apertures. Their walls consist of a granular primary layer, covered at the inside and at the outside by secondary fibrous radial hyaline material. The large pores are only found in the dorsal chamber walls. Some of the chambers show secondarily formed marginal openings, through which the protoplasm emerged to form a next chamber. The primary apertures show, just as in *Planorbulina*, sigmoid lips formed by the granular primary wall.

This structure of the walls so much resembles that found in *Planorbulina*, that it seems inevitable to place *Cymbaloporetta* close to the former genus. Moreover, it can be stated that both genera are not really bilamellar, but that the walls are formed primarily by a granular wall which is strengthened by secondary hyaline thickenings. This can be proved by the junctions of two walls of adjacent chambers: here the outer thickening of the older chamber is not found at the junction, so that the later wall forms a wedge into the older one. It is also visible from a vertical section: the basal poreless chamber walls show the primary granular wall at the inside, covered by the outer secondary thickening only; but where this basal wall bends upwards to form the outer wall, pierced by coarse pores, an inner hyaline thickening is added, so that (seen in low magnification) such outer walls get a "bilamellar", more accurately "trilamellar" structure. This means that in transverse sections no real septa are seen, but only these thickened outer walls, later overlapped by new chambers. Thus *Cymbaloporetta* does not belong to the bilamellar Foraminifera.

Miniacina miniacea (Pallas) Fig. 440–451

Millepora miniacea PALLAS, 1766, p. 251.

Polytrema miniacea (Pallas), CARPENTER, PARKER & JONES, 1862, p. 228, 235, pl. 13 fig. 18–20.

Polytrema miniaceum (Pallas), CARTER, 1876, p. 185; MÖBIUS, 1880, p. 85, pl. 7; BRADY, 1884, p. 721, pl. 100 fig. 5–9, pl. 101 fig. 1; HERON-ALLEN & EARLAND, 1922, p. 221–226, pl. 8 fig. 1–31; HOFKER, 1927, p. 27–31, pl. 12, pl. 13 fig. 1–7, pl. 14 fig. 1–11.

Miniacina miniacea (Pallas), GALLOWAY, 1933, p. 305; LOEBLICH & TAPPAN, 1964, p. 705, fig. 577, 4–7.

In Sta. 1442 all specimens found are smaller than those from Sta. 1443 and the Pacific; yet their inner structure is that of *Miniacina*. All specimens observed were megalospheric. They had a relatively small proloculus, followed by a short spiral of 3–4 chambers at the base of the stem, mostly just beneath the aperture of the test. The initial set is followed by a mass of irregular chambers, forming the base of the test. Mostly a more or less slender stem is formed, consisting of very elongate chambers which open at the top of the stem. Around the stem more globular chambers are added later, which do not communicate laterally but leave openings between, the so-called hollow pillars. These "pillars" may remain open or can be closed by a thin plate which has a granular microstructure.

The walls between the initial chambers are simple, granular; they may be surrounded by a thickening secondary wall which is calcareous radial. Later chambers show two lamina within and outside the thin primary granular lamellum and thus seem to simulate a bilamellar structure. The wedge-like attachment of the wall of a later chamber in the wall of a former one indicates that at least the outer lamellum is a secondary thickening; the primary, often very thin inner lamellum forms the top of the wedge, indicating that this lamellum was the first formed one. Therefore the microstructure of *Miniacina* is not bilamellar in reality.

The specimens were attached to corals, Bryozoa, shells and calcareous algae.

About this species, very common in the samples off Barbados (where *Homotrema* is entirely missing), CUSHMAN (1931, p. 144) says: "Although *Polytrema* has been recorded from the Atlantic, it is probable that most, if not all, the records are *Homotrema*, at least as far as the West Indian region is concerned." The present author studied many samples from the tidal zone of the Caribbean Islands, where *Homotrema rubrum* (Lamarck) was extremely common (1964, p. 85, fig. 220–221), but *Polytrema* (*Miniacina*) was missing. The cause may be depth, but in the East Indies both species are found in depths varying from about 20–500 m and even deeper.

Eponides repandus (Fichtel & Moll) Fig. 452–461

Nautilus repandus FICHTEL & MOLL, 1789, p. 35, pl. 3 fig. a–d.
Eponides repandus MONTFORT, 1808, p. 127, 32e genre.
Pulvinulina repanda CARPENTIER, PARKER & JONES, 1862, p. 210.
Eponides repanda (Fichtel & Moll), CUSHMAN, 1931, p. 49, pl. 10 fig. a–c.
Poroeponides lateralis (Terquem), CUSHMAN, 1944, p. 34.
Sestronophora arnoldi LOEBLICH & TAPPAN, 1957, p. 229.

This is a wide-spread and very variable species; in specimens gathered in sub-tropical environments, such as the Mediterranean, the most common form is that, which has been figured by FICHTEL & MOLL and is still present in the collection of these authors in the Mus. Nat. Hist. in Vienna; thus the description of a neotype from the Mediterranean by LOEBLICH & TAPPAN (1962, p. 35–36) was not necessary.

Young specimens all have the features of the typical form. In localities where *Poroeponides* is found as well, outgrown microspheric specimens have the characteristics of the normal form without the secondary pores in the septa of later chambers; these are typically formed later by resorption of the test wall. In some localities specimens, with a very large proloculus, of the A_2-generation may exist; they have a cribrate plate over the umbilicus, constructed by the last formed chamber, and have been called *Sestronophora*; RESIG (1962) showed for the first time that all three forms belong together, forming one species with several generations which may or may not occur in one locality (see also COLOM, 1964, p. 34–36); it seems that the species is dimorphic in subtropical and colder environment, whereas all three forms may occur under very favourable conditions.

In Sta. 1442 the porous outgrown A_1-generation is most common, the cribrate form is very rare. Young specimens of the A_1-generation show the normal form of *Eponides repandus* without secondary pores on the apertural face, whereas all microspheric forms observed which remain of moderate size, show the form without pores and cribrations.

The normal form without pores or cribrations does not have an umbilical hollow at the ventral side, the chambers reach the ventral centre of the test and close it.

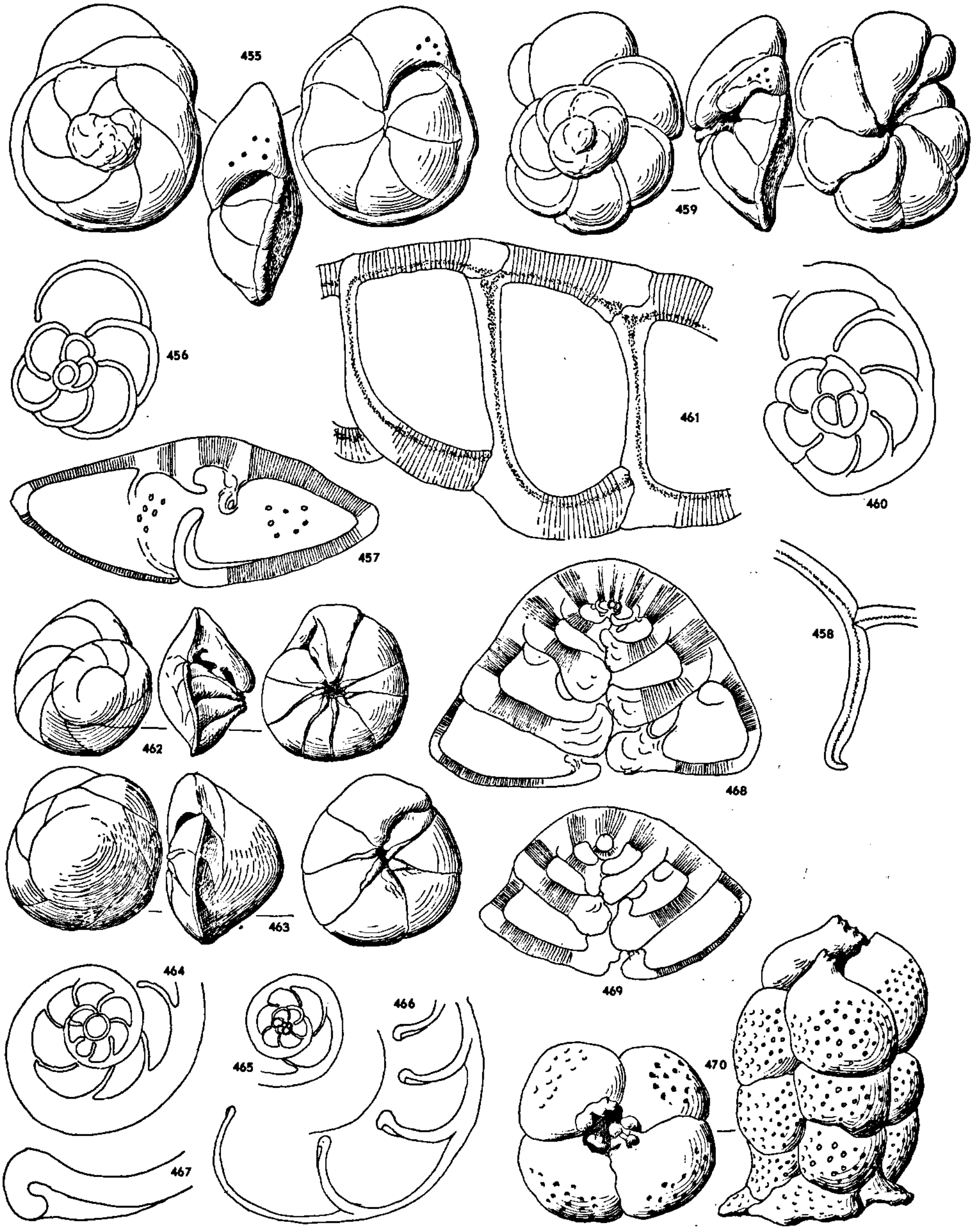
Large specimens of the form with pores (in the apertural walls of later chambers) show an open umbilicus, as here the last formed chambers do not reach the centre of the ventral side; these last formed chambers are usually inflated, forming a lobulate periphery with depressed sutures at the ventral side.

In the A_2-form the later chambers do not fuse together in the ventral centre either; the porous apertural face, however, forms a cribrate plate over this open umbilicus. The very large proloculus of this generation can be seen on the figure of the type-specimen given by LOEBLICH & TAPPAN (1964, fig. 546, 6).

In the microspheric generation all specimens observed from quite different localities are coiled to the right; all specimens of the A-generations are coiled to the left. This phenomenon is not restricted to *Eponides*; it was already found in the following species too: *Asterorotalia dentatus* (Parker & Jones); *A. papillosus* (Brady) (see also BHATIA, 1956, pl. 4 fig. 1–2); *A.* (*Rotalidium*) *concinnum* (Millet); *A. annectens* (Parker & Jones) (see also BHATIA, 1956, pl. 3 fig. 1–2); *Planulina wuellerstorffi* (Schwager); *Pseudorotalia schroeteriana* (Parker & Jones); *Caucasina lappa* (Cushman & Parker). See also the planktonic species in this paper.

We do not know yet what the meaning is of this difference in coiling-direction in the different generations of Foraminifera. It is obvious that in all cases where in a population several coiling-directions are observed, authors will have to give the generations with their coiling-directions, as is done in modern publications.

The test wall of *Eponides repandus*, the genotype of *Eponides*, is remarkable. In horizontal sections the initial chamber walls show outer thickened parts, whereas the initial septa are simple; the latter show an inner granular thin layer, which at the outside gradually becomes more hyaline calcareous radial, and is entirely granular in the first chambers. In the later chambers there is a middle granular layer, which in the septa may be thickened at both inner and outer sides by hyaline calcareous layers and forms the inner granular layer in the outer walls; the latter may be thickened secondarily by a hyaline, calcareous radial layer at the outer side only. That this outer thickening is a secondary one, can be seen where a next chamber is fastened to the wall of a former one: here we find that the later wall is wedgelike inserted in the wall of the former chamber, which wall thus was thickened outwards after insertion of the next chamber wall. This structure cannot be called "bilamellar" as has been done by REISS (1963, p. 82), who, moreover, suppressed *Eponides*, since he believed that *E. repandus* (Fichtel & Moll) Montfort was a nomen dubium, which is not the case. In reality fossil and recent species of *Eponides*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show a large variation in test wall structures, from granular throughout, to granular and calcareous radial; with simple septa,or "double" and even trilamellar septa. None of the species studied by the present author are typically bilamellar. Some of these species have very fine pores, as in *E. repandus*, others show coarser pores.

Eponides repandus was very common in Sta. 1442 (100 m deep) but very rare in Sta. 1443 (200 m).

Neoeponides antillarum (d'Orbigny) Fig. 462–469

Rosalina antillarum D'ORBIGNY, 1839, p. 75, pl. 5 fig. 4–6.
Truncatulina antillarum (d'Orbigny), FORNASINI, 1902, p. 53.
Eponides antillarum (d'Orbigny), CUSHMAN, 1931, p. 42, pl. 9 fig. 2.
Rotalia antillarum (d'Orbigny), HOFKER, 1956, p. 166, pl. 25 fig. 11–21.

Outgrown specimens of this species, especially from the microspheric generation, are nearly identical with the genotype chosen by REISS (1960) for *Neoeponides*: *Rosalina schreibersii* d'Orbigny from the Tortonian of Austria. It is questionable whether the species from the Recent Caribbean is not identical with this genotype. The sections reproduced by LOEBLICH & TAPPAN (1964,

Fig. 455–461. *Eponides repandus* (Fichtel & Moll). – Barbados, sta. 1442: 455, megalospheric specimen, coiling to the left, the specimen shows apertural pores in the apertural face and belongs to the A_1 generation (× 20); 456, horizontal section through the initial spiral (× 60); 457, tangential transverse section, showing the way in which a septum may be seen double (× 60); 458, part of horizontal section, the thin primary granular wall lies within septum and outer wall, and the wedge-like insertion of a next chamber (× 150); 459, specimen of the A_2-generation, showing the evolute chambers at the ventral side, forming a hollow umbilicus (× 20); 460, horizontal section through the initial part of this specimen (× 60); 461, part of transverse tangential section, more to the axis than 457, with the simple septa and the granular primary wall (× 113).

Fig. 462–469. *Neoeponides antillarum* (d'Orbigny). – Barbados, sta. 1443: 462, megalospheric specimen, coiling to the right, from three sides (× 20); 463, microspheric specimen, coiling to the left (× 20); 464, horizontal section through initial spiral of megalospheric specimen (× 60); 465, similar, microspheric (× 60); 466, part of horizontal section, showing the simple septa, but secondarily thickened only near the apertural rim (× 45); 467, end of septum in horizontal section (× 150); 468, transverse section through microspheric specimen (× 45); 469, similar, megalospheric (× 45).

Fig. 470. *Sporadotrema cylindricum* (Carter). – Barbados, sta. 1442: from two sides (× 12).

p. 682, fig. 547, 2a from a microspheric specimen, 2b from a megalospheric specimen of *R. schreibersii*) strongly suggest this identity. The horizontal section, 2a, shows simple granular septa, and not, as described on p. 681, double and radial, obviously taken from the description given by REISS (1960, p. 17). The same may be said about *Neoeponides antillarum*.

There are two forms in sample 1443, where the species is common. One form, the microspheric generation, shows a dome-like dorsal side in which only the chambers of the last formed whorl can be seen, the more initial chambers are covered by the thick secondary thickening of the test wall. The margin is sub-acute, whereas the ventral side is nearly flat with 6–7 chambers in the last formed whorl. The chamber sutures at the dorsal side are strongly oblique (as far as they are visible), those of the ventral side are radial, thickened towards the centre into bosses of calcareous material surrounding the narrow umbilical hollow. The apertural face of the last formed chamber is truncate with a hollow part near the periphery (inframarginal sulcus).

Sections show that the whole test is granular and that the septa are simple, slightly curved to form the apertural lip which is strengthened by an outer secondary thickening, the latter only occurring near the apertural border and not running over the whole septum and the inner outer wall. This thickening forms the lip described by REISS (1960) and LOEBLICH & TAPPAN (1964), but does not make the septum a "primarily double" one. The tena of the chamber walls at the ventral centre become very thick by secondary thickening, forming the star-like ornamentation around (and soon filling up) the central shallow umbilical hollow. No toothplates can be detected. The aperture is a narrow slit at the ventral margin of the last formed chamber.

The second (megalospheric) generation shows a much lower dorsal side, though it remains convex, whereas the ventral side is not flattened, but also distinctly convex, often more so than the dorsal side. The central secondary thickening at the dorsal side is not as pronounced as in the microspheric form, and the ventral central thickened tena are not so conspicuous. The sulcus is more pronounced, the poreless margin slightly more keeled. The chamber walls and the septa are simple, though the outer chamber walls are secondarily thickened; the microstructure is granular. In both forms the margin is poreless, as is the apertural face (the later poreless septum). All these features point strongly to the vicinity of *Alabamina.*

In the genotype of *Neoeponides*, from Austria, the test walls as well as the septa do not differ from those of *N. antillarum*; they have a granular microstructure and the septa are simple, except for the secondary thickening at the apertural border. The pores in both species are distinct, piercing the dorsal and ventral walls of the chambers, but margins and apertural faces (septa) are entirely poreless. It is very probable that *Eponides procera* (Brady) from the Pacific, *N. antillarum* and *N. schreibersii* form one single species, widespread in tropical seas. They must be placed in the Alabaminidae, or else they form a primitive group of the Eponidae.

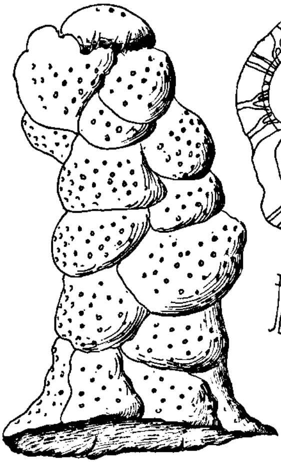
Sporadotrema cylindricum (Carter) Fig. 470–473

Polytrema cylindricum Carter, 1880, p. 441, pl. 18 fig. 1.

Sporadotrema cylindricum (Carter), Hickson, 1911, p. 447, pl. 30 fig. 3–7, pl. 31 fig. 10–17, pl. 32 fig. 21–22, 24, 29, 32–33; Heron-Allen & Earland, 1915, p. 729; Hofker, 1927, p. 224, pl. 8 fig. 2, 5–6, pl. 9 fig. 1–4, 6, pl. 10 fig. 1–10, 12–13.

In 1927 I named only those specimens which have an orange colour *Sporadotrema cylindricum*; but Loeblich & Tappan (1964, p. 705) also gather the deep-red specimens named *S. mesentericum* Hickson by me (1927) in this species. In the Caribbean, all specimens have the deep-red colour.

All specimens observed had a very large proloculus, followed by three rounded chambers which form the raspberry embryon. Only these chambers have a primary wall, pierced by regular distinct pores. Then the stem is built up by whorls of 2–4 chambers around an axis. These chambers show very large openings formed by the fusion of many pores of the primary wall at their outside; the fusion takes place in the secondary thickened wall. The axial walls are poreless, as are the short necks of the apertures. At the end of the stem the chambers of the last formed whorl each have an irregular opening (aperture) axially. The short apertural necks show double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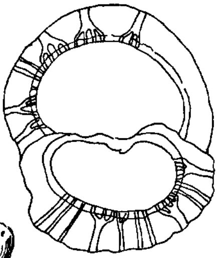
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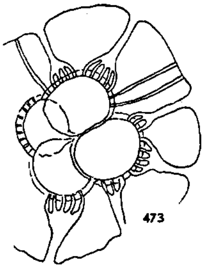
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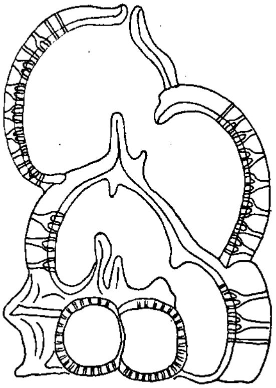
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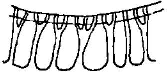
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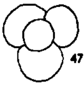
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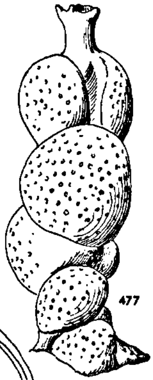
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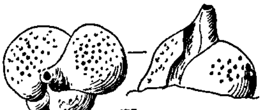
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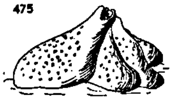
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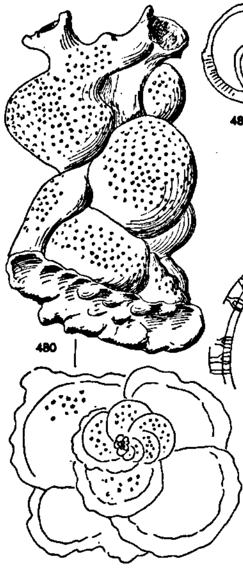
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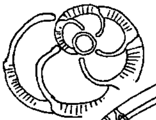
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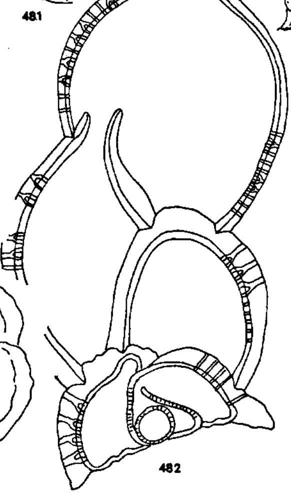
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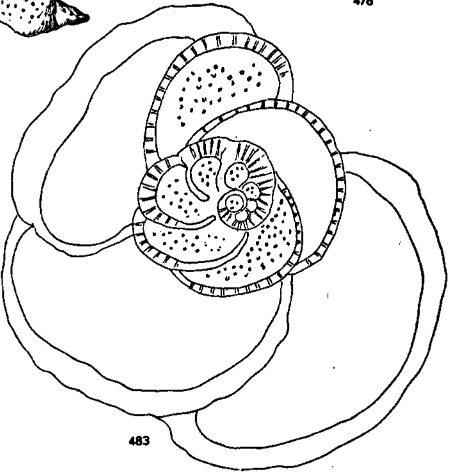
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walls too. As, however, the pores in the inner primary lamellum do not differ from those found in the initial chamber walls (lacking secondary thickenings), it is obvious that the outer wall is formed later and that the inner lamellum is the primary wall. Thus it is certain that the two lamellae do not form a bilamellar wall in the sense of SMOUT (1959) and REISS (1963).

The whole structure of the tests as well as the finer structures of the walls prove that *Sporadotrema* differs only from *Biarritzina proteiformis* (Goës) in the more rapid coiling spiral of the latter and in the colour of the wall. Since *Biarritzina proteiformis* Goës in all its characteristics resembles *B. carpenteriaeformis* (Halkyard) from the Eocene, both species must belong to one genus. *Biarritzina* Loeblich & Tappan was erected in 1964, *Sporadotrema* Hickson in 1911; so *Biarritzina* must be a younger synonym of *Sporadotrema*. The thickening by a second lamellum and the fusing of the pores into canals in the latter give a strong case of difference from the species known as *Carpenteria*, which all have a primary wall only and no lamellation whatever. But in *Carpenteria utricularis* (Carter) the honeycomb-structure at the outside of the walls is formed by a separate, though incomplete, poreless lamellum and it may be that such a lamellum gave rise to the complicated structure of the walls in *Sporadotrema* (and *Biarritzina*); in so far both genera *Carpenteria* and *Sporadotrema* may be allied, since the initial part of the tests of both seems to be identical.

Fig. 471–474. *Sporadotrema cylindricum* (Carter). – Barbados, sta. 1442: 471, large specimen (× 12); 472, transverse section through the stem of 471 (× 45); 473, transverse section through the base, showing proloculus and following chambers, the septa are the simple primary walls which form the inner layer of the outer wall (× 30); 474, young specimen, longitudinal section (× 30).
Fig. 475–483. *Biarritzina proteiformis* (Goës). – Barbados, sta. 1443: 475–476, young specimens (× 12); 477, outgrown specimen (× 12); 478, centre of basal side of specimen 477, showing megalospheric proloculus (× 12); 479, testwall of later chambers of the base of microspheric specimen (× 60); 480, microspheric individual, side view and base (× 12); 481, transverse section through basal part of specimen 480, with the simple septa (× 60); 482, longitudinal section of young specimen, showing that the walls of the initial chambers are simple, the later walls double, due to secondary thickening (× 30); 483, horizontal section through the base of microspheric specimen (× 60).

Biarritzina proteiformis (Goës) Fig. 474–484

Carpenteria balaniformis var. *proteiformis* Goës, 1882, p. 94, pl. 6 fig. 208–214; pl. 7 fig. 215 fig. 215–219.

Carpenteria proteiformis (Goës) Brady, 1884, p. 679, pl. 97 fig. 8–14; Cushman, 1915, p. 49, pl. 20 fig. 2, pl. 21 fig. 1; 1921, p. 361, pl. 73 fig. 2–3; 1931, p. 140, pl. 26 fig. 1; Hofker, 1930, p. 130, pl. 46 fig. 5, pl. 51 fig. 1, 4–5, 7, pl. 52 fig. 6, 8.

Young specimens have the test of a *Carpenteria*: around a more or less spiral initial part a small crater of chambers is built, which in this species are distinctly inflated. The aperture of the last formed chamber lies on top of the volcano on a short poreless neck. Later chambers with drop-like form are built over the neck of a former chamber so that a kind of stem is formed with several strongly inflated chambers around its axis.

The walls of the proloculus of the A_2-generation as well as many initial chambers of the B-generation are simple, pierced by distinct pores which are mostly densely placed. Later chambers also have this primary wall with densely placed pores, but here it is covered by a second lamellum in which the primary pores fuse into much

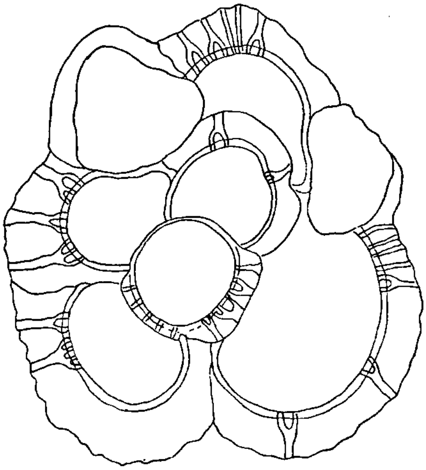

Fig. 484. *Biarritzina proteiformis* (Goës). – Barbados, sta. 1443: transverse section through the base of a megalospheric specimen, showing the simple, primary septa of the initial chambers, and some sand grains incorporated in the test (× 60).

coarser canals which lead towards the surface. Two, three or even more pores may form such a canal. In this way the surface of older chambers is pitted by these canal-openings. In the basal initial part of the stem large sand grains may be incorporated in the walls of the chambers; a poreless part of the wall encloses such a grain. The megalospheric test in most specimens is a slender one; microspheric tests have a more irregular and compact structure.

CUSHMAN, 1931, p. 141, wrote: "There are numerous records referred to this species and specimens very similar to the West Indian species occur in various parts of the Pacific, but whether or not they are the same, needs further study". The present author compared the Pacific specimens at hand with the West Indian ones and came to the conclusion that they are identical in all their characteristics.

Numerous specimens occurred in sample 1442, 100 m deep, all of a dark red colour, and all relatively small, not branching as found in the Indonesian Archipelago. One specimen was found in Sta. 1443, and several off St. Croix (800 m).

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