STUDIES ON THE FAUNA OF CURAÇAO AND OTHER CARIBBEAN ISLANDS: No. 83

FORAMINIFERA FROM THE TIDAL ZONE IN THE NETHERLANDS ANTILLES AND OTHER WEST INDIAN ISLANDS

by

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('s-Gravenhage)

INTRODUCTION

Through the kindness of Dr. P. WAGENAAR HUMMELINCK the author was enabled to study a number of samples from localities in the tidal zone of several West Indian islands. Previously, by courtesy of Dr. T. MORTENSEN, abundant material from some deep-water samples collected off Santa Cruz, Virgin Islands, could be studied, the foraminifera dentata of which were described in 1956. The latter material mainly consisted of dredged samples from a depth of 500 fathoms (17.5°N and 64°W), and contained a typical deep-sea fauna. Comparison of MORTENSEN's and HUMMELINCK's samples shows marked differences; these may be of importance, as the deep-sea samples and the shallow-water samples are from the same Caribbean area.

	DEEP-SEA (Santa Cruz)	TIDAL ZONE (various islands)
Globigerinidae	very abundant	very rare
Globorotalidae	very abundant	very rare
Lagenidae	very abundant	absent
arenaceous forms	very abundant	only certain species more common
Miliolidae	rare, but for *Pyrgo*	extremely abundant
Peneroplidae	rare, except for *P. orbitolitoides*	very abundant, but no *P. orbitolitoides*
Articulina	abundant	rare

Uvigerinidae	abundant	absent
Bolivinidae	abundant	rare
Cassidulinidae	abundant	absent
Streblus	rare	rare, except for certain species
Elphidiononion	rare	common
Cancris	common	very rare
Rotorbinella	rare	common
Planorbulinae	rare	abundant
Cushmanella	common	absent
Nonionella	common	absent
Höglundina	common	absent
Lamarckina	common	absent
Sphaeroidina	common	absent
Buliminidae	common	absent
Amphistegina	absent	common

The results support the view that abundance of species of Lagenidae, planktonic species and arenaceous forms under normal conditions indicates a deep-water facies; large quantities of Miliolidae, together with *Streblus*, Peneroplidae and *Elphidiononion*, point to shallow (coastal) -water conditions.

A similar distribution was found by the author in many parts of the world (Indo-Pacific, Mediterranean, Iceland, Greenland, North Atlantic); in deeper water the larger Lagenidae appear to be especially numerous. It is believed that the above difference can be found also in geological times, though abundance of planktonic species does not always indicate greater depth: the author knows of localities with shallow, coastal water, where the bottom mud consists of a real globigerina ooze. However, abundance of planktonic Foraminifera, together with abundant larger Lagenidae (*Lenticulina, Robulus, Frondicularia*) and abundant arenaceous forms, points to deeper water; *Streblus* and *Elphidium*, together with abundant Miliolidae, point to shallow water.

In Upper Cretaceous sediments, abundance of planktonic forms together with larger Lagenidae, abundant arenaceous species and *Stensiöina* points to deeper sea; the absence of planktonic forms, and the presence of Peneroplidae and Orbitoididae, or thick-shelled Gavelinellidae and Miliolidae in more tropical seas, point to coastal water. Consequently, it may be concluded that the Maestrichtian Tuff Chalk of South Limburg, in Holland, is a coastal or even tidal zone sediment, whereas the Danske Kalk in Denmark, from the same geological period, is a deeper-sea sediment.

The abundance of Uvigerinidae and Cassidulinidae in Tertiary sediments indicates deeper-sea conditions, whereas in Upper Cretaceous and Lower Tertiary time the abundance of *Rotalia* species (which replace *Streblus* here) is typical of shelf sediments. The genus *Pararotalia*, indicative of shallow water from the Upper Cretaceous onwards, particularly in tropical regions, is, remarkably enough, absent from shallow waters in the present Caribbean; it is abundant in the tropical seas of the Pacific Ocean, the Indian Ocean, on the coasts of Africa, and it was typical of the Middle Tertiary shallow-sea deposits in Middle America.

Miliolidae, except for *Pyrgo*, are mainly restricted to shallow-water conditions, large Lagenidae to deep-water surroundings. In some cases these differences may be caused by temperature; a much more stringent factor may be the presence or absence of photosynthetic symbiotic cells in the protoplasm, or, possibly, also photosynthetic processes in the protoplasm of the Foraminifera themselves, as the author (1930, p. 379–404) believes to have proved for *Quinqueloculina annectens*, from the Bay of Naples, in which the forming of true amylum seems evident. Photosynthetic phenomena may be assumed to be present in the protoplasm of *Streblus* and *Elphidium*. The protoplasm of many deep-sea forms, *Astrorhiza*, *Bathysiphon*, of many Lagenidae, and also of the allied Polymorphinidae never contains symbiotic algae or large quantities of oil or amylum. Yet Pseudomorphinidae may be also abundant in Cretaceous shallower-water deposits; nowadays they are present mainly in the deep sea.

No less remarkable is the horizontal distribution of the Foraminifera in the tidal zone in the West Indian islands. In some localities only one or a very few species are dominant, and it may be taken for granted that in such localities conditions were less favorable for Foraminifera so that only few species were able to endure those conditions; they then propagated in enormous numbers. The author's investigations (1954) in the former Zuiderzee in Holland proved that not only is the low salinity of the water one of these adverse circumstances, but that the variations in summer and winter temperatures also form a barrier for many species. The tidal zones in the Antilles may present a fine object for study in that direction. We would mention here such species as *Clavulina angularis*, found in large quantities in the former Saliña of Oranjestad on Aruba; *Triloculina oblongoides* n.sp., station 1371, Bonaire; *Miliolinella labiosa*, found in many pools; *Trochammina inflata*, only found in the mangrove zone; *Pseudoeponides anderseni*, only abundant in two stations, 1151 and 452; *Rotorbinella* cf. *mira*, only found between the mangroves. The study of these forms may result in a better understanding of the influence of extreme conditions on the occurrence of Foraminifera and the origin of the dominating position of one or a very few species in a biotope (reference may be made to *Orbitolina* from the

Lower Cretaceous; if present, it dominates, often forming the only living species in the "Urgonian" facies).

In another biotope, the larger Peneroplidae may be dominant. These forms are typical of clear, tropical, shallow water; in some localities they form the bulk of the foraminiferal fauna. Scarce specimens of *Globigerina* and *Globorotalia* at some of the beaches must have been washed in, and have not been taken into consideration. It is remarkable that in most of the samples from the Caribbean tidal zone the genera *Streblus* and *Discopulvinulina* are rare or absent, though they are dominant in the biotope of many other coastal waters. The only commoner species is *Streblus tepidus*; and it is remarkable that a closely related form is abundant in the former Zuiderzee in Holland, and another related form is typical of the coastal waters of the Caspian Sea.

Certain species are characteristic of the tidal zones. Some faunae are extremely rich in species of the Peneroplidae, such as *Puteolina adunca, P. discoidea, P. compressa*; in these faunae, Miliolidae are also abundant. In some localities, species of *Quinqueloculina* form the bulk of the material, in other localities *Valvulina oviedoina*. In localities with Rhizophores, *Trochammina inflata* was found together with *Rotorbinella* cf. *mira*. What were the conditions that selected those particular species?

The abundance of the above groups facilitates a detailed study. Further examination may reveal not only many structural peculiarities, but also data on reproduction, ecology and symbiosis, especially if the Foraminifera are studied for some years in such localities, easily accessible as they are. Such data may be of great importance for the knowledge of fossil faunae and the interpretation of their evolution in time. Since many specimens are filled with protoplasma, they obviously live in the tidal zone. They can be studied easily in the laboratory as well as in their normal habitat.

It must be pointed out that collecting Foraminifera was only one of the purposes of obtaining samples; by applying special methods of sampling, many more species would have been found in some of the localities. BERMUDEZ (1935) described 117 species from off Havana. We found 78 species; some rare species have not been mentioned, as they are believed to have been washed in. Certain localities are rich in species, e.g. 1067, 1125A, 1127; others are very poor in Foraminifera, which may be due to the method of sampling – from some places only rest-samples from plants, corals, etc., could be studied. One locality in Bonaire and several in St. Martin yielded a multitude of species. Puteolinae are abundant in some localities but absent in the samples from Curaçao; New Providence, Bimini and Aves would be favorable for studying these interesting forms. *Orbitolites hemprichii* might be studied in some places in Curaçao. It is remarkable that not only the number of species but also the abundance of individuals is much greater in the (northern) Windward Group than in the (southern) Leeward Islands. Species indicated with a thick line in Table 1 are dominant. Their biology might conceivably be studied in situ; very little is known about their propagation cycles, feeding and habitats. It is possible that even in Curaçao, Foraminifera can be studied in certain localities on the coast. The available samples from Curaçao are certainly not representative of the actual foraminiferal fauna of the island.

The miliolids with thick tests or with heavy ribs on the tests are generally found at the open beaches (*Miliola tricarinata, Quinqueloculina cuvieriana, Q. lamarckiana, Q. linneana, Q. bidentata, Triloculina carinata*), whereas those with thin tests are found in the lagoons not exposed to heavy waves (*Q. quadrilateralis, T. rotunda, Miliolinella labiosa, Q. oblonga, T. oblongoides, Pyrgo subsphaerica*).

In localities where larger *Puteolinae* are abundant (*P. angulata, P. compressa, P. discoidea*), *Rotorbinella rosea*, one of the most common species is practically absent. *Valvotextularia candeiana* is generally present in samples with larger *Puteolinae.*

It may be concluded that the common species are: *Orbitolites hemprichii* (in 50% of the localities), *Puteolina angulata* (47%), *Rotorbinella rosea* (43%), *Puteolina protea* (40%), *Dendritina elegans* (39%), *Quinqueloculina quadrilateralis* (35%), *Homotrema rubrum* (34%), *Asterigerina carinata* (31%), *Triloculina rotunda* (31%), *Miliolinella labiosa* (28%), *Quinqueloculina linneana* (28%), *Amphistegina gibbosa* (26%), *Cymbaloporetta squammosa* (26%), *Neoalveolina pulchra* (26%), *Planorbulina acervalis* (25%), *Rotor-*

Table 1. DISTRIBUTION OF SAMPLES O
treated i

LOCALITIES		Aruba					Curaçao								Bonaire														Klein Bonaire			
SPECIES	Sal. Oranjestad	1002	1004	1006	1014	1301	1023A	1036A	1039	1323	1325A	1348	1351	1354	303	1055	1055A	1056A	1057A	1058C	1059A	1059B	1064A	1065	1067	1068a	1071	1378	1049A	1049B	1049C	1371
Trochammina inflata								—																								
Miliola tricarinata																																
Spiroloculina antillarum		—	—							—							—								—							—
Spiroloculina ornata							—			—						—									—							
Quinqueloculina cuvieriana																																
Quinqueloculina lamarckiana		—																							—	—						
Quinqueloculina polygona			—																						—							
Quinqueloculina bidentata		—	—			—		—	—																—							—
Quinqueloculina quadrilateralis				—			—		—	—	—	▬	—			—	—						—	—								—
Quinqueloculina agglutinans								—																								
Quinqueloculina oblonga			—							—		—			—					—		—			—						—	
Triloculina carinata			—	—					—				—							—		—	—		—							
Triloculina rotunda											—		—				—						—	—								—
Triloculina linneiana						—							—			—																
Triloculina oblongoides										—							—						—	—								—
Sigmoilopsis arenata									—																—							
Miliolinella labiosa								—	—						—		—						—	—	—							
Pyrgo subsphaerica			—																													
Cornuspiramia antillarum																		—				—			—							
Articulina mucronata								—																	—							
Articulina sagra								—																								
Articulina paucicostata																																
Puteolina angulata		—		—		—							—					—				—	—		—					—		—
Puteolina compressa						▬																				—						
Puteolina marginalis																																
Puteolina discoidea		—																—							▬					—		—
Puteolina protea		—	—			—							—			—	—	—		—			—		—	—				—		—
Puteolina crassa																																
Orbitolites hemprichii		—		—		—			—	—	—	—	—				—	—				—	—	—	—	—				—		
Neoalveolina pulchra						▬							—												—							
Dendritina elegans	—	—	—	—					—	—			—			—		—					—		—						—	—
Paleopeneroplis inornatus																																
Hauerina ornatissima								—	—																							
Hauerina bradyi	—							—															—									—
Valvulina oviedoiana											—														—							
Clavulina tricarinata				—					—																—							
Clavulina angularis	▬											—												—								
Clavulina nodosaria										▬																						
Valvotextularia candeiana	—	—	—			—														—												
Cibicides lobatulus									—																							
Bolivina rhomboidalis																									—							
Bolivina subexcavata										—							—			—							—			—		—
Bolivina tortuosa																	—															
Bolivina lanceolata									—	—							—															
Spirillina densepunctata								—																								
Neoconorbina orbicularis				—																	—	—			—							—
Discopulvinulina floridana		—																				—			—					—		
Discopulvinulina valvulata																									—							
Cymbaloporetta squammosa		—	—							—						—				—	—	—			—		—		—	—		
Tetromphalus bulloides																																—
Planorbulina acervalis		—							—				—			—									—	—				—	▬	—
Homotrema rubrum		—		—	—	—	—							—						—	—					—	—	—		—		—
Asterigerina carinata		—	—			—												—														
Amphistegina gibbosa			—			▬													▬									—		—		
Streblus catesbyanus								—																								
Streblus parkinsonianus			—		—																											
Streblus tepidus					—																											
Streblus advenus					—												—															
Streblus compactus																																
Pseudoeponides anderseni		—						—																								
Valvulineria candeiana																																
Discorynopsis aguayoi																																
Rotorbinella conica																																
Rotorbinella mira		—		—																			—	—	—							
Rotorbinella cf. *mira*								▬																								
Rotorbinella granulosa		—																												—		
Rotorbinella rosea						—			—				—					—		—	—	—			—	—	—	—				
Elphidiononion poeyanum	—	—	—		—			—																	—					—		—
Elphidiononion incertum			—												—																	
Elphidium discoidale		—																														
Elphidium lanieri																																
Heterostegina antillarum						—																										
Number of species in samples	5	19	15	9	5	13	3	13	13	11	4	4	11	1	3	7	11	8	1	8	4	9	11	7	28	7	4	3	1	12	3	16
	38						38								46																	

— present ▬ dominant

CARIBBEAN SHALLOW WATER FORAMINIFERA

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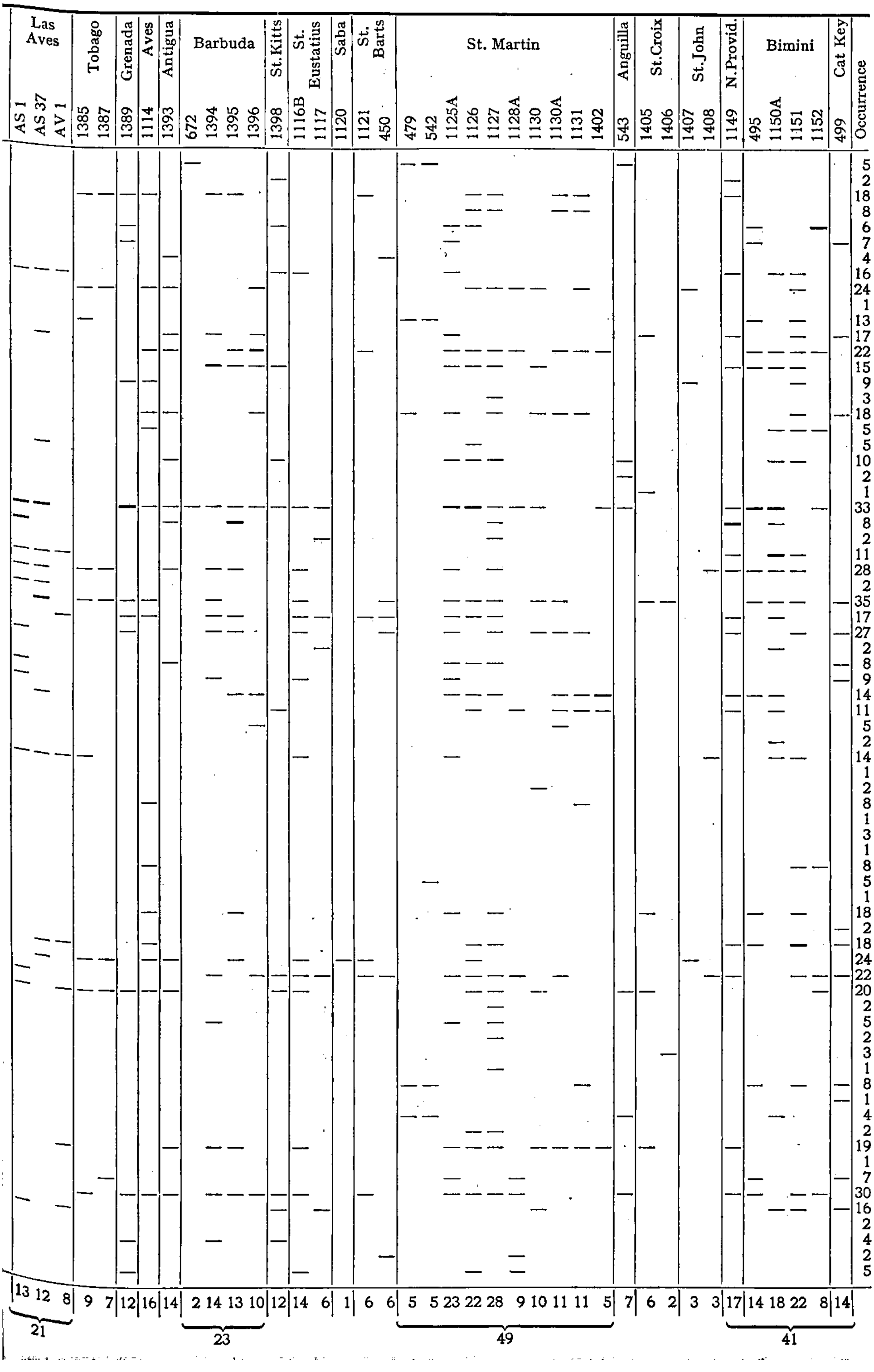


binella mira (25%), *Spiroloculina antillarum* (25%). This assemblage points to reef conditions, and most of the samples were taken in those environments. Similar conditions may have prevailed in the Lutetian (younger Eocene) of the Paris Basin, were miliolids and peneroplids also form the bulk of the material, together with *Asterigerina* and some other rotaliids.

The genus *Streblus* is rare in the tidal samples; only certain smaller forms, together with *Pseudoeponides anderseni*, a closely related form, are more abundant in some localities, which include the swamps with *Rhizophora*.

Thick-shelled *Rotorbinella granulosa*, together with the Miliolidae with thick walls, are restricted to the open beaches; but this species is never common.

Some species are restricted to the (northern) Windward group: *Discorynopsis aquayoi* (frequently found in the mangrove swamps), *Rotorbinella conica*, *Streblus compactus*, *Articulina paucicostata*, *Triloculina linneana*.

The material and the types of new species are stored in the collections of the Netherlands Geological Survey, Haarlem.

DESCRIPTION OF LOCALITIES [Map, see p. 115]

Actual intertidal zone, usually about 30 cm. – "Lower zone" reaching from low water level to approximately 1½ m below. – All rock consists of limestone, unless otherwise stated.
Station number. Locality, date. – Type of bottom and vegetation; level.

Aruba

1002 Punta Braboe, W of Oranjestad, 3.1.1949. – Exposed rock with few algae, sand; tidal and lower zone. (Greatly disturbed by dredging work, recently.)
1004 Lagoen Boekoeti (Lagoon Bucuti), E of Oranjestad, 29.12.1948. – Rocky shore of muddy lagoon with *Thalassia*, sandy mud; tidal and lower zone.
1006 Boekoeti (Bucuti), S of Oranjestad, 25.6.1930. – Reef debris with muddy sand, some *Thalassia*; tidal zone, with small pools.
1014 Salinja Master, W of Savaneta, 2.1.1949. – Abandoned salt pan on sandy shore, 50 × 35 × ⅔ m; muddy, 24 mg Cl'/l.
1301 Malmok, NW coast at Arasji, 14.8.1955. – Rocky beach, with sand and boulders of non-calcareous rock, with *Porites* and *Thalassia*; tidal and lower zone as deep as 1 m.
s.n. Salinja Oranjestad, 18.6.1930. – Abandoned salt pan on sandy shore; muddy, and very shallow.

Curaçao

1023A Plaja Hoeloe (Hulu), S of St. Kruis Baai, 19.3.1949. – Rocky shore with sand; tidal zone.

1036A Spaanse Water, New Haven, 10.4.1949. – Very muddy lagoon, on *Rhizophora*; tidal and lower zone.

1039 Fuik Baai, SE of Newport Bath, 20.11.1948. – Rocky shore of muddy lagoon with some *Thalassia*; tidal and lower zone.

1325A Sint Jan, lagoon, E. part, 6.3.1955. – Corner of narrow lagoon, far from entrance, sandy mud with much *Halimeda* and *Zoanthus*, about 1 m deep.

1348 Fuik Baai, pool in coral shingle wall, 11.1.1955 (J. S. Zaneveld). – Pool, 20 × 7 × ½ m in porous wall, *Caulerpa racemosa* dominating.

1351 Awa Blanco, W. side, 25.1.1955 (J. S. Zaneveld). – Muddy sand and rock debris in shallow lagoon, much *Acetabulum* and *Penicillus*; tidal and lower zone as deep as 1 m.

1354 St. Joris Baai, N. side of entrance, 20.2.1955. – Rocky cliff with debris, scanty *Thalassia*; tidal and lower zone.

1323 Santa Marta Baai, lagoon behind coral shingle wall, 25.2.1955. – Rather isolated pool, 200 × 30 × 1¼ m, sandy mud with much *Thalassia*, abundant *Cassiopea*.

Bonaire

303 Salinja di Lac, NE of Cay, 25.2.1949. – Sandy mud on shore of abandoned salt pan (1094; 53 mg Cl′/l).

1055 Paloe Lechi (= Playa Lechi), overflow of Salinja, 4.9.1948. – Rocky beach with coral debris and muddy sand; low-tide and lower zone.

1055A Paloe Lechi, overflow of Salinja, 22.8.1930. – Muddy pool, 4 × 3 × ¾ m, in porous wall of coral shingle.

1056A Paloe Lechi, 4.9.1948. – Beach rock; mid-tide zone.

1057A Kralendijk, 20.9.1948. – Beach rock; high-tide zone.

1058C De Hoop, S of Kralendijk, 10.9.1948. – Sandy reef; 1–3 m deep.

1059A Punt Vierkant, 9.9.1948. – Rocky shore with debris, *Turbinaria* and *Sargassum*; mid- and low-tide zone.

1059B Punt Vierkant, 9.9.1948. – Sandy reef; 1–2 m deep.

1064A Lac, Poejito, 12.10.1930. – Muddy *Rhizophora* lagoon with *Thalassia*; lower zone.

1065 Lac, entrance to Poejito, 17.9.1948. – Mudflat with *Halimeda* and *Thalassia*; lower zone.

1067 Lac, E. point of Cay, 17.9.1948. – Sandflat with *Thalassia*; 1½–2 m deep.

1068a Lac, Boca, behind reef, 1.10.1948. – Sandy reef with debris, continuous wave action; 1–2 m deep.

1071 Boca Onima, 19.9.1948. – Rocky shore in surf; tidal zone.

1378 Boca Spelonk, 14.4.1955 (J. S. Zaneveld). – Rocky shore in surf; tidal zone.

Klein Bonaire

1049A East coast near landing, 13.9.1948. – Sandy beach with some rock debris; tidal zone.

1049B East coast at landing, 13.9.1948. – Reef debris on sandy beach; tidal and lower zone.

1049C East coast near landing, 13.9.1948. – Sandy reef; 1–3 m deep.

1371 Northeast coast, 13.4.1955. – Shallow limestone flat, with rock pools and fissures filled with sand; tidal zone, and somewhat below.

Aves de Sotavento

AS 1 Lagoon near Ave de Sotavento, 19.5.1956 (P. H. de Buisonjé). – Sandy bottom, about 7 m deep.

AS 37 Between Ave the Sotavento and Devils Key, 21.5.1956 (P. H. de Buisonjé). – About 4 m deep.

Aves de Barlovento

AV 1 Southeastern entrance of lagoon, 18.5.1956 (P. H. de Buisonjé). – About 22 m deep.

Tobago

1385 Buccoo Bay, 16.1.1955. – Sandy bottom with *Acropora cervicornis*, *Halimeda*; 2 m deep.

1387 Buccoo Reef, 16.1.1955. – Reef flat with sandy coral debris; high tide zone with small pools.

Grenada

1389 White Bay, Point Salines, 26.1.1955. – Beach rock in surf; tidal zone.

Islote Aves

1114 Northern lagoon, 12.5.1949. – Sandy shore with some coral debris and beach rock; tidal zone.

Antigua

1393 Deep Bay, 17.7.1955. – Rocky non-calcareous shore with sandy spots; tidal zone.

Barbuda

672 Bryant's Cave pool, 6.7.1955. – Muddy pool in sink hole; ¼ m deep, mg Cl′/l.

1394 Martello Tower beach, 8.7.1955. – Vast sand beach; 1–2 m deep, in surf.

1395 Two Feet Bay, 10.7.1955. – Surf-swept limestone shore with small sandy pools; tidal zone.

1396 Great Lagoon, S of Codrington Village, 4.7.1955. – Muddy sand with *Bathophora* and *Thalassia*, near *Rhizophora*; about ½ m deep.

St. Kitts

1398 West of Basseterre, 30.6.1955. – Sandy, non-calcareous rock debris; tidal and lower zone, in surf.

St. Eustatius

1116B Gallows Bay, 15.7.1949. – Andesite rock; 1–2 m deep.

1117 Downtown, Billy Gut, 13.7.1949. – Sandy shore, andesite rock; tidal zone, in surf.

Saba

1120 Fort Bay, 21.7.1949. – Andesite rock; tidal zone, in surf.

St. Barts

450 Eastern corner of Gustavia Harbour, 1.6.1949. – Sandy dioritic rock debris, at water line.

1121 South of Public, near Gustavia, 4.6.1949. – Rocky shore, andesite debris with sand; tidal zone, in surf.

St. Martin

479 Great Key, in Simson Bay Lagoon, 2.8.1949. – Sandy shore of small island in large lagoon.

542 Devil's Hole Swamp, near Simson Bay, 4.8.1949. – Pool (25 × 15 × 1) with *Batophora* and *Avicennia* in sink hole, near sea shore; 13800 mg Cl′/l.

1125A Great Bay, Point Blanche Bay, 26.6.1949. – Rocky shore with some sand; low-tide and lower zone, in surf.

1126 Great Bay, E. shore, 11.6.1949. – Rocky beach, few *Thalassia*; tidal zone.

1127 Great Bay, NE. shore, 16.5.1949. – Rocky beach with muddy sand, *Thalassia*; low-tide and lower zone.

1128A Great Bay, NE. shore, 26.5.1949. – Sand beach near wooden wreck; tidal and lower zone.

1130 Simson Bay Lagoon outlet, 27.5.1949. – Sandy lagoon with *Rhizophora* and *Thalassia*; lower zone.

1130A Simson Bay Lagoon near former outlet, 6.6.1955. – Muddy pool with *Bathophora* near *Rhizophora*, salting up after enclosure of the lagoon; about ½ m.

1131 Simson Bay Lagoon, Little Key, 2.8.1949. – Muddy sand with *Rhizophora*, *Thalassia* and *Bathophora*.

1402 Simson Bay Lagoon near Flamingo Pond, 27.6.1955. – Sandy shore of large lagoon, salting up after enclosure; 28,360 mg Cl′/l.

Anguilla

543 Forest Point Saltwell, 18.VI.1949. – Narrowly excavated well in limestone rock, not far from sea shore, 3½ m below surface, water 1 × 1 × ½ m, with some clayish mud; 4,070 mg Cl′/l.

St. Croix

1405 Krausse Lagoon, entrance, 15.6.1955. – Outlet of large lagoon with *Rhizophora* and *Cymodocea*, sandy bottom; 1 m deep.

1406 Krausse Lagoon, basin, 15.6.1955. – Shallow part of muddy *Rhizophora* lagoon, with *Batophora* and eelgrass; about ½ m deep.

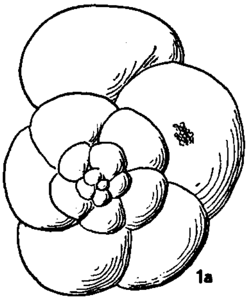
St. John

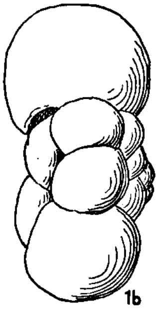
1407 Turner Bay, 18.6.1955. – Among boulders of non-calcareous rock; tidal zone, in surf.

1408 Bay S of Cruz Bay, 19.6.1955. – Sandy non-calcareous rock debris; tidal zone.

New Providence

1149 Between Hog Island and Athol Island, 16.8.1949. – Sand with *Thalassia*; 2–3 m.


1a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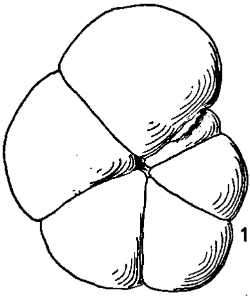
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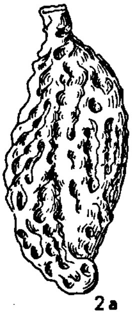
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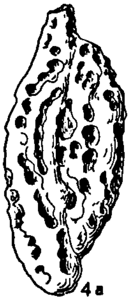
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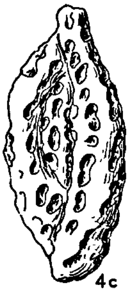
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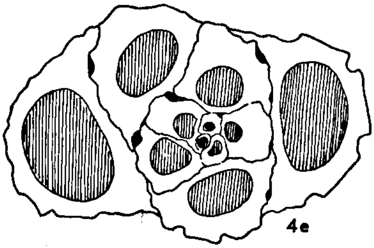
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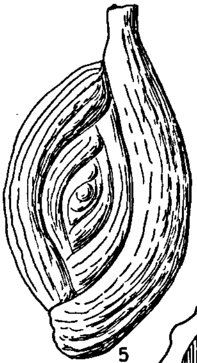
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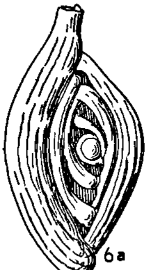
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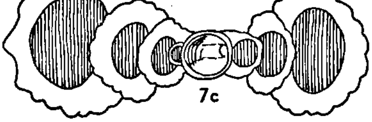
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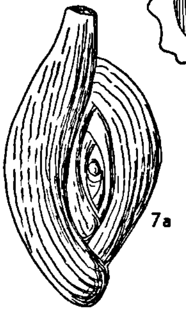
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South Bimini

1150A	Northern lagoon, 17.8.1949. – Sandy mud with *Thalassia*, near *Rhizophora*; low-tide and lower zone.

North Bimini

495	Shore of lagoon near Alice Town, 20.8.1949.– Sand among decaying *Thalassia*.
1151	Laboratory Dock, 20.8.1949. – Sandy mud with *Thalassia*; about 1 m deep.
1152	Entrance Point, W. shore, 18.8.1949. – Rocky beach with sand; tidal zone with rock pools.

Cat Key

499	Near landing, 21.8.1949. – Among sandy debris.

SYSTEMATICS

In order to help later students of Caribbean Foraminifera to identify the species dealt with in this paper, a short description is given of the most typical characteristics concerned. Furthermore, figures of all species are given, in many cases together with a transverse section.

Genera and families have been discussed only if new data are available.

Trochammina inflata (Montagu) Fig. 1

Nautilus inflatus Montagu, 1808, p. 81, pl. 18 fig. 3.
Rotalina inflata (Montagu) Williamson, 1858, p. 50, pl. 4 fig. 93–94.
Trochammina inflata (Montagu) Carpenter, Parker & Jones, 1862, p. 141, pl. 11 fig. 5.

Fig. 1. *Trochammina inflata* (Montagu). — Anguilla, sta. 543: dorsal side, apertural face, and ventral side of same specimen (× 55).

Fig. 2–4. *Miliola tricarinata* (d'Orbigny). — 2–3, New Providence, sta. 1149 : 2, broad sides, narrow side, and apertural face of same specimen; 3, same views of small specimen. — 4, St. Kitts, sta. 1398: broad sides, narrow side, apertural face, and transverse section (2–4d × 13; 4e × 55).

Fig. 5–7. *Spiroloculina antillarum* d'Orbigny. — 5, Cuba, beach near Habana, Bermudez coll. — 6, Aruba, sta. 1002: side view and apertural face of same specimen. — 7, Bonaire, sta. 1067: broad side, apertural face and transverse section of same specimen (5–7b × 55; 7c × 160).

Test trochoid, low-spired, with about three whorls of inflated, nearly globular chambers, about 5–6 in the last whorl. At the dorsal side the depressed sutures are strongly curved backward, at the ventral side they are nearly radial and straight. On the ventral side is a distinct but narrow umbilical cavity. First chambers at the dorsal side distinct, often dark-coloured, later chambers brownish to yellowish. Agglutination generally very fine, outer wall smooth and often shiny. Aperture a narrow slit at the ventral suture of the last-formed chamber, with a narrow lip.

The species is common in a few samples from brackish-water pools and mangrove lagoons.

CURAÇAO: Spaanse Water, sta. 1036A. BARBUDA: Bryant's Cave pool, 672. ST. MARTIN: Simson Bay Lagoon, 479; Devil's Hole Swamp, 542; ANGUILLA: Forest Point Saltwell, 543.

MILIOLIDAE

Some genera in this group are characterized by chamber walls totally enclosing all chambers, so that the inner wall of each chamber is not formed by the outer wall of one of the former chambers, but by its own wall. The group is particularly abundant in the Lower Cretaceous and Eocene; many species have a porous plate over the tooth at the aperture (trematophore). This cribate aperture is also found in *Hauerina* and *Nevillina*, and is generally present in *Miliola*. Moreover, in *Miliola* the wall is ornamented with shallow or more distinct rows of pits. *Lacazina* also belongs to this group.

It is obvious that the structural differences between *Miliola* and *Quinqueloculina* can be observed in transverse sections only; a section was made from all species collected. This resulted in the discovery of a true *Miliola* existing in the Caribbean Sea, *Miliola tricarinata* (d'Orbigny). In transverse section it shows distinct tubiform chambers; the walls have the distinct pitting already mentioned and figured by d'ORBIGNY (1840).

Miliola tricarinata (d'Orbigny) Figs. 2–4

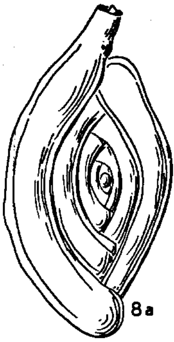
Quinqueloculina tricarinata D'ORBIGNY, 1839, Cuba p. 187, pl. 11 fig. 7–9, 11; CUSHMAN, 1921, p. 68, pl. 16 fig. 11–12.
Miliolina kerimbatica HERON-ALLEN & EARLAND, 1915, p. 574, pl. 43 fig. 13–23.

Test elongate, compressed. Chamber walls irregularly mottled and pitted. Aperture rounded, with a simple tooth, at the end of an elongation of the last-formed chamber. – Length up to 2.5 mm, breadth 1.2 mm; thickness 0.75 mm. – A transverse section reveals a *Miliola* structure, with tube-like chambers, the walls also forming the inner wall of each chamber. Moreover, the pits in earlier chambers are not filled up by the walls of later ones, so that hollows are found between the adjacent chamber walls. The arrangement of the chambers is *quinqueloculine*, as in *Miliola.*

Some specimens are from St. Kitts, Basseterre; Dr. BERMUDEZ forwarded some fine large ones from off Habana, Cuba. As CUSHMAN (1921) stated, this description is an example of d'ORBIGNY's accuracy, since later authors considered some figured specimens to be aberrant (strongly pitted wall).

D'ORBIGNY's species is identical with HERON-ALLEN & EARLAND's species *Q. kerimbatica*; consequently, the latter is a synonym. *Miliolina kerimbatica* Heron-Allen & Earland was analysed by KEYZER (1925 p. 113–116, fig. 15), who also observed that the chamber walls entirely surround each chamber. The same applies to his *Quinqueloculina "seminulum"* (which cannot be the species described by BORNEMANN) and *Triloculina fichteliana* d'Orbigny. All these species have a world-wide distribution, which may prove that they had a long geological range and are primitive species. The presence of totally enveloping chamber walls in miliolids is a primitive feature; it may be that Pacific species particularly show this structure (in the Pacific many "living fossils" are found). In the Caribbean, only *M. tricarinata* d'Orbigny has such a structure.

"Triloculina" kerimbatica (Heron-Allen & Earland) is mentioned by GRAHAM & MILITANTE (1959, p. 55, pl. 8 fig. 1–6) from the Philippines.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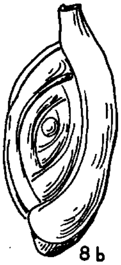
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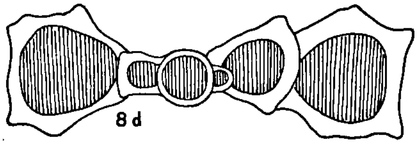
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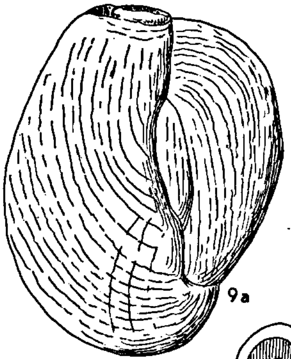
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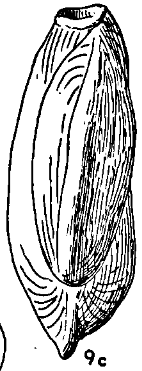
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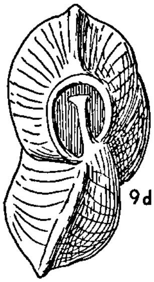
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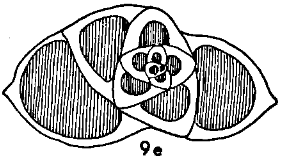
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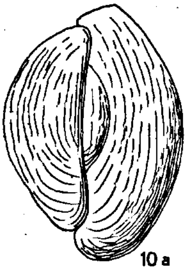
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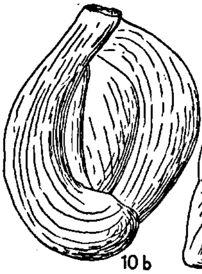
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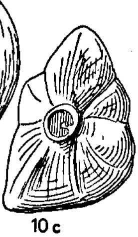
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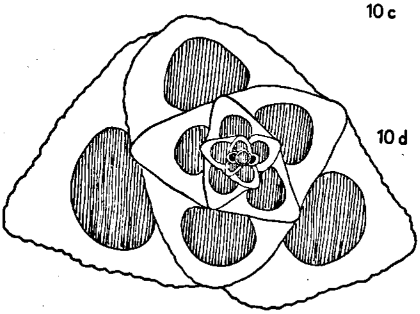
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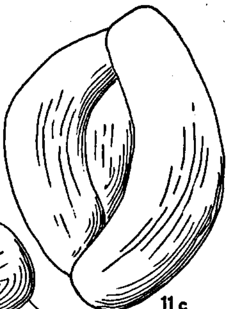
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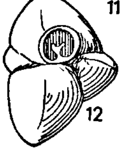
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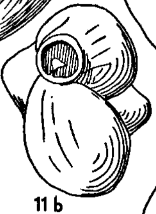
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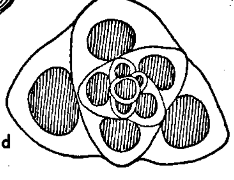
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St. Kitts: Basseterre, sta. 1398. New Providence: between Hog I. and Athol I., 1149.

Spiroloculina antillarum d'Orbigny Figs. 5–7

Spiroloculina antillarum d'Orbigny, 1839, Cuba p. 166, pl. 9 fig. 3–4; Cushman, 1922, p. 63, pl. 44 fig. 14–15; Cushman & Todd, 1944, p. 44, pl. 6 fig. 28–32 (here all literature).

This species is characterized by its elongate form, with long apertural neck, the slightly overlapping chambers, which are broader than in many other species, and the distinct elongate furrows in the test wall (these are not real costae; in transverse section, the furrows have rounded elevations between them). The aperture is round and shows a slightly bifurcate tooth. – Length 0.60–1.10 mm; breadth 0.40–0.60 mm; thickness of the last-formed chamber (in the inner part the test is much thinner) 0.15 mm.

This is one of the common Antillean species. Specimens from off Habana were received from Bermudez.

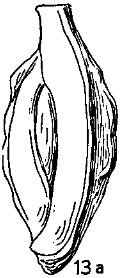
In some, otherwise characteristic specimens, distinct openings in the test are found near the central axis. The species generally has a very large proloculus in the A-form.

Aruba: Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004. Curaçao: Santa Marta Baai, lagoon, 1323. Bonaire: Playa Lechi, 1055A; Cay, Lac, 1067. Klein Bonaire: 1371. Tobago: Buccoo Bay, 1385; Buccoo Reef, 1387. Grenada: White Bay, 1389. Islote Aves: 1114. Barbuda: Martello Tower beach, 1394; Two Feet Bay, 1395. St. Barts: Public, 1121. St. Martin: Great Bay, 1126, 1127; Simson Bay Lagoon, 1130A, 1131. New Providence: between Hog I. and Athol I., 1149.

Fig. 8. *Spiroloculina ornata* d'Orbigny. — a, Cuba, beach near Habana, Bermudez coll. — b–d, Bonaire, sta. 1067: broad side, apertural face, and transverse section of same specimen (a–c × 55; d × 210).

Fig. 9. *Quinqueloculina cuvieriana* d'Orbigny. — St. Kitts, sta. 1398: broad side, aperture, narrow side, apertural face, and transverse section (× 27).

Fig. 10–12. *Quinqueloculina lamarckiana* d'Orbigny. — 10, Aruba, sta. 1002: broad sides, apertural face and transverse section of same specimen, probably B–form. — 11–12, Cat Key, near Bimini, Bahamas, sta. 499: 11, broad sides, apertural face and transverse section of same specimen, megalospheric form; 12, apertural face (10a–c, 11–12 × 55; 10d × 160).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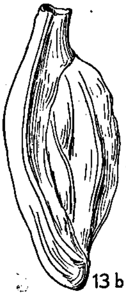
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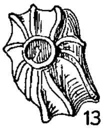
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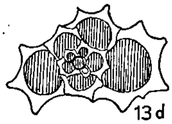
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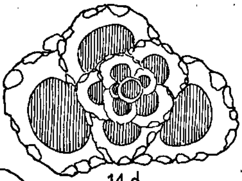
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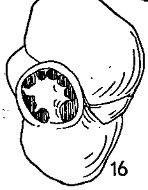
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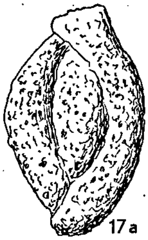
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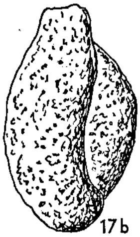
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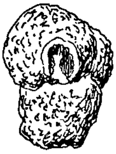
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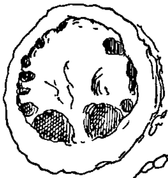
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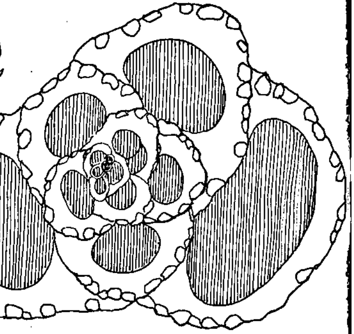
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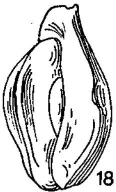
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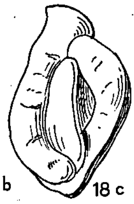
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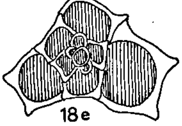
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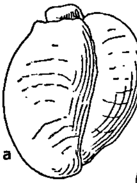
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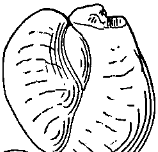
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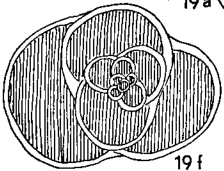
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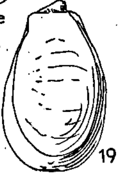
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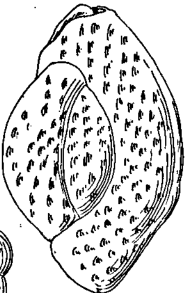
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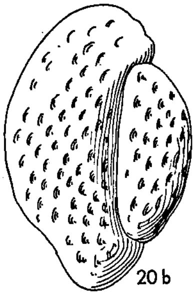
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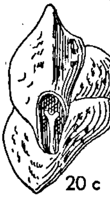
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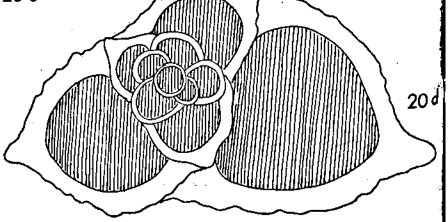

20 d

Spiroloculina ornata d'Orbigny Fig. 8

Spiroloculina ornata D'ORBIGNY, 1839, Cuba p. 137, pl. 12 fig. 7; CUSHMAN & TODD, 1944, p. 45, pl. 6 fig. 33, 44.

Test elongate, with long apertural neck. At the broad side each chamber shows, at least at its outer margin, a distinct rib, and in apertural view there are two of these ribs at the margin, whereas the marginal wall forms a right angle with the broad side. The aperture is round, and has a simple tooth. The transverse section shows that the chambers are not overlapping each other; each chamber ends at the rib of the former chamber. – Length about 0.65 mm, breadth 0.30 mm; thickness of last-formed chamber 0.08 mm.

The species is less common than *S. antillarum*.

CURAÇAO: Playa Hoeloe, sta. 1023A; Santa Marta Baai, lagoon, 1323. BONAIRE: Playa Lechi, 1055; Cay, Lac, 1067. ST. MARTIN: Great Bay, 1126, 1127; Simson Bay, 1130A, 1131.

Quinqueloculina cuvieriana d'Orbigny Fig. 9

Quinqueloculina cuvieriana D'ORBIGNY, Cuba 1839, p. 190, pl. 11 fig. 19–21.

Test much compressed, relatively large, with an acute periphery; chambers on one side strongly overlapping. Somewhat elongate oval aperture with a tooth broadening at the end; wall mostly lustrous,

Fig. 13. *Quinqueloculina polygona* d'Orbigny. — Bonaire, sta. 1067: side views, apertural face and transverse section of same specimen (×27).

Fig. 14–17. *Quinqueloculina bidentata* d'Orbigny. — 14–16, St. Eustatius, sta. 1116B: 14, side views, apertural face and transverse section of megalospheric specimen; 15–16, apertural faces of different microspheric specimens. — 17, Aves de Sotavento, sta. AS37: side views, apertural faces, and transverse section (14a–c, 15–17c ×13; 14d, 17d–e ×55).

Fig. 18. *Quinqueloculina quadrilateralis* d'Orbigny. — Curaçao, sta. 1348: side view, narrow side, broad side, apertural face, and section of same specimen (×27).

Fig. 19. *Triloculina rotunda* d'Orbigny. — North Bimini, Bahamas, sta. 1151: side views, apertural face, narrow side of same specimen; e, another aperture, and, f, transverse section (a–e ×27, f ×55).

Fig. 20. *Triloculina carinata* d'Orbigny. — Antigua, sta. 1393: side views, apertural face, and transverse section (a–c ×55; d ×125).

and with more or less distinct longitudinal furrows. The transverse section reveals that each chamber on one side is attached to the marginal keel of an earlier chamber, and on its other side is covering part of an earlier chamber. – Length up to 2 mm, or more; breadth 1.2 mm; thickness 0.7 mm.

The species is common in samples with large *Puteolina*.

GRENADA: White Bay, sta. 1389. ST. KITTS: Basseterre, 1398. ST. MARTIN: Great Bay, 1125A, 1126. NORTH BIMINI: 495, 1152.

Quinqueloculina lamarckiana d'Orbigny Figs. 10–12

Quinqueloculina lamarckiana D'ORBIGNY, 1839, Cuba p. 189, pl. 11 fig. 14–15.

This species differs from *Q. cuvieriana*; it has a more rounded margin and is less compressed. The walls are much thicker in transverse section. Longitudinal striae are not distinct. Each chamber is slightly broader on one side. The aperture is rounded, and has a slightly bifid tooth. – Length 0.70 mm; breadth 0.50 mm; thickness 0.30 mm.

In the B-form the longitudinal striae are more distinct than in the A-form.

ARUBA: Punta Braboe, sta. 1002. BONAIRE: Cay, Lac, 1067; Boca, Lac, 1068a. GRENADA: White Bay, 1389. ST. MARTIN: Great Bay, 1125A. NORTH BIMINI: 495. CAT KEY: 499.

Quinqueloculina polygona d'Orbigny Fig. 13

Quinqueloculina polygona D'ORBIGNY, 1839, Cuba p. 98, pl. 12 fig. 21–23.

Test strongly elongate with long apertural neck; the last-formed chamber at the aboral end is protruding. Several distinct costae give a polygonal shape to the chambers. In transverse section may be observed that each chamber is attached to the costae of a previous chamber. Walls relatively thin. – Length 1.25 mm; breadth 0.6 mm; thickness 0.25 mm.

ARUBA: Lagoen Boekoeti, sta. 1004. BONAIRE: Cay, Lac, 1067. ANTIGUA: Deep Bay, 1393. ST. BARTS: Gustavia, 450.

Quinqueloculina bidentata d'Orbigny Figs. 14–17

Quinqueloculina bidentata D'ORBIGNY, 1839, Cuba p. 197, pl. 12 fig. 18–20.

Test oval, with elongate chambers; in adult specimens the rough surface causes the quinqueloculine structure of the test to be indistinct; in most specimens only three chambers are visible from the outside. The true quinqueloculine structure appears in transverse sections.

As in *Q. annectens* (Schlumberger) from the Mediterranean (HOFKER, 1930, Neapel p. 387, fig. 8), the agglutination is restricted to the surface, and sand (chalk) grains are imbedded in the chalk substance of the test. As can be seen in transverse section, the inner wall of each chamber is formed by the outer wall of one of the earlier chambers, which is indicative of a true *Quinqueloculina.* A similar agglutination is found in many species from the Lower Cretaceous, but their walls are as in *Miliola.* The megalospheric specimens are much smaller than the microspheric; length of megalospheric specimens about 1.2 mm; length of microspheric specimens about 2.5 mm. The transverse section is somewhat triangular and has rounded angles. The walls are thick, especially in the microspheric form. The aperture is rounded to slightly elongate, and may possess a bifurcate tooth which, however, in many cases is transformed into a dentate plate, the dents of which fuse with the inner wall, leaving free only a series of irregular openings. – This feature, which is found in the microspheric form especially, appears to be also present in *Quinqueloculina curta* Cushman. On the basis of the peculiar tooth, CUSHMAN & LEROY (1939, p. 15–19, pl. 3–4) established a new genus, *Cribrolinoides. Quinqueloculina bidentata* could be placed in that genus also. The necessity of establishing this new genus is not recognized; all intermediate forms between simple and complicated tooth are found in *Q. curta* and *Q. bidentata.*

CUSHMAN (1921) mentions the species from the tidal zone of Runaway Bay, Jamaica. In the examined material it is abundant, together with large Puteolinae, in shallow water samples.

ARUBA: Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Malmok, 1301. CURAÇAO: Spaanse Water, 1036A; Fuik Baai, 1039. BONAIRE: Cay, Lac, 1067. KLEIN BONAIRE: 1371. AVES DE SOTAVENTO: AS 1; AS 37. AVES DE BARLOVENTO: AV 1. ST. KITTS: Basseterre, 1398. ST. MARTIN: Great Bay, 1125A.

St. Eustatius: Gallows Bay, 1116B. New Providence: between Hog I. and Athol I., 1149. South Bimini: 1150A. North. Bimini: 1151.

Quinqueloculina quadrilateralis (d'Orbigny) Fig. 18

Triloculina quadrilateralis d'Orbigny, 1839, Cuba p. 173, pl. 9 fig. 14–16.

Test oval, each chamber at the margin strongly inflated, with two distinct costae. Each chamber is square in transverse section. As the walls of each chamber are attached to the costae of earlier chambers, the sutures of two of the outer chambers cannot be observed and they cannot be distinguished from the costae; as a result, the outside of the specimen seems to be triloculine. The transverse section, however, reveals the structure to be quinqueloculine throughout. – Length about 0.8–1.0 mm; breadth 0.75 mm; thickness 0.35 mm.

This species is generally common in many samples.

Aruba: Boekoeti, sta. 1006. Curaçao: Plaja Hoeloe, 1023A; Spaanse Water, Fuik Baai, 1039; Santa Marta Baai, lagoon, 1323; St. Jan, 1325A; Fuik Baai pool, 1348; Awa Blanco, 1351. Bonaire: Playa Lechi, 1055, 1055A; Lac, Poejito, 1064A, 1065. Klein Bonaire: 1371. Tobago: Buccoo Bay, 1385; Buccoo Reef, 1387. Islote Aves: 1114. Antigua: Deep Bay, 1393. Barbuda: Great Lagoon, 1396. St. Martin: Great Bay, 1126, 1127, 1128A; Simson Bay Lagoon, 1130, 1131. St. John, Turner Bay, 1407. North Bimini, 1151.

Quinqueloculina agglutinans d'Orbigny Figs. 27–30

Quinqueloculina agglutinans d'Orbigny, 1839, p. 195, pl. 12 fig. 11–13; Cushman, 1921, p. 65, pl. 15 fig. 9–10.

The species differs from *Q. bidentata* in the more rounded form, the darker agglutination, the typically smooth border of the aperture, and in specimens from deeper water in the peculiar crenulation of the inner border of the aperture, as figured by d'Orbigny. In shallow water forms the walls are very thin and fragile, particularly when dry. Sections show the walls to consist of two parts, an outer agglutinated part and an inner hyaline part. This is found also in *Q. bidentata*, where the agglutination consists of a single outer layer of sand grains, whereas in *Q. agglutinans* more layers are present.

Both species seem to be closely related; in *Q. bidentata* the outer wall in most specimens consists of chalk grains, whereas in *Q. agglutinans* it mainly consists of quarz grains.

CARMAN (1933, p. 31) described a species from the Bermudas, with all characteristics of *Q. agglutinans*, as *Dentostomina bermudiana*. Other features point to a close relationship with *Q. bidentata*. *Dentostomina*, therefore, may be considered as a younger synonym of *Quinqueloculina*.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A.

Quinqueloculina oblonga (Montagu) Figs. 31–32

Vermiculum oblongum MONTAGU, 1803, p. 522, pl. 14 fig. 9.
Triloculina oblonga (Montagu) D'ORBIGNY, 1826, p. 300, no. 16; 1840, p. 175, pl. 10 fig. 3–5; CUSHMAN, 1921, p. 69, pl. 17 fig. 5–6.

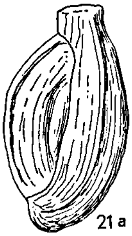
Test elongate, the last-formed chamber slightly protruding at both ends; the aperture without a neck. The tooth is single, in some cases with slight traces of bifurcation; the aperture may be contorted and is broader than it is high. – A transverse section shows that actually the test is not triloculine but quinqueloculine. The walls are extremely thin and later walls are smoothly covering earlier ones, causing the sutures to be nearly invisible; this gives the impression of a "triloculine" arrangement.

ARUBA: Lagoen Boekoeti, sta. 1004. CURAÇAO: Santa Marta Baai, lagoon, 1323; Fuik Baai, 1348. BONAIRE: Salinja di Lac, 303; De Hoop, 1058C; Punt Vierkant, 1059B; Lac, Cay, 1067. KLEIN BONAIRE: 1049C. TOBAGO: Buccoo Bay, 1385. ST. MARTIN: Devil's Hole Swamp, 542; Simson Bay Lagoon, 479. NORTH BIMINI: 495, 1151.

Triloculina carinata d'Orbigny Fig. 20

Triloculina carinata D'ORBIGNY, 1839, Cuba p. 179, pl. 10 fig. 15–17.

The stout test is characterized by more or less distinct pits arranged in a lozenge-shaped pattern. The later chambers have a distinct and blunt marginal keel. As the chambers are attached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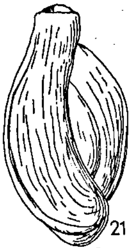
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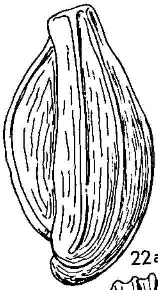
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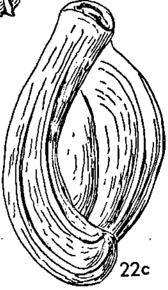
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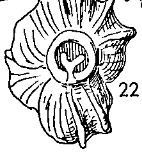
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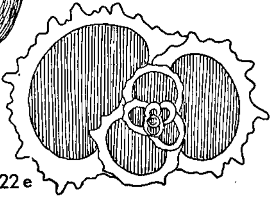
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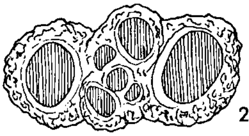
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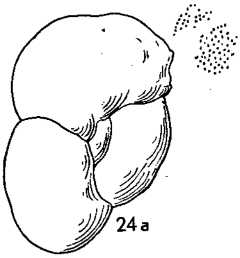
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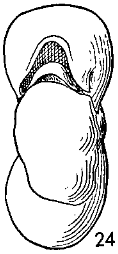
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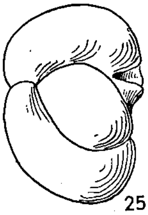
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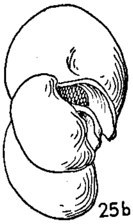
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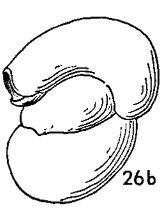
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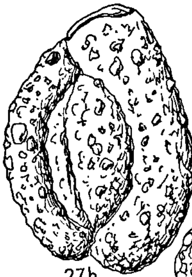
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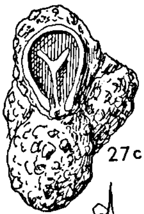
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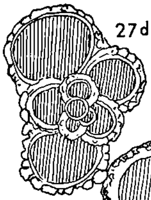
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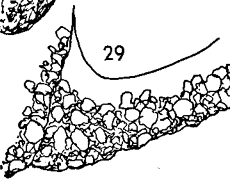
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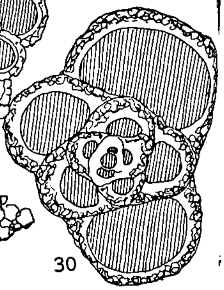
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with their walls to the keels of earlier chambers, only the keels of the last two chambers are visible. This structure also causes the trilocular arrangement of the last-formed chambers, as the quinqueloculine inner part, even in megalospheric specimens, does not have a keel. The aperture is narrow, elongate, with a long bifurcate tooth.

ARUBA: Lagoen Boekoeti, sta. 1004; Boekoeti, 1006. CURAÇAO: Fuik Baai, 1039; Awa Blanco, 1351. BONAIRE: De Hoop, 1058C; Punt Vierkant, 1059B; Lac, Poejito, 1064A; Lac, Cay, 1067. AVES DE SOTAVENTO: AS 37. ANTIGUA: Deep Bay, 1393. BARBUDA: Martello Tower beach, 1394; Great Lagoon, 1396. ST. MARTIN: Great Bay, 1125A. ST. CROIX: Krausse Lagoon, 1405. NEW PROVIDENCE: between Hog I. and Athol I., 1149. NORTH BIMINI: 1151. CAT KEY: 499.

Triloculina rotunda d'Orbigny Fig. 19

Triloculina rotunda D'ORBIGNY, 1826, p. 299, No. 4; CUSHMAN, 1929, p. 59, pl. 14 fig. 3.

Test slightly elongate to round; margin strongly rounded; mostly faint transverse striae on the outer wall. Aperture round, not protruding, with a bifurcate tooth. Surface lustrous. In transverse section the walls appear to be extremely thin, the chambers strongly inflated and overlapping; after a single quinqueloculine stage the other chambers have a triloculine arrangement. – Length about 0.8 mm; breadth 0.70 mm; tickness 0.50 mm.

Fig. 21–22. *Triloculina linneiana* d'Orbigny. — 21, St. Martin, sta. 1125A: side views, and apertural face of same specimen. — 22, Barbuda, sta. 1395: side views, narrow side, apertural face, and transverse section of same specimen (21–22d ×27, 22e ×55).

Fig. 23. *Sigmoilopsis arenata* (Cushman). — Bonaire, sta. 1067: broad sides, narrow side, and apertural face of same specimen; e, transverse section (a–d ×27; e ×55).

Fig. 24–26. *Miliolinella labiosa* (d'Orbigny). — St. Martin, sta. 1131: 24, side view with the pits of the surface above, and narrow side of same specimen; 25, broad side and narrow side of same specimen; 26, narrow side and broad side of another specimen (×55).

Fig. 27–30. *Quinqueloculina agglutinans* d'Orbigny. — 27, Curaçao, sta. 1036A: broad sides, and apertural face of same specimen; d, transverse section. — 28–30, St. Croix, 500 m depth off Frederiksted, Mortensen coll.: apertural face and transverse sections of same specimen (27 ×55; 28 ×13; 29 ×155; 30 ×27).

This species is very common.

Curaçao: St. Jan, sta. 1325A; Awa Blanco, 1351. Bonaire: Playa Lechi, 1055A; Lac, Poejito, 1064A, 1065. Klein Bonaire: 1371. Islote Aves: 1114. Antigua: Deep Bay, 1393. Barbuda: Two Feet Bay, 1395; Great Lagoon, 1396. St. Barts: Public, 1121. St. Martin: Great Bay, 1125A, 1126, 1127, 1128A; Simson Bay Lagoon, 1130A, 1131, 1402. South Bimini: 1150A. North Bimini: 495, 1151, 1152.

Triloculina linneiana d'Orbigny Figs. 21–22

Triloculina linneiana d'Orbigny, 1839, Cuba p. 172, pl. 9 fig. 11–13; Cushman, 1921, p. 70, pl. 17 fig. 3–4.

Test elongate oval, with a slightly protruding apertural part. Chambers broad, strongly overlapping, with several distinct costae in the length of each chamber, and minor costae between the larger ones. Aperture rounded, with bifid tooth. Transverse sections reveal a quinqueloculine beginning of the test, soon followed by a triloculine arrangement. The megalospheric tests are somewhat smaller than the microspheric. – Length 1.0–1.3 mm; breadth 0.75–0.6 mm; thickness 0.65–0.4 mm.

Common in many samples.

Aruba: Malmok, sta. 1301. Curaçao: Awa Blanco, 1351. Bonaire: Playa Lechi, 1055. Barbuda: Martello Tower beach, 1394; Two Feet Bay, 1395; Great Lagoon, 1396. St. Kitts: Basseterre, 1398. St. Martin: Great Bay, 1125A, 1126, 1127; Simson Bay Lagoon, 1130. New Providence: between Hog I. and Athol I., 1149. South Bimini: 1150A. North Bimini: 495, 1151.

Triloculina oblongoides nov. spec. Fig. 29

Test elongate to oval; last-formed chamber the longest, and rounded over the antapical end of the test. A transverse section is slightly triangular with rounded sides and angles. Chambers inflated with depressed sutures. At the compressed aperture, the last-formed chamber is somewhat flaring. Wall smooth, generally not lustrous, in transmitted light smooth and hyaline. Tooth long, flaring, slightly protruding from the aperture, with a row of elongate, slightly irregular openings at the distal end. Generally, the small proloculus is followed by a coil of quinqueloculine chambers, subsequently becoming triloculine. – Length about 0.3 mm.

This is obviously one of the species mentioned by CUSHMAN (Bull. U.S. Nat. Mus. *161*, 1932, p. 51) who stated: "It is very evident that more than one species is included in the various references to Montagu's *oblonga*".

Abundant in some localities on Bonaire and Klein Bonaire.

CURAÇAO: Santa Marta Baai, lagoon, 1323. BONAIRE: Playa Lechi, 1055A; Lac, Poejito, 1064A, 1065. KLEIN BONAIRE: 1371. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. ST. JOHN: Turner Bay, 1407. NORTH BIMINI: 1151.

Sigmoilopsis arenata (Cushman) Fig. 23

Spiroloculina arenata CUSHMAN, 1921, p. 63, pl. 14 fig. 17.
Sigmoilina arenata (Cushman) CUSHMAN & TODD, 1944, p. 74, note.
Sigmoilopsis arenata (Cushman) FINLAY, 1947, p. 270.

Test finely arenaceous or rather roughly calcareous. Last-formed chamber protruding at both ends of the elongate small test. The last-formed chamber overlaps the previous chambers at one side more than at the other. Aperture round, without tooth. Arrangement of the chambers in transverse section as in *Sigmoilina*, first somewhat quinqueloculine, later more spiroloculine. – Length about 1 mm; breadth 0.5 mm; thickness 0.2 mm.

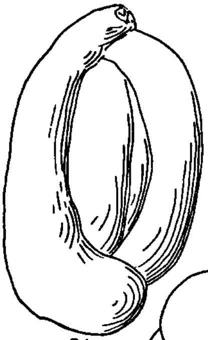
The species is not common.

CURAÇAO: Fuik Baai, sta. 1039. BONAIRE: Lac, Cay, 1067. ST. MARTIN: Great Bay, 1127.

Miliolinella labiosa (d'Orbigny) Figs. 24–26

Triloculina labiosa D'ORBIGNY, 1839, Cuba p. 157, pl. 10 fig. 12–14; CUSHMAN, 1921, p. 70, pl. 16 fig. 13–14.

Test often somewhat irregular, as the later chambers do not entirely cover a whole side but are shorter, so that the three youngest chambers are visible in one whorl. In the initial part a whorl consists of two chambers, and a quinqueloculine arrangement is scarcely visible. The walls are extremely thin, never lustrous, and with high magnification appear to be covered with fine pits. The aperture is wide open, often somewhat triangular, and at its base a



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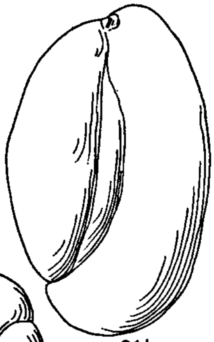

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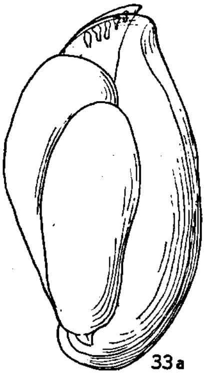

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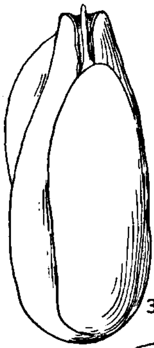

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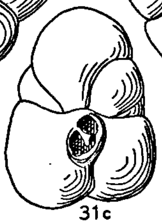
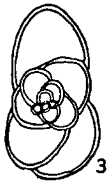


31c

32a



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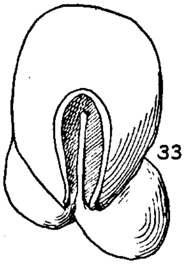

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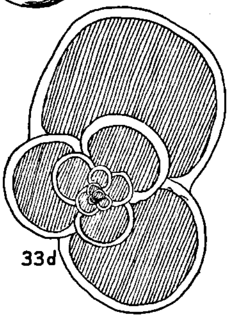

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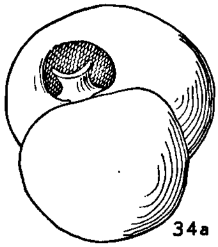

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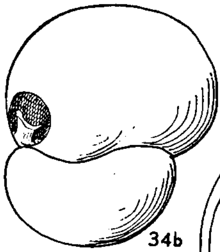

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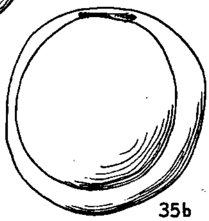
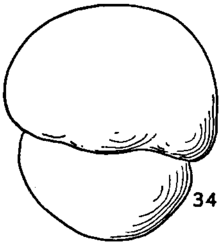
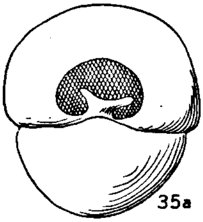


35b



34c



35a

36

broad and protruding (labiate) tooth is present. – Larger diameter up to 0.6 mm.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A; Fuik Baai, 1039. BONAIRE: Salinja di Lac, 303; Playa Lechi, 1055A; Lac, Poejito, 1064A, 1065; Lac, Cay, 1067; Lac, Boca 1068a. ISLOTE AVES: 1114. ANTIGUA: Deep Bay, 1393. BARBUDA: Great Lagoon, 1396. ST. MARTIN: Simson Bay Lagoon, 479; Great Bay, 1125A, 1127; Simson Bay Lagoon, 1130, 1130A, 1131. NORTH BIMINI: 1151. CAT KEY: 499.

Pyrgo subsphaerica (d'Orbigny) Figs. 34–35

Biloculina subsphaerica D'ORBIGNY, 1839, p. 162, pl. 8 fig. 25–27; CUSHMAN, 1921, p. 73.
Pyrgo subsphaerica (d'Orbigny) BERMUDEZ, 1935, p. 172.

The globular test has two chambers, both of them semi-globular, the last one having a rounded margin; the walls are extremely thin and lustrous. The aperture of the last-formed chamber is round, and has a bifid tooth. In oil the proloculus, which is large in all specimens, appears to be directly followed by a bilocular arrangement of chambers. – The largest specimen is about 0.5 mm in diameter.

This small species is common in a mangrove lagoon on South Bimini.

ARUBA: Lagoen Boekoeti, sta. 1004. ISLOTE AVES: 1114. SOUTH BIMINI: 1150A. NORTH BIMINI: 1151, 1152.

Cornuspiramia antillarum (Cushman) Fig. 36

Nubecularia antillarum CUSHMAN, 1922, p. 58, fig. 7–8.
Cornuspiramia antillarum (Cushman) CUSHMAN, 1928, p. 158.

Fig. 31–32. *Quinqueloculina oblonga* (Montagu). — Bonaire, sta. 1067: 31, broad sides and apertural face of same specimen; 32, apertural face and transverse section of another specimen (× 55).

Fig. 33. *Quinqueloculina oblongoides* nov. spec. — Klein Bonaire, sta. 1371: a, broad side with the tooth, studied in oil; b–d, narrow side, apertural face and transverse section of same specimen (a–c × 125, d × 160).

Fig. 34–35. *Pyrgo subsphaerica* d'Orbigny. — South Bimini, sta. 1150A: 34, three views of same specimen; 35, another specimen from two sides (34 × 55, 35 × 33).

Fig. 36. *Cornuspiramia antillarum* (Cushman). — Bonaire, sta. 1056C: specimen on a piece of shell (× 33).

The attached test begins with a proloculus and a spiral chamber of aragonitic material, later covered by a layer of fine calcareous agglutinated material. From the initial part several large compressed irregularly branching tubular chambers are running over the substratum, mainly shells. The open ends of the tubes form the foramina.

The species is common; many shells and tests of larger Foraminifera are covered with the branches of this species; however, it is apparently not a parasite, as several eroded shells of lamellibranchiates were found, covered with *Cornuspiramia*.

BONAIRE: Playa Lechi, sta. 1056A; Punt Vierkant, 1059B; Lac, Cay, 1067. AVES DE SOTAVENTO: AS 37. ST. MARTIN: Great Bay, 1126.

Articulina

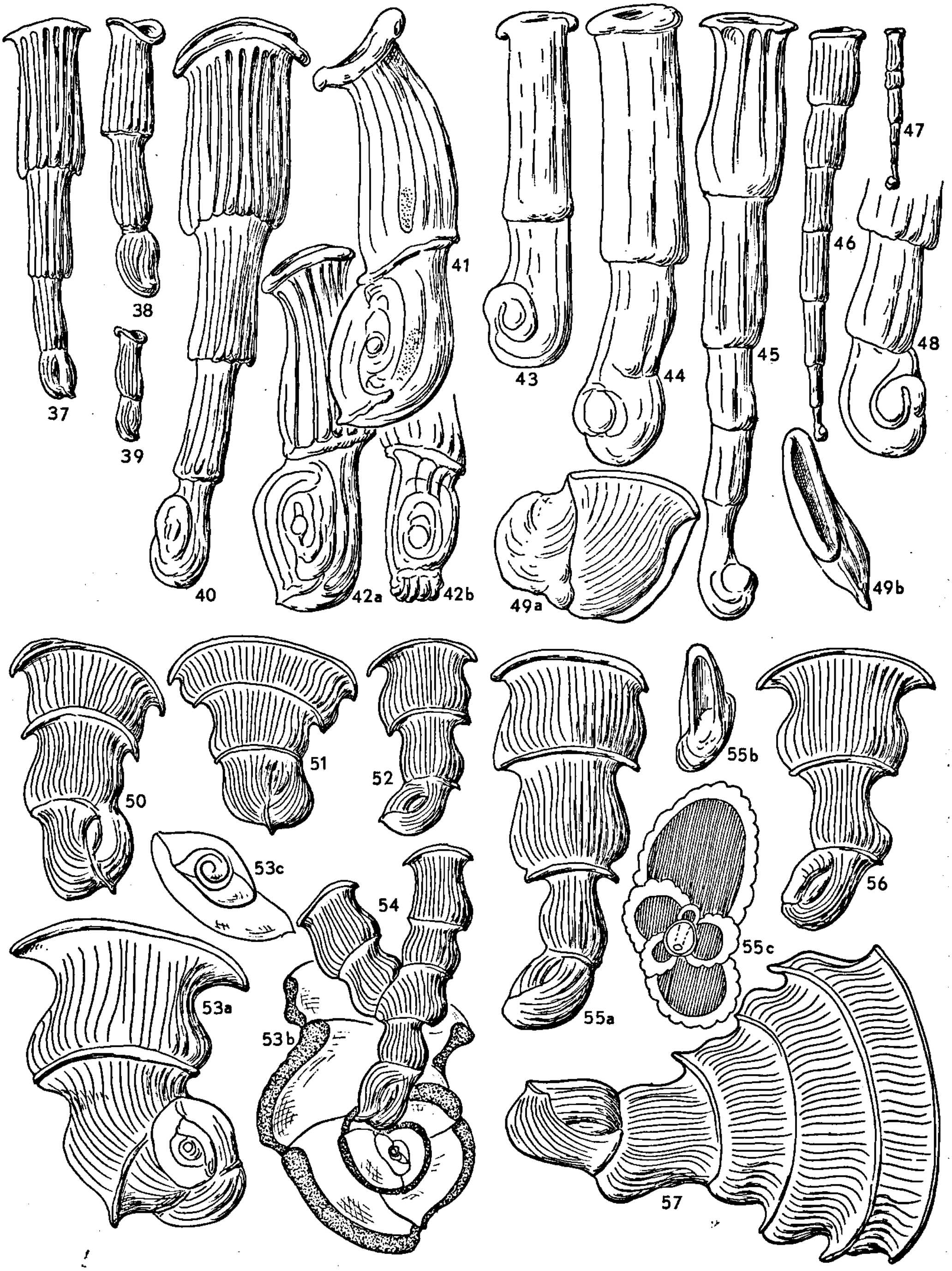
This genus has been analysed by CUSHMAN (1944); many questions, however, remain to be solved. CUSHMAN (1944, p. 2) stated that most species show a triloculine part, which may occasionally have a quinqueloculine beginning. Nevertheless, in transverse sections, specimens of *Articulina mucronata* appear to be wholly quinqueloculine. Moreover, CUSHMAN stated that *Vertebralina*, which so closely resembles *Articulina*, has a planispiral arrangement of the chambers in the initial part; for that reason he removed this group from *Articulina*, and placed it in the Ophthalmidiidae. There are striking differences, however, between the Miliolidae s.s. and *Articulina*. All Miliolidae have a more or less developed tooth, in many cases with a cribrate plate (*Miliola*); in *Articulina* this tooth is absent at all stages of development, just as in the Ophthalmidiidae. Before the uniserial set of chambers starts, the last-formed chambers in *Articulina* are arranged in a spiral, as in *Flintina* and many Ophthalmidiidae. Moreover, in many individuals of *Articulina paucicostata* a large proloculus is present, followed by one or two spiral chambers, as is typical of Ophthalmidiidae. It would be more appropriate to place *Articulina* and *Vertebralina* in one single group in the Ophthalmidiidae, in the neighbourhood of *Wiesnerella*. Some highly specialised Ophthalmidiidae may have had a quinqueloculine arrangement of chambers. There are no arguments for placing *Articulina* in the group of the Miliolidae; it forms an intermediate group between Miliolidae and Ophthalmidiidae. Moreover, *Articulina* species have very fine pits on the surface of the test, a typical feature of the Peneroplidae (but also of *Miliolinella*).

In the shallow waters off the north coast of Cuba, BERMUDEZ (1935) found 6 species of *Articulina*: *sagra* d'Orbigny, *mexicana* Cushman, *lineata* Brady, *mayori* Cushman, *antillarum* Cushman and "*Vertebralina*" *cassis* d'Orbigny. At the north coast of Jamaica, CUSHMAN (1921) found 3 species of *Articulina*, viz. *conico-articulata* (Batsch), synonym for *mucronata*, *sagra* d'Orbigny and *lineata* Brady. In the samples from deeper water off Santa Cruz, about 150 fathoms deep, the author found 5 species, *mexicana* Cushman, *sagra* d'Orbigny, *paucicostata* Cushman, *lineata* Brady and *mucronata* (d'Orbigny). From a sample off Habana, Cuba, BERMUDEZ sent the author the following 4 species: *lineata* Brady, *mexicana* Cushman, *paucicostata* Cushman, *mucronata* (d'Orbigny). In the tidal zone samples, only two species are common. *Articulina sagra* d'Orbigny was found in several samples from the mud between the roots of *Rhizophora*, and *Articulina mucronata* (d'Orbigny) was abundant in some shallow-water samples in which Peneroplidae were also abundant (1067, Bonaire; 1150A, South Bimini). It must be concluded that in the Antilles *Articulina* is not common at all. The figured specimens of *Articulina paucicostata* are from Cuba and from off Frederickstedt, St. Croix, and in the new material this species has been found only in a single specimen from the latter island.

Articulina mucronata (d'Orbigny) Figs. 49–57

Vertebralina mucronata D'ORBIGNY, 1839, p. 52, pl. 7 fig. 16–19.
Articulina mucronata (d'Orbigny) CUSHMAN, 1944, p. 12, pl. 2 fig. 11–18 (here all literature).

The test is variable, as appears from the figures. Slender specimens and very broad ones are present with apparently the same "triloculine"-coiled part, and very stout specimens with a "*Flintina*" initial part. The proloculus with *Flintina* part is smaller than that with a "triloculine" part; in all specimens studied in sections, the "triloculine" and the *Flintina* initial parts appeared to be actually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quinqueloculine. Abnormal specimens with branching uncoiled part were also found. In individuals with *Flintina* part, at least 6 chambers are of the *Flintina* type.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A. BONAIRE: Lac, Cay, 1067. ANTIGUA: Deep Bay, 1393. ST. KITTS: Basseterre, 1398. St. Martin: Great Bay, 1125A, 1126, 1127. ANGUILLA: Forest Point Saltwell, 543. SOUTH BIMINI: 1150A, 1151.

Articulina sagra d'Orbigny Figs. 37–42

Articulina sagra D'ORBIGNY, 1839, p. 183, pl. 9, fig. 23–26; CUSHMAN, 1944, p. 11, pl. 2 fig. 6–10 (here all literature).

The small coiled part is actually quinqueloculine. The last-formed chambers of this part may be slightly protruding, and the short series of uniserial chambers is built upon it. These chambers are never flaring as in *mucronata*, but always tubiform; each chamber is broader at its base than the previous one, and overlaps the lip of the latter with its distinct costae. At the end chamber the lip of the rounded or oval aperture is more heavily built, in most cases.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A. ANGUILLA: Forest Point Saltwell, 543.

Fig. 37–42. — *Articulina sagra* d'Orbigny. — 37–38, Curaçao, sta. 1036A; – 39, Bonaire, sta. 1067. — 40, Cuba, near Habana, Bermudez coll. — 41–42, St. Croix, near Frederiksted, 150 fathoms, Mortensen coll.: two specimens, 41 and 42 in oil, to show the inner structure (37–38, 40 × 55; 39 × 27; 41–42 × 100).

Fig. 43–48. — *Articulina paucicostata* Cushman. — 43–44, Cuba, near Habana, Bermudez coll. — 45, Thatch Island, St. Croix, Mortensen coll. — 46–48, Cuba, near Habana: 48, initial part in oil, showing inner structure (43–45, 48 × 100; 46–47 × 27).

Fig. 49–57. *Articulina mucronata* (d'Orbigny). — 49, Cuba, near Habana, Bermudez coll.: broad side and apertural face of immature specimen. — 50–52 and 54–57, Bonaire, sta. 1067: 54 is an abnormal specimen with bifurcating end; 55b, initial part with aperture; 55c, transverse section of initial part. — 53, South Bimini, sta. 1150A: b, horizontal section; c, initial part of it (50–53a, 54, 56 × 27; 53b, 55a–b × 55; 53c, 55c × 160; 57 × 57).

Articulina paucicostata Cushman Figs. 43–48

Articulina paucicostata CUSHMAN, 1944, p. 14, pl. 3 fig. 13–14.

All specimens from deeper water have a very small initial part, consisting only of the large proloculus (the neck chamber belonging to the proloculus) and a second chamber around these first two chambers which, in most cases, strongly protrudes from the coiled part. Consequently, it cannot be determined whether the initial part is triloculine or otherwise arranged. In one case, the tubular set of uniserial chambers consists of 6 chambers, but most individuals are smaller. The walls of the first chambers of the uniserial part have few costae, and the number increases in later chambers. It is doubted whether this species does not represent a generation of *A. sagra.* Typical *sagra,* with its quinqueloculine initial part, has very small proloculi (about 18 μ in diameter); the proloculus of typical *paucicostata* is larger (about 25 μ); both, however, are megalospheric, as may be concluded from the neck chamber.

ST. CROIX: Krausse Lagoon, sta. 1405; St. Croix, at a depth of 150 fathoms.

The Caribbean species of Peneroplidae

In the Caribbean a multitude of peneropline species is found which should be carefully analysed, in order to avoid confusion.

CUSHMAN (1930) was the first to attempt to disentangle this group as far as found in the Caribbean. He listed:

Peneroplis pertusus (Forskål)
Peneroplis carinatus d'Orbigny(?)
Peneroplis proteus d'Orbigny
Peneroplis bradyi Cushman
Peneroplis discoideus Flint
Dendritina antillarum d'Orbigny
Spirolina arietina (Batsch)
Monalysidium politum Chapman(?)
Archaias angulatus (Fichtel & Moll)
Archaias compressus (d'Orbigny)
Sorites marginalis (Lamarck)
Amphisorus hemprichii Ehrenberg
Borelis pulchra (d'Orbigny)

Hofker (1930 Siboga) analysed many Peneroplidae and described a new species from the Caribbean – also found in the Pacific, but rarely – as *Praesorites orbitolitoides.* One species, mentioned in the same paper as *Archaias discoideus* (Flint), was afterwards renamed *Orbitolites annulatus* Hofker (1952, *72*, p. 103).

Henson (1950) examined the Peneroplidae in general. He emphasized the presence of pillars and not of septa between the chamberlets as typical of the genus *Archaias.* He assumed *Archaias aduncus* and *A. angulatus* to belong to the group with pillars, whereas *Archaias compressus* (d'Orbigny) he subdivided into *Archaias* sp. x, *Meandropsina* sp. x and *Taberina* sp. x. He considered *Peneroplis discoideus* Flint to be a variant of *P. proteus* d'Orbigny.

Hofker (1950–1953) described many Peneroplidae, amongst which the following species from the Caribbean have been analysed:

Dendritina elegans d'Orbigny
Dendritina (*Monalysidium*) *politum* (Chapman)
Puteolina bradyi (Cushman)
Puteolina protea (d'Orbigny)
Puteolina crassa Hofker
Puteolina (*Archaias*) *compressa* (d'Orbigny)
Puteolina (*Archaias*) *angulata* (Fichtel & Moll)
Orbitolites orbitolitoides (Hofker)
Orbitolites crassipora Hofker
Orbitolites marginalis Lamarck
Neoalveolina pulchra (d'Orbigny)

Hofker stated that the structure of the septa dividing the chamberlets in *Puteolina* (*Archaias*) *compressa* is different from that in *Puteolina* (*Archaias*) *angulata,* and suggested that *Archaias aduncus* is a form of *A. compressa.*

Smout & Eames (1958) also studied *Archaias.* Only a single Recent species of that group was recognized by them in the Caribbean, *A. angulatus.* They did not follow Hofker, who placed this species in *Puteolina* (though it shows distinct pits at the surface), and they emphasized the importance of pillars instead of septa between the chamberlets. *Puteolina* (*Archaias*) *compressa* (d'Orbigny) is placed by these authors in the genus *Cyclorbiculina* Silvestri, a monotypic genus. They consider Hofker's form Fig. 50b (1950–1953) to be identical with the fossil species *Archaias floridensis* (Conrad); however, this is not correct.

New data will be given for the species found in the Caribbean.

All more highly developed species found in the Caribbean have pits at the surface and multiple round apertures. Some species have very flat tests which are entirely planospiral and evolute; the walls of the first chambers (proloculus and neck chamber) have fine protopores; all these species have a group of undivided chambers, following the protoconch. Other species have a planospiral test, the first part of which is more or less involute. A similar feature is found in the simpler true Peneroplidae, with planospiral and undivided chambers: some species are entirely evolute and others are partly involute. The more involute the species in the first-mentioned group, the more complicated are the septa dividing the chambers into chamberlets.

Totally evolute tests are found in *Puteolina orbitolitoides* (Hofker). For reasons to be discussed later, all these species are placed in *Puteolina* Hofker. Another totally evolute form is *Orbitolites* (*Amphisorus*) *hemprichii* (Ehrenberg). Slightly involute in the first chambers is *Puteolina discoidea* (Flint) which, contrary to CUSHMAN (1930), is not a *Peneroplis* with undivided chambers but a form with distinct septa between chamberlets. More involute are *Puteolina angulata* and *P. compressa*, of which *P. angulata* has the most complicated septa and the most involute tests.

It is noteworthy that totally evolute tests have a larger number of undivided chambers following the proloculus than involute tests, and that the more involute the tests, the shorter is the undivided set of chambers. If the presence of undivided chambers is a primitive characteristic, this may lead us to consider evolute tests as more primitive than involute tests. The sequence of forms may be as follows.

$$\begin{tikzcd}
\textit{Puteolina bradyi} \arrow[r] \arrow[d] & \textit{Puteolina protea} \arrow[d] \\
\textit{Puteolina orbitolitoides} \arrow[d] & \textit{Puteolina crassa} \arrow[d] \\
\textit{Puteolina marginalis} \arrow[d] & \textit{Puteolina compressa} \arrow[d] \\
\textit{Puteolina discoidea} & \textit{Puteolina angulata}
\end{tikzcd}$$

The megalospheric form of all these species begins with a round proloculus and a second chamber partly surrounding the proloculus; both chambers have fine protopores in the wall. These initial chambers are followed by chambers in a single sequence, communicating by one or more rows of rounded apertures piercing the walls; in the forms with chambers divided into chamberlets, the dividing walls have transverse openings. These openings may be small or wide; in most advanced forms, such as *Puteolina angulata,* more than one opening may pierce the dividing septa, thus forming the so-called "pillars". These "pillars" are not real pillars, as in *Dictyoconus* or *Chapmanina.* They generally have a distinct basal communication with the outer wall, and basal ridges on the chamber wall running from one pillar to the next in the same row of "pillars"; these are distinct relics of a true septal dividing wall with more than one opening, which thus formed "pillars". In *Puteolina compressa,* the beginning of "pillars" is frequently found in specimens with small openings appearing near the lateral walls. Actually, there is no typical difference between true septa between the chamberlets with one opening in the middle of the septum, and septa with more than one opening when the test becomes thicker, forming "pillars", as in *Puteolina angulata.* SMOUT and EAMES considered *"Cyclorbiculina" compressa* and *Archaias angulata* to be distinctly different: in the first species each secondary septum reaches both lateral walls of the chamber, so that at the outside a distinct suture without pits becomes visible; in *Archaias,* on the other hand, a suture is never visible at the outer wall, and consequently the pits continuously cover the whole breadth of the chambers. There are exceptions to this rule: in some tests of true *Archaias angulatus,* distinct sutures have been observed, at which pits are absent. In many tests of *"Cyclorbiculina" compressa,* particularly in later chambers, secondary septa do not reach the outer walls, the pits cover the whole wall, and no distinct suture is formed; in these cases the septa also have openings between the lateral wall and the part of the septum which remains, thus forming "pillars" (Fig. 118, 109, 111).

From these observations it may be concluded that no real difference exists between *Cyclorbicula* and *Archaias* as stated by

HENSON and by SMOUT & EAMES, and that from a biological standpoint it is preferable to replace these genera by one single genus (*Puteolina*) with the following characteristics:[1])

Test consisting of rapidly broadening planospirally-coiled chambers, communicating by one, two or more rows of rounded openings; consequently, these openings appear as apertures in the last-formed chamber. Outer lateral walls pitted. Chambers totally evolute or, at least in the more initial part, more or less involute. Proloculus rounded, in the megalospheric form with neck chamber, the walls of which have protopores. In more advanced species the chambers may become circular; in other species they may be divided by secondary septa into chamberlets. These septa may have a single opening as communication for the chamberlets of one chamber or, in the most advanced and involute forms, more than one opening may be present; in cases when these multiple openings are also found near the outer lateral walls, the communication between septum and wall may be lost, or some communication remains near the basal wall of the chamber. In that case these strongly pierced septa have been designated as a row of "pillars".

Puteolina with simple chambers has been mentioned by earlier authors as "*Peneroplis*". However, as the wall of the type of *Peneroplis* has a different outer structure, *Puteolina* cannot belong to this genus. *Puteolina discoideus* Flint was placed by CUSHMAN (1930) in *Peneroplis*; it has distinct secondary septa and a finely pitted surface, and does not belong to *Peneroplis* either. *Archaias compressus* (d'Orbigny) and *Archaias angulatus* (Fichtel & Moll) were placed by CUSHMAN in the genus *Archaias* Montfort, 1808, whereas SMOUT & EAMES placed *A. angulatus* in *Archaias,* and *A. compressus* in *Cyclorbiculina* Silvestri 1937.

It is possible to combine these species into one of the genera proposed by MONTFORT in 1808; CUSHMAN preferred *Archaias*, the first genus mentioned. However, CUSHMAN, as well as SMOUT & EAMES and HENSON, believed this genus *Archaias* to be restricted

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[1]) It is not in accordance with the rules of nomenclature to place *Archaias* and *Cyclorbiculina* under de heading *Puteolina*; nevertheless it would be absurd to place simpler forms in a genus especially created only to contain much more highly complicated forms.

to forms with "pillars" (not mentioned by Montfort). The genus *Puteolina* should be reserved for forms characterized by pits in the outer walls, and *Archaias* and *Cyclorbiculina* should be classified as sub-genera. This results in the following species for the West Indian region:

Puteolina bradyi Cushman
Puteolina proteus (d'Orbigny)
Puteolina orbitolitoides (Hofker)
Puteolina marginalis (Lamarck)
Puteolina crassa Hofker
Puteolina discoidea (Flint)
Puteolina (*Archaias*) *compressa* (d'Orbigny)
Puteolina (*Archaias*) *angulata* (Fichtel & Moll).

The flat, evolute species might possibly be placed in *Puteolina* (*Sorites*).

It is the author's opinion that the species *Peneroplis pertusus* (Forskål) and *Spirolina arietinus* (Batsch) do not occur in the West Indian region, and that Hofker's *Orbitolites marginalis* (1952) belongs to another group, as will be explained presently. *P. annulatus* Hofker may be synonymous with *P.* (*Sorites*) *marginalis* (Lamarck), and *P. orbitolitoides* (Hofker) does not belong to the genus *Orbitolites* (see later).

The above characteristics of the genus *Puteolina* allow a well-defined group of species to be established, which may be considered as a distinct biological unit. It is impossible to decide whether all fossil species mentioned by Smout & Eames as *Archaias* actually belong to this unit. The genus *Cyclorbiculina* Silvestri must be dropped, as *Puteolina* (*Archaias*) *compressa* has the characteristics of the group *Puteolina* (*Archaias*), and the definition given by Silvestri does not apply to the more primitive species of *Puteolina*.

The species described by Cushman as genotype of *Amphisorus* Ehrenberg belongs to quite another group. In this species, *A. hemprichii* Ehrenberg, the second chamber more or less envelops the proloculus, with walls devoid of protopores. The first two chambers are succeeded by rows of chambers, eight of which can be discerned, rapidly surrounding the protoconch; in a later stage the chambers become more irregular, often forming a lozenge pattern. Particularly in the microspheric test, irregular brood chambers may be formed at the periphery. No strongly broadening chambers with secondary septa are present, but the so-called chamberlets are actually true chambers, communicating by foramina directed towards the margin, while other foramina connect the rhomboid chambers of one row with the next ones or with later chambers on either side. In the brood chambers, the foramina generally become large, to facilitate passage of the embryons.

This structure of the test, causing what can be called a lozenge-shaped pattern (only one layer of chambers is present and not two, as Cushman, 1930, stated, at least in the West Indian form), strongly resembles the structure of *Orbitolites complanata* Lamarck from the Lutetian of Paris. For comparison this genotype of *Orbitolites* has also been studied. The megalospheric proloculus is large, thin-walled, and is followed by an irregular neck chamber. At the dorsal side of the test this protoconch (without pores in the walls) is covered with irregularly placed smaller chambers. Then a cluster of chambers begins to form a single layer around the protoconch, and is later divided into chamberlets; these are connected by foramina with the chamberlets of the next chambers, and also with those of the same chamber, as in *Amphisorus hemprichii* on a simpler scale. Consequently, since each chamber causing the lozenge-shaped pattern seen at the outside of the test is broadest in the direction at right angles to the flat side of the test, it is divided into 4–7 chamberlets in *Orbitolites complanata*, whereas in *Amphisorus hemprichii* this secondary division is not found, as the test is only one chamberlet thick. By condensing the transverse row of chamberlets, into which each chamber is divided in *Orbitolites*, into one chamber, *Amphisorus* may be obtained. It is obvious that *Amphisorus* belongs to the same biological unit as *Orbitolites complanata*, and that *Amphisorus hemprichii* is a true but simplified *Orbitolites*. In the present seas, more complicated forms are found, such as *Orbitolites duplex*; there is strong evidence (HOFKER, 1930 Siboga) that such Pacific species as *Orbitolites duplex, O. marginalis* and *Marginopora vertebralis* also belong to this group of *Orbitolites* [1]. In the proloculus, the structure of the chambers, and the arrangement of the foramina they differ from the West Indian group of *Puteolina*, and obviously belong to a different stock; and so we have here a quite different group, possibly not belonging to the Peneroplidae. The *Orbitolites* group has no secondary chamberlets, but chambers always arranged in a lozenge-shaped pattern; in both groups, however, the tests are aragonitic. *Orbitolites*, unlike the more complex *Puteolina*, does not have annular chambers divided into chamberlets, but chambers arranged as in *Lepidorbitoides* or in *Lepidocyclina*. This group includes:

Orbitolites complanata Lamarck – Lutetian.
Orbitolites duplex Carpenter – Pacific and Indian Oceans.
Orbitolites marginalis Lamarck – Pacific Ocean, Caribbean.
Orbitolites (*Marginopora*) *vertebralis* Quoy & Gaimard – Pacific Ocean.
Orbitolites (*Amphisorus*) *hemprichii* (Ehrenberg) – Caribbean, possibly Indian Ocean and Pacific.

Puteolina (Archaias) angulata (Fichtel & Moll)
Figs. 58–62, 71–76, 100–108, 111–113

Nautilus angulatus FICHTEL & MOLL, 1798, p. 113, pl. 22 fig. a–e.
Puteolina (*Archaias*) *angulata* (Fichtel & Moll) HOFKER, 1952, p. 461–463, fig. 49–51, also fig. 50b.
Archaias angulatus (Fichtel & Moll) SMOUT & EAMES, 1958, p. 210–213, pl. 39 fig. 1–5.

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1) Nomenclatorially, all these species have to be placed in the genus *Orbitolites* (Lamarck, 1801). *Marginopora* (Blainville, 1830) and *Amphisorus* (Ehrenberg, 1840) cannot have more than subgeneric status.

Test stout, in the megalospheric generation either rounded, with subacute margin and broad truncate apertural face with many round apertures scattered over the face, or later flaring, with fan-shaped test, a truncated margin along the apertural face and with two or more rows of round apertures. The smaller the proloculus, the more flaring the test; this may lead to several coils formed by a group of chambers; the chambers, however, never meet at their ends in order that circular chambers are not developed. The surface of each chamber is covered with distinct pits which in most cases are not interrupted by the secondary septa separating the chamberlets from each other; the septa have several openings, two of them just at the lateral walls, thus dividing the septa into narrow "pillars". In the initial part, the chambers are generally strongly involute.

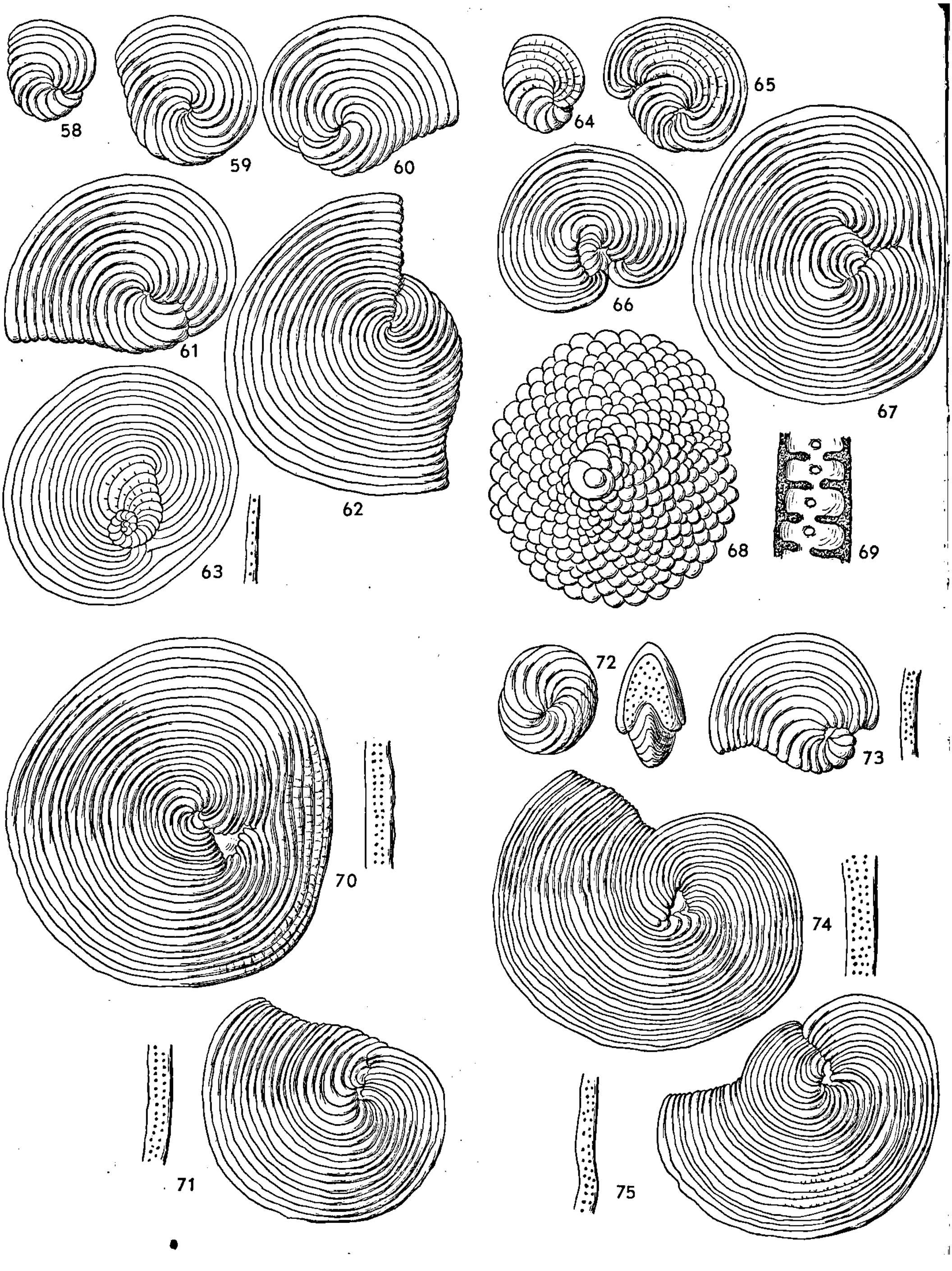
ARUBA: Punta Braboe, sta. 1002; Boekoeti, 1006; Malmok, 1301. CURAÇAO: Awa Blanco, 1351. BONAIRE: Playa Lechi, 1056A; Punt Vierkant, 1059B; Lac, Poejito, 1064A; Lac, Cay, 1067. KLEIN BONAIRE: 1049B, 1371. AVES DE SOTAVENTO: AS 1, AS 37. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. ANTIGUA: Deep Bay, 1393. BARBUDA: Bryant's Cave pool, 672; Martello Tower beach, 1394; Two Feet Bay, 1395; Great Lagoon, 1396. ST. KITTS: Basseterre, 1398. ST. EUSTATIUS: Gallows Bay, 1116B; Billy Gut, 1117. ST. MARTIN: Great Bay, 1125A, 1126, 1127, 1128A; Simson Bay, 1130, 1402. ANGUILLA: Forest Point Saltwell, 543. NEW PROVIDENCE: between Hog I. and Athol I., 1149. SOUTH BIMINI: 1150A. NORTH BIMINI: 495, 1152.

Puteolina (Archaias) compressa (d'Orbigny)

Figs. 86, 109, 114–118

Orbiculina compressa D'ORBIGNY, 1839, Cuba p. 73, pl. 8 fig. 4–7.
Archaias compressus (d'Orbigny) CUSHMAN, 1930, p. 48, pl. 17 fig. 1–2.
Puteolina (*Archaias*) *compressus* (d'Orbigny) HOFKER, 1952, p. 457–460, fig. 44–48.

In specimens with a large proloculus, the test is closely coiled and involute, and has a rather narrow apertural face. The smaller the proloculus, the more flattened is the test. Later chambers more and more flaring, until they become circular, particularly in microspheric forms, the diameter of the test of which is 5–6 mm. Two rows of small round apertures at the margin which is sub-truncate. The septa dividing the chambers into chamberlets in most specimens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reach the lateral walls and form a suture, on which the distinct pits of the surface are missing; however, in later circular chambers, openings may be found in the septa, not only in the middle, but also at the lateral wall; in this case real "pillars" are formed.

There is no actual difference between *P. angulata* and *P. compressa* justifying a distinction into different genera. The whole structure of this species is more primitive than in *P. angulata.* In *P. angulata,* most chambers have an uninterrupted pitted structure, whereas *P. compressa* generally has pits interrupted at the sutures of the septa of the chamberlets (but not always). This difference caused by openings in the septa, is of a specific, and not of a generic nature, as suggested by SMOUT & EAMES (1958).

ARUBA: Malmok, sta. 1301. BONAIRE: Lac, Boca, 1068a. AVES DE SOTAVENTO: AS 1. ANTIGUA: Deep Bay, 1393. BARBUDA: Two Feet Bay, 1395. ST. MARTIN: Great Bay, 1127. NEW PROVIDENCE: between Hog. I. and Athol I., 1149. SOUTH BIMINI: 1150A.

Puteolina (Sorites) marginalis (Lamarck) Figs. 77–85

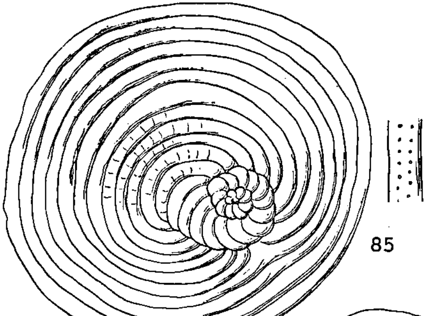
Orbulites marginalis LAMARCK, 1816, p. 196, no. 1.
Orbitolites annulatus HOFKER, 1952, p. 103–104, fig. 52.
Sorites marginalis (Lamarck) CUSHMAN, 1921, p. 49, pl. 18 fig. 1–4.

Fig. 58–62, 71–75. *Puteolina angulata* (Fichtel & Moll). — 58–62, South Bimini, sta. 1150A. — 71, New Providence: the margin with a double row of apertures. — 72–75, South Bimini, sta. 1150A; 72, A_2 specimen; 73, specimen with features which point to *Puteolina discoidea*, the two rows of apertures at the margin point to *P. angulata*; 74, microspheric form with the broad margin, with three rows of apertures; 75, this specimen, though having a margin with two rows of apertures, shows tendencies toward *P. compressa* – in the later chambers the chamberlets are indicated from without, and here the "pillars" form sutures at the outer wall (× 25).

Fig. 63. *Puteolina orbitolitoides* Hofker. — St. Croix, off Frederiksted, 150 fathoms, Mortensen coll.: test and margin with a single row of apertures (× 25).

Fig. 64–67, 70. *Puteolina compressa* (d'Orbigny). — 64–67, Aves de Sotavento, sta. AS1. — 70, New Providence, sta. 1149; the margin with a double row of apertures, probably A_1 specimen.

Fig. 68–69. *Orbitolites hemprichii* (Ehrenberg). — Buck Island, beach: total test and outer margin as seen from the inside, to show the single row of chamberlets and of apertures (68 × 25, 69 × 55).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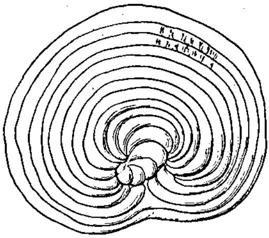
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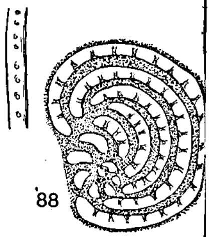
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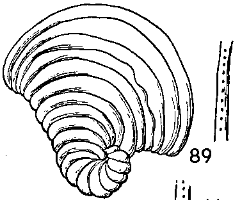
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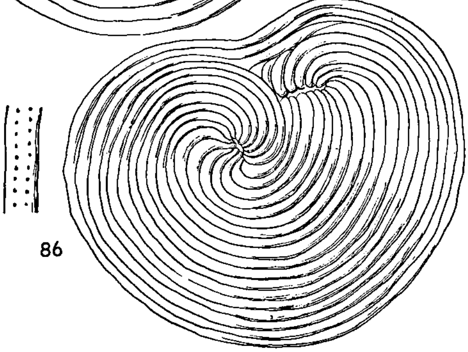
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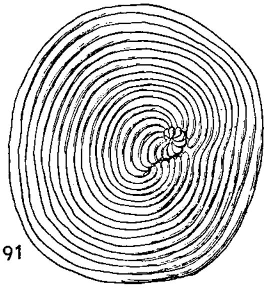
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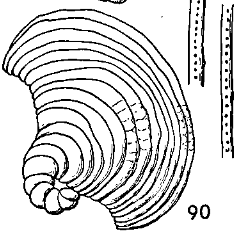
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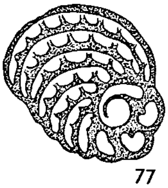
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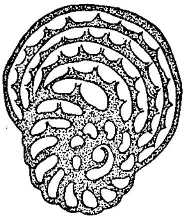
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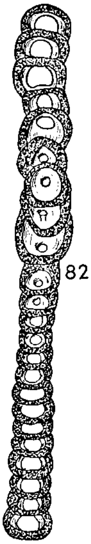
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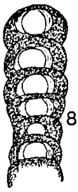
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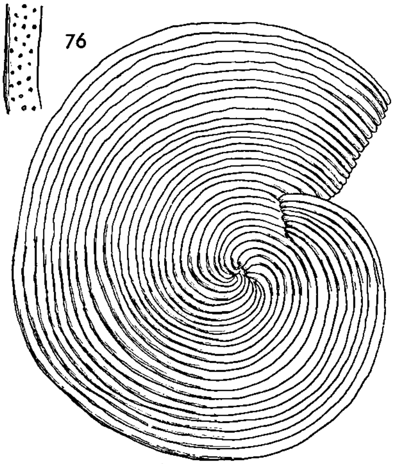
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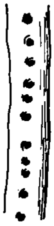
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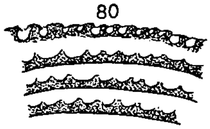
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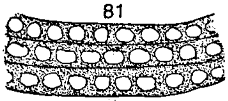
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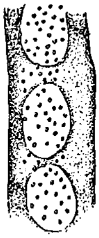
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Test in fullgrown specimens circular, flat, consisting of one layer of chambers divided into chamberlets; proloculus followed by a long neck-chamber and some undivided evolute chambers when a large proloculus is present, or by a much larger number of undivided chambers when a small proloculus is present. Later chambers flaring and in the end embracing, circular, and divided into chamberlets. Walls distinctly pitted, with a row of round apertures at the periphery. Each septum dividing the chamberlets has a large round opening in the middle.

This species is not identical with the species called *Orbitolites marginalis* in 1930 (HOFKER, Siboga) and 1952 (HOFKER, J.R.M.S.). It is the species figured by CUSHMAN, 1930 (pl. 18 fig. 1–4). *Orbitolites annulatus* Hofker may be a synonym of *Puteolina marginalis* (Lamarck). It is not at all certain that "*O. marginalis*" from the Pacific is identical with *O. marginalis* from the Caribbean.

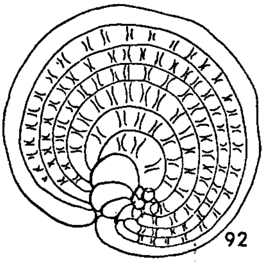
ST. EUSTATIUS: Billy Gut, sta. 1117. ST. MARTIN: Great Bay, 1127.

Fig. 76. ***Puteolina angulata*** (Fichtel & Moll). — South Bimini, sta. 1150A; microspheric specimen, at the margin three rows of foramina (× 25).

Fig. 77–85. ***Puteolina marginalis*** (Lamarck). — Buck Island, St. Croix (Mortensen coll.): 77, initial part of A_2-form; 78, initial part of A_1-form; 79, margin with one row of apertural openings; 80, marginal part of test, with larger openings (brood-chamber?); 81, chamberlets near margin; 82, transverse section; 83, upper part of same transverse section; 84, surface, showing that the septa of the chamberlets do not form sutures at the outer wall, since the pits continue at the septa, which would lead to the supposition of "pillars" according to SMOUT & EAMES (76, 85 ×25, 77–83 ×55, 84 ×210).

Fig. 86. ***Puteolina compressa*** (d'Orbigny). — Congolay, St. Croix, Mortensen coll.: test with double row of apertures at the margin (×25).

Fig. 87–91. ***Puteolina discoidea*** (Flint). — 87, 89–90, South Bimini, sta. 1150A: 87, the indications of the septa are seen in the last-formed chambers, at the margin only one row of apertures; 89–90, both with margin; 91, microspheric form. — 88, Bonaire, sta. 1067, test seen in oil, to show the first row of undivided chambers and the septa of the chamberlets (87, 89–97 ×25; 88 ×55).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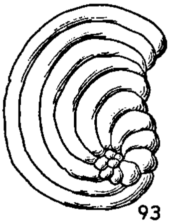
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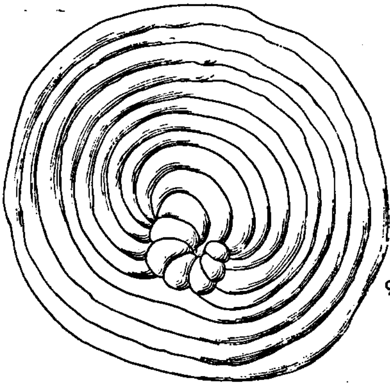
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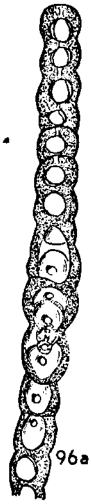
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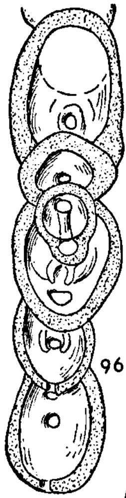
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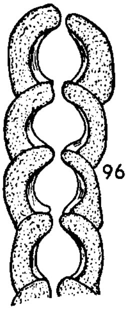
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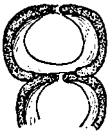
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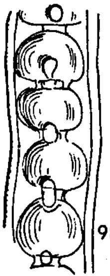
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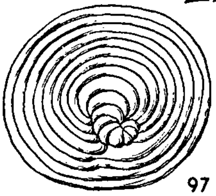
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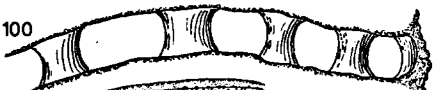
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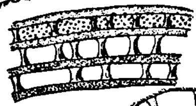
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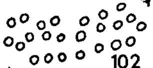
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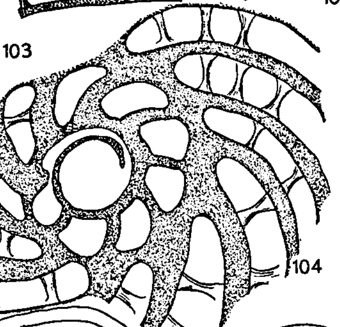
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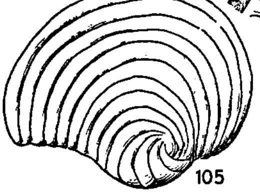
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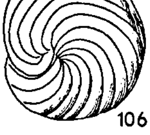
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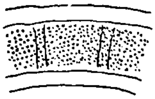
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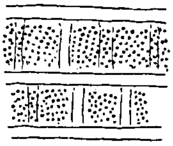
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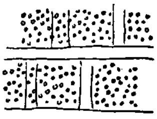
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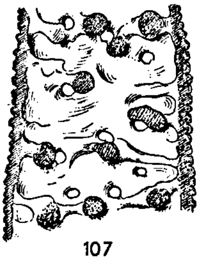
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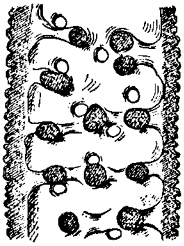
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Puteolina (Sorites?) discoidea (Flint)

Figs. 87–99, 110

Peneroplis discoideus FLINT, 1897, p. 304, pl. 49 fig. 1–2; CUSHMAN, 1930, p. 41, pl 15 fig. 5–8.

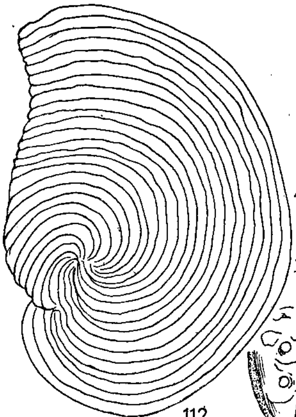
First chambers in a planispiral coil, distinctly involute; the proloculus cannot be seen from the outside, in contrast to *Puteolina marginalis* and *P. orbitoilitoides*. Later chambers flaring, in the end becoming embracing and circular. In specimens with larger proloculus the later chambers are all flaring; specimens with a smaller proloculus have more embracing chambers.

CUSHMAN placed the species in *Peneroplis*, but the wall shows very fine pits, often arranged in fine striae, which indicates the species to be a *Puteolina*. According to CUSHMAN, this species has no chamberlets. Although the openings in the dividing septa of the chamberlets are very large, so that only traces of the septa are

Fig. 92–99. *Puteolina discoidea* (Flint). — Aves de Sotavento, sta. AS1: 92–93, two specimens, the first one in oil to show the septa; 94, surface with the small pits; 96a transverse section, b middle part of same section, c marginal part of that section, showing the large openings in the septa between the chamberlets, d another part of that section; 97, the individual sectioned; 98, last formed chamber loosened from the test and seen from within, showing the openings in the septa and the location of the row of apertures at the margin; 99, margin (92–93, 95 × 27; 94, 96b–d, 98 × 160; 96a, 99 × 55; 97 × 25).

Fig. 100–108. *Puteolina angulata* (Fichtel & Moll). — North Bimini, sta. 1150A: 100, opened chamber to show the "pillars", and the pitting of the outer wall; 101, two opened chambers, another with the outer wall with pits; 102, pits; 103, margin with the apertures in full-grown specimen, possibly microspheric; 104, horizontal section of megalospheric test; 105, young test of A_1-form; 106, test of A_2-form; 107–108, two parts of chambers, cut tangentially, to show the "pillars" as upstanding parts of septa between the chamberlets when a pillar is near the outer wall, a real suture is formed without pits (100 and 102 × 210; 101 and 103 × 55; 104, 107–108 × 160; 105–106 × 27).

Fig. 109–111. Outer surfaces of chambers of the three species of *Puteolina* mostly found together in the samples concerned (× 100). — 109, *P. compressa*: in some of the septa between the chamberlets the pits are lacking, in others the pits are continuous, suggesting "pillars". — 110, *P. discoidea*: the small pits are nearly always continuous at the septa. — 111, *P. angulata*: the pits are continuous or interrupted at the septa between the chamberlets (*adunca*). The three species are different in the size of the pits.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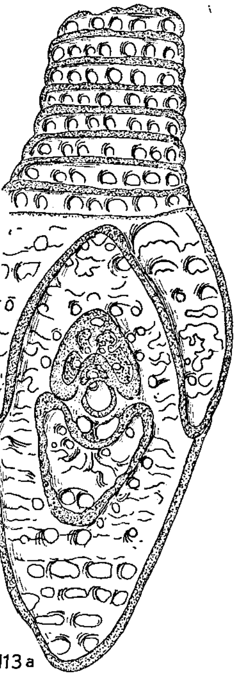
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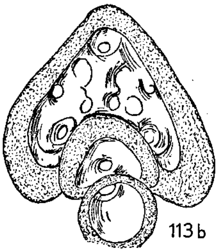
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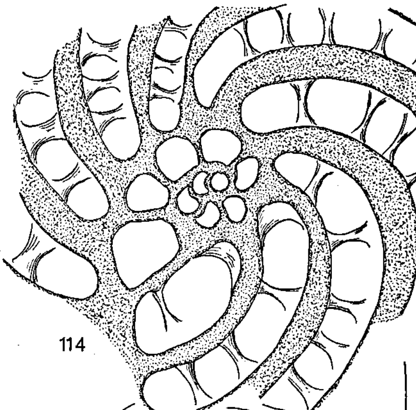
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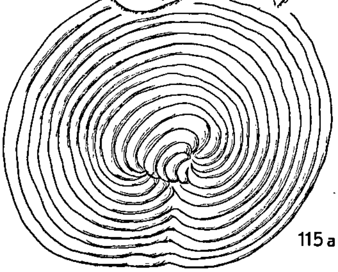
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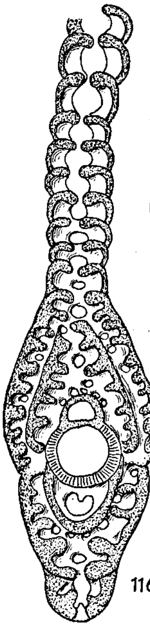
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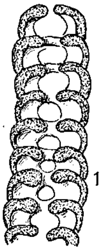
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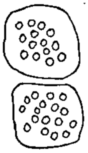
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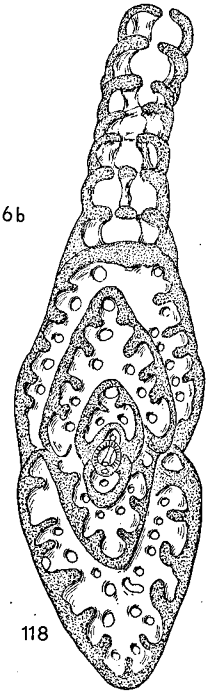
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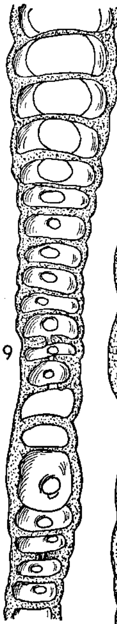
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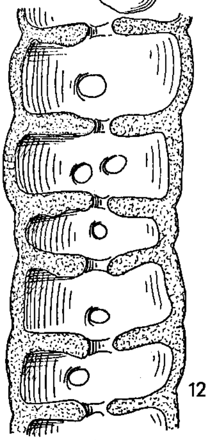
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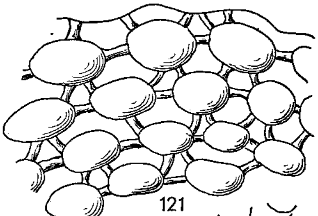
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122

found in the embracing chambers, the septa can be observed in each chamber. Consequently, the species may be considered as a slightly involute *Puteolina* of the "*Sorites*"-group.

ARUBA: Punta Braboe, sta. 1002. BONAIRE: Playa Lechi, 1056A; Lac, Cay, 1067. KLEIN BONAIRE: 1049B, 1371. AVES DE SOTAVENTO: AS 1, AS 37. AVES DE BARLOVENTO: AV 1. NEW PROVIDENCE: between Hog I. and Athol I., 1149. SOUTH BIMINI: 1150A, NORTH BIMINI: 1151.

Puteolina protea (d'Orbigny) Figs. 135–146

Peneroplis proteus D'ORBIGNY, 1839, Cuba p. 61, pl. 7 fig. 1–2.
Puteolina protea (d'Orbigny) HOFKER, 1952, p. 452–455, fig. 41.

Initial part of test lenticular; chambers totally involute and approximately extending up to the thickened central part. The younger part often flaring and fan-shaped, or more or less rectilinear. Wall finely pitted. Aperture of first chambers with a distinct tooth, in younger chambers of close-coiled specimens in two forking rows; in the fan-shaped chambers the aperture is a single row of rounded openings. – In sectioned tests the teeth can be observed at the base of each chamber. In abnormal specimens two sets of

Fig. 112–113. *Puteolina angulata* (Fichtel & Moll). — South Bimini, sta. 1150A: entire test and transverse section of same specimen, showing the septal walls in the coiled chambers and the "pillars", actually septa with many openings between the chamberlets of the flaring chambers; 113b, central part of the section (112 × 17; 113a × 57; 113b × 160).

Fig. 114–118. *Puteolina compressa* (d'Orbigny). — Aves de Sotavento, sta. AS1: 114, horizontal section through large specimen, obviously microspheric (proloculus 16 μ), in the peripheral part brood chambers were found; 115a, same specimen; 115b, margin with one row of large openings in the brood chambers; 116, section through A_2-specimen; 117, pits on the surface; 118, section through A_1-specimen, showing transitional stages between real "septa" into real "pillars" (114, 117 × 160; 115 × 27; 116, 118 × 57).

Fig. 119–122. *Orbitolites hemprichii* (Ehrenberg). — Buck Island, St. Croix: 119, transverse section, showing the widening of the openings in the septa towards the brood chambers; 120, tangential section through a row of chambers, showing the openings between the septa and the apertural openings in the marginal wall; 121, part of test filled with canadabalsam and decalcified, to show the foramina between the chambers; 122, marginal part of specimen with brood chambers (119, 122 × 57; 102–121 × 160).

uniserial chambers may be present; in some specimens the later parts of two tests are fused together.

The species is common.

ARUBA: Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Malmok, 1301. CURAÇAO: Awa Blanco, 1351. BONAIRE: Playa Lechi, 1055, 1055A, 1056A; De Hoop, 1058C; Lac, Poejito, 1064A; Lac, Cay, 1067; Lac, Boca, 1068a. KLEIN BONAIRE: 1049B, 1371. AVES DE SOTAVENTO: AS 1, AS 37. TOBAGO: Buccoo Bay, 1385; Buccoo Reef, 1387. ANTIGUA: Deep Bay, 1393. BARBUDA: Martello Tower Beach, 1394; Two Feet Bay, 1395. ST. EUSTATIUS: Gallows Bay, 1116B. ST. MARTIN: Great Bay, 1125A, 1127. ST. JOHN: bay S. of Cruz Bay, 1408. NEW PROVIDENCE: between Hog I. and Athol I., 1149 SOUTH BIMINI: 1150A. NORTH BIMINI: 495, 1151.

Puteolina crassa Hofker Figs. 147–148

Puteolina crassa HOFKER, 1952, p. 455–456, fig. 42.

This species strongly resembles *P. protea*. The test wall is thicker, the pits are much coarser, and the chambers are higher.

The species is scarce, and apparently occurs in somewhat deeper water.

AVES DE SOTAVENTO: AS 1; AS 37.

Orbitolites (Amphisorus) hemprichii (Ehrenberg) Figs. 119–128

Amphisorus hemprichii EHRENBERG, 1838, p. 134, pl. 3 fig. 3.
Orbitolites marginalis Lamarck, HOFKER, 1952, p. 109–110, fig. 57.
Orbitolites duplex Carpenter, of authors.

CUSHMAN (1930) identified the specimen of pl. 16 fig. 7 in BRADY's Challenger Report 1884 as his *Amphisorus hemprichii* Ehrenberg. BARKER (1960) doubted this; in his opinion these Pacific forms all belong to *Marginopora vertebralis*. Specimens of Pacific *Amphisorus* differ from those found in the West Indies, but some groups undoubtedly belong to *Orbitolites duplex* Carpenter as described from the East Indies. HOFKER (1930 Siboga) gave a description of the inner structure of these forms (*O. marginalis*, *O. duplex*, *Marginopora vertebralis*); their structure is more complicated than in the West Indian form; the simplest form in the Pacific is *O. marginalis*

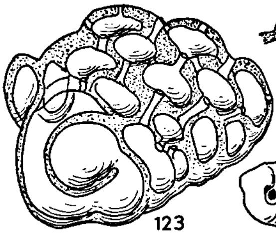
Lamarck, which most closely resembles the species from the Caribbean. The similarity of *Orbitolites* (*Amphisorus*) *hemprichii* to the Pacific forms, as stated by CUSHMAN, has led to the erroneous conclusion that the Caribbean form has two layers of chambers. The main difference consists in *O. duplex* and *Marginopora* having circular later chambers, whereas the chambers of *Amphisorus hemprichii* are not chamberlets of circular chambers but lozenge-shaped chambers, a fact which also causes the difference in the situation of the foramina between these chambers. Moreover, CUSHMAN's opinion that *Amphisorus* has two layers of chambers, obviously based on *Orbitolites duplex*, gives rise to misunderstanding; all transverse sections show only one layer of chambers.

The megalospheric proloculus has no pores, is large and somewhat irregular, and is followed by a second chamber embracing the first; a single chamber then follows (Figs. 127–128), followed again by 8–10 rows of chambers (not chambers with chamberlets); in younger stages the chambers are added more irregularly, each chamber communicating with chambers of other rows.

The same structure but further developed is found in Eocene *Orbitolites complanata*, the chambers of which are divided into chamberlets. In many full-grown megalospheric specimens the last-formed chambers are irregular brood chambers, containing megalospheric embryons (Fig. 126).

It is not certain that the species, fully described by many authors as *Orbitolites marginalis* Lamarck from the Pacific (see HOFKER, 1930 Siboga), is identical with the Caribbean species; nor is it certain that LAMARCK had this species in mind and not the species defined by CUSHMAN as such from the Challenger Report and figured by him in 1930. BARKER (1960) stated that similar specimens have been called *Sorites hofkeri* by LACROIX (1940). This name seems to apply to the specimens with simple chambers described by me (1930 Siboga) from the Pacific; *Praesorites orbitolitoides*, however, is another species.

By restricting the name *Orbitolites* (*Amphisorus*) *hemprichii* (Ehrenberg) to the group with lozenge-shaped small chambers (not chamberlets of circular chambers) found in the Caribbean, a definite species is established which has no relation to the species beginning with a peneropline set of chambers, classified as *Puteolina*. *Amphisorus hemprichii* Ehrenberg, as defined by CUSHMAN (except for the double layer of chambers, which is not present), is an *Orbitolites*, as stated above.



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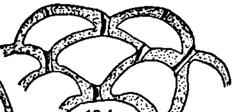

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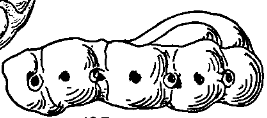

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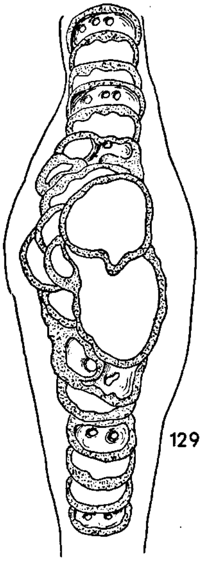

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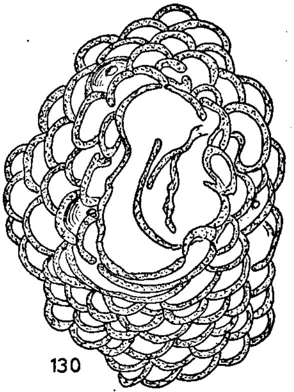

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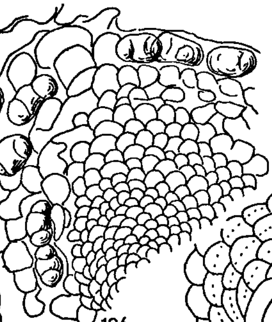

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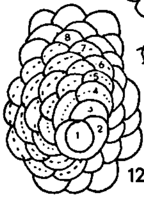

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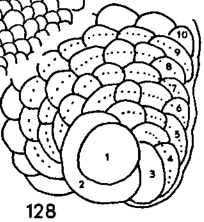

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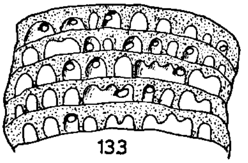

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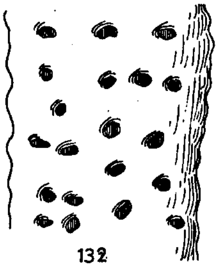

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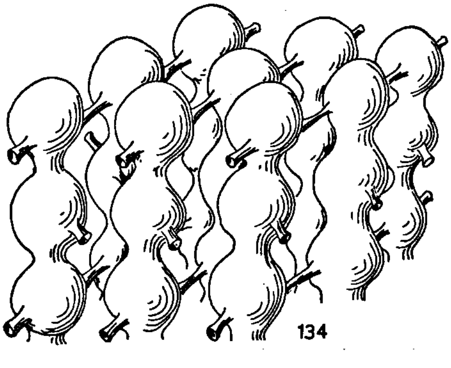

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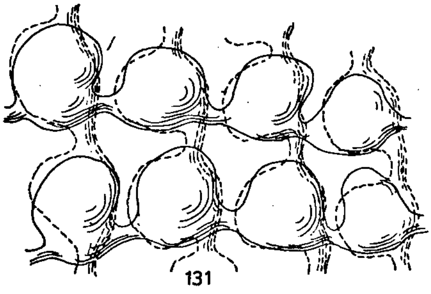

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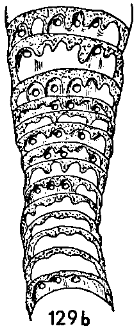


129 b

ARUBA: Punta Braboe, sta. 1002; Boekoeti, 1006; Malmok, 1301. CURAÇAO: Fuik Baai, 1039; Santa Marta Baai, lagoon, 1323; St. Jan lagoon, 1325A; Fuik Baai, pool, 1348; Awa Blanco, 1351. BONAIRE: Playa Lechi, 1055A, 1056A; Punt Vierkant, 1059B; Lac, Poejito, 1064A, 1065; Lac, Cay, 1067; Lac, Boca, 1068a. KLEIN BONAIRE: 1049B. AVES DE SOTAVENTO: AS 37. TOBAGO: Buccoo Bay, 1385; Buccoo Reef, 1387. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. BARBUDA: Martello Tower beach, 1394. ST. EUSTATIUS: Gallows Bay, 1116B. ST. BARTS: Gustavia, 450. ST. MARTIN: Great Bay, 1125A, 1126, 1127; Simson Bay Lagoon, 1130, 1130A. ST. CROIX: Krausse Lagoon, 1405, 1406. SOUTH BIMINI: 1150A. NORTH BIMINI: 495, 1151, 1152. CAT KEY, 499.

Neoalveolina pulchra (d'Orbigny) Fig. 161

Alveolina pulchra D'ORBIGNY, 1839, Cuba p. 70, pl. 8 fig. 19–20; CUSHMAN, 1921, p. 77, pl. 19 fig. 7–9.

Borelis pulchra (d'Orbigny) BERMUDEZ, 1935, p. 192; CUSHMAN, 1930, p. 55, pl. 15 fig. 9–10.

Neoalveolina pulchra (d'Orbigny) HOFKER, 1952, p. 111–115, fig. 58–60.

This species was analysed in detail by the author in 1952. It was pointed out that the Mediterranean form and the Red Sea form must belong to the same species, and that *Neoalveolina pygmaea schlumbergeri* Reichel is synonymous with *Neoalveolina pulchra* (d'Orbigny).

Fig. 123–128. *Orbitolites hemprichii* (Ehrenberg). — 123–125, St. Martin, sta. 1130: 123, young specimen with megalospheric proloculus and long neck chamber and the first rows of chambers with their foramina; 124, part of test, chambers with foramina; 125, the specimen of Fig. 123, margin with apertures. — 126, Bonaire, sta. 1056C: broken specimen with brood chambers filled with embryons, in oil. — 127–128, Buck Island, St. Croix: 127, A_1; 128, A_2, central parts, showing the arrangement in rows of the first set of chambers (123–124 × 160; 125–126 × 27; 127–128 × 55).
Fig. 129–134. *Orbitolites complanata* Lamarck. — Lutetian of Paris: 129 transverse section, showing the erratic chambers on the dorsal side of the protoconch; 130, horizontal section of the initial part; 131, two rows of chamberlets as seen in decalcified canada balsam preparation; 132, margin with many rows of apertures; 133, part of transverse section near the periphery; 134, schematic drawing to show the arrangement of the foramina between the layers of chamberlets as seen in a canadabalsam preparation (129–130, 132–133 × 55; 131 × 65).

Specimens were found in many samples, mostly in globular forms.

ARUBA: Malmok, sta. 1301. CURAÇAO: Awa Blanco, 1351. BONAIRE: Lac, Cay, 1067. AVES DE BARLOVENTO: AV 1. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. BARBUDA: Martello Tower beach, 1394; Two Feet Bay, 1395. ST. EUSTATIUS: Gallows Bay, 1116B; Billy Gut, 1117. ST. BARTS: Gustavia, 450; Public, 1121. ST. MARTIN: Great Bay, 1125A, 1126, 1127. NEW PROVIDENCE: between Hog I. and Athol I., 1149. SOUTH BIMINI: 1150A.

Dendritina elegans (d'Orbigny) Figs. 149–155

Peneroplis elegans D'ORBIGNY, 1839, Cuba p. 61, pl. 7 fig. 1–2.
Dendritina elegans (d'Orbigny) HOFKER, 1952, p. 228–230, fig. 3–5.

CUSHMAN (1930, p. 35) combined *Peneroplis elegans* and *Peneroplis pertusus* (Forskål). The present author considers the West Indian species to be different from the Mediterranean form.

In many tests the apertures are fused together into structures which are typical for *Dendritina*. The ornamentation of the test, when studied with high magnification, does not show the typical striae of *Peneroplis*, but consists of rows of fine pits. The shape of the test is variable; in some cases the chambers are embracing, and the uniserial row of rounded chambers at the end shows several rounded apertures. (These forms may have been confused with *Peneroplis arietinus*.) – The original aperture may be enlarged to allow the plasmodiospores to leave the last-formed chambers. The proloculus of these plasmodiospores is larger than of the mother tests.

ARUBA: Salinja Oranjestad; Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Boekoeti, 1006. CURAÇAO: Fuik Baai, 1039; Santa Marta lagoon, 1323; Awa Blanco, 1351. BONAIRE: Playa Lechi, 1055, 1056A; Lac, Poejito, 1064A; Lac, Cay, 1067. KLEIN BONAIRE: 1049C, 1371. AVES DE SOTAVENTO: AS 1. GRENADA: White Bay, 1389. BARBUDA: Martello Tower beach, 1394; Two Feet Bay, 1395. ST. EUSTATIUS, Gallows Bay, 1116B. ST. BARTS: Gustavia, 450. ST. MARTIN: Great Bay, 1125A, 1127; Simson Bay Lagoon, 1130, 1130A, 1131. NEW PROVIDENCE: between Hog I. and Athol I., 1149. NORTH BIMINI, 1151. CAT KEY, 499.

Palaeopeneroplis nov. gen.

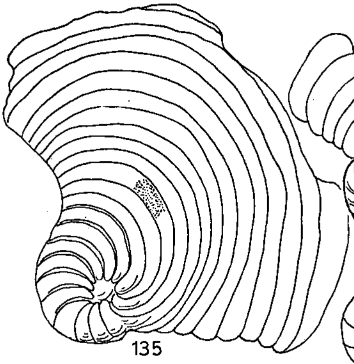
In the Lutetian of the Paris Basin, Peneroplidae are found which, even in well-preserved specimens, show no trace of ornamentation of the walls. They have been described by LE CALVEZ (1952) as *Spirolina cylindrica* Lamarck, *Spirolina laevigata* d'Orbigny, *Dendritina depressa* (Lamarck) and *Dendritina laevigata* (Terquem). The structure of the aperture in these species is dendritine.

In the material from the West Indian islands, however, one species was found with an aperture as in *Peneroplis*, and with characteristics of *Puteolina protea*. In specimens studied from various localities, the test is smooth, without pits or striae. Not only the proloculus has pores, but several of the next chambers are also porous, as in *Peneroplis*; in the megalospheric form, 7–8 chambers with pores are present. It may be concluded that the Dendritines from the Lutetian and the recent "*Peneroplis*" belong to an ancient group without ornamentation. It is proposed to classify these peneropline forms as a genus, *Palaeopeneroplis*, type species *P. inornatus* nov. spec.

Palaeopeneroplis inornatus nov. spec. Figs. 156–160

Test in the early stage consisting of strongly embracing chambers, reaching the centre. Younger chambers flaring, the whole test resembling *Puteolina proteus*. Apertures forming two rows of small round openings in the small specimens without flaring chambers; in specimens with flaring chambers one single row of openings. Margin rounded. The megalospheric proloculus with neck chamber is followed by (19) simple chambers with one basal aperture and a distinct tooth. Wall without pits or striae, smooth, lustrous.

This species may be related to *Peneroplis carinatus* d'Orbigny, as described by CUSHMAN (1930, p. 36, pl. 12 fig. 7–10, pl. 14 fig. 1) from the Caribbean. In that case, *Dendritina carinata* (d'Orbigny), described by HOFKER (1950, *71*, p. 230–232, fig. 6–8) from the Pacific, is another species, as it has a dendritine aperture, whereas *P. ornatus* has this type of aperture only in the first chambers. The Pacific species has a pitted surface, whereas CUSHMAN described the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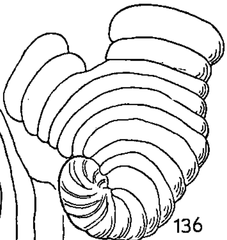
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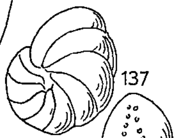
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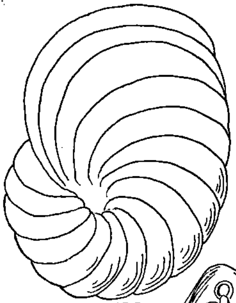
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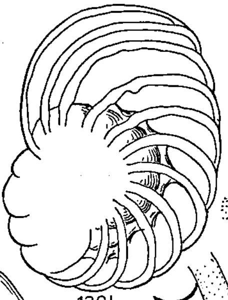
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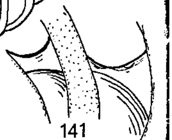
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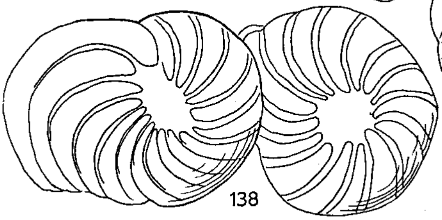
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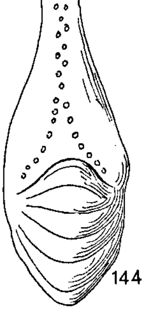
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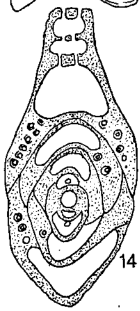
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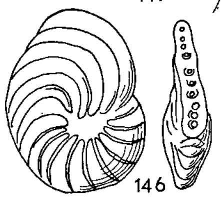
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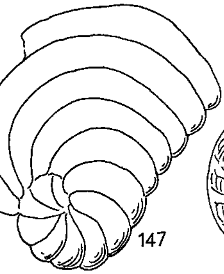
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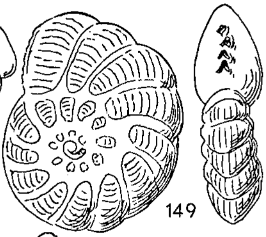
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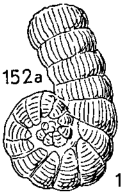
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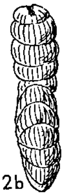
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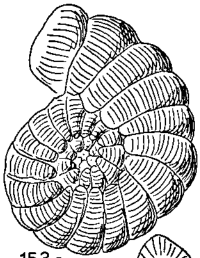
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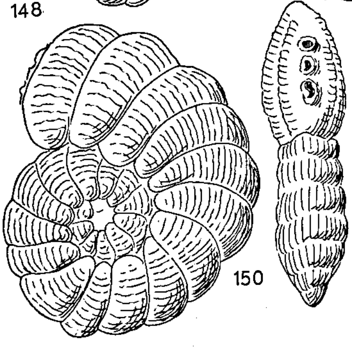
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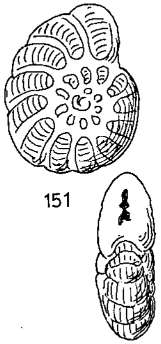
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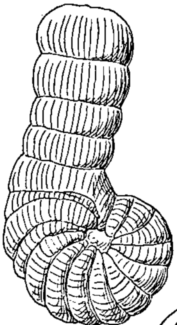
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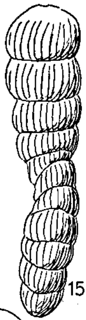
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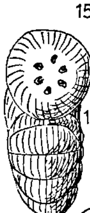
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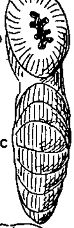
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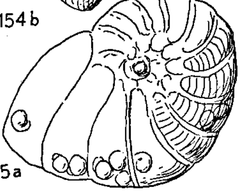

155a

Caribbean form, with dendritine aperture, as having a smooth surface. D'ORBIGNY's species was from the coast of Patagonia and may be different from the Caribbean form.

ST. EUSTATIUS: Billy Gut, sta. 1117. SOUTH BIMINI: 1150A.

Hauerina d'Orbigny, 1846

Genotype: *Hauerina compressa* d'Orbigny.

The author (1952, 72, p. 119–121, fig. 63–65) published an analysis of *Hauerina fragilissima* (Brady) and of *H. ornatissima* (Karrer). The genus has two characteristics in common with some Peneroplidae: a porous wall in the megalospheric proloculus of *H. fragilissima* and the presence of an internal coating on the walls of the chambers. Another striking similarity with some Peneroplidae is the occurrence of transverse septa with a single large opening in the chambers of *H. ornatissima.* Such septa are found also in the chambers of "*Archaias*".

Fig. 135–146. *Puteolina protea* (d'Orbigny). — 135–136, Bonaire, sta, 1067: 135, wall pitted; 136, abnormal specimen. — 137, Bonaire, sta. 1056C: from two sides. — 138, St. Martin, sta. 1127: abnormal specimen. — 139–145, St. Eustatius, sta. 1116B: 139a from the outside, 144 apertural face, 139b the same test in oil, to show the teeth at the apertures of the chambers at the margin of the foregoing whorl; 140, pores; when grinding down the test in the position of Fig. 144, the septa of some of the first chambers were disclosed, Figs. 142–143; these figures show the apertures and the marginal teeth; Fig. 145 is the result of the grinding, the transverse section; Fig. 141 shows the teeth, higher enlarged, from aside. — 146, Bonaire, sta. 1067: specimen from two sides (135–137, 146 ×27; 138–139, 144–145 ×55; 141–143 ×160).

Fig. 147–148. *Puteola crassa* Hofker. — Aves de Sotavento, sta. AS1: entire test and the pits at the surface (147 ×27; 148 ×160).

Fig. 149–155. *Dendritina elegans* (d'Orbigny). — St. Martin, sta. 1131: from two sides. — 150, Bonaire, sta. 1067: from two sides. — 151, Bonaire, sta. 1056A: from two sides. — 152–153, Curaçao, sta. 1155: 152, same specimen from three sides; 153, another specimen from two sides. — 154, New Providence, sta. 1149: same specimen from three sides. — 155, St. Martin, sta. 1127: specimens of megalospheric generation with embryons; the proloculi of the embryons are slightly larger than that of the mother-animal; a, side view in oil; b, apertural face to demonstrate the enlarged aperture to let the young pass (149–151, 155 ×55; 152–154 ×27).

In the material from the Antilles two species have been found: *Hauerina ornatissima* and *H. bradyi*. The latter is not greatly different from *H. fragilissima*, and the internal coating is present. But also in *H. ornatissima* the internal coating is present, forming the whole chamber, which is therefore covered by its own wall, and not, as in *Quinqueloculina*, by its wall and the wall of a former chamber. By this difference, *Miliola* is distinguished from *Quinqueloculina*.

The aperture of *Miliola* is generally closed by a so-called trematophore, with a tooth underneath, as observed in many species from the Lutetian in the Paris Basin.

H. ornatissima has a similar reduced tooth below the typical trematophore. Complicated apertures in the apertural face of Peneroplidae are rather common and may be compared with the trematophores of *Miliola*. Internal septal structures are found in many Cretaceous and Eocene miliolids with internal coating. Peneroplidae, *Miliola* and *Hauerina* seem to be closely related. Many Peneroplidae have pits on the walls, comparable with those in *Miliola*. With *Flintina*, *Heterillina*, *Trillina*, *Lacazina*, the genera *Hauerina*, *Miliola* and the Peneroplidae form a close assemblage of Foraminifera with cribrate aperture, aragonitic tests, porous walls in the initial part, pitted surface and in many groups internal coating in the chambers. In more developed forms internal septa of various structure are frequently found in many of the chambers. *Hauerina* and Peneroplidae, possibly also *Nevillina* (internal coating has not been observed in *N. coronata* Sidebottom) and some species of *Miliola* are the only recent groups.

The trematophorids had their greatest distribution from Lower Cretaceous to Eocene.

Hauerina (?) **ornatissima** (Karrer) Figs. 162–165

Quinqueloculina ornatissima KARRER, 1868, p. 151, pl. 3 fig. 2.
Hauerina ornatissima (Karrer) BRADY, 1884, p. 192, pl. 7 fig. 15–22; CUSHMAN, 1921, p. 72; BERMUDEZ, 1935, p. 166.

Test in transverse section quinqueloculine; the structure is obscured by ornamentation. Chambers forming nearly half of the coil. Wall of each chamber with fine longitudinal striae, interrupted by many transverse partitions with a single, basal, triangular opening.

As the type, *H. compressa* d'Orbigny, does not show any traces of these partitions, it is doubted whether our species belongs to *Hauerina*. The aperture is cribrate and formed by the last-formed partition of the chamber, which forms ridges and stolons, resulting in the trematophoric aperture. The proloculus does not have pores as was stated for *Hauerina*. An analysis was made of the transverse partitions in the more carinate form from the Pacific (Hofker 1952, *72*, p. 120–122, fig. 64–65), which was identified by Barker (1960, p. 14) as *Hauerina involuta* Cushman.

Curaçao: Spaanse Water, New Haven, sta. 1036A; Fuik Baai, 1039. Aves de Sotavento: AS 1. Antigua: Deep Bay, 1393. St. Martin: Great Bay, 1125A, 1126, 1127. Cat Key, 499.

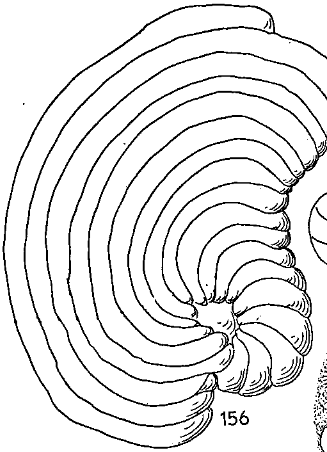
Hauerina bradyi Cushman Figs. 166–167

Hauerina compressa H. B. Brady (not *H. compressa* d'Orbigny), 1884, p. 190, pl. 11 fig. 12–13.
Hauerina bradyi Cushman, 1917, p. 62, pl. 23 fig. 2; Cushman, 1921, p. 72; Bermudez, 1935, p. 166.

The test is flattened, thin-walled, younger chambers forming ⅓ to ¼ of a coil, somewhat irregular in shape. Aperture cribrate. A transverse section shows the proloculus to have pores in the wall. It is followed first by a more or less quinqueloculine group of chambers, then by a typically sigmoiline set of more flaring chambers.

The sigmoiline type of younger chambers was also observed in the Pacific *Hauerina fragilissima* (Brady) (Hofker, 1952, *73* p. 119–120, fig. 63) which also has pores in the wall of the proloculus.

Aruba: Salinja Oranjestad, Curaçao, Spaanse Water, New Haven, sta. 1036A. Bonaire: Lac, Poejito, 1064A. Klein Bonaire: 1371. Aves de Sotavento: AS 1. Barbuda: Martello Tower Beach, 1394. St. Eustatius: Gallows Bay, 1116B. St. Martin: Great Bay, 1125A. Cat Key: 499.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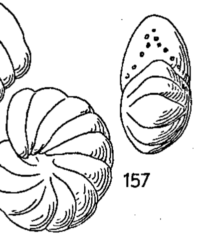
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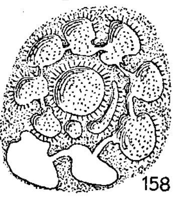
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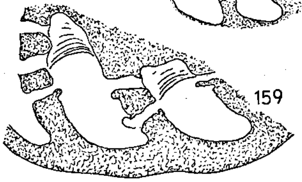
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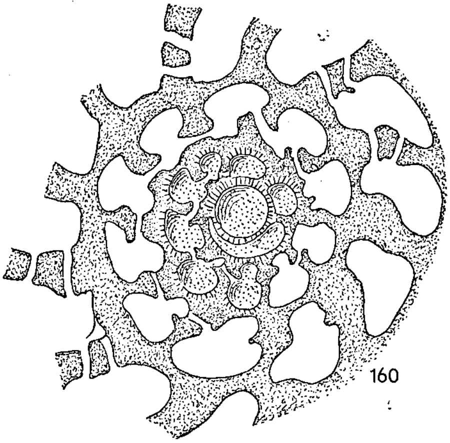
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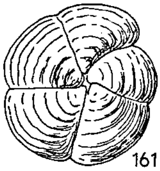
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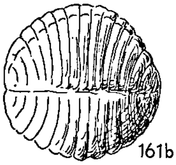
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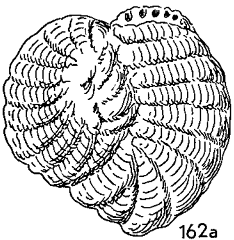
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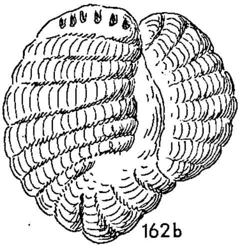
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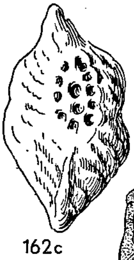
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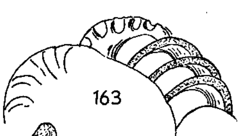
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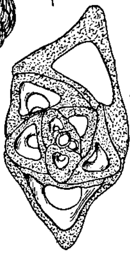
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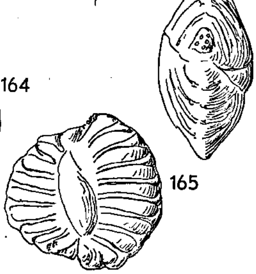
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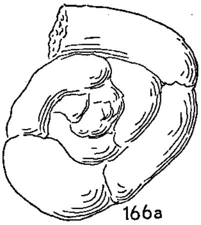
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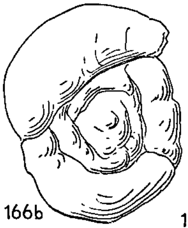
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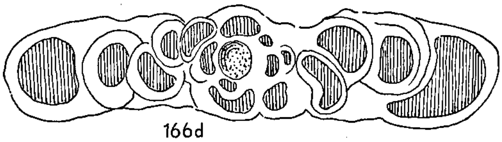
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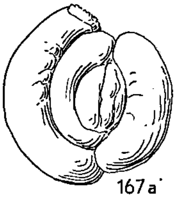
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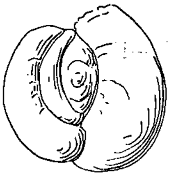
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VALVULINIDAE

This family, established by CUSHMAN, comprises a group of genera which, in their more primitive forms, show a triserial arrangement in the initial part and, in some groups, may also contain more than three chambers to a whorl (*Marssonella*; for detailed analysis of the group, see HOFKER, 1957, p. 78–89). All real Valvulinidae have a more or less developed toothplate, extending from one aperture to the next in the typical forms, and in many cases constituting a prominent plate over the last-formed aperture. The wall is agglutinated and porous.

Whether this group began in the Jurassic is doubtful, as species described from that formation are poorly known and may belong to other groups. Species found by the author in the Santonian, with toothplates, a triserial arrangement of the chambers and pores in the walls, must belong to this family (*Valvoreussella* Hofker, 1957). Their toothplates may have consisted of a pseudochitinous substance. Species assigned to *Marssonella* from older strata ought to be analysed for these characteristics; most species from the Lower Cretaceous which have been studied by the author do not have the characteristics of real Valvulinidae, as is in fact the case in the type species of *Marssonella*. The Arenobuliminae do not belong to this group, since they lack the characteristics of the type genus, *Valvulina*. The same applies to *Eggerella*.

Marssonella, definitely known from the lower part of the Upper Cretaceous, seems to belong to the family, although the initial coiling is not triserial. Many other genera mentioned by CUSHMAN as belonging to the Valvulinidae, such as *Pernerina*, *Orbignyna*, *Ataxophragmium*, *Hagenowella*, and *Plectina*, do not have

Fig. 156–160. *Paleopeneroplis inornatus* nov. spec. — 156, 158–160, South Bimini, sta. 1150A: 156, outgrown test; 158, central part of horizontal section of same specimen, showing the large set of chambers with pores in the walls; 159, optical view of same specimen in oil, showing the teeth at the margin; 160, horizontal section of another specimen. — 157, St. Eustatius, sta. 1117: test of A_2-generation (156–157 × 27; 158–160 × 160).

Fig. 161. *Neoalveolina pulchra* (d'Orbigny). — St. Martin, sta. 1127: specimen from two sides (× 57).

Fig. 162–165. *Hauerina*(?) *ornatissima* (Karrer). — 162–164, Antigua, sta. 1393: 162, same specimen from three sides; 163, view of the same individual in oil, showing the trematophore and the secondary septa; 164, transverse section of this test. — 165, St. Martin, sta. 1127: a smaller specimen from two sides (× 57).

Fig. 166–167. *Hauerina bradyi* Cushman. — Cuba, near Habana (Bermudez coll.): test from three sides and transverse section. — 167, Curaçao, sta. 1036A: same indications (166a–c, 167 × 57; 166d × 160).

the characteristics of *Valvulina* and do not belong to the Valvulinidae. It is believed that only genera with the basic characteristics of *Valvulina* (pores in the walls, and toothplates) belong to the Valvulinidae.

Valvulina d'Orbigny, 1826

This is considered the central genus of the Valvulinidae. Some Jurassic forms are assigned to this genus, viz. *Valvulina haeusleri* (Galloway) and *V. cuneiformis* Chapman, but they are little known. A few species are known from the Cretaceous, e.g. *V. bullata* Brotzen; a close study by the author revealed that it does not belong to this genus, as it lacks the characteristics of the type species, i.e. a porous wall and a real toothplate. All other known species are from Tertiary to Recent, the oldest known by the author being from the Montian.

CUSHMAN (1937, *8*, p. 2) described the genus as follows: "Test free or attached, spiral, conical, triserial, usually umbilicate, typically with three chambers throughout, but in the megalospheric form with the adult having more than three chambers to a whorl; wall arenaceous, of coarse or fine material, surface very rough or smooth; aperture with a distinct, valvular tooth".

The type species, *Valvulina triangularis* d'Orbigny, from the Lutetian of the Paris Basin, shows the triserial arrangement in the megalospheric form only; hence this should be a typical feature of the genus. Species, the test of which has more than three chambers to a whorl, should not be assigned to this genus. The type species has other typical characteristics not mentioned by CUSHMAN. In the type species, and also in other species mentioned by Mrs. LE CALVEZ (1952, p. 10–15), from the Lutetian of Paris, typical pores are found in the walls between the arenaceous grains. In well-preserved specimens, these pores do not completely penetrate the wall, but their opening is closed with a fine layer of hyaline chalk. This was also found in the recent species *V. oviedoiana* d'Orbigny. The pores are considered characteristic of the genus. The "valvular tooth" is the most distal part of a typical toothplate in Paleocene, Eocene and Recent species. This toothplate is generally also more or less arenaceous, with a large amount of fine microgranular chalk, no traces of pores, and running obliquely through the lumen of the chamber, from the valvular tooth of one aperture to that of the next one; it has an attached part and a free folded part, the latter forming their valvular tooth. Real *Valvulina* belongs to the Dentata (cf. HOFKER, 1951 Siboga, p. 19; 1956 Spolia, p. 24–25).

The following amended description of the genus is presented:

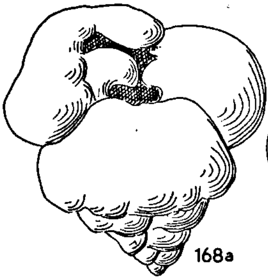
Test free or attached, conical, trochoid, mostly triserial. As the aperture is very large, parts of it may remain open when new chambers are added. Walls in younger chambers mostly smooth, in older chambers often irregularly thickened, arenaceous, with much chalky cement, and with distinct pores not reaching the surface; a fine layer of hyaline chalk closes the pores in well-preserved specimens. Aperture sutural, more or less loop-shaped, with a large flange formed by the toothplate which partly closes the aperture. This toothplate begins at the previous toothplate and runs obliquely through the chamber; its free folded part forms the tooth. The tooth is attached to the distal border of the aperture. Paleocene to Recent.

A detailed study of the Recent species *"Valvulina" conica* Parker & Jones and *"Valvulina" fusca* (Williamson), many specimens of which were present in samples of the Ingolf-Expedition, indicates that they do not belong to the genus *Valvulina*. The walls are not cemented with chalk but with a ferruginous substance, as in many species of *Trochammina*; moreover, pores and toothplates are absent; the aperture is loop-shaped, and the valvular lip is only formed by a basal dent at the sutural side of the loop, as described by HÖGLUND (1947, p. 188); an inner toothplate is absent. Like many species of *Trochammina*, these species are generally found as attached forms (*Tritaxis fusca* (Williamson)).

Valvulina oviedoiana d'Orbigny Figs. 168–174

Valvulina oviedoiana D'ORBIGNY, 1839, p. 103, pl. 2 fig. 21–22; CUSHMAN, 1937, *8* p. 10, pl. 2 fig. 4–5 (There all literature).

Test roughly triangular, short or elongate, chambers triserial; all chambers fairly distinct, last-formed chambers largely inflated.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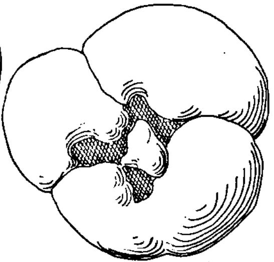
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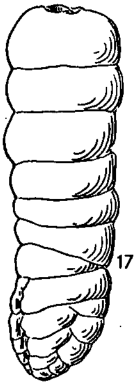
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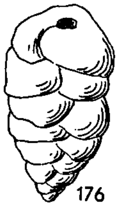
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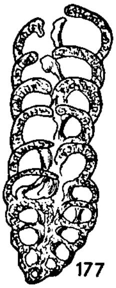
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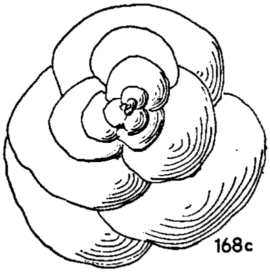
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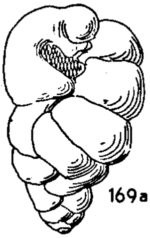
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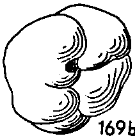
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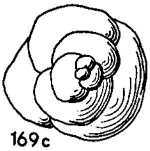
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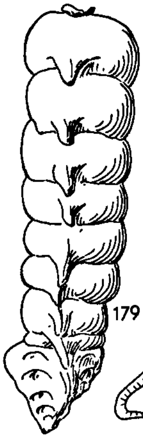
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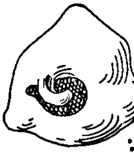
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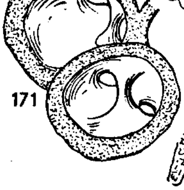
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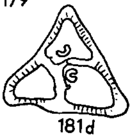
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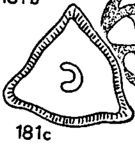
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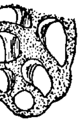
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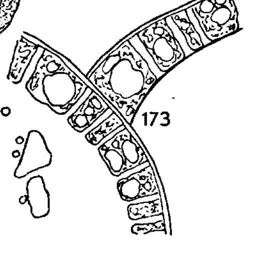
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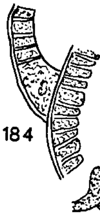
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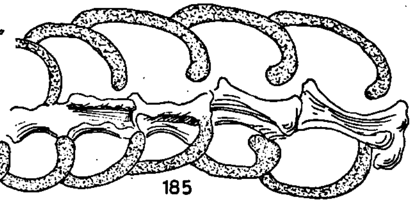
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Sutures distinctly depressed. Wall in the early part thickened and roughly arenaceous, in the later part smooth, finely agglutinated with much calcareous cement. Aperture a large sutural opening closed by a flat, slightly bent tooth, the flange-shaped, free, folded part of an irregular toothplate, which is slightly agglutinated and devoid of pores. Walls have distinct pores, which do not reach the surface; a fine layer of clear substance covers them on the outside. – Length up to 1.50 mm; breadth up to 1 mm.

The species comes from shallow waters in the West Indies. It was found in large quantities at sta. 1131, St. Martin, Simson Bay Lagoon, tidal zone, and in many other localities.

In samples containing many specimens, three different forms may be observed; they were also described and figured by BERMUDEZ, 1935, p. 154, pl. 2 fig. 1–3. One is triangular with distinct buds on each chamber, causing a rough surface; a second form has smoother walls and the last-formed chambers are voluminous; in the third form the specimens are more elongate and remain slender at the oral end. These three forms have been found in samples from

Fig. 168–174. *Valvulina oviedoina* d'Orbigny. — Cuba, near Habana, Bermudez coll.: 168, B-generation, test from three sides; 169, A_2-generation, from three sides; 170, A_1-generation, from three sides; 171, initial chambers showing the toothplates within the chambers; 172, part of longitudinal section, showing toothplates and chamberwalls; 173, part of same section, showing the structure of the walls; 174, pores and sand grains in the wall; the pores are closed by a chitinous layer at the outer surface (168 – 170 × 27; 171 × 160; 172 × 27; 173 × 240).

Fig. 175–178. *Clavulina parisiensis* d'Orbigny. — Lutetian of Paris: 175–176, total tests; 177, transverse section; 178, part of wall, seen in oil, showing the pores (175—177 × 27; 178 × 160).

Fig. 179–185. *Clavulina tricarinata* d'Orbigny. — St. Martin, sta. 1131: 179–180, two tests; 181a, apertural face; b, transverse section through the last formed chamber; c, transverse section through the forelast chamber, to demonstrate the angle which the toothplate makes with that of the next chamber; d, transverse section through the triangular part, showing three chambers with toothplates; 182, pores in the outer wall; 183, section through the initial part, showing the proloculus and the centrally standing toothplates in the next chambers; 184, part of transverse section through the wall, with pores and covering chitinous layer; 185, end part of longitudinal section, showing the toothplates which in the uniserial part become free, as in *Loxostoma* in the Bolivinidae (179–180 × 27; 181, 183, 185 × 57; 182, 184 × 160).

Simson Bay and Havana, Cuba; in several other localities one of the forms may be absent, in which case few specimens were found. It is obvious that these three forms together represent the variation in the species. This variation is believed to be caused by trimorphism, the large form being the B-form, the rough form the A_1-form, the slender form the A_2: the large form has a very small proloculus, the rough form a larger one, and the slender form a very large proloculus. (See also CUSHMAN, 1937, *8*, p. 17–18, pl. 3).

CURAÇAO: St. Jan Lagoon, sta. 1325A. BONAIRE: Lac, Cay, 1067. AVES DE SOTAVENTO: AS 37. BARBUDA: Two Feet Bay, 1395; Great Lagoon, 1396. ST. MARTIN: Great Bay, 1125A, 1126, 1127; Simson Bay Lagoon, 1030A, 1131, 1402. NEW PROVIDENCE: between Hog I. and Athol I., 1149. SOUTH BIMINI: 1150A. NORTH BIMINI: 495.

Clavulina d'Orbigny, 1826

This genus must be closely related to real *Valvulina*. The first part of the test is triserial, whereas the younger part is uniserial. In many species, e.g. in the genotype, *C. parisiensis* d'Orbigny (Figs. 175–177) from the Lutetian of Paris, the uniserial chambers become rounded, whereas in other species they are distinctly triangular in transverse section. The genotype could be studied through the kindness of Mrs. LE CALVEZ, who supplied beautiful material from Villers-St.-Frédéric. in which *C. parisiensis* is abundant. In both the genotype and the West Indian species *C. tricarinata*, a real toothplate was observed in each of the chambers; the chamber walls, as in all real Valvulinidae, have distinct pores with an outer lining. Since these features are typical of the genotype, *C. parisiensis*, they have to be added to the characteristics of the genus. The description of the genus *Clavulina* should be as follows:

Test elongate, the early stages triserial, the later stages uniserial. The early portion generally triangular and the later part angular or rounded in transverse section; chambers simple, not divided. Wall generally finely arenaceous with much cement and distinct pores. Aperture in the triserial part similar to *Valvulina*, sutural, with toothplate which forms a free folded part partly closing the aperture; in the adult part the aperture is areal and terminal, more or less circular, with a conspicuous toothplate running free through the lumen of each chamber, forming a slightly protruding tooth. In the uniserial part the successive toothplates are found under an angle of 120° with each other, so that the triserial arrangement is maintained in the uniserial part.

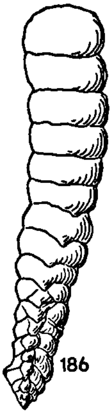
Clavulina tricarinata d'Orbigny Figs. 179–185

Clavulina tricarinata D'ORBIGNY, 1839, Cuba p. 114, pl. 2 fig. 16–18.
Clavulina angularis FLINT (non d'Orbigny), 1897, p. 289, pl. 36 fig. 2.
Valvulina triangularis d'Orbigny, forma *Clavulina angularis* GOËS, 1882, p. 86, pl. 11 fig. 387–389. – Additional literature in: CUSHMAN, 1937, *8* p. 22.

Test elongate, in some cases slightly tapering, triangular in section, slightly increasing in diameter towards the apertural end; last chamber inflated. Triserial part generally slightly broader than the uniserial part, with more or less distinct chambers; uniserial chambers distinct, with three angles slightly overlapping the former chamber. Sutures in the uniserial part distinct, slightly depressed. Wall finely arenaceous with distinct small pores in the outer chamber walls, which are smoothly finished. Aperture more or less circular, with a thick distinct toothplate; the free folded part parallel to the border of the aperture. This toothplate originates from the upper border of the former toothplate and may form a slightly protruding lip at the aperture. Toothplate calcareous with traces of sandgrains. All chambers with a toothplate, which in the triserial part is attached to the axial wall of the chamber; in the uniserial chambers the toothplate is free, running through the middle of the chambers. Colour of test greyish. – Length of test up to 2 mm.

In well-preserved specimens, the pores are covered with a fine calcareous substance, as in *Valvulina*.

ARUBA: Boekoeti, sta. 1006. CURAÇAO: Fuik Baai, 1039. BONAIRE: Lac Cay, 1067. ST. KITTS: Basseterre, 1398. ST. MARTIN: Great Bay, 1126, 1128A; Simson Bay, 1130A, 1131, 1402. NEW PROVIDENCE: between Hog I. and Athol I., 1149. SOUTH BIMINI: 1150A.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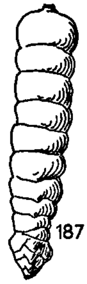
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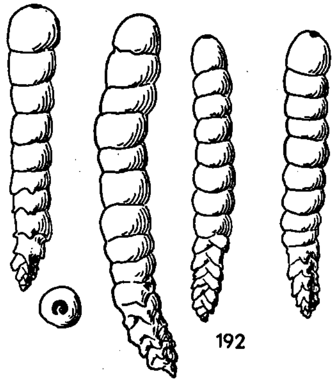
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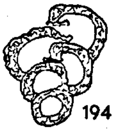
193 b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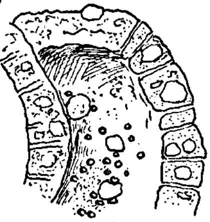
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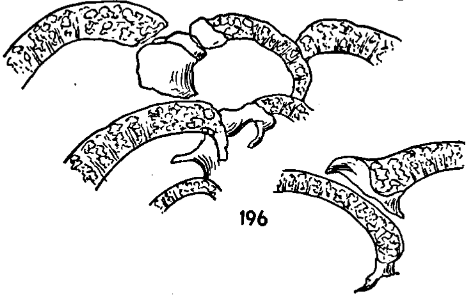
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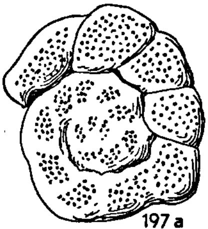
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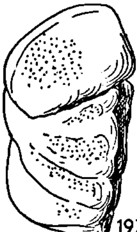
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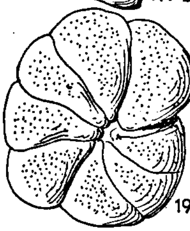
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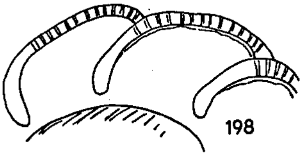
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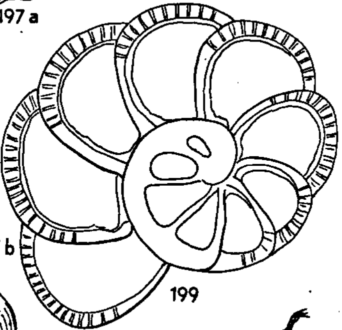
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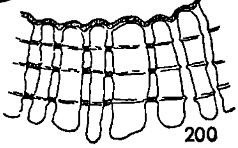
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Clavulina angularis d'Orbigny Figs. 186–191

Clavulina angularis D'ORBIGNY, 1826, p. 268, pl. 12 fig. 7.

Test elongate, the triserial part distinctly triangular in section, the uniserial chambers rounded. The chambers of the triserial part are distinct, with depressed sutures and sharp angles, the sutures of the uniserial part are depressed and the chambers inflated. Wall finely arenaceous, with fine but distinct pores, and smoothly finished. Aperture terminal, round, with a small neck in some specimens and a distinct toothplate which runs through all chambers from aperture to aperture. – Length of specimens up to 1.50 mm, diameter 0.40 mm.

The species is common in a sample from Aruba, Salinja Oranjestad, collected in 1930, and present in three different forms. One of these forms is large (up to 4 mm); the triserial part consists of at least 8–9 rows of chambers; the following uniserial chambers have the same shape as *Clavulina tricarinata* (5 chambers) and the youngest chambers are typically round in transverse section. A second form shows a much shorter triangular initial part, followed by few (3–4) chambers of the *tricarinata*-form and in the youngest part the chambers become rounded. In the third form, only the short triangular part is triangular, followed directly by rounded chambers.

This variation leads to the conclusion that these three forms represent the three generations of the species.

Fig. 186–191. *Clavulina angularis* d'Orbigny. — Aruba, Salinja Oranjestad: 186, B-form; 187, A_2-form; 188, A_1-form; 189, last part of specimen Fig. 186; 190, last-formed chamber opened to show toothplate; 191, apertural face (186–188 ×13; 189–191 ×27).

Fig. 192. *Clavulina nodosaria* d'Orbigny. — Curaçao, sta. 1155, 4 specimens, and an apertural face. (×27).

Fig. 193–196. *Valvotextularia candeiana* (d'Orbigny). — Aves de Sotavento, sta. AS1; 193, whole test from two sides; 194, longitudinal section of initial part, showing the toothplates in the chambers; 195, one chamber in transverse section, showing the pores in the wall; 196, part of a longitudinal section, showing walls and the toothplates closing the apertures (193 ×27; 194 ×55; 195–196 ×160).

Fig. 197–200. *Cibicides refulgens* Montfort. — 197, whole test from three sides; 198–200, sections which show wall and pore structures of the type species.

The test consists of fine sand grains, some of them dark, causing the whole test to be greyish.

ARUBA: Salinja Oranjestad. CURAÇAO: Fuik Baai, sta. 1348. BONAIRE: Lac, Poejito, 1065. BARBUDA: Great Lagoon, 1396. ST. MARTIN: Simson Bay Lagoon, 1130A.

Clavulina nodosaria d'Orbigny Fig. 192

Clavulina nodosaria D'ORBIGNY, 1839, Cuba p. 110, pl. 2 fig. 19–20; BERMUDEZ, 1935, p. 154, pl. 11 fig. 7.
Textularia gibba d'Orbigny, forma *bigenerina* GOËS, 1882, p. 79, pl. 5 fig. 162–164.
Clavulina laevigata GOËS, 1894, p. 40, pl. 8 fig. 356–357.

Test slender, smaller than the other *Clavulina* species in the region. Triangular part large, consisting of 5–7 rows. All chambers of this part have a definite angle at their initial end, giving this part a rough appearance. Some of the following uniserial chambers may also show these angles, but in other specimens the chambers are rounded. The aperture is round, generally with short neck, and a toothtplate runs through all chambers. The wall is finely agglutinated, with fine pores between the sand grains, smoothly finished, mostly yellow or brown. – Length up to 0.5 mm.

The species is apparently not common. It was found off Havana, Cuba, and in two samples of HUMMELINCK's collection.

CURAÇAO: Santa Marta lagoon, sta. 1323. SOUTH BIMINI: 1150A.

Valvotextularia candeiana (d'Orbigny) Figs. 193–196

Textularia candeiana D'ORBIGNY, 1839, Cuba, p. 143, pl. 1 fig. 25–27; CUSHMAN, 1921, p. 50, pl. 11, fig. 7–8; BERMUDEZ, 1935, p. 151.
Valvotextularia candeiana (d'Orbigny) HOFKER, 1956, Sp.zool. p. 34–35, pl. 2 fig. 13–30.

In 1956 I stated that the aperture does not have a lip. However, in several specimens the aperture was found to be closed or nearly closed by a thick, irregular, calcareous lip; consequently, the species actually belongs to the dentate Foraminifera. Distinct pores can be observed in the coarsely agglutinated wall, particularly in transverse section.

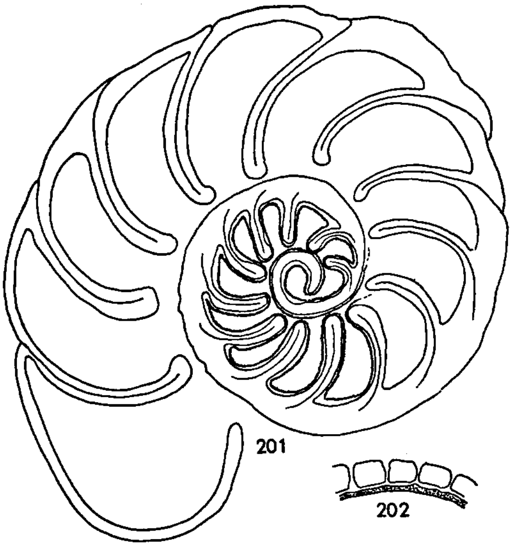
It is the only textularid species in the samples.

ARUBA: Salinja Oranjestad; Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Malmok, 1301. BONAIRE: De Hoop, 1058C. AVES DE SOTAVENTO: AS 1; AS 37. AVES DE BARLOVENTO: AV 1. TOBAGO: Buccoo Bay, 1385. ST. EUSTATIUS: Gallows Bay, 1116B. ST. MARTIN: Great Bay, 1125A. ST. JOHN: S of Cruz Bay, 1408. SOUTH BIMINI: 1150A. NORTH BIMINI: 1151.

Cibicides Montfort, 1808

The genotype is *Cibicides refulgens* Montfort, which is common in the deeper water of the North Atlantic. The present author (1957, p. 91) emphasized the granular texture of the wall and supposed that this genus may actually be arenaceous. In living specimens of *Cibicides lobatulus* (Walker & Jacob), the author observed that, in forming a new chamber, the outer protoplasm (hyaloplasm) forms a thick coating first; many small particles of chalk are embedded in this layer, and these particles are moved both in the underlying protoplasm and in pseudopodia surrounding the sides on the drop-shaped new chamber. This strongly suggests agglutination. Together with this agglutination, the outer layer hardens, but at intervals it remains liquid, and here the pores are formed. In *Cibicides refulgens*, at the outside opening of each pore in a non-thickened wall, a sieve plate can be seen, which has been described by several authors. In secondarily thickened older walls, new sieve plates are added in the pores, flush with the surface of each added layer of chalk, and as many as three or four of these sieve plates may be observed.

Many genera of Foraminifera with larger pores in older chambers (never in the last-formed chamber) secrete an inner layer of a pseudochitinous substance or of hyaline chalk. In all cases observed, the pores are not visible in this inner layer and consequently it must be closed at the inner side. In fossil Gavelinellae, the diameter of the pores increases during geological time and an inner lining of the chamber walls is formed when the pores reach a diameter of about 4 μ.



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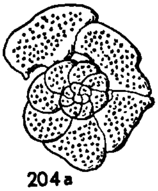

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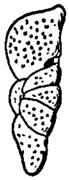

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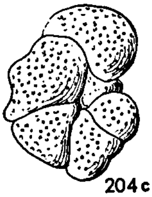

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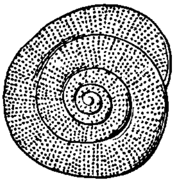

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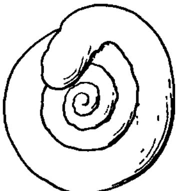

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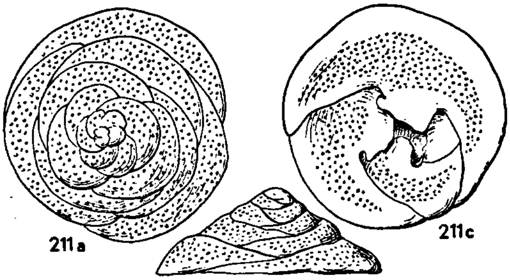

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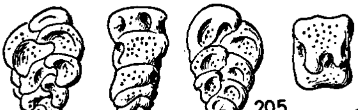

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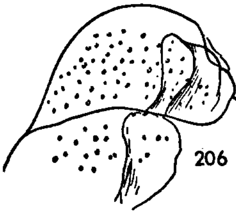

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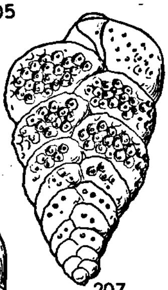

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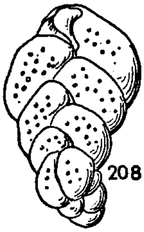

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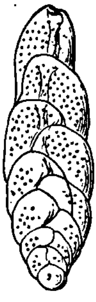

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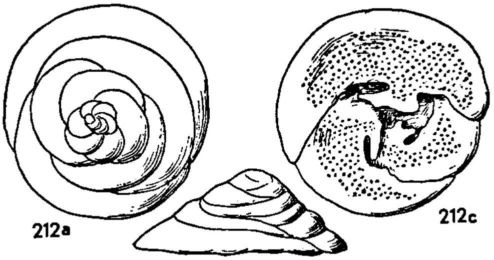

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Figures 197–200 show some of these structures in the type species, *C. refulgens*; Figs. 201–202 are sections through *Gavelinella costata* Brotzen, the genotype of *Gavelinella*. It can be seen that the process of forming double septa in *Gavelinella* is different from that in *Cibicides*. The sections reveal that in *Gavelinella* the double septa are formed by the proximal wall of the next chamber; in the older chambers an inner pseudochitinous coating may be added, which closes the pores (Fig. 202). Fig. 203 (see p. 114) shows two species of Upper Cretaceous *Gavelinella*, the pores of which increased in size in course of time, an inner coating being added when the diameter of the pores reached 4 µ.

The genus *Gavelinella* obviously belongs to a group of Foraminifera which is quite different from the *Cibicides* group, and the double septa of *Gavelinella* have no relation to the double septa of *Cibicides*, which are formed by the calcareous inner lining. REISS (1957, p. 127–145) placed *Gavelinella* in his superfamily Bilamellidae; later, he added *Cibicides* to this superfamily on the strength of "double septa" (1959, p. 355–357, pl. 1). It is evident that if *Gavelinella* is a bilamellid Foraminifer, *Cibicides* is not, though its chamber walls have an inner hyaline coating. The same inner coating without pores can be observed in fossil *Cibicides beaumontianus* (d'Orbigny), also mentioned by REISS. Real double septa

Fig. 201–202. *Gavelinella costata* Brotzen. — The sections reveal that in the genotype of *Gavelinella* the double septa are formed by the proximal wall of the next chamber; in the older chambers an inner pseudochitinous coating may be added, which closes the pores Fig. 202. [Fig. 203, see p. 114.]

Fig. 204. *Cibicides lobatulus* (Walker & Jacob). — Curaçao, sta. 1039: dorsal side, apertural face and ventral side (× 50).

Fig. 205–206. *Bolivina rhomboidales* (Millet). — Bonaire, sta. 1067: 205, total test, in different views; 206, last part of test, showing the shape of the toothplate (× 170).

Fig. 207. *Bolivina subexcavata* Cushman & Wickenden. — Bonaire, sta. 1055A (× 125).

Fig. 208. *Bolivina tortuosa* Brady. — Bonaire, sta. 1055A (× 125).

Fig. 209. *Bolivina* (*Loxostoma*) *lanceolata* Parker. — Curaçao, sta. 1039 (× 57).

Fig. 210. *Spirillina densepunctata* Cushman. — Curaçao, sta. 1036: dorsal side, side-view and ventral side (× 55).

Fig. 211–212. *Neoconorbina orbicularis* (Terquem). — Bonaire, sta. 1067: dorsal side, side view and ventral side of two specimens (× 55).

(Bilamellidae) are formed by the proximal walls of successive chambers (to be compared with the inner walls in the genus *Miliola*, see above); a hyaline inner coating of the older wall, closing the pores, is found in Foraminifera in which the pores became too large and had to be closed. It is incorrect to group both phenomena under the same heading. *Cibicides* is not a bilamellid Foraminifer. On the basis of its agglutinated walls, it is placed close to the Agglutinantia.

Cibicides lobatulus (Walker & Jacob) Fig. 204

Nautilus lobatulus WALKER & JACOB, 1798, p. 642, pl. 14 fig. 36.
Truncatulina lobatula D'ORBIGNY, 1839, Canaries p. 134, pl. 2 fig. 22–24.
Cibicides lobatula (Walker & Jacob) CUSHMAN, 1931, p. 118, pl. 21 fig. 3.
Truncatulina (*Cibicides*) *lobatula* (Walker & Jacob) HOFKER, 1930, Faroës p. 13–20, fig. 25–33.

The flat dorsal side shows the complete spiral of chambers, with the dorsal part of the apertures of the last-formed chambers along the spiral suture; the convex ventral side only shows the inflated chambers with depressed sutures of the last-formed whorl. Margin lobulate, sub-acute. Aperture marginal, extending over the dorsal side. On both sides distinct deuteropores. Wall not hyaline, consisting of small calcareous particles.

The typical specimens described by the author from the Faroës have distinct pores at the dorsal side, and very fine pores at the ventral side; specimens from the West Indies have distinct pores on both sides. They may belong to different species, or they may represent a variation of the normal type.

In 1959 (p. 115–116, fig. 16–20) the author proved that *Planorbulina* in its type-species, *P. mediterranensis* d'Orbigny, has the structure of *Cymbaloporetta*, analysed in 1951 (Siboga, p. 477–484) and that each chamber has two foramina, a proto- and a deuteroforamen. *Cibicides*, on the other hand, never shows two foramina in each chamber. Recently, NYHOLM (1961, p. 157–195) described wild-growing tests of *C. lobatulus* and compared them with *Planorbulina*, believing that these stages are "planorbulinoid"; it is emphasized that actually there is no relation between *Planorbulina* and *Cibicides*.

CURAÇAO: Fuik Baai, sta. 1039.

Bolivina rhomboidalis (Millet) Figs. 205–206

Textularia rhomboidalis MILLET, 1899, p. 559, pl. 7 fig. 4.
Bolivina rhomboidalis (Millet) CUSHMAN, 1922, p. 28; BERMUDEZ, 1935, p. 194; CUSHMAN, 1937, 9 p. 138, pl. 18 fig. 7.

Test small, triangular, with truncate periphery. Each chamber with a distinct rim at the distal suture, causing the surface to appear depressed. Wall distinctly perforate. Transverse section rectangular. Aperture small, loop-shaped.

The species was recorded from the Malay-Archipelago, the Mediterranean, the Falkland Islands, and the Caribbean.

BONAIRE: Lac, Cay, sta. 1067. ST. MARTIN: Simson Bay Lagoon, 1130.

Bolivina subexcavata Cushman & Wickenden Fig. 207

Bolivina subexcavata CUSHMAN & WICKENDEN, 1929, p. 9, pl. 4 fig. 4; HOFKER, 1956, S. Cruz p. 67, pl. 7 fig. 12–20.

Test small, triangular, margin subacute to acute. Walls hyaline; scattered pores, each in a pit. Aperture loop-shaped, sutural, with a protruding free folded part of the toothplate.

This species, which is one of the most common bolivinids in the samples, was fully analysed in 1956.

CURAÇAO: Santa Marta Baai, sta. 1323. BONAIRE: Playa Lechi, 1055A; De Hoop, 1058C; Boca Onima, 1071. KLEIN BONAIRE: 1049B, 1371. Islote Aves: 1114. ST. MARTIN: Simson Bay Lagoon, 1131.

Bolivina tortuosa Brady Fig. 208

Bolivina tortuosa BRADY, 1884, p. 420, pl. 52 fig. 31–32; HOFKER, 1951, p. 75–76, fig. 39; HOFKER, 1956, S. Cruz p. 61–62, pl. 6 fig. 22–29.

This peculiar *Bolivina* is scarcely present in some of the samples. The distinct pores, the twisted initial part, and the typical toothplate together with the texture of the wall, which is not hyaline but opaque, are typical features.

TAPPAN (1957, p. 227, pl. 73 fig. 1–2) did not consider this species a *Bolivina* and created a new genus name, *Sigmavirgulina.* The figures show a trochoid initial part. The present author, however, observed beyond doubt that the microspheric as well as the megalospheric generation begins with a biserial bolivinid initial part, and that the toothplates are similar to those of *Bolivina* and not of *Virgulina.* Consequently, the initial part is not trochoid as figured by TAPPAN. Though the granular wall points to *Virgulina,* all genera around real *Virgulina* have very fine pores, whereas *B. tortuosa* has coarse pores. For these reasons the original name is maintained.

It may be that *Sigmavirgulina* was a form quite different from that described by me.

BONAIRE: Playa Lechi, sta. 1055A.

Bolivina (Loxostoma) lanceolata Parker Fig. 209

Bolivina lanceolata PARKER, 1954, p. 514, pl. 7 fig. 17–20.
Bolivina (Loxostoma) lanceolata Parker, HOFKER, 1956, S. Cruz p. 64, pl. 7 fig. 1–7.

The elongate, hyaline, somewhat keeled test mostly ends with a loxostomate part with a free folded toothplate through the end chambers.

The subgeneric name (*Loxostoma*) is not used here in the sense of EHRENBERG (which has priority) but according to CUSHMAN. It only means that in later chambers the aperture becomes areal and terminal.

CURAÇAO: Fuik Baai, sta. 1039; Santa Marta Baai, 1323. BONAIRE: Playa Lechi, 1055A.

Spirillina densepunctata Cushman Fig. 210

Spirillina vivipara Ehrenberg var. *densepunctata* CUSHMAN, 1931, p. 4, pl. 1 fig. 5.

Test circular, much compressed, consisting of about 5 whorls. The last-formed part of the spiral sharply bends to below the ventral side and the slitlike aperture is found at the ventral inner border of this part. At the dorsal side the spiral chamber is slightly inflated, and has depressed sutures. The margin is acute with a slight keel which is poreless, as is the ventral side. Both sides are slightly convex, but on the dorsal side the spiral itself is inflated. Distinct pores in more or less radial rows are present on the dorsal side.

The last part of the spiral, also figured by CUSHMAN in 1931, seems to be characteristic. The test is hyaline, colourless.

The species was reported by CUSHMAN as scarce off Puerto Rico. In the Lesser Antillean samples it is present at only one station on Curaçao.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A.

Neoconorbina orbicularis (Terquem) Figs. 211–212

Rosalina orbicularis TERQUEM, 1876, p. 75, pl. 9 fig. 4.
Discorbina orbicularis (Terquem) BRADY, 1884, p. 647, pl. 88 fig. 4–8(?); CUSHMAN, 1921, p. 60; BERMUDEZ, 1935, p. 205.
Neoconorbina orbicularis (Terquem) HOFKER, 1956, S. Cruz p. 171–174, pl. 26 fig. 4–8.

This species has been fully analized by the author (1956). There is much confusion as to its proper name. BARKER (1960, p. 182) points out that RZEHAK (1888) renamed TERQUEM's species to *Discorbina terquemi*, as two species may be included in the name of *Rosalina orbicularis*, one by TERQUEM, 1876, and one by D'ORBIGNY, 1850. However, the species figured by BRADY (1884, fig. 5) from Bermuda is apparently not the same species as the one common in the West Indies and at the coast of Belgium. BARKER classified all four specimens figured by BRADY as *Neoconorbina terquemi* (Rzehak); however, it is obvious that the true nature of the latter species is unknown, as the four specimens figured by BRADY belong to four different species, probably all belonging to *Neoconorbina*. The species, described by the author in 1956, can be easily distinguished by the different shape of the suture, the tenon of the last-formed chamber, and the distribution of the pores on both sides. *Rosalina orbicularis* d'Orbigny is a Tertiary species; it is not certain whether it is identical with the Recent species from the English and Belgian coasts. The species figured by CUSHMAN (1949, p. 43, pl. 8 fig. 3) as *Discorbina orbicularis* (Terquem) var. *selseyensis* (Heron-

Allen & Earland) does not belong to the genus *Neoconorbina*, and it is to be regretted that CUSHMAN, who described *Discorbis orbicularis* (Terquem) from Belgium (1949, p. 42), did not give any figures. *Neoconorbina neapolitana* Hofker, found in the Mediterranean (HOFKER, 1960, p. 252, pl. D fig. 115) is not the same species.

ARUBA: Boekoeti, sta. 1006. BONAIRE: Punt Vierkant, 1059A; 1059B; Lac, Cay, 1067. KLEIN BONAIRE: 1371. ISLOTE AVES: 1114. NORTH BIMINI: 1151; 1152.

Discopulvinulina Hofker, 1951

For clarity's sake the characteristics of this genus are repeated here:

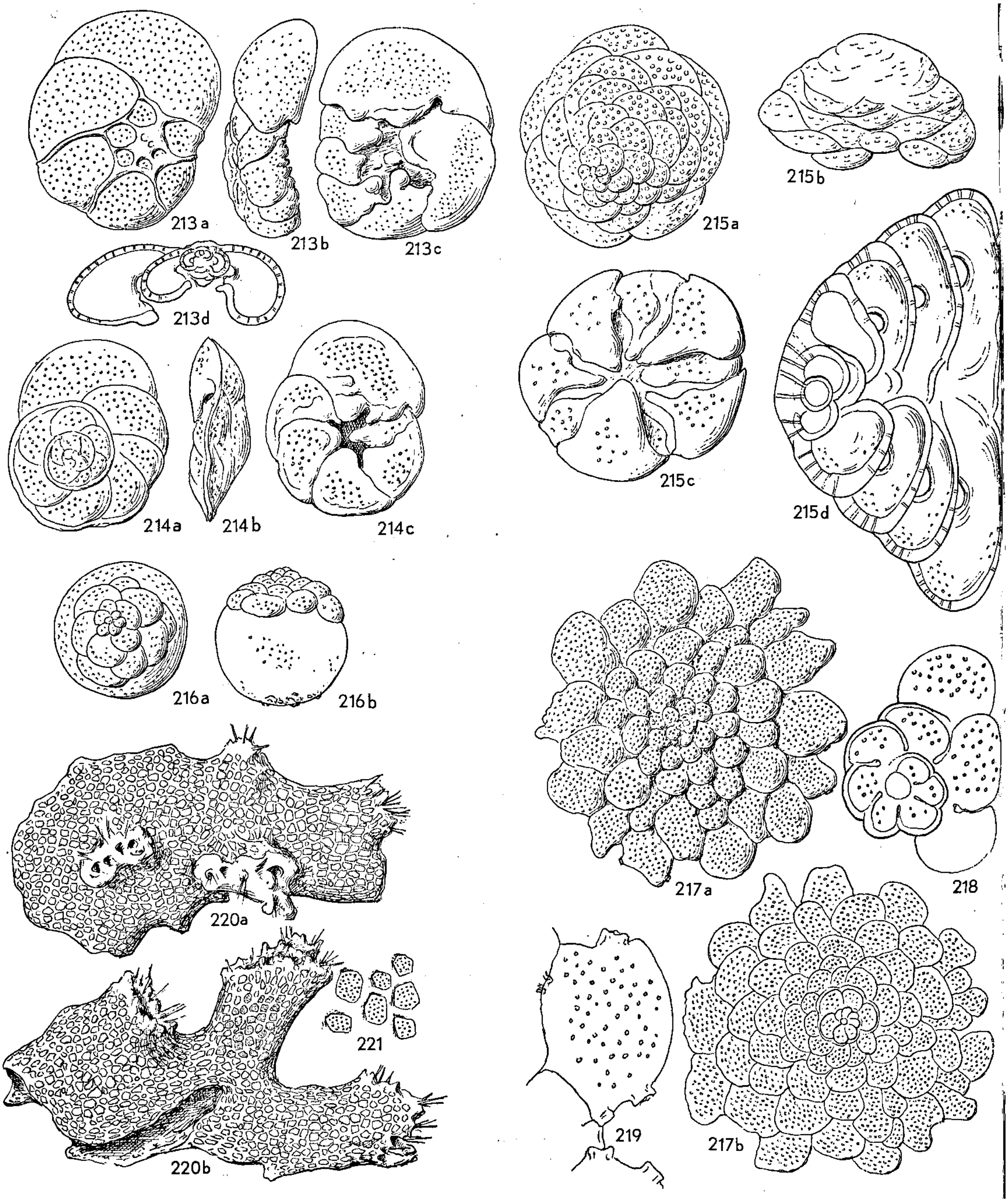
Trochoidal, first coils of chambers always visible at the dorsal side, later coils at this side often more or less overlapping earlier coils; on the ventral side, only the last-formed whorl of chambers visible. The chambers on the dorsal side always with pores; on the ventral side that distribution of pores is variable. In most species the margin is subacute to acute, often without pores. The ventral side shows an open, often very narrow, umbilical hollow. The last-formed chamber in many species forms one half of the ventral side and of the margin, but it may also be smaller. The ventral suture of the last-formed chamber, beginning at its proximal part, shows a more or less distinct, often rather small and inconspicuous, protoforamen; this protoforamen is connected with a strongly reduced toothplate within the chamber lumen; this inner toothplate may be nearly absent in many species; in all cases the external part of the toothplate forms a distinct lip, devoid of pores, distally placed from the protoforamen and separating the protoforamen from the deuteroforamen, which is always located at the distal ventral suture of the last-formed chamber. This deuteroforamen may have a thickened rim. The deuteroforamen often reaches the distal margin at the ventral side. Most species are flat, never conical. In 1956 (HOFKER, S. Cruz p. 178), totally overlapping chambers at the dorsal side were mentioned as being found in *Hanzawaia* Assano, 1944. Recently, BUTLER (1959 B.L. 59, 19) stated that HOFKER

(1955) placed the genus *Hanzawaia* in *Discopulvinulina* Hofker, which means that *Discopulvinulina* is a synonym of *Hanzawaia*, as the latter was established earlier. This, however, is not correct. The description of *Hanzawaia* leaves no doubt that the chambers at the dorsal side are totally overlapping. When redescribing *Cibicides concentricus* Cushman (HOFKER 1955, p. 128–130, fig. 1) this species was removed from *Hanzawaia* and placed in *Discopulvinulina*, because the chambers at the dorsal side do not totally overlap. Only those species which have totally overlapping dorsal chambers are to be placed in the genus *Hanzawaia*, as the type species, *Hanzawaia nipponica* Asano, has totally overlapping chambers at the dorsal side. Since *Hanzawaia concentrica* Cushman is not the genotype, the genus *Hanzawaia* is not disturbed by the removal of this species.

Discopulvinulina floridana (Cushman) Fig. 213

Discorbis floridanus CUSHMAN, 1922, p. 30, pl. 5 fig. 11–12.
Discorbis floridana CUSHMAN, 1931, p. 21, pl. 4 fig. 7–8.
Rosalina floridana (Cushman) PARKER, 1954, p. 52, pl. 8 fig. 19–20.

Test somewhat elongate, at the dorsal side slightly convex, at the ventral side concave; margin rounded. At the dorsal side, the central chambers are invisible owing to secondary calcareous thickening; last-formed whorl consisting of 6 chambers, the two youngest of which are large and broad; sutures slightly limbate, curved backward. The visible parts of the chamber walls at the dorsal side have distinct pores. At the ventral side each chamber shows a narrow deuteroforamen near the margin, a non-prominent poreless tenon, and a small but distinct protoforamen. The tena form a starlike figure with the umbilical hollow, into which some of the tena of earlier whorls protrude. Ventral wall finely punctate. In a transverse section, no real toothplate is found. The deuteroforamen is nearly marginal; below each tenon an opening connects the umbilical hollow with the lumen of each chamber. The first sets of chambers are closed at their ventral side by a round mass of calcareous material.


213 a
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217 b

On the basis of these characteristics, the species is placed in the genus *Discopulvinulina* Hofker. A transverse section shows that the chambers slightly overlap at the dorsal side. The species does not belong to BROTZEN's *Rosalina*, the test of which is more conical, and not to the genus *Neoconorbina* Hofker, the test of which is conical and the apertures of which have real and not reduced toothplates.

The figures given by CUSHMAN and PARKER are incorrect as to the ventral side, which cannot be analysed in dry state.

According to PARKER the species is common in shallow water; CUSHMAN mentioned it as also occurring in shallow water, but rarely. In the material examined the species is scarce.

ARUBA: Punta Braboe, sta. 1002. BONAIRE: Punt Vierkant, 1059B; Lac, Cay, 1067. KLEIN BONAIRE; 1049B. ST. MARTIN: Devil's Hole Swamp, 542.

Discopulvinulina valvulata (d'Orbigny) Fig. 214

Rosalina valvulata D'ORBIGNY, 1826, p. 271, no. 4; D'ORBIGNY, 1839, Canaries p. 136, pl. 2 fig. 19-21; D'ORBIGNY, 1839, Cuba p. 96, pl. 3 fig. 21–23.
Discorbis valvulata (d'Orbigny) CUSHMAN, 1921, p. 59, pl. 14 fig. 4–5; CUSHMAN, 1931, p. 33, pl. 7 fig. 3.

Test strongly compressed, dorsal side slightly conical, ventral side concave in the centre. At the dorsal side all chambers visible, 6–7 in the last-formed whorl; sutures rounded, slightly or not depressed, in the older chambers more distinct and with a thickened margin. At the ventral side sutures depressed, slightly lobulate;

Fig. 213. *Discopulvinulina floridana* (Cushman). — St. Martin, sta. 542: dorsal side, side view, ventral side and transverse section of same specimen (× 55).
Fig. 214. *Discopulvinulina valvulata* (d'Orbigny). — Bonaire, sta. 1067: dorsal side, side view and ventral side (× 55).
Fig. 215. *Cymbaloporetta squammosa* (d'Orbigny). — Bonaire, sta. 1071: dorsal side, side view, ventral side, and transverse section (a–c × 55; d × 160).
Fig. 216. *Tetromphalus bulloides* (d'Orbigny). — Cat Cay, near Bimini, sta. 499: dorsal and side view (× 55).
Fig. 217–219. *Planorbulina acervalis* Brady. — North Bimini, sta. 1151: 217, dorsal side, and ventral side; 218, initial part seen in oil from the ventral side; 219, chamber at the periphery, showing more than one aperture (217 × 27; 218–219 × 125).
Fig. 220–221. *Homotrema rubrum* (Lamarck). — Curaçao, sta. 1354: 220a, dorsal side; b, same specimen from aside; 221, surface (220 × 13; 221 × 57).

umbilical hollow narrow, but open, tena and margin thickened. At the dorsal side fine but distinct pores, at the ventral side pores in the central part of the chamber wall only. A species with these characteristics is a *Discopulvinulina*.

BONAIRE: Lac, Cay, sta. 1067.

Cymbaloporetta squammosa (d'Orbigny) Fig. 215

Rotalia squammosa D'ORBIGNY, 1826, p. 272, no. 8; D'ORBIGNY, 1839, Cuba p. 91, pl. 3 fig. 12–14.
Rosalina poeyi D'ORBIGNY, 1893, Cuba p. 92, pl. 3 fig. 18–20.
Cymbaloporetta squammosa (d'Orbigny) CUSHMAN, 1931, p. 83, pl. 16 fig. 4; BERMUDEZ, 1935, p. 214; HOFKER, 1951, Siboga p. 477–484; HOFKER, 1956, S. Cruz p. 188–189, pl. 28 fig. 11–20.

This species has been fully described by the author in 1951 and 1956. The form with a high conical test was described by D'ORBIGNY as *R. squammosa*; a transverse section of that form was given by HOFKER (1956, S. Cruz fig. 17). The flat form was named *R. poeyi* by D'ORBIGNY; CUSHMAN (1921, p. 58) found only flattened forms at the coast of Jamaica, and called them *Cymbalopora poeyi* (d'Orbigny). It seems that actually both forms belong to one single species; as *R. squammosa* was mentioned first by D'ORBIGNY in 1839 (the name from 1826 being a *nomen nudum*, as CUSHMAN stated in 1921), *C. squammosa* (d'Orbigny) is the correct name for this species. The flat form seems to have more pores in the ventral chamber walls than the high form. Moreover, coalescence of the chamber tena over the umbilicus is not as common in the flat form as in the high form. The high form is more common in deeper water and the flat form in shallow water.

ARUBA: Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004. CURAÇAO: Santa Marta Baai, 1323. BONAIRE: Playa Lechi, 1055; De Hoop, 1058C; Punt Vierkant, 1059A, 1059B; Lac, Cay, 1067; Boca Onima, 1071. KLEIN BONAIRE: 1049A, 1049B; ISLOTE AVES: 1114. BARBUDA: Two Feet Bay, 1395. ST. MARTIN: Great Bay, 1125A; 1127. ST. CROIX: Krausse Lagoon, 1405. NORTH BIMINI: 495, 1151.

Tetromphalus bulloides (d'Orbigny) Fig. 216

Rosalina bulloides d'Orbigny, 1839, Cuba p. 104, pl. 3 fig. 2–5.
Tetromphalus bulloides (d'Orbigny) Cushman, 1931, p. 86, pl. 16 fig. 5.

The test is flattened; it consists of a trochoid part followed by some erratic-growing chambers. The pores are distinct. A "floating" chamber is present, and its pores are similar to those in the chamber walls; at the distal part it has larger rounded openings, each provided with a short neck. The colour of the wall is brownish.

Klein Bonaire: sta. 1371. Cat Key: 499.

Planorbulina acervalis Brady Figs. 217–219

Planorbulina acervalis Brady, 1884, p. 657, pl. 92 fig. 4.

Test rounded, much compressed; the ventral side is flat in most specimens; margin acute; at the dorsal side the chambers are inflated. Fullgrown specimens have somewhat elongate chambers at the periphery, giving the margin an irregular appearance.

The first chambers are arranged in a flat spiral, slightly trochoid, with basal and sutural septal foramina, one in each chamber. Younger chambers are more erratic, and have a more or less annular arrangement. In this part of the test the chambers have more than one foramen connecting them with younger chambers; these foramina have a distinct collar.

Pores distinct, coarse, on both sides of the test.

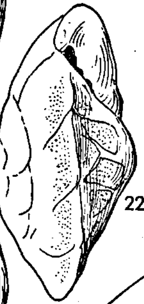
The specimens are attached at the flat ventral side.

Aruba: Punta Braboe, sta. 1002. Curaçao: Fuik Baai, 1039; Awa Blanco, 1351. Bonaire: Playa Lechi, 1055; Lac, Cay, 1067; Lac, Boca, 1068a. Klein Bonaire: 1049B, 1049C; 1371. Aves de Sotavento: AS 37. Aves de Barlovento: AV 1. Islote Aves: 1114. St. Martin: Great Bay, 1126, 1127. New Providence: between Hog I. and Athol I., 1149. North Bimini: 495, 1151. Cat Key: 499.

Homotrema rubrum (Lamarck) Figs. 220–221

Millepora rubra Lamarck, 1816, p. 202.
Polytrema rubra (Lamarck) Dujardin, 1841, p. 258–259.


222a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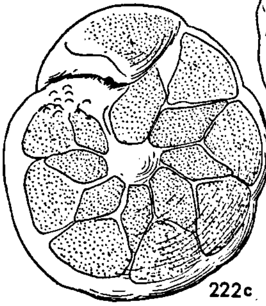
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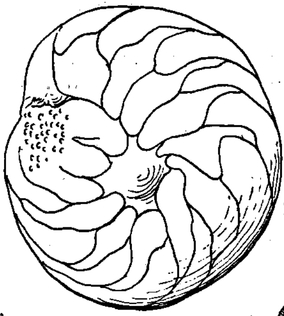
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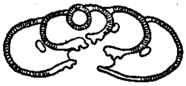
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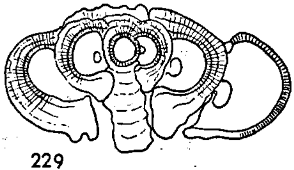
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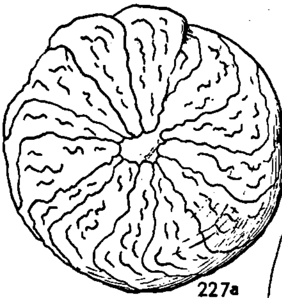
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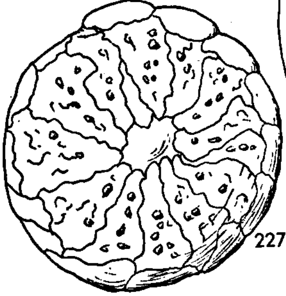
227b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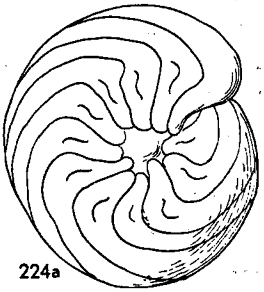
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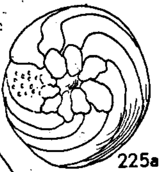
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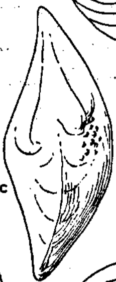
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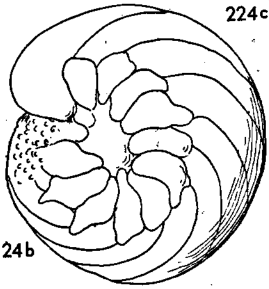
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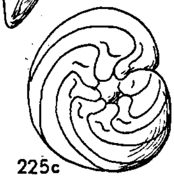
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Homotrema rubrum (Lamarck) HICKSON, 1911, p. 445–447, pl. 30, 32; HOFKER, 1927, p. 31–35, pl. 13 fig. 8–9, pl. 14 fig. 12–30, pl. 15; EMILIANI, 1951, p. 143–147, pl. 15–16.

This dark-red species, which lives attached to chalk-algae, shells and corals, is commonly present in most of the samples. EMILIANI pointed out that it forms crusts, hemispherical bodies, or branches on a stem. The outside is characteristic and has many areoli, densely porous and surrounded by slightly thickened dark-red shining sutures. The inner structure of the test has been adequately described by HICKSON, HOFKER, and EMILIANI. Openings at the end of elevated irregular parts are leading to a canal system, representing the apertures; in many specimens sponge spiculae protrude from these apertures.

It seems that in the West Indies this species is present only, and that *Miniacina* (*Polytrema*) is absent. In recent papers *Polytrema* and *Homotrema* may have been confused. They are quite different, as pointed out by HOFKER (1927). All specimens from the Caribbean have the characteristics of *Homotrema*.

ARUBA: Punta Braboe, sta. 1002; Boekoeti, 1006; Master, 1014; Malmok, 1301. CURAÇAO: Plaja Hoeloe, 1023A; St. Joris Baai, 1354. BONAIRE: De Hoop, 1058C; Punt Vierkant, 1059A; Lac, Boca, 1068a; Boca Onima, 1071; Boca Spelonk, 1378. KLEIN BONAIRE: 1049B; 1371. AVES DE SOTAVENTO: AS 37. TOBAGO: Buccoo Bay, 1385; Buccoo Reef, 1387. ISLOTE AVES: 1114. ANTIGUA: Deep Bay, 1393. BARBUDA: Two Feet Bay, 1395. ST. EUSTATIUS: Gallows Bay, 1116B. SABA: Fort Bay, 1120. ST. BARTS: Public, 1121. ST. MARTIN: Great Bay, 1126. ST. JOHN: Turner Bay, 1407.

Fig. 222–223. *Asterigerina carinata* d'Orbigny. — Bonaire, sta. 1056A: 222, dorsal side, apertural face, and ventral side; 223, aperture with proto- and deuteroforamen and the toothplate of another specimen (222 × 55; 223 × 125).

Fig. 224–226. *Amphistegina gibbosa* d'Orbigny. — 224, Islote Aves, sta. 1114: dorsal side, apertural face, and ventral side. — 225, Aves de Barlovento, sta. AV1: ventral side, apertural view, and dorsal side. — 226, Aruba, sta. 1301: ventral side (224–225 × 55; 226 × 27).

Fig. 227. *Amphistegina lessonii* d'Orbigny. — Sorong, New Guinea, 31 m deep: dorsal side, side view, and ventral side (× 33).

Fig. 228. *Streblus flevensis* Hofker. — Zuiderzee, Holland: transverse section through megalospheric specimen, to prove that in this species there is no secondary thickening of the walls (× 55).

Fig. 229. *Streblus batavus* Hofker. — North Sea: transverse section showing the secondary thickening of the wall in older chambers (× 55).

Asterigerina carinata (d'Orbigny) Figs. 222–223

Asterigerina carinata D'ORBIGNY, 1839, Cuba p. 117, pl. 5 fig. 25; HOFKER, 1956, S. Cruz p. 175–178, pl. 26 fig. 13–23; HOFKER, 1959, p. 250–251, fig. 4–7.

Asterigerina carinata, the genotype of *Asterigerina*, was fully described by the author. The test is lenticular or planoconical, the dorsal side being flat. The periphery is slightly lobular at the last-formed chambers, the margin acute, poreless. At the dorsal side all chambers are visible and have strongly oblique smooth sutures; the spiral sutures often broader; sutures hyaline. More or less distinct chalk-knobs occur near the apertural face. At the ventral side the centre is occupied by a smooth hyaline chalk-knob, surrounded by secundary chamberlets which form a star-like figure; the primary chambers are partly visible near the margin and are alternating with the secundary chamberlets. The aperture is sutural, at the base of a truncate apertural face; the latter may have secundary irregular openings in the wall, which otherwise is poreless (See Fig. 223). The aperture is a "foramen compositum".

The species is common in beach samples; it is absent in samples in which larger species are abundant.

ARUBA: Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Malmok, 1301. BONAIRE: Playa Lechi, 1056A. AVES DE SOTAVENTO: AS 1. BARBUDA: Martello Tower beach, 1394; Great Lagoon, 1396. ST. KITTS: Basseterre, 1398. ST. EUSTATIUS: Gallows Bay, 1116B; Billy Gut, 1117. ST. BARTS: Gustavia, 450; Public, 1121. ST. MARTIN: Great Bay, 1125A, 1126, 1127, 1128A; Simson Bay Lagoon, 1130A. ST. JOHN: S. of Cruz Bay, 1408. NEW PROVIDENCE: between Hog I. and Athol I., 1149. NORTH BIMINI: 1151, 1152. CAT KEY: 499.

Amphistegina gibbosa d'Orbigny Figs. 224–226

Amphistegina gibbosa D'ORBIGNY, 1839, Cuba p. 120, pl. 8 fig. 1–3; CUSHMAN, 1921, p. 62.

Amphistegina lessonii d'Orbigny, CUSHMAN, 1931, p. 79, pl. 16 fig. 1–3; BERMUDEZ, 1935, p. 213.

Test lenticular, one side more convex than the other, consequently distinctly asymmetrical in side view. At the dorsal side about 12 chambers are visible, reaching the central hyaline and smooth chalk mass; sutures strongly curved backward; only one distinct median poreless secondary suture of sigmoidal shape. Margin subacute, never keeled. At the ventral side a distinct pustulate area at the slit-like aperture. The normal chambers at the ventral side occupy about half of the test; they end at the regular and distinct secondary chamberlets surrounding the central chalk knob. These chamberlets distally end in a rounded angle from which the sutures of the normal chambers start; these sutures are regularly curved backward. No secondary poreless sutures in the normal and secondary chambers.

ARUBA: Lagoen Boekoeti, sta. 1004; Malmok, 1301. BONAIRE: Kralendijk, 1057A; Boca Spelonk, 1378. KLEIN BONAIRE: 1049B. AVES DE SOTAVENTO: AS 1. AVES DE BARLOVENTO: AV 1. TOBAGO: Buccoo Bay, 1385; Buccoo Reef, 1387. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. ANTIGUA: Deep Bay, 1393. ST. KITTS: Basseterre, 1398. ST. EUSTATIUS: Gallows Bay, 1116B. ST. MARTIN: Great Bay, 1126, 1127; Simson Bay, 1130. ANGUILLA: Forest Point Saltwell, 543. ST. CROIX: Krausse Lagoon, 1405. NORTH BIMINI: 1152.

D'ORBIGNY distinguished this species from the common Pacific species and called it *Amphistegina gibbosa.* As it is more convex at the ventral side than the pacific species, which is more compressed and more symmetrically lenticular, he called the latter *Amphistegina lessonii.* CUSHMAN believed that *A. lessonii* and *A. gibbosa* could not be distinguished, and named the Caribbean species also *A. lessonii.* Yet the difference is obvious, as can be seen from the figures given here; CUSHMAN's figures 1–3 (1931) are all typical *A. gibbosa.* CUSHMAN stated the structure of the West Indian species to be simple and the sutures to be not complex; however, in all specimens from Pacific localities the structure is complex. For comparison the description of the Pacific *Amphistegina* follows.

Amphistegina lessonii D'ORBIGNY, 1826, p. 304, no. 3, pl. 17 fig. 1–4; Modèles, no. 98 – See Fig. 220.

Test much compressed, lenticular, at both sides equally convex. At the dorsal side about 13–14 chambers visible, reaching the central chalk knob which is hyaline but very narrow. Sutures over the larger part of the test radial, with a sharp angle near the margin and then strongly bending backward. Sutures irregularly curved; many irregular secondary sutures without pores at this side. Periphery acute, often slightly keeled. At the ventral side the normal chambers only visible at the periphery, where they form a narrow part at the margin. Most of the ventral side is

occupied by the secondary chamberlets which have an irregular shape with curved radial sutures and often a pointed distal part bending backward. Here many secondary poreless short sutures are formed which often form distinct chalk knobs. At the ventral side a larger chalk knob is found. Aperture slit-like or slightly crescent-shaped, mostly with very few chalk knobs. The three generations of adult specimens have been figured by the author in 1927 (pl. 29 fig. 1–3; of young specimens: HOFKER, 1951, p. 444–448, fig. 304a–b.

The difference between the two species *A. gibbosa* and *A. lessonii* is obvious:

	lessonii	*gibbosa*
Shape	compressed, lenticular, symmetrical	not so compressed, lenticular, assymmetrical
Sutures dorsal side	complicated, with distinct angle at periphery, secondary sutures many and irregular	simple, curved, with only one simple sec. suture
Normal chambers ventral side	only forming a narrow part at the periphery	forming the larger part of ventral side
Ventral chamberlets	somewhat triangular, large, forming larger part, with complex sutures	small, rhomboidal, with simple sutures
Ventral secondary sutures	many secondary sutures, often forming knobs	no secondary sutures at all

Streblus Fischer, 1817

In the analysis of the Rotaliidae from Kruisschans (HOFKER, 1958, p. 55–57) a description was given of the two generations of *Streblus beccarii* (Linné) found on the beach at Rimini, Italy. The species occurs in shallow water in the Adriatic, in the Bay of Naples, and in some localities in the Mediterranean. It is also found in shallow water on the west coast of Europe and the south coast of England. In the North Sea another species occurs which is abundant in the shallow waters of Holland and England, i.e. *Streblus batavus* (HOFKER 1951, Siboga p. 492–502). The author had numerous samples from the Red Sea, the Black Sea, the coasts of Africa, the Pacific Ocean and America, but *Streblus beccarii* (Linné) was absent. From literature it might be concluded that the species is cosmopolitan; however, this is incorrect. The author has never found *Streblus beccarii* (Linné) in the Caribbean samples, and such references to this species must be based on erroneous determination.

In order to avoid confusion as to *Streblus beccarii* (Linné), a full description and figure of this species from Rimini follow; however, at least two more species are present on the beach of Rimini.

Four species of *Streblus* are found in the shallow waters of the Caribbean: *Streblus parkinsonianus* (d'Orbigny), *Streblus catesbyana* (d'Orbigny), *Streblus tepidus* (Cushman) and *Streblus advenus* (Cushman). They are definite species with distinct characteristics, and not "varieties" of *Streblus beccarii* (L.), as has been supposed by many authors.

Streblus beccarii (Linné), from Rimini beach. Figs. 230–231

Nautilus beccarii LINNAEUS, 1767, p. 1162. – *Streblus beccarii* FISCHER, 1817, p. 75. – *Rotalia beccarii*, D'ORBIGNY, 1826, p. 275, no. 42; Modèles, no. 74.

WILLIAMSON'S *Rotalina beccarii* from the British Isles (1858, p. 48, pl. 4 fig. 90–92) is not the same as the species from Rimini, but is *Streblus batavus* Hofker. There is no reason to change the generic name *Streblus* Fischer into *Hammonia*, as proposed by Russian authors; PLANCUS' name *Cornu Hammonis* (1739) and GUALTIERI'S name *Ammonia unita* (1767) have no generic meaning. LINNAEUS first used a binary nomenclature for this species. FISCHER was the first to state that the species does not belong to *Nautilus*; it is the genotype for his genus *Streblus*.

Microspheric generation. Test nearly circular, at the dorsal face all chambers visible, with smooth surface and a thick but hyaline wall. All tests are slightly yellow. At the dorsal side the sutures are slightly curved backward, oblique, and the spiral suture is relatively broad and distinct. The pores are fine and densely placed (index 48–0.2 × 500). The periphery is rounded. The ratio between diameter and thickness of the test is about 2. At the ventral side of the test, the chambers of the last-formed whorl are visible, and the sutures are radial; many sutures have a distinct indentation at the protoforamen. The protoforamen is particularly visible at the last-formed chambers. The tena, at the umbilical part of each chamber, are poreless, smooth at their surface, always slightly bent backward, and do not reach the centre, in which a small central knob is observed. A distinct area around the umbilical hollow is devoid of pores. – Diameter of test about 0.65 mm; thickness 0.33 mm.

Megalospheric generation. Test circular, at the dorsal side all chambers visible; the surface smooth, the walls hyaline. The chamber sutures are slightly curved and distinctly bent backward, the spiral suture is narrow. The dorsal chamber wall is pierced by fine pores (index 40–0,2, × 500) and is very thick. The periphery is strongly rounded. The ratio between diameter and thickness of the test is nearly 2. At the ventral side, the sutures of the last whorl of chambers are visible; they are radial, and where they meet, an indentation at the proximal suture of each chamber can be observed, the protoforamen. The tena are poreless and are slightly bent backward; they are blunt, leaving the umbilical hollow wide open; at its centre this hollow has a relatively small chalk knob. A distinct area around the umbilical hollow is poreless. Diameter of the test 0.66 mm; thickness 0.33 mm. One of the most striking features of megalospheric *Streblus beccarii* (the megalospheric form is by far the more common form) is that the later chambers at the ventral side are short and leave the tena of the chambers of previous whorls uncovered. This is also seen in the figures given by PLANCUS. Reference to these figures was made by LINNAEUS (see CUSHMAN, 1931, pl. 12 fig. 1–2). PLANCUS' figures represent a megalospheric specimen, as is evident from the dorsal side.

The characteristics of real *Streblus beccarii* are:

a. the chamber sutures are strongly bent backward and slightly curved at the dorsal side;

b. the test is thick, the periphery strongly rounded, and only the last-formed chambers are slightly lobulate at the periphery;

c. the umbilicus is wide open at the ventral side in the megalospheric form;

d. the pores are present over the whole dorsal chamber wall; at the ventral side the tenon is free of pores;

e. a relatively small chalk knob is present in the centre of the umbilical cavity.

It is remarkable that the more ornamented species, so abundant in the Mediterranean and on the coasts of the Indian Ocean, are totally absent in the Caribbean. *Streblus beccarii* is found in the latest Tertiary of the Mediterranean region, and in Recent samples. It seems that the *Streblus* faunule in the Adriatic Sea and in the Bay of Naples has a strong resemblance to that of the Caribbean (HOFKER, 1960, p. 254–256). None of the many species found on the coasts of the Pacific, at least in the tropical areas, is found in the Mediterranean or in the Caribbean. This implies that there are strictly defined geographical regions in which groups of *Streblus* developed independently. Transitional forms between these species are not known, and the many "varieties" of *Streblus beccarii* do not exist. Further study of the genus *Streblus* may contribute data on distribution, development series, biological units, environmental conditions, etc. Care should be taken to avoid describing various species as *Streblus beccarii*: a species which is solely restricted to some Atlantic and Mediterranean coasts of Europe, and has developed at the very end of the pre-Recent.

SMOUT (1954) and REISS (1957, 1958) stressed the value of secondary thickening of the test wall of Foraminifera, and assumed that the presence or absence of thickened lamellae might be an indication of the group to which a species belongs.

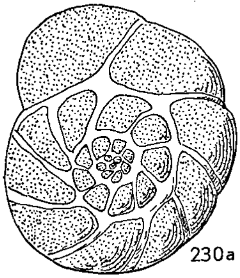
It is believed that too much value has been attributed to this feature of secondary thickening which causes "lamellar" structure. The genus *Streblus* is a very homogeneous genus. and all species show the same basal characteristics. Not all species show traces of "lamellae". Two species will be considered: *Streblus flevensis* Hofker, allied to *S. tepidus* Cushman, which is totally devoid of thickening of the test wall in all three generations (Hofker, 1954, p. 75, fig. 11); and *Streblus batavus* Hofker from the North Sea. When the figures 228 and 229 of median transverse sections of these species are compared, it is seen that the primary wall in *S. batavus* is as thick as the primary (and only) wall of *S. flevensis*. Practically none of the species of *Streblus* found in brackish water have secondary chalk layers on the wall, whereas species from deeper water often have thickened walls. This does not mean a thickening of each new chamber, as suggested by Smout and Reiss, in Rotaliid species, but that in *S. batavus* all previous chambers have about three lamellae. If lamellar structure were to be used as a superfamily character, as it is by these authors, two species (or rather groups) of one typical genus would have to be divided into two superfamilies.This cannot be done. *Streblus* (together with many other Rotaliid genera, see Hofker, 1962, p. 106–114) provides proof that the lamellar structure of the wall may be of specific value but should never be used for distinguishing forms, even in generic groups. In the author's opinion the thickening of the walls is determined by environmental conditions and by specific genes. The lamellar structure of a species should not be over-emphasized, for this would lead to taxonomic confusion and error.

Streblus catesbyanus (d'Orbigny)

Figs. 232–233, 235

Rosalina catesbyana d'Orbigny, 1839, Cuba p. 99, pl. 4 fig. 22, 24.

Test rounded. At the dorsal side all chambers visible; dorsal side in most cases somewhat flattened. Periphery strongly rounded, lobulate; chambers fairly inflated, particularly the younger ones. Dorsal sutures weakly curved, bending backward. All sutures slightly depressed, narrow. At the ventral side only the last-formed chambers visible, the radial sutures showing an indentation at the protoforamen. Tena without pores, somewhat pointed, running partly over the umbilical cavity, covered with fine but distinct pustules; the ends of the tena directed slightly downward. Umbilical cavity wide; in larger tests the downward-bent tena of the chambers of former whorls are visible, looking like chalk knobs; real chalk knobs always missing. Aperture in a poreless apertural face, wide open, somewhat loop-shaped. Large specimens up to 0.70 mm, mostly smaller; thickness of test up to 0.25 mm.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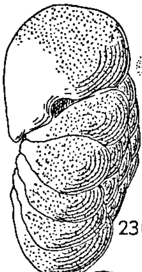
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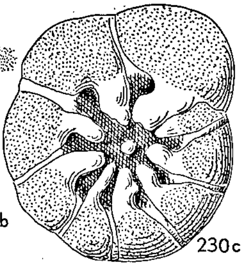
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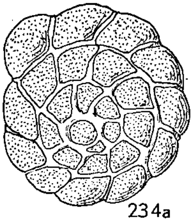
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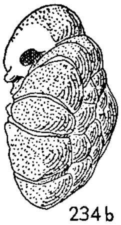
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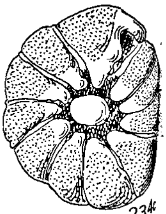
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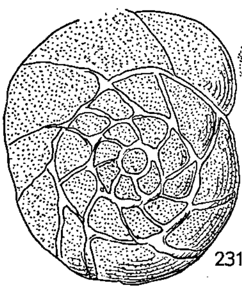
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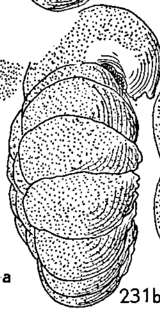
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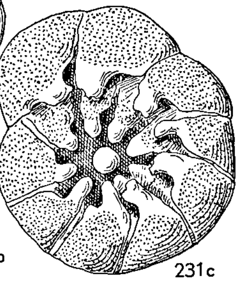
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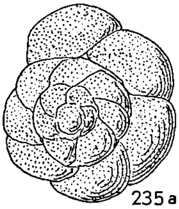
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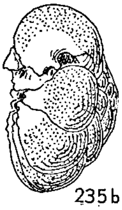
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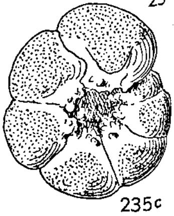
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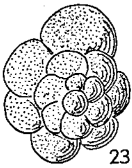
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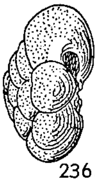
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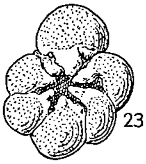
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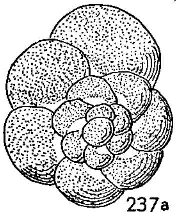
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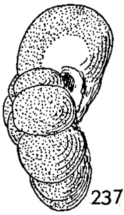
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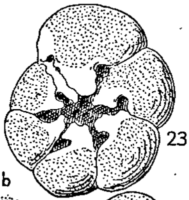
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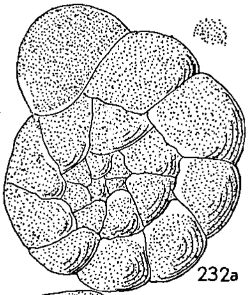
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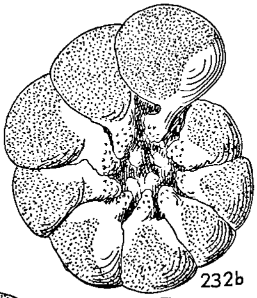
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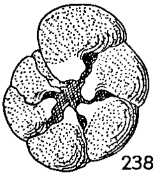
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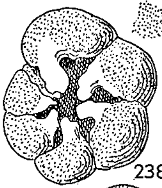
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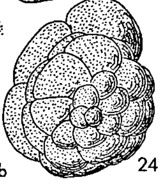
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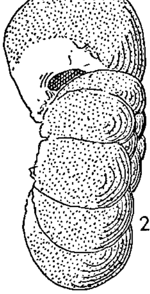
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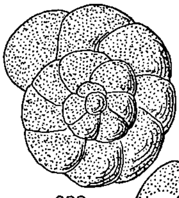
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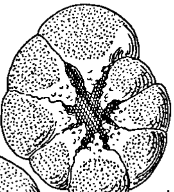
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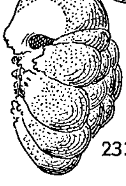
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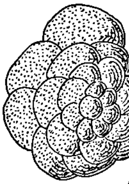
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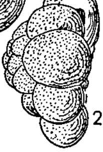
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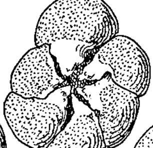
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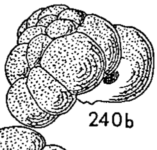
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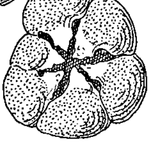
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The species is known to the author from Cuba, St. Martin, and other places in the Caribbean; Falmouth, coast of England; mouth of Thames, England; Caspian Sea, Russia; Suez Harbor; Miocene of Austria; Rimini, Adriatic Sea.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A. ST. MARTIN: Great Bay, 1127.

It is remarkable that specimens from the Bay of Naples which have most characteristics in common with this species from the Caribbean, show toothplate-openings at the dorsal side, which points to the genus *Poroeponides* Uchio. This might indicate a close relationship of the two genera (HOFKER, 1960, p. 255, fig. 136).

Streblus parkinsonianus (d'Orbigny) Fig. 234

Rosalina parkinsoniana D'ORBIGNY, 1839, Cuba p. 99, pl. 4 fig. 25–27.

Test stout, thick, circular. At the dorsal side all chambers visible, with distinct sutures between the chambers, often slightly limbate. Chambers in the last-formed whorl trapezoid, sutures slightly bent backward; 11–12 chambers in this whorl. Periphery of the last-formed chambers slightly lobulate, strongly rounded. At the ventral side only the chambers of the last-formed whorl visible,

Fig. 230–231. *Streblus beccarii* (Linné). — Rimini, Italy, the type locality: 230, dorsal side, apertural face and ventral side of microsperic specimen; 231, dorsal side, apertural face and ventral side of megalospheric specimen (× 55).

Fig. 232–233. *Streblus catesbyanus* (d'Orbigny). – 232, Cuba, Habana, Playa Baracoa: dorsal side, ventral side and apertural face. — 233, St. Martin, sta. 1127: dorsal side, ventral side and apertural face of same specimen (× 55).

Fig. 234. *Streblus parkinsonianus* (d'Orbigny). — Aruba, sta. 1004: dorsal side, from aside, and ventral side of same specimen (× 55).

Fig. 235. *Streblus* cf. *catesbyanus* (d'Orbigny). — St. Martin, sta. 1127: dorsal side, apertural face and ventral side of same specimen (× 55).

Fig. 236. *Streblus tepidus* (Cushman). — Cuba, Cienfuegos: dorsal side, apertural face and ventral side of same specimen (× 55).

Fig. 237–238. *Streblus advenus* (Cushman). — Cuba, Habana: 237, dorsal side, apertural face, and ventral side of same specimen; 238, ventral sides of two other specimens (× 55).

Fig. 239–240. *Streblus tepidus* (Cushman). — Bonaire, sta. 1055A: 239, dorsal side, side view, and ventral side of same specimen; 240, ventral side, apertural face, and dorsal side of another specimen (× 55).

with radial, strongly depressed sutures. Protoforaminal indentation sometimes visible in the last-formed chambers, but mostly absent. Sutures straight, chambers elongate. Tena smooth, thick, poreless; often also a poreless area along the sutures. Umbilical cavity nearly filled with a large, smoothly finished chalk knob. Deuteroforamen slightly loop-shaped, distinct in a poreless apertural face. Pores fine, chamber walls thick. Colour of test yellowish to brownish. – Diameter of test up to 0.78 mm; thickness 0.40 mm.

The species is already known from late-Tertiary deposits and seems to have developed from *Streblus ammoniformis* (d'Orbigny); the latter is characterised by the higher developed and more pointed tena which cover most of the umbilical cavity (HOFKER, 1960, p. 56–57); the central chalk knob is generally absent.

S. parkinsonianus is known to the author from the Mediterranean (Port Said, Suez, Bay of Naples), the Red Sea, off Damman; it is common in the Caribbean. It was described and figured from the Bay of Naples (HOFKER, 1960, p. 254, fig. 130, 132).

ARUBA: Lagoen Boekoeti, sta. 1004; Master, 1014. BARBUDA: Martello Tower beach, 1394. ST. MARTIN: Great Bay, 1125A, 1127.

Streblus tepidus (Cushman) Figs. 236, 239–241

Rotalia beccarii (Linné) var. *tepida* CUSHMAN, 1928, Carn. Inst. p. 79, pl. 1; CUSHMAN, 1931, p. 61, pl. 13 fig. 3.

Test small, dorsal side mostly strongly convex, ventral side flattened or slightly concave. Margin rounded, periphery lobulate as the chambers are inflated. At the dorsal side all chambers visible, with strongly rounded and depressed chamber sutures; about 6 chambers in the last-formed whorl. At the ventral side the strong and pointed tena nearly reach the centre and only a narrow umbilical cavity is present. Tena nearly always with fine pustules. In most chambers at the ventral side the protoforaminal indentation at the proximal suture is distinct, and the tena remain free, so that a star-like deeper hollow is formed together with the umbilical cavity. Only the tena are poreless. Pores extremely fine, walls very thin and hyaline. – Diameter of the test not more than 0.40 mm; thickness about 0.30 mm.

The species is known to the author from Cienfuegos, Cuba, and from several shallow water stations in the Antilles; CUSHMAN reports it to be widely distributed in the West Indian region. PHLEGER & PARKER (1951) mention it from numerous stations at 2–9 m depth. *Streblus flevensis* (Hofker) from the Zuiderzee, Holland (1954, p. 76, fig. 11) is another and different species with stronger flattened though also rough tena, which are overlapping each other. *S. tepidus* is not known to the author from fossil deposits; references to this species should be restudied.

ARUBA: Master, sta. 1014. ST. MARTIN: Great Bay, 1127.

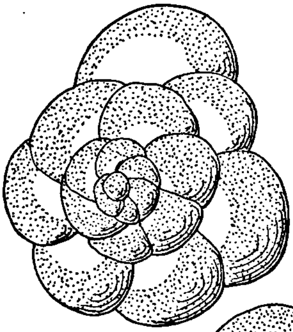
Streblus advenus (Cushman) Figs. 237–238

Discorbina rosacea BRADY (non d'Orbigny), 1884, p. 644, pl. 87 fig. 1.
Discorbis advena CUSHMAN, 1922, p. 40; CUSHMAN, 1931, p. 13, pl. 2 fig. 8.

Test rounded; dorsal side slightly convex, ventral side somewhat concave. At the dorsal side all chambers visible, last-formed whorl with about 6 chambers; sutures distinctly curved, slightly depressed. Peripheral margin rounded, lobulate. At the ventral side only the chambers of the last-formed whorl are visible, with strongly depressed radial sutures. Each chamber at the ventral side shows a broad and flattened smoothly finished tenon, poreless, mostly with the inner part bent backward along the distinct protoforaminal indentation. Umbilical cavity relatively large, without filling. Pores fine; at the dorsal side of each chamber at the inner proximal angle a distinct but small part is free of pores. Aperture a crescent-shaped opening, often with small lip, in a poreless part of the apertural face. – Test relatively small, diameter 0.40 mm at the most, thickness about 0.13 mm.

To the author the species is known from the Caribbean sea; CUSHMAN mentions it from various localities in the Caribbean area; somewhat similar specimens were found in the Miocene of Dax, France, in the Bay of Torquai, England, in the mouth of the Thames, at Samoun Anchorage, Turkey, and at the beach of Rimini, Adriatic Sea, Italy. Slightly different specimens were found at Van Gogh Station, 1°15′S., 99°36′E., Indonesian Archipelago, 683 fathoms.

ARUBA: Master, sta. 1014. BONAIRE: Playa Lechi, 1055A. ST. CROIX: Krausse Lagoon, 1406.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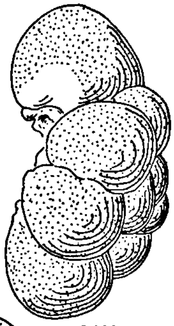
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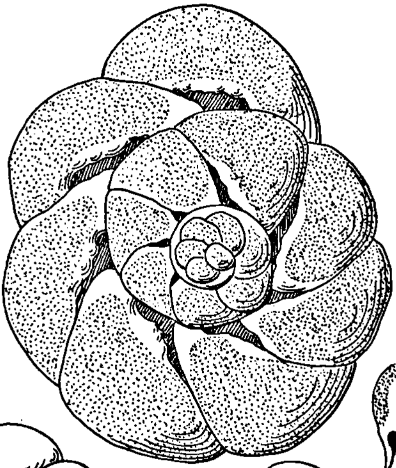
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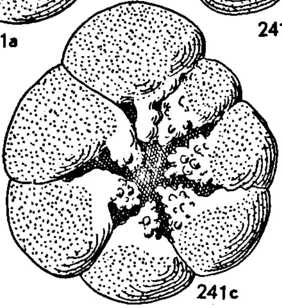
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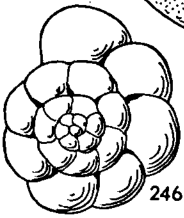
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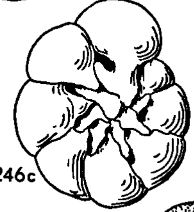
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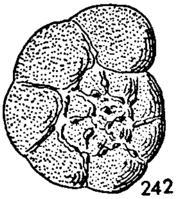
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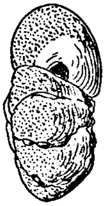
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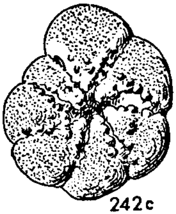
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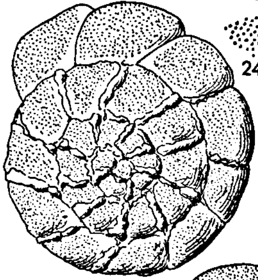
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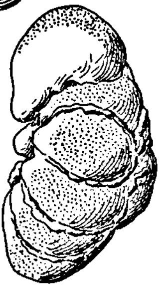
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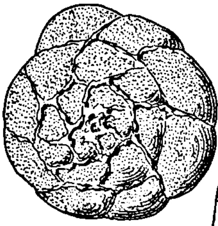
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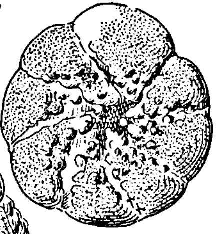
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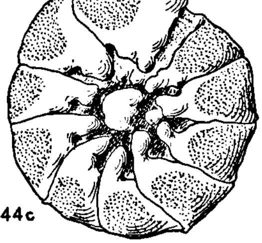
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Streblus compactus nov. spec. Figs. 242–243

Test small, rounded, convex on both sides, with slightly lobulate periphery. Chambers 7–8 in the last-formed whorl, all visible on the dorsal side, with sutures slightly bent backward; sutures hyaline, limbate by irregular chalk knobs. Chambers with fine pores at the dorsal side. Margin strongly rounded. At the ventral side the sutures are nearly radial, strongly depressed, ornamented with more or less distinct chalk bosses which become more numerous near the tena. Tena thick, the indentation at the protoforamen nearly absent, and nearly totally covering the umbilical cavity which thus is very small. Nearly the whole ventral wall of the chambers has fine pores; they only are absent at the extreme end of the tena. Aperture crescent-shaped, in a poreless part of the apertural face. – Length up to 0.55 mm; thickness 0.30 mm.

The species was found among muddy sand of a rocky beach at St. Martin.
ST. MARTIN: Great Bay, sta. 1127.

Streblus ornatus Cushman Fig. 244

Rotalia beccarii var. *ornata* CUSHMAN, 1918, p. 18, pl. 8 fig. 7–7c (see *Rosalina ornata* d'Orbigny, 1839).

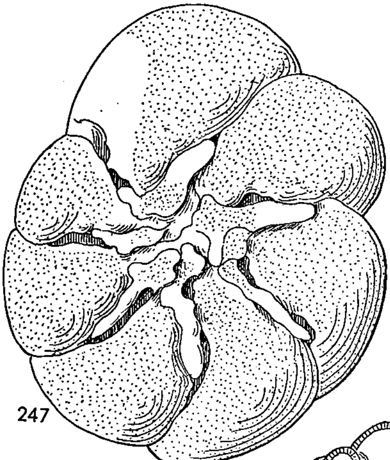
Test at the dorsal side slightly convex; margin strongly rounded. At the ventral side the tena are strong, but not with smaller chalk knobs, as found in *tepidus*. In the centre of the ventral umbilical hollow a distinct chalk knob. At the dorsal side the sutures of the

Fig. 241. *Streblus tepidus* (Cushman). — Cuba, Matanzas, Cardenas Bay, Bermudez coll.: dorsal side, side view and ventral side of same specimen (× 160).

Fig. 242–243. *Streblus compactus* nov. spec. — St. Martin, sta. 1127: 242, dorsal side, apertural face, and ventral side of a megalospheric specimen; 243, dorsal side, side view, and ventral side of a microspheric specimen (× 55).

Fig. 244. *Streblus ornatus* Cushman. — Florida, Miami beach: dorsal side, side view, ventral side, and pores (a–c × 55; d × 160).

Fig. 245–246. *Pseudoeponides anderseni* Warren. — 245, St. Martin, sta. 479: dorsal side. – 246, St. Martin, sta. 542: side view, dorsal side and ventral side (245 × 160; 246 × 55).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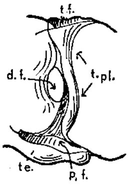

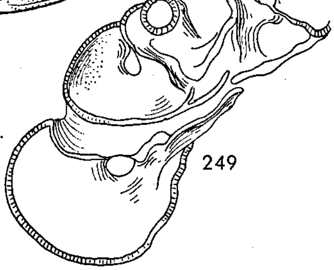
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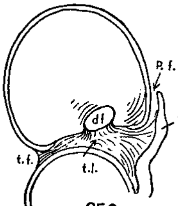

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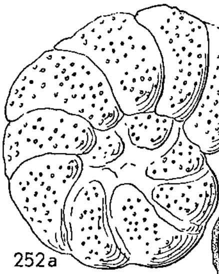
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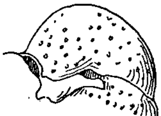
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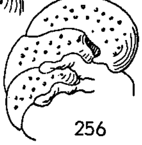
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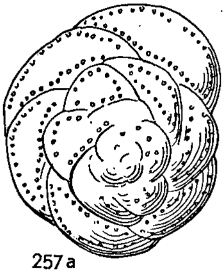
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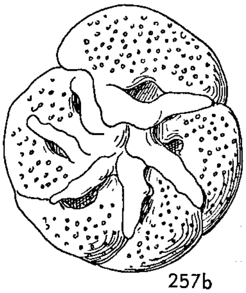
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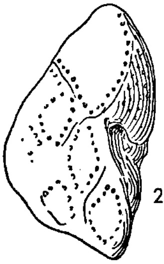
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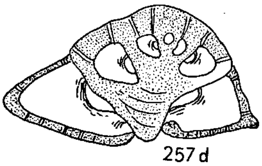
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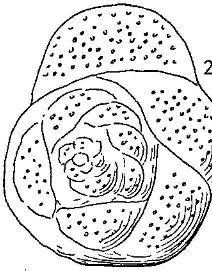
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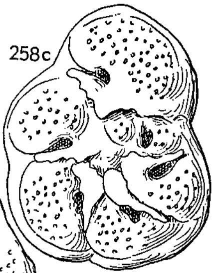
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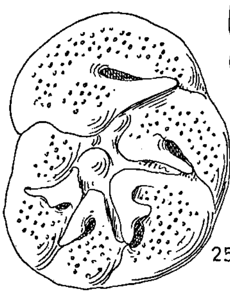
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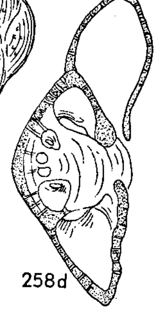

258d

numerous chambers are limbate and hyaline, with many irregular chalk knobs. The pores are slightly larger than in most species of *Streblus*.

The species is abundant at the coast of Florida, and may be present in the sea around the northern Antilles. *S. compactus* n.sp. actually may be related to this species.

Pseudoeponides anderseni Warren Figs. 245–250

Pseudoeponides anderseni WARREN, 1957, p. 39, fig. 12–15; PARKER & ATHEARN, 1959, p. 341, pl. 50 fig. 28–31.
Helenina anderseni (Warren) SAUNDERS, 1957, p. 375, fig. 1–2.

In the description of the genus *Pseudoeponides* Uchio, the present author (1958, *9* p. 46–48) stated that the type of the genus has a distinct ventral protoforamen with a distinct backward tenon between protoforamen and deuteroforamen, a toothplate in each chamber extending from the protoforamen to a typical toothplate foramen on the dorsal side of the chambers, always situated sutural, so that the genus is closely related to *Streblus*.

Compared with the genotype, which has 5 chambers in a whorl, this species shows 7–8 chambers in the last-formed whorl; the tena

Fig. 247–250. *Pseudoeponides anderseni* Warren. — St. Martin, sta. 479: 247, ventral side of specimen Fig. 245; 248, section through last formed chamber, showing the toothplate (t.pl.), the dorsal toothplate-foramen at the suture (t.f.), the deuteroforamen at the septum (d.f.), the protoforamen at the base of the toothplate (p.f.), and the tenon (te.); 249, transverse section; 250, part of section showing the situation of the toothplate and the foramina (× 160).

Fig. 252–256. *Discorinopsis aguayoi* (Bermudez). — St. Martin, sta. 542: 252, dorsal side, apertural face, ventral side, and transverse section; 253, part of tangential section, showing the simple septum; 254–256, last formed chambers seen from the ventral sides, to demonstrate the apertural conditions (× 55).

Fig. 257. *Rotorbinella conica* nov. spec. — Cuba, shore near Habana, Bermudez coll.: dorsal side, ventral side, side view, and transverse section of same specimen (× 55).

Fig. 258–259. *Rotorbinella mira* (Cushman). — St. Martin, sta. 1131: 258, dorsal side, apertural face, ventral side, and transverse section; 259, ventral side of another specimen (× 55).

are much better developed, strongly bent backward and covering a large part of the ventral sutures and leaving a narrow ventral part of the protoforamen free, whereas their umbilical part (they cover the whole umbilical hollow), just as in the type-species, is pierced by fine pores. At the dorsal side, the toothplate-foramina are not, as in the type-species, triangular, but more slit-like, as they are found along the axial part of each suture. Transverse sections show the toothplates to extend from the protoforamen at the ventral side to the toothplate-foramen at the dorsal one. The deuteroforamina, just as in the genotype, are oval, sutural or slightly areal, and small. The tests are small and hyaline.

WARREN (1957) did not emphasize the typical tena bent backward, though his fig. 14 shows a trace of them. The tena cannot be easily observed in dry material, as they are flush with the ventral surface. PARKER & ATHEARN (1959) and TODD & LOW (1961, p. 18, fig. 2) depicted the typical tena. SAUNDERS (1957) stated that the dorsal openings are formed along the sutures; he believed that in the type-species of *Pseudoeponides* Uchio these openings were found areally; the author (1958, *9*) indicated that in the type-species the openings are also sutural. Consequently the genus *Helenina* Saunders becomes a synonym of *Pseudoeponides* Uchio.

ARUBA: Punta Braboe, sta. 1002. CURAÇAO: Spaanse Water, New Haven, 1036A. ST. MARTIN: Simson Bay Lagoon, 479; Devil's Hole Swamp, 542; Simson Bay Lagoon, 1131. NORTH BIMINI: 495, 1151. CAT KEY: 499.

Valvulineria candeiana (d'Orbigny) Fig. 251

Rosalina candeiana D'ORBIGNY, 1839, Cuba p. 97, pl. 4 fig. 2–4.
Truncatulina candeiana (d'Orbigny) CUSHMAN, 1921, p. 57, pl. 13 fig. 4–5.
Discorbis candeiana (d'Orbigny) CUSHMAN, 1931, p. 19, pl. 7 fig. 4.

Test rounded, trochoid, flat, with lobulate margin. At the dorsal side all chambers visible, at the ventral side only those of the last-formed whorl with an open umbilicus which, however, is nearly entirely closed by the thin lips at the umbilical aperture of the chambers. Visible aperture at the ventral side, sutural. Pores distinct at both sides and at the margin. Test brownish, except for the last-formed chamber.

The open umbilical apertures and the large lips covering the umbilical cavity strongly point to *Valvulineria*; this species may be closely related to *Discorinopsis*.

The species is rare. It occurred in several specimens at Cat Key, near Bimini.
CAT KEY: Sta. 499.

Discorynopsis aguayoi (Bermudez) Figs. 252–256

Discorbis aguayoi BERMUDEZ, 1935, p. 204, pl. 15 fig. 10–14.

Specimens found at St. Martin and Anguilla are identical to those described by BERMUDEZ. CUSHMAN & BRÖNNIMANN (1948, p. 15–21) established *Discorinopsis aguayoi* var. *vadescens*; ARNOLD (1954, p. 5) showed this to be *D. aguayoi*. The genus *Discorinopsis* was established by COLE for *Discorbis*-like species with the umbilical part filled-up by a spongy mass of test material. The type-species of *Discorinopsis* is *D. gunteri* Cole (1941). ARNOLD (1954) compared *D. aguayoi* and *D. gunteri* and concluded that also *D. aguayoi* was a *Discorinopsis*. On the other hand, sections, never published before, reveal that the spongy mass of test substance in the umbilical hollow is similar to fillings in *Rotorbinella*. In the last-formed chambers, where this growth has not yet developed, the filling starts with a distinct tenon, fastened to the proximal border of the deuteroforamen and running over the slit-like protoforamen. This tenon is nothing but a typical external toothplate, as found in many species of *Discopulvinulina*; in older chambers chalk masses are added to this toothplate and then form the irregular mass covering the umbilical part at the ventral side. A similar feature has been detected by the author in *Stensiöina* and *Boldia*. In transverse section can be observed that all these tena are covering each other and, together with the poreless ventral parts of the chamber-walls, form the spongy mass in the umbilicus.

It seems that *Discorinopsis* is closely related to a group of species found for the first time in the Paleocene and Eocene (e.g. *Rotorbinella mariei* van Bellen); it only differs from *Rotorbinella* in the latter having an umbilical chalk knob. Typical *Rotorbinella* also has many features in common with *Discopulvinulina. Rotorbinella, Discopulvinulina,* and *Discorinopsis* may form a closely related group of genera.

ST. MARTIN: Simson Bay Lagoon, sta. 479; Devil's Hole Swamp, 542. ANGUILLA: Forest Point, 543. SOUTH BIMINI: 1150A.

Rotorbinella Bandy, 1944

BANDY (1944, p. 372) established the genus *Rotorbinella,* with the genotype *R. calliculus* Bandy from the Eocene. CUSHMAN's description (1950, p. 294) is rather short: "Test free, trochoid, close coiled, ventrally with a simple umbilical plug; ventral sutures sometimes with re-entrants; aperture a slit at the inner margin of the ventral face of the last-formed chamber, not reaching to the periphery".

BERMUDEZ (1952, p. 75) gives a more detailed description: "Concha trocoide; cámeras numerosas, todas visibles por la cara dorsal y sólo las de la última vuelta por la ventral, aumentado rápidamente de tamano suturas poco notables, algunas veces las dorsales limbades y las ventrales sencillas con canales a recentrantes; pared calcárea, perforada, hialina, y a menudo lustrosa; región umbilical ocupada por un umbo grande, macizo; abertura como una ramura simple en la base de la cara septal de la última cámara sin llegar a la periferia".

Several species of the genus have been studied; they have the following features in common. The sutures of the chambers on the dorsal side are curved backward; a typical protoforamen (re-entrants) on the ventral side at each suture, whereas in the neighbourhood of this protoforamen the suture is partly covered by a typical outgrowth of the poreless lip(tenon); the relatively small deuteroforamen is found near the margin; the umbilical area is filled with a chalk knob, and in many specimens parts of the poreless lips (tena) are fastened to this knob; the pores are large and the walls hyaline and thick, particularly those in the central part; the margin is poreless.

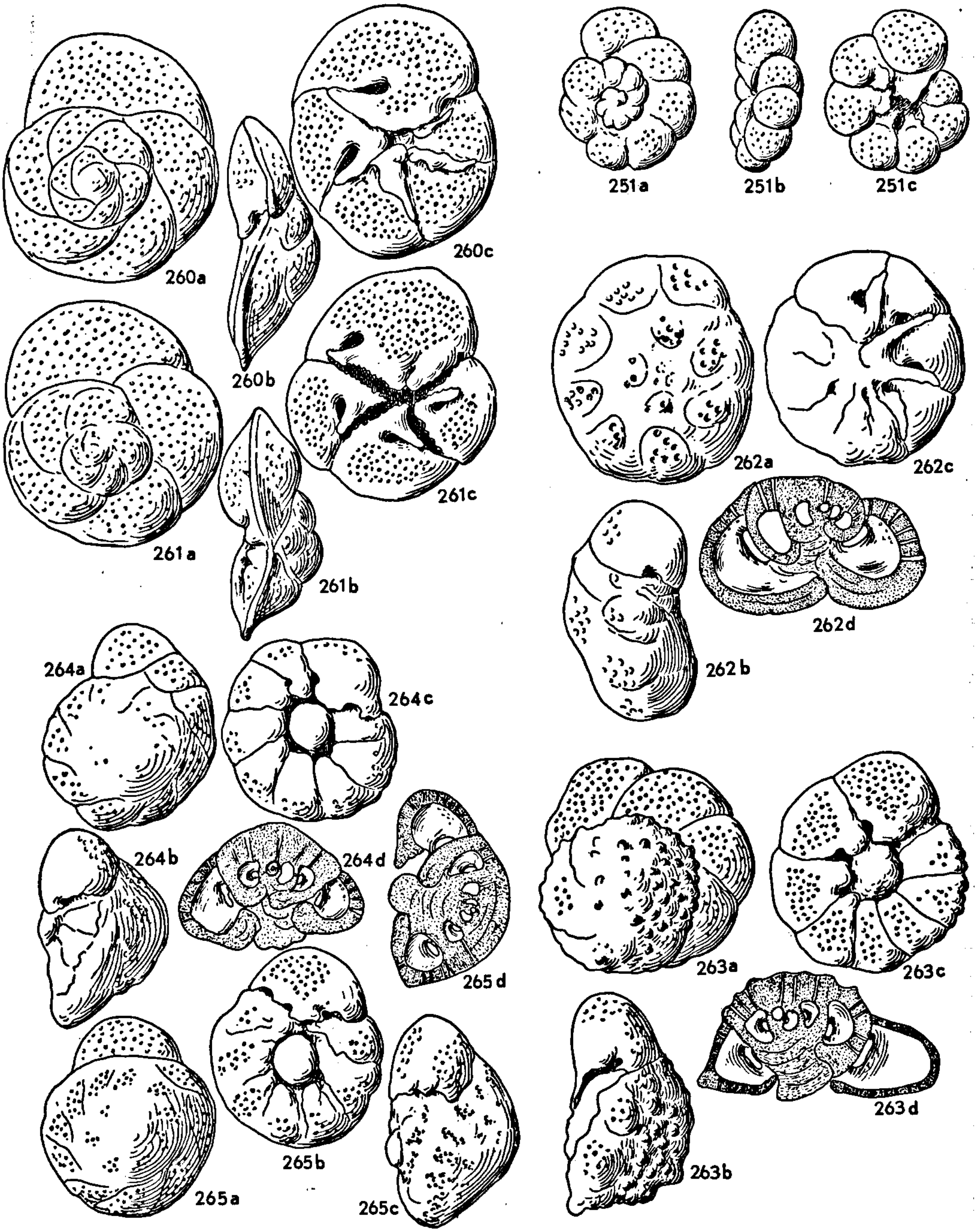
These characteristics were found in *Rotorbinella propinqua* (Terquem) from the Lutetian of Paris, *R. mariei* (van Bellen) from the Montian of Holland, *R. mira* Cushman and *R. rosea* (d'Orbigny) from the Caribbean, *R. granulosa* (Heron-Allen & Earland) from Cuba, and in a new species, *R. conica* from Cuba. It is typical for all these species, that seen from the apertural side, the last-formed chamber is inclining towards the ventral side. The tendency of partly covering the protoforamen by poreless extensions of the tena is also typical, but is found in many groups of the Biforaminata.

The group differs from *Discopulvinulina* by the presence of a central ventral chalk knob. Yet, *Rotorbinella* seems to be closely related to *Discopulvinulina*. Many species have been correctly listed by BERMUDEZ as *Rotorbinella*. Several species may be added to this listing.

Rotorbinella conica nov. spec. Fig. 257

Test conical at the dorsal side, nearly flat at the ventral side. At the dorsal side the sutures of the chambers are curved backward, chambers low, 6 in the last-formed whorl. At the ventral side sutures of the chambers bent backward, with conspicuous open protoforamina partly covered by long narrow outgrowths of the poreless lip(tenon). Part of this lip is directed toward the centre and in older chambers connected with a central inconspicuous knob. The deuteroforamen is a narrow halfmoon-shaped slit near the margin at the ventral side. At the dorsal side the hyaline walls have rows of large pores along the sutures of the chambers only, at the ventral side each chamberwall has numerous pores; only an area near the protoforamen and the lip is devoid of pores. CUSHMAN probably referred to specimens of this new species, when, describing *Discorbis mira* (1931, p. 26) he observed: "the punctae near the outer margin of the chamber, less frequent elsewhere".

In transverse section the dorsal walls appear to be thick, and have secondary layers of chalk; the umbilicus is filled with hyaline chalk material. The septal foramina are placed at the proximal wall of each chamber, and they are sutural. The lips of the last-formed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chambers are not connected with the central knob. – Diameter of test about 0,60 mm, height 0.35–0.50 mm.

Type material from CUBA, near Habana, at a depth of about 30 feet; common.
ST. MARTIN: Great Bay, Sta. 1126, 1127.

Rotorbinella mira (Cushman) Figs. 258–260

Discorbis turbo BRADY (not d'Orbigny), 1884, p. 642, pl. 87 fig. 8.
Discorbis mira CUSHMAN, 1922, p. 39, pl. 6 fig. 10–11; CUSHMAN, 1931, p. 25, pl. 5 fig. 5–6.

Test trochoid, low-conical at the dorsal side, nearly flat at the ventral side. At the dorsal side all chambers visible, the initial part of them brownish, caused by a pseudochitinous inner lining. At the ventral side only the chambers of the last-formed coil visible, with protoforamina at each suture, and a large but narrow poreless outgrowth over each suture, starting from the central part of the test; this central part with chalk-filling makes the umbilicus invisible.

At the dorsal side, the sutures of the chambers are curved backward; at the ventral side the sutures are nearly radial, starting at the centre. At the dorsal side large and distinct pores on the wall of each chamber, except on the broad sutures; at the ventral side no pores on the tena. Margin poreless. Suture of last-formed chamber with protoforamen, partly covered by an outgrowth of the tenon;

Fig. 251. *Valvulineria candeiana* (d'Orbigny). — Cat Key, near Bimini, sta. 499: dorsal side, side view and ventral side of same specimen (×55).

Fig. 260. *Rotorbinella mira* (Cushman). — Bonaire, sta. 1067: dorsal side, side view, and ventral side of same specimen (×55).

Fig. 261. *Rotorbinella* cf. *mira* (Cushman). — Curaçao, sta. 1036: dorsal side, side view, and ventral side of same specimen (×55). Possibly this form is a distinct species: the tena differ greatly from the typical form.

Fig. 262. *Rotorbinella granulosa* (Heron-Allen & Earland). — St. Martin, sta. 1128A: dorsal side, side view, ventral side, and transverse section of same specimen (×55).

Fig. 263–265. *Rotorbinella rosea* (d'Orbigny). — 263, St. Barts, sta. 1121: dorsal side, apertural face, ventral side, and transverse section of same specimen. — 264, St. John, sta. 1408: dorsal side, apertural face, ventral side, and transverse section of same specimen. — 265, St. Eustatius, sta. 1116B: dorsal side, ventral side, side view, and transverse section of same specimen (×55).

part of this lip slightly bent towards the centre, and at the distal end of the suture, near the margin, a small sub-lunular opening.

In transverse section the septal foramina appear to be narrow, long and sutural. The dorsal wall is thick in the centre of the test; the ventral umbilicus is closed by a central plug which is as high as the surrounding chambers. – Diameter about 0.6 mm; height about 0.25 mm.

The species has been confused by several authors with *"Discorbis" turbo* d'Orbigny (see HOFKER, 1951, Siboga p. 449–452, fig. 305–306) which is found in the Pacific. CUSHMAN's *Discorbis mira* is also known from the Pacific; however, later he mentioned it from the Caribbean, and this must be the same species as described above.

CUSHMAN mentioned the species from depths of 1–34 m in the Caribbean and rarely from greater depths. In the material studied it was found in shallow-water samples from St. Martin and other islands.

ARUBA: Punta Braboe, sta. 1002; Boekoeti, 1006. BONAIRE: Lac, Poejito, 1064A, 1065; Lac, Cay, 1067. AVES DE BARLOVENTO: AV 1. ANTIGUA: Deep Bay, 1393. BARBUDA: Martello Tower beach, 1394; Two Feet Bay, 1395. ST. EUSTATIUS: Gallows Bay, 1116B. ST. MARTIN: Great Bay, 1125A, 1126, 1127; Simson Bay Lagoon, 1130, 1130A, 1131, 1402. ST. CROIX: Krausse Lagoon, 1405. NEW PROVIDENCE: between Hog I. and Athol I., 1149.

Rotorbinella cf. **mira** (Cushman) Fig. 261

A form, restricted to one habitat with *Rhizophora* on Curaçao, and apparently similar to *Rotorbinella mira*, has more inflated chambers at the dorsal side, somewhat depressed sutures, only four chambers in the last-formed whorl and tena at the ventral side with crenulated border.

This form is probably only a sub-species of *mira*.

CURAÇAO: Spaanse Water, New Haven, sta. 1036A.

Rotorbinella granulosa (Heron-Allen & Earland) Fig. 262

Discorbina valvulata (d'Orbigny) var. *granulosa* HERON-ALLEN & EARLAND, 1915, p. 695, pl. 52 fig. 1–6; BERMUDEZ, 1935, p. 203.

Test more or less lenticular, with rounded margin. Walls very thick and hyaline. All chambers visible at the dorsal side; in the central part the sutures may be obscured by thick layers of secondary chalk; sutures slightly bent backward. Pores only at the dorsal side, very large; surface shining. At the ventral side the sutures are radial; in the last-formed chambers distinct protoforamina, covered by narrow and long outgrowths of the tena; in the older chambers this structure is obscured by the thickening of the wall. Central part of the ventral side closed by a central plug which fuses with the poreless lips of the apertures. Aperture a narrow slit at the ventral side of the margin. No pores at the ventral side. In transverse section, the walls appear to be thick, particularly at the ventral side; the septal foramina are narrow sutural slits. – Length 0.60 mm; thickness 0.30 mm.

ARUBA: Punta Braboe, sta. 1002. KLEIN BONAIRE: 1049B. TOBAGO: Buccoo Reef, 1387. ST. MARTIN: Great Bay, 1125A, 1128A. NORTH BIMINI: 495. CAT KEY: 499.

Rotorbinella rosea (d'Orbigny) Figs. 263–265

Rotalia rosea D'ORBIGNY, 1826, p. 272, no. 7, Modèles no. 36; D'ORBIGNY, 1839, Cuba p. 72, pl. 3 fig. 9–11; CUSHMAN, 1931, p. 62, pl. 13 fig. 5.
Truncatulina rosea (d'Orbigny) BRADY, 1884, p. 667, pl. 96 fig. 2.
Rotorbinella rosea (d'Orbigny) BERMUDEZ, 1952, p. 75.

Test pink to dark-red, only the last-formed chamber white. Dorsal side conical to strongly convex, ventral side nearly flat. In the generally slightly smaller A_2-form the dorsal side is covered with tubercules which may give the test a rough appearance, whereas in the A_1-form and the B-generation the somewhat larger tests are smooth at the dorsal side and the last-formed chamber very long and often inflated. – At the dorsal side only the last-formed chambers are clearly visible, the initial part being covered by thick layers of chalk. In the microspheric form the number of chambers of the last-formed coil is 9–10, in the megalospheric forms mostly 8. At the dorsal side the sutures are strongly bent backward, whereas at the ventral side they are nearly radial, with a large, somewhat protruding knob in the umbilical area. Protoforamina are visible only in the last-formed chambers, in the earlier chambers they are closed by the thickening of the sutures. The sutures of the last-formed chamber show a narrow slit-like deuteroforamen near the ventral margin, which in most cases is sharp; the poreless tenon is blunt and directed towards the centre; the protoforamen lies in the central part of the suture, and is not covered by an outgrowth of the tenon. At the dorsal side most of the walls of the chambers have distinct and often large pores; at the ventral side these pores are more irregularly distributed and are absent in the central part of the chamberwalls. The margin is always poreless. – Diameter of test about 0.50 mm, thickness about 0.30 mm; the megalospheric tests often smaller. – Transverse sections show the walls to be thick and the narrow septal foramina to be sutural. The older chambers are covered at the inside with a dark-brown pseudochitinous layer.

This remarkable species is typical for the tidal zone in the West-Indies; it occurs at the northern coasts of South America, on both sides of the continent. It was found as scarce specimens in some assemblages off Santa Cruz at a depth of 150 fathoms. In the material studied it was common at stations 1056A and 1059A, Bonaire, 1121, St. Barts, and 1116B, St. Eustatius, all in the tidal zone. CUSHMAN (1931) mentioned it from depths of 1–40 fathoms, but some specimens were found at larger depths also.

It is worth mentioning that this species is found exclusively in assemblages with many specimens of *Homotrema*, another red Foraminifer. *Rotorbinella rosea* may be actually living on or near the attached tests of *Homotrema*; in that case it might be called a typical instance of mimicry in Foraminifera.

ARUBA: Malmok, sta. 1301. CURAÇAO: Fuik Baai, 1039; Awa Blanco, 1351. BONAIRE: Playa Lechi, 1056A; De Hoop, 1058C; Punt Vierkant, 1059A, 1059B; Lac, Cay, 1067; Lac, Boca, 1068a; Boca Onima, 1071; Boca Spelonk, 1378. TOBAGO: Buccoo Bay, 1385. GRENADA: White Bay, 1389. ISLOTE AVES: 1114. ANTIGUA: Deep Bay, 1393. BARBUDA: Martello Tower beach, 1394; Two Feet Bay, 1395; Great Lagoon, 1396. ST. KITTS: Basseterre, 1398. ST. EUSTATIUS: Gallows Bay, 1116B. ST. BARTS: Public, 1121. ST. MARTIN: Great Bay, 1125A, 1126, 1127, 1128A. ANGUILLA: Forest Point, 543. NEW PROVIDENCE: between Hog I. and Athol I., 1149. NORTH BIMINI: 495, 1151, 1152.

Elphidiononion poeyanum (d'Orbigny) Figs. 266–269

Polystomella poeyana D'ORBIGNY, 1839, Cuba p. 55, pl. 6 fig. 25–26.
Elphidium poeyanum (d'Orbigny) BERMUDEZ, 1935, p. 187; HOFKER, 1956, S. Cruz p. 141–142, pl. 21 fig. 8–18.

Test rounded, with a distinctly lobulate periphery. Chambers fully involute, with slightly depressed and slightly rounded sutures. The sutural parts of the walls are strongly bent inward, and the deep canal at each suture is bridged by clear, poreless chalk, leaving free a row of rounded openings. Margin rounded. Apertural face without pores, often showing small tubercules or openings; aperture consists of several rounded openings at the base of the apertural face. Wall hyaline, shining, thin. – In some small specimens the lobulate periphery is absent and a central disc may be present.

ARUBA: Salinja Oranjestad; Punta Braboe, sta. 1002; Lagoen Boekoeti, 1004; Master, 1014. CURAÇAO: Spaanse Water, New Haven, 1036A. BONAIRE: Lac, Cay, 1067. KLEIN BONAIRE: 1049B, 1371. AVES DE SOTAVENTO: AS 1. AVES DE BARLOVENTO: AV 1. ST. KITTS: Basseterre, 1398. ST. EUSTATIUS: Billy Gut, 1117. ST. MARTIN: Simson Bay Lagoon, 1130. SOUTH BIMINI: 1150A. NORTH BIMINI: 1151. CAT KEY: 499.

Elphidiononion incertum (Williamson) Fig. 270

Polystomella umbilicatula, var. *incerta* WILLIAMSON, 1858, p. 44, pl. 3 fig. 82.
Elphidium incertum (Williamson) CUSHMAN, 1930, p. 18, pl. 7 fig. 4–9.

Small specimens with lobulate periphery and depressed sutures; the chambers have a "poreless" area in the centre, which, however, has some large pores. These large pores are also present along the sutures; bridges between the pores hyaline, which is characteristic for *Elphidionion.*

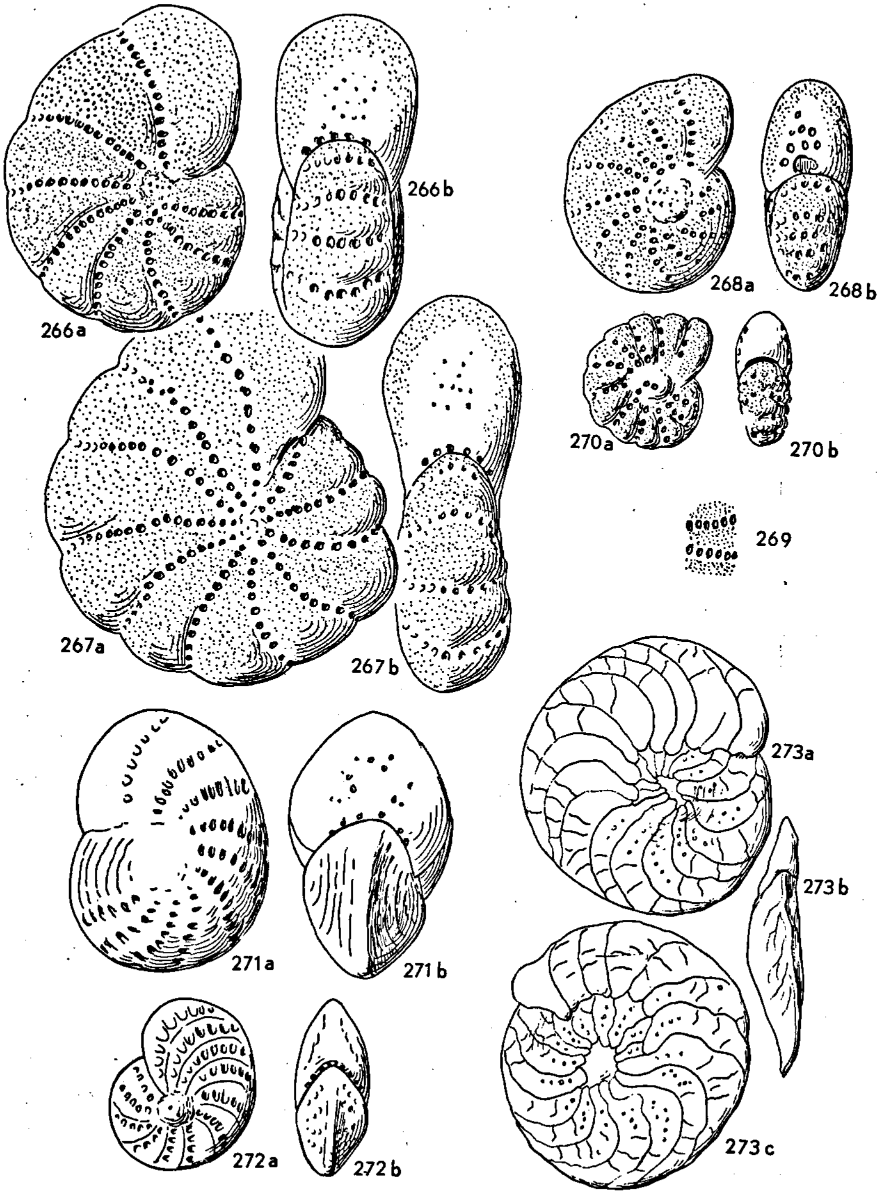
ARUBA: Lagoen Boekoeti, sta. 1004. BONAIRE: Salinja di Lac, 303.

Elphidium discoidale (d'Orbigny) Fig. 272

Polystomella discoidale D'ORBIGNY, 1839, Cuba p. 56, pl. 6 fig. 23–24.

Small tests with curved sutures, a distinct central plug, a subacute margin, openings at the sutures with real alar prolongations between the walls which are covered with the same fine pores as found in other parts of the wall.

ARUBA: Punta Braboe, sta. 1002. GRENADA: White Bay, 1389. BARBUDA: Martello Tower Beach, 1394. ST. KITTS: Basseterre, 1398.


266a
266b
268a
268b
270a
270b
269
267a
267b
273a
273b
271a
271b
272a
272b
273c

Elphidium lanieri (d'Orbigny) Fig. 271

Polystomella lanieri D'ORBIGNY, 1839, Cuba p. 54, pl. 7 fig. 12–13.
Elphidium lanieri (d'Orbigny) BERMUDEZ, 1935, p. 187.

Test slightly elongate, periphery smooth; apertural face broad, with an irregular row of pores at the base and some pores on the face itself. Openings between the real alar prolongations elongate, in the older parts of the test separated by distinct costae.

Apparently very rare.
ST. BARTS: Gustavia, sta. 450. ST. MARTIN: Great Bay, 1128A.

Heterostegina antillarum d'Orbigny Fig. 273

Heterostegina antillarum D'ORBIGNY, 1839, Cuba p. 121, pl. 7 fig. 23, 25.

Test small for the genus, much compressed, mostly at one side more convex than at the other, with acute margin with a poreless rim containing the canal system (marginal chord). At the more convex side the chambers are distinctly more overlapping than at the flatter side. Sutures in most cases distinct, strongly curved backward, with secondary sutures of the secondary partitions dividing the chamberlets. In the more central parts of the alar prolongations one or more rows of small chalk knobs are found on

Fig. 266–269. *Elphidiononion poeyanum* (d'Orbigny). — 266, South Bimini, sta. 1150A. — 267, Klein Bonaire, sta. 1049B. — 268–269, Cat Cay, near Bimini: test from two sides, and part of test to show the poreless parts between the sutural openings (× 55).

Fig. 270. *Elphidiononion incertum* (Williamson). — Aruba, sta. 1004: two views of same specimen (× 55).

Fig. 271. *Elphidium lanieri* (d'Orbigny). — St. Martin, sta. 1128A: two views of same test (× 55).

Fig. 272. *Elphidium discoidale* (d'Orbigny). — St. Barts, sta. 450: two views of same specimen (× 55).

Fig. 273. *Heterostegina antillarum* d'Orbigny. — Aruba, sta. 1301: three views of same specimen (× 55).

the surface of each chamber. The chambers at both sides do not completely reach the centre, where a hyaline chalk knob is found.

The difference with *Heterostegina suborbicularis* from the Pacific is the small size of the test and absence of chamberlets in the first coils of chambers in up to 19 chambers.

ARUBA: Malmok, sta. 1301. GRENADA: White Bay, 1389. ST. EUSTATIUS: Gallows Bay, 1116B. ST. MARTIN: Great Bay, 1126, 1128A.

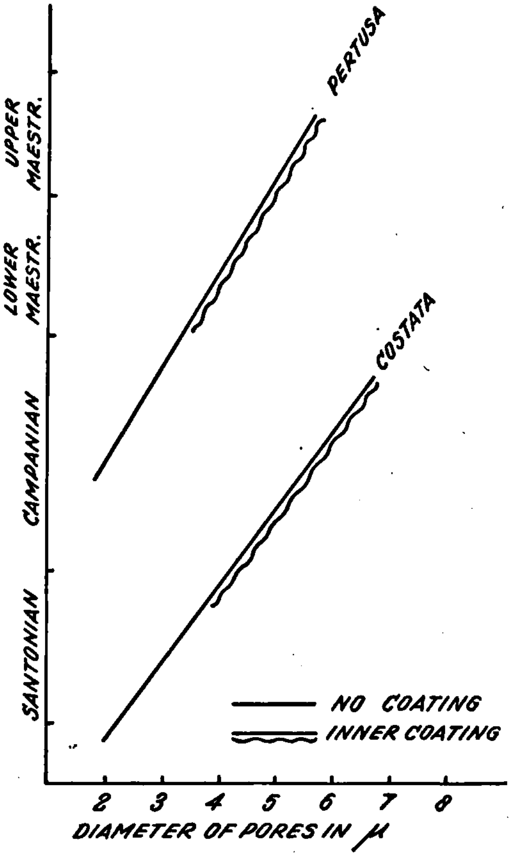


Fig. 203. Diagram showing the increase of pore-diameters of *Gavelinella costata* Brotzen and *Gavelinella pertusa* (Marsson) in the Upper Cretaceous: both species develop an inner chitinous lining when the pores have increased to μ in diameter. [See p. 75.]

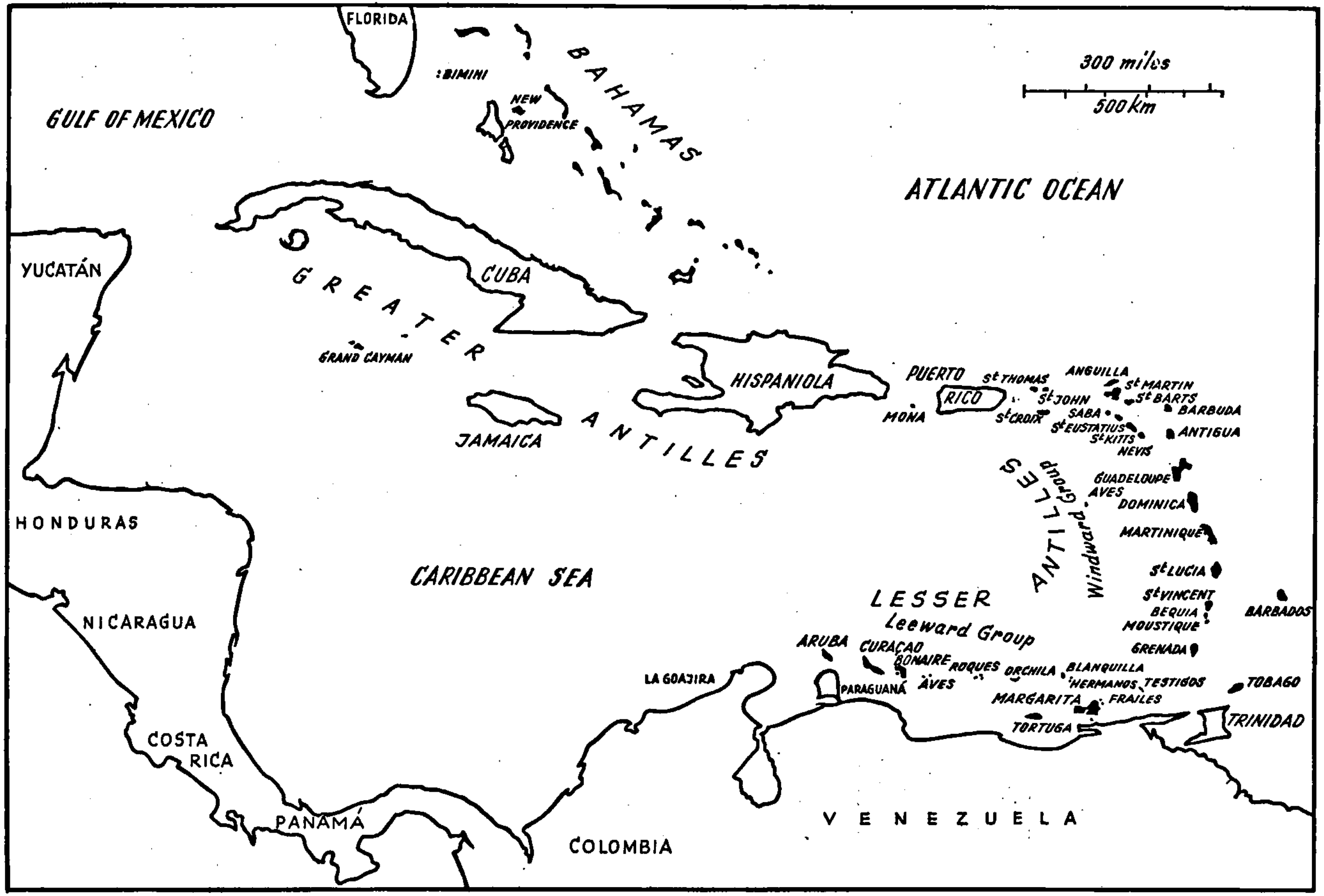


Fig. 274. Sketch map of the Caribbean, showing localities of West Indian foraminifera treated in this paper.

REFERENCES

Arnold, Z. M., 1954. Discorinopsis aguayoi (Bermudez) and Discorinopsis vadescens Cushman and Brönnimann: A study of variation in cultures of living Foraminifera. *Contr. Cushman Found. For. Res. 5*, p. 4–13, pl. 1.

Bandy, O. L., 1944. Eocene Foraminifera from Cape Blanco, Oregon. *Journ. Pal. 18*, p. 366–377, pl. 60–62.

Barker, R. W., 1960. Taxonomic notes on the Challenger Report, Foraminifera. *Soc. Econ. Pal. and Min., Spec. Publ. 9*, p. I–XXIV, pl. 1–115.

Bellen, R. C. van, 1946. Foraminifera from the Middle Eocene in the Southern part of the Netherlands province of Limburg. *Meded. Geol. Stichting (C) V, 4*, p. 1–145, pl. 1–13.

Bermudez, P. J., 1935. Foraminiferos de los costas norte de Cuba. *Mem. Soc. Cubana Hist. Nat. Fel. Poey 9*, p. 129–224, pl. 10–17.

Bermudez, P. J., 1952. Estudio de los Foraminiferos rotaliformes. *Bol. Geol. Venez. 2, 4*, p. 1–230, pl. 1–35.

Brady, H. B., 1884. *Report on the Foraminifera* ... Challenger-Reports *9*, XXI + 814 pp., 116 pls.

Butler, E. A., 1959. Miocene – Upper Oligocene Foraminifera of Louisiana. *Louis. Geol. Survey, Pal. Studies 1*, pl. 1.

Calvez, Y. le, 1952. Révision des Foraminifères lutétiens du Bassin de Paris. Valvulinidae, Peneroplidae, Ophthalmidiidae, Lagenidae. *Mém. Carte géol. France IV.*

Carman, K., 1933. Dentostomina, a new genus of the Miliolidae. *Contr. Cushman Lab. For. Res. 9*, p. 31.

Carpenter, W. B., 1856, Researches in the Foraminifera. Pt. 1, containing general introduction and monograph of the genus Orbitolites. *Phil. Trans. 146*, p. 181–236, pl. 4–9.

Carpenter, W. B. & Parker, W. K. & Jones, T. R., 1862. *Introduction to the study of the Foraminifera.* Ray Soc., London, 319 pp., 22 pls.

Cole, W. S., 1941. Stratigraphic and paleontologic studies of wells in Florida. *Bull. Florida Geol. Survey, 19*, p. 1–91, pl. 1–18.

Cushman, J. A., 1917. A monograph of the Foraminifera of the North Atlantic Ocean; Miliolidae. *Bull. U.S. Nat. Mus., 71, 6*, p. 1–108, pl. 1–39.

Cushman, J. A., 1918. Some Pliocene and Miocene Foraminifera of the Coastal Plain of the U.S. *Bull. U.S. Geol. Survey 676*, p. 1–100, pl. 1–31.

Cushman, J. A., 1921. Foraminifera from the West coast of Jamaica. *Proc. U.S. Nat. Mus. 59*, p. 47–82, pl. 11–19.

Cushman, J. A., 1922. Shallow-water Foraminifera of the Tortugas region. *Publ. Carn. Inst. 311*, p. 1–85, pl. 1–14.

Cushman, J. A., 1926. Recent Foraminifera from Porto Rico. *Publ. Carn. Inst. 344*, p. 73–84, pl. 1.

Cushman, J. A., 1928. Foraminifera and their economic use. *Cushman Lab. For. Res., Spec. Publ. 1*, p. 1–401, pl. 1–50.

Cushman, J. A., 1929. Foraminifera of the Atlantic Ocean, Miliolidae. *Bull. U.S. Nat. Mus. 104, 6*, p. 1–129, p. 1–22.

Cushman, J. A., 1930. Foraminifera of the Atlantic Ocean, Nonionidae to Peneroplidae. *Bull. U.S. Nat. Mus. 104, 7*, p. 1–79, pl. 1–18.

CUSHMAN, J. A., 1931. Foraminifera of the Atlantic Ocean, Rotaliidae. *Bull. U.S. Nat. Mus. 104, 8*, p. 1–179, pl. 1–26.

CUSHMAN, J. A., 1937. A monograph of the foraminiferal family Valvulinidae. *Cushman Lab. For. Res., Spec. Publ. 8*, p. 1–210, pl. 1–24.

CUSHMAN, J. A., 1937. A monograph of the foraminiferal family Virgulinidae. *Cushman Lab. For. Res., Spec. Publ. 9*, p. 1–228, pl. 1–24.

CUSHMAN, J. A., 1944. The genus Articulina and its species. *Cushman Lab. For. Res., Spec. Publ. 10*, p. 1–21, pl. 1–4.

CUSHMAN, J. A., 1949. Recent Belgian Foraminifera. *Mém. Inst. R. Sci. Nat. Belg. 111*, p. 1–59, pl. 1–10.

CUSHMAN, J. A., 1950. *Foraminifera, their classification and their economic use.* 4th. ed. Cambridge, Mass., 605 pp., 55 pls.

CUSHMAN, J. A. & BRÖNNIMANN, P., 1948. Some new genera and species of Foraminifera from the brackish water of Trinidad. *Contr. Cushman Lab. For. Res. 24*, p. 15–21, pl. 3–4.

CUSHMAN, J. A. & LEROY, L. W., 1939. Cribrolinoides, a new genus of the Foraminifera, its development and relationships. *Contr. Cushman Lab. For. Res. 15*, p. 15–19, pl. 3–4.

CUSHMAN, J. A. & TODD, R., 1944. The genus Spiroloculina and its species. *Cushman Lab. For. Res., Spec. Publ. 11*, p. 1–82, pl. 1–9.

CUSHMAN, J. A. & WICKENDEN, R. T. D., 1929. Recent Foraminifera from off Juan Fernandez Islands. *Proc. U.S. Nat. Mus. 75, 9*, p. 1–16, pl. 1–6.

DUJARDIN, M. F., 1841. *Histoire naturelle des Zoophytes; Infusoires.* Paris, 684 pp., 2 pls.

EHRENBERG, C. G., 1838. Ueber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *Abh. Akad. Wiss. Berlin 1838*, p. 59–147, pl. 1–4.

EMILIANI, C., 1951. On the species Homotrema rubrum (Lamarck). *Contr. Cushman Found. For. Res. 2*, p. 143–147, pl. 15–16.

FICHTEL, L. & MOLL, J. P. C., 1798. *Testacea microscopica aliaque minuta ex generibus Argonauta et Nautilus ad naturam delineata et descripta.* 123 pp., 24 pls.

FINLAY, H. J., 1947. New Zealand Foraminifera: Key species in stratigraphy, No. 5. *New Zealand Journ. Sci. Techn. 28*, p. 259–292, pl. 1–9.

FISCHER, G. DE WALDHEIM, 1817. Adversaria zoologica. *Mém. Soc. Imp. Nat. Moscou 5*, p. 357–471, pl. 13.

FLINT, J. M., 1897. Recent Foraminifera. *Rep. U.S. Nat. Mus.*, p. 249–349, pl. 1–80.

GOËS, A., 1882. On the reticularian Rhizopoda of the Caribbean Sea. *Kongl. Svensk. Vet. Akad. Handl. 19, 4*, p. 1–151, pl. 1–12.

GOËS, A., 1894. A synopsis of the Arctic and Scandinavian recent marine Foraminifera hitherto discovered. *Kongl. Svensk. Vet. Akad. Handl. 25, 9*, p. 1–127, pl. 1–25.

GRAHAM, J. J. & MILITANTE, P. J., 1959. Recent Foraminifera from the Puerto Galera Area, Northern Mindoro, Philippines. *Stanford Univ. Publ. 6, 2*, p. 1–132, pl. 1–19.

HENSON, F. R. S., 1950. *Middle Eastern Tertiary Peneroplidae (Foraminifera) with remarks on the phylogeny and taxonomy of the families.* Thesis, Leiden, 70 pp., 10 pls.

HERON-ALLEN, E. & EARLAND, A., 1915. Foraminifera from the Kerimba Archipelago. *Trans. Zool. Soc. London 20*, p. 363–390, pl. 7–14; p. 543–794, pl. 40–53.

HICKSON, S. J., 1911. On Polytrema and some allied genera. *Trans. Linn. Soc. London* (*Zool.*) *14*, p. 442–462, pl. 10–12.

HOFKER, J., 1927. Tinoporidae, etc. *Siboga Rep. IVa, 1*, p. 1–78, pl. 1–38.

HOFKER, J., 1930. Notizen über die Foraminiferen des Golfes von Neapel; II, Quinqueloculina annectens (Schlumberger). *Pubbl. Staz. Zool. Napoli 10*, p. 379–404, pl. 13.

HOFKER, J., 1930. Astrorhizidae to Peneroplidae. *Siboga Rep. IVa, 2*, p. 79–170, pl. 39–64.

HOFKER, J., 1930. Foraminifera. *Zool. Faroës IIa*, p. 1–21.

HOFKER, J., 1950–1953. Recent Peneroplidae. *Journ. R. Micr. Soc. 70–73*: 1950, *70*, p. 388–396; 1951, *71*, p. 223–239, 342–356; 1952, *71*, p. 450–463; 1952, *72*, p. 102–122; 1953, *73*, p. 40–46.

HOFKER, J., 1951. Foraminifera dentata. *Siboga Rep. IVa, 3*, p. 1–513.

HOFKER, J., 1954. Foraminiferen. *Veranderingen Flora en Fauna Zuiderzee*, p. 74–89.

HOFKER, J., 1955. Discopulvinulina cushmani Hofker, a new name for Hanzawaia concentrica (Cushman). *Contr. Cushman Found. For. Res. 6*, p. 128–130.

HOFKER, J., 1956. Tertiary Foraminifera of coastal Ecuador; pt. 2, Additional notes on the Eocene species. *Journ. Pal. 30*, p. 891–958.

HOFKER, J., 1956. Foraminifera dentata. Foraminifera of Santa Cruz and Thatch-Island, Virginia-Archipelago, West-Indies. *Spolia zool. Musei Hauniensis 15*, p. 1–237.

HOFKER, J., 1957. Foraminiferen der Oberkreide von Nordwestdeutschland und Holland. *Beihefte Geol. Jahrb. 27*, p. 1–464.

HOFKER, J., 1958. Supplément sur quelques Rotalidés (espèces de Streblus, de Pseudoeponides et de Pararotalia) dans les couches Plio-Pleistocènes du Kruisschans. *Mém. Inst. R. Sci. Nat. Belg. 142*, p. 55–63.

HOFKER, J., 1958. The taxonomic position of the genus Pseudoeponides Uchio. *Contr. Cushman Found. For. Res. 9*, p. 46–48.

HOFKER, J., 1959. Die asterigerinen Foraminiferen. *Pal. Zeitschr. 33*, p. 247–265.

HOFKER, J., 1959. The genera Eponides, Lacosteina, Nuttalides, Planorbulina and Halkeyardia. *Contr. Cushman Found. For. Res. 10*, p. 111–118.

HOFKER, J., 1960. Foraminiferen aus dem Golf von Neapel. *Pal. Zeitschr. 34*, p. 233–262.

HOFKER, J., 1962. Studien an planktonischen Foraminiferen. *N. Jahrb. Geol. Pal., Abh. 114*, p. 81–134.

HÖGLUND, H., 1947. Foraminifera in the Gullmar Fjord and the Skagerak. *Zool. Bidrag Uppsala 26*, p. 1–328, pl. 1–32.

KARRER, F., 1868. Die Miocene Foraminiferen-Fauna von Kostej im Banat. *Sitz. ber. Akad. Wiss. Wien 58*, p. 111–133, pl. 1–5.

KEYZER, C. J., 1925. On the variability in East Indian Foraminifera. *Temminckia 1*, p. 75–153, pl. 4–6. (Thesis, Leiden).

LAMARCK, J. B. P. A. DE, 1801. *Système des Animaux sans vertèbres.*

LAMARCK, J. B. P. A. DE, 1816. *Histoire naturelle des Animaux sans vertèbres. 2*, p. 193–197.

LINNAEUS, C., 1767. *Systema naturae, 1*. Ed. 12.

LACROIX, E., 1940. Les Orbitolites de la baie de Caudra (Indochine). *Bull. Inst. Océan. Monaco 787*, p. 1–34.

LOEBLICH, A. R. & TAPPAN, H., 1957. Eleven new genera of Foraminifera. *Bull. U.S. Nat. Mus. 215*, p. 223–232, pl. 72–73.

MONTAGU, 1803. *Testacea brittanica.* 3 vols., 1803–1808.

Montagu, 1808. *Testacea brittanica. Suppl.*

Millet, F. W., 1898–1904. Report on the recent Foraminifera of the Malay Archipelago. *Journ. R. Micr. Soc.*; 17 parts.

Montfort, D. de, 1808. *Conchyologie systématique et classification méthodique des Coquilles. 1.*

Nyholm, K. G., 1961. Morphogenesis and biology of the Foraminifer Cibicides lobatulus. *Zool. Bidrag Uppsala 33*, p. 157–196, pl. 1–5.

Orbigny, A. d', 1839. Foraminifères de Cuba: De la Sagra, *Hist. phys. pol. nat. de Cuba*, Paris, p. 1–180, pl. 1–12.

Orbigny, A. d', 1840. Foraminiferas: De la Sagra, *Historia fisica, politica y natural de la isla de Cuba*, 180 pp., 12 pls. – Atlas, vol. 8, 1855.

Orbigny, A. d', 1839. Foraminifères des îles Canaries: *Hist. nat. Isles Canaries. 2*, pt. 2, p. 119–146, pl. 1–3.

Parker, F. L., 1954. Distribution of Foraminifera in the Northern Gulf of Mexico. *Bull. Mus. Comp. Zoöl. 3*, p. 454–588, pl. 1–13.

Parker, F. L. & Athearn, W. D., 1959. Ecology of marsh Foraminifera in Poponesset Bay, Mass. *Journ. Pal. 33*, p. 333–343, pl. 50.

Reiss, Z., 1957. The Bilamellidae, nov. superfam. and remarks on Cretaceous Globorotaliidae. *Contr. Cushman Found. For. Res. 8*, p. 127–145, pl. 18–20.

Reiss, Z., 1958. Classification of lamellar Foraminifera. *Micropal. 4*, p. 51–70, pl. 1–5.

Reiss, Z., 1959. Structure of so-called Eponides and some other Rotaliidae. *Bull. Geol. Survey Israël 29, 1*, p. 1–20, pl. 1–3.

Reiss, Z., 1959. The wall-structure of Cibicides, Planulina, Gyroidinoides and Globorotalites. *Micropaleontology 5*, p. 355–357, pl. 1.

Reiss, Z. & Merlin, P., 1958. Structure of some Rotaliidae. *Bull. Geol. Survey Israël 21*, p. 1–19, pl. 1–5.

Saunders, J. B., 1957. Emendation of the foraminiferal genus Palmerinella Bermudez, 1924, and erection of the foraminiferal genus Helenia. *Journ. Wash. Acad. Sci. 47*, p. 370–374, pl. 1–7.

Smout, A. H., 1954. *Lower Tertiary Foraminifera of the Qatar Peninsula.* Brit. Mus. Nat. Hist., 97 pp., 15 pl.

Smout, A. H. & Eames, F. E., 1958. The genus Archaias (Foraminifera) and its stratigraphical distribution. *Paleontology 1*, p. 207–225, pl. 39–42.

Terquem, O., 1876. *Essai sur le classement des animaux qui vivent sur la plage de Dunkerque. 2*, p. 55–100, pl. 7–12.

Todd, R. & Low, D., 1961. Near-shore Foraminifera of Martha's Vineyard Island, Massachusetts. *Contr. Cushman Found. For. Res. 12.*

Walker, G. & Jacob, E., 1798. An arrangement and description of minute and rare shells: Adams, *Essays on the Microscope*, 2nd. ed., London, p. 629–645, pl. 14.

Warren, A. D., 1957. Foraminifera of the Buras – Scofield Region, Southeast Louisiana. *Contr. Cushman Found. For. Res. 8*, p. 29–40, pl. 3–4.

Williamson, W. E., 1858. *On the recent Foraminifera of Great Britain.* Ray Soc., London.