THE FORAMINIFERA OF THE SABA BANK EXPEDITION, 1972 (CICAR CRUISES 34, 35)

by

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With 19 text-figures

Introduction

Bottom samples obtained by means of a Van Veen grab during the 1972 Saba Bank Expedition (CICAR cruises 34 and 35) appeared to comprise many samples with Foraminifera. This material was kindly put at my disposal by Dr. D. van Harten of the Geological Institute of the University of Amsterdam, where the material had been deposited. Complementary to this, a large amount of samples from many stations of the Saba Bank area were obtained from the residues in containers with larger material stored in the Rijksmuseum van Natuurlijke Historie at Leiden, but many of these residues contained only few Foraminifera. Dr. W. Vervoort of the Leiden Museum asked me to identify all the Foraminifera from both collections. As a result 1360 cardboard slides could be added to the collection of Caribbean Foraminifera in the Rijksmuseum van Natuurlijke Historie. Dr. D. van Harten, Dr. W. Vervoort, and Messrs. J. C. den Hartog and M. Slierings are kindly thanked for their help and advise.

As the author already described numerous species from the Caribbean region (Hofker, 1956, 1964, 1969, 1971, 1972, 1976), he will only describe here some of the species found in so far as they are new or were imperfectly known.

The Saba Bank

The Saba Bank (fig. 1) seems to be a submerged island to the south-east of the island of Saba; the sea-floor between Saba and the Bank is rather deep, and the submerged island seems not to have had any connection with Saba. Like the other islands around the Bank, both are of volcanic origin. The platform of the bank itself, found between 17°12′ N to 17°45′ N and 63°12′ W to 63°50′ W, is nearly flat with its highest part about 16 m below sea-level, and going down to the north and the west till 74 m in the north and till 50 m in the west (beginning of the slope). This flat platform may indicate that the rising sea at the end of the last glacial period submerged the island slowly, abrasing the volcanic tops into a flat platform. In the north-west the island originally formed a kind of bay in which the sea-floor formed a shelf, now seen as a sloping floor from 80 m (St. 125) to about 300 m (St. 129). The north-east coast, the south coast and the west coast are very steep as may be learned from the transverse sections through the Bank and its surroundings (fig. 3).

On the platform of the Saba Bank the water is very clear and the light can

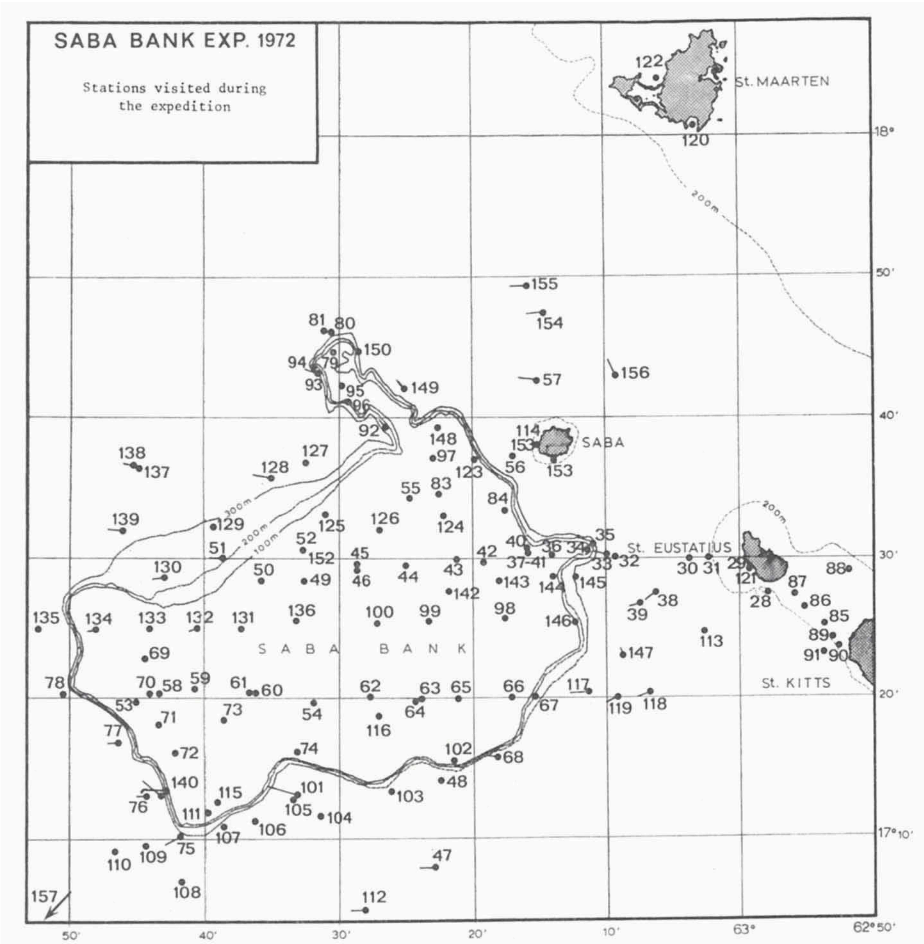


Fig. 1. Saba Bank and environments, with all stations explored.

penetrate to the sea-floor at most parts. There is a kind of promontory on the north side of the bank, where the sea-floor is deeper (84-125 m), closing the bay from the east. It is remarkable that in this sloping bay one species occurs, which is not found elsewhere around the island, viz., *Liebusella polyphragma* (Goës); this floor of the bay mainly consists of muddy sand with pteropods; obviously this environment is favourable for this species, which occurs here in abundancy (found abundantly also by Goës (1882: 87) to the E and N of the Lesser Antilles). The general outline of the Saba Bank is a rectangle with its longer sides directed from the north-east to the south-west.

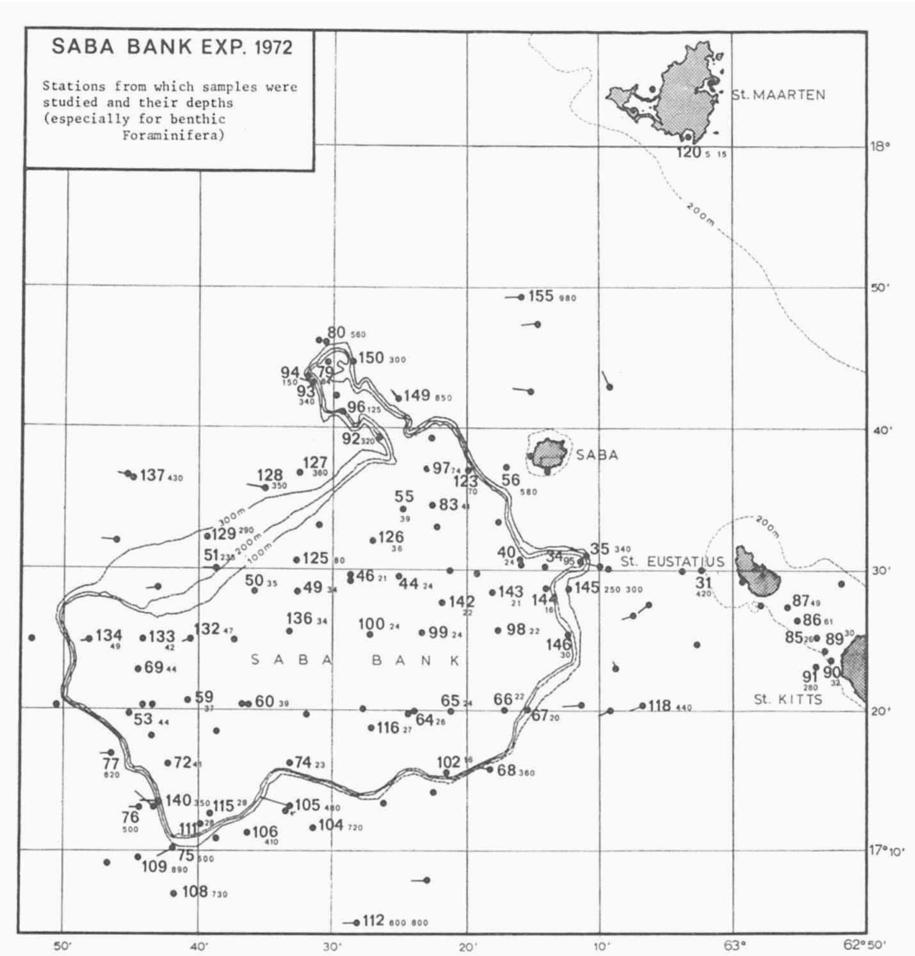


Fig. 2. Saba Bank and environments with the stations studied, with their depths between parentheses, containing Foraminifera.

Corals are found mostly along the east and south coasts (St. 144, 146, 102, 111, but also on the bank itself, St. 100). Calcareous sands are found on the bank itself, muddy sand, often consisting of volcanic material, on the deeper slope; here are found the pteropods and foraminiferal planktonic oozes.

In order to give an impression of the characteristics of the different stations, such as position, depth, temperature and type of sediment, the reader is referred to table 1, dealing with samples containing benthic Foraminifera. Many other samples were studied and found to contain Foraminifera, mostly,

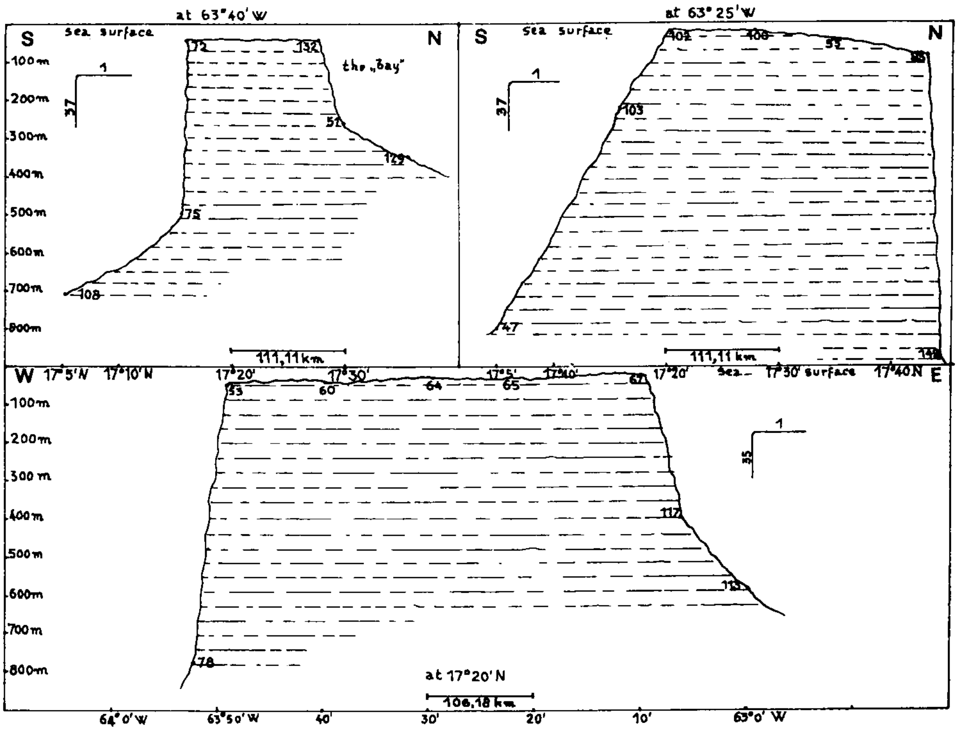


Fig. 3. Saba Bank, three sections, showing its surface and the slopes.

however, in small quantities and without remarkable species. These samples were put on slides, but not sorted out to the species. The 58 samples of Foraminifera-bearing sediments give a good survey of the benthic species occurring in the Saba Bank region.

In table 2 the numbers and characteristics are listed of the stations from which planktonic Foraminifera were studied.

TABLE I

Samples of Foraminifera-bearing sediment studied from the Saba Bank region with its slopes, arranged according to increasing depth (= decreasing sea-floor-temperature).

St						
120	18° 1'N	63° 3'W	Groot Baai, St. Maarten	5-15 m	21°C	muddy sand, turtle grass
102	17°16'N	63°21'W	S. Saba Bank	16 m	21°C	coral reef
144	17°29'N	63°13'W	E. Saba Bank	16 m	21°C	rocky, corals
67	17°20'N	63°15'W	SE. Saba Bank	20 m	21°C	coral reef
46	17°30'N	63°28'W	Central Saba Bank	21 m	21°C	sand, stones, algae
98	17°26'N	63°17'W	E. Saba Bank	22 m	21°C	sand, stones, algae
66	17°20'N	63°17'W	SE. Saba Bank	22 m	21°C	sand, dead coral
74	17°16'N	63°33'W	S. Saba Bank	23 m	21°C	coral reef
99	17°26'N	63°23'W	Central Saba Bank	24 m	21°C	calcareous stones, algae
100	17°25'N	63°27'W	Central Saba Bank	24 m	21°C	rock, stones, corals
40	17°31'N	63°16'W	E. Saba Bank	24 m	21°C	sand, stones, *Acropora*
65	17°20'N	63°20'W	SE. Saba Bank	24 m	21°C	sand, stones, shells
44	17°30'N	63°25'W	Central Saba Bank	24 m	21°C	stones, algae
45	17°30'N	63°28'W	Central Saba Bank	25 m	20°C	sand, shell gravel
116	17°19'N	63°27'W	S. Saba Bank	27 m	20°C	sand, shell gravel
111	17°12'N	63°40'W	SW. Saba Bank	28 m	20°C	sand, scattered corals
89	17°24'N	62°53'W	SW. of St.Kitts	30 m	20°C	stones, algae
146	17°26'N	63°12'W	E. Saba Bank (slope)	30 m	20°C	sand, stones, corals
90	17°23'N	62°53'W	NW. of St.Kitts	32 m	20°C	stones, algae
50	17°28'N	63°36'W	Central Saba Bank	35 m	20°C	sand, shells, stones
126	17°33'N	63°27'W	N. Saba Bank	36 m	20°C	rocky, sand, stones
59	17°21'N	63°41'W	W. Saba Bank	37 m	20°C	sand, stones, algae
60	17°23'N	63°45'W	W. Saba Bank	39 m	20°C	coarse sand, algae
55	17°34'N	63°24'W	NE. Saba Bank	39 m	20°C	sand, stones, algae
72	17°16'N	63°42'W	SW. Saba Bank	41 m	19°C	sand, shells, algae
83	17°38'N	63°27'W	NE. Saba Bank	41 m	19°C	rocky, stones
133	17°25'N	63°42'W	W. Saba Bank	42 m	19°C	stones, algae
69	17°23'N	63°45'W	W. Saba Bank	44 m	19°C	sand, stones, algae
87	17°27'N	62°56'W	SE. of St.Eustatius	49 m	19°C	calcareous stones
134	17°25'N	63°47'W	W. Saba Bank	49 m	19°C	calcareous stones, algae
86	17°26'N	62°55'W	SE. of St.Eustatius	61 m	19°C	stones, sand
123	17°37'N	63°20'W	NE. Saba Bank	70 m	19°C	sandy gravel, *Halimeda*
97	17°37'N	63°23'W	NE. Saba Bank	74 m	19°C	calcareous gravel
125	17°33'N	63°31'W	N. Saba Bank	80 m	18°C	muddy sand
79	17°45'N	63°30'W	N. Saba Bank	84 m	18°C	stones
34	17°31'N	63°11'W	E-slope Saba Bank	95 m	18°C	sand, Foraminifera
96	17°41'N	63°29'W	N-slope Saba Bank	125 m	16°C	sand
51	17°30'N	63°39'W	NW-slope Saba Bank	235 m	13°C	muddy sand
91	17°23'N	62°54'W	NW. of St.Kitts	280 m	12°C	calcareous stones
129	17°32'N	63°39'W	NW-slope Saba Bank	290 m	12°C	sandy mud

St						
150	17°45'N	63°28'W	NE slope Saba Bank	300 m	12°C	sand, globigerines
93	17°43'N	63°32'W	N-slope Saba Bank	340 m	12°C	sand
35	17°31'N	63°11'W	E-slope Saba Bank	340 m	12°C	clayey sand
128	17°36'N	63°37'W	N-slope Saba Bank	350 m	12°C	pteropode ooze
127	17°37'N	63°32'W	N-slope Saba Bank	360 m	11°C	pteropode ooze
106	17°11'N	63°36'W	SW-slope Saba Bank	410 m	11°C	muddy sand
31	17°30'N	63° 2'W	W. of St.Eustatius	420 m	11°C	sand, Foraminifera
137	17°38'N	63°43'W	NW. of Saba Bank	430 m	10°C	pteropode ooze
105	17°13'N	63°33'W	S-slope Saba Bank	480 m	9°C	muddy sand
75	17°10'N	63°42'W	SW-slope Saba Bank	500 m	9°C	muddy sand
80	17°46'N	63°30'W	N-slope Saba Bank	560 m	8°C	globigerine ooze
56	17°37'N	63°17'W	W. of Saba	580 m	8°C	muddy sand
112	17° 6'N	63°28'W	S. of Saba Bank	600-800 m	7.5°C	
77	17°17'N	63°47'W	W-slope Saba Bank	620 m	7.5°C	muddy
104	17°12'N	63°31'W	S. of Saba Bank	720 m	7°C	muddy sand
108	17° 7'N	63°42'W	SW. of Saba Bank	730 m	7°C	pteropode ooze
149	17°43'N	63°25'W	NE. of Saba Bank	850 m	6°C	muddy sand, pteropods
109	17° 9'N	63°45'W	SW. of Saba Bank	890 m	5°C	sandy clay, pteropods
155	17°49'N	63°16'W	N. of Saba	980 m	5°C	pteropod ooze

TABLE 2

List of the stations and their characteristics from which only planktonic Foraminifera were studied.

143	17°28'N	63°17'W	E. Saba Bank	21 m	22°C	calcareous stones, algae
142	17°27'N	63°21'W	Central Saba Bank	22 m	20°C	sand, stones, algae
64	17°20'N	63°24'W	Central Saba Bank	26 m	20°C	stones
85	17°25'N	62°54'W	NW. St.Kitts	26 m	20°C	calcareous stones
115	17°12'N	63°38'W	SW. Saba Bank	26 m	20°C	sand, scattered corals
136	17°25'N	63°33'W	Central Saba Bank	34 m	20°C	sand, shells
49	17°29'N	63°32'W	Central Saba Bank	34 m	20°C	sand, gravel
93	17°43'N	63°32'W	N-slope Saba Bank	44 m	19°C	sand
132	17°25'N	63°39'W	Central Saba Bank	47 m	18°C	muddy sand, *Lithothamnion*
94	17°43'N	63°32'W	N-slope Saba Bank	330-150 m	14°C	soft bottom
145	17°29'N	63°13'W	E-slope Saba Bank	300-250 m	14°C	soft bottom
92	17°40'N	63°27'W	NE-slope Saba Bank	320 m	12°C	sand
140	17°12'N	63°43'W	SW-slope Saba Bank	350-600 m	11°C	soft bottom
68	17°16'N	63°18'W	SE-slope Saba Bank	360 m	11°C	calcareous stones
118	17°20'N	63° 7'W	SE. Saba Bank	440 m	9°C	soft bottom
76	17°14'N	63°44'W	SW-slope Saba Bank	500 m	8°C	muddy sand
30	17°30'N	63°04'W	W. St.Eustatius	680 m	7°C	andesite pebbles

Species described in this paper; the new species are marked with an asterisk (*)

Alphabetical list of the benthic foraminifera, found in rich samples in the Saba Bank region, and their stations (fig. 2)
(in parentheses the depths of the sea-floor in m)

Alliatinella caribbeana Hofker 75(500)
Ammolagena clavata (Parker & Jones) 129(290), 150(200), 93(340), 31(420), 105(480), 80(560), 56(580), 155(980)
Ammonia advena Cushman 102(16)
Amphicoryna intercellularis (Cushman) 129(290), 150(300), 80(560), 112(600)
Amphicoryna rugosa (d'Orbigny) 129(290), 128(350), 75(500), 80(560), 56(580), 77(620), 108(730), 149(850)
Amphistegina gibbosa d'Orbigny. In all samples from 5-95 m
Angulogerina occidentalis (Cushman) 125(80), 34(95), 106(410), 104(720), 108(730), 149(890), 155(980)
Anomalina flintii Cushman 112(600), 104(700), 108(730), 149(850), 155(980)
Archaias angulatus (Fichtel & Moll) 120(5-15), 67(20), 74(23), 40(24), 116(27), 111(28), 146(30), 59(37), 55(39), 72(41), 69(44), 87(49), 123(70), 125(80); very large specimens in 45(25), 49(34)
Archaias annulatus (Hofker) 114(16), 67(20), 74(23), 100(24), 44(24), 50(35), 55(39), 72(41), 84(41), 133(42), 69(44), 134(49), 123(70), 79(84)
Archaias compressus (d'Orbigny) 120(5-15), 116(27), 90(32), 50(35), 126(36), 59(37), 60(39), 55(39), 72(41), 83(41), 133(42), 69(44), 123(70), 97(74), 125(80), 79(84), 34(95)
Articulina lineata Brady 102(16), 46(21), 98(22), 99(24), 65(24), 44(24), 59(37), 60(39), 55(39), 72(41), 125(80) and, scattered, deeper
Articulina mayori Cushman 89(30), 50(35), 55(39), 72(41), 83(41), 86(61)
Articulina mucronata (d'Orbigny) 120(5-15), 111(28), 89(30), 146(30), 59(37), 72(41), 87(49)
Articulina sagrai d'Orbigny 102(16), 67(20), 46(21), 74(23), 100(24), 44(24), 116(27), 90(32), 50(35), 59(37), 55(39), 72(41), 83(41), 69(44), 86(61), 79(84)
Asterigerina carinata d'Orbigny 120(5-15), 144(16), 67(20), 66(22), 44(24), 99(24), 100(24), 40(24), 65(24), 116(27), 111(28), 146(30), 50(37), 60(39), 72(41), 133(42), 69(44)

Biarritzina proteiformis (Goës) 51(235), 91(280), 93(340)
Bigenerina irregularis Phleger & Parker 40(24), 123(70), 94(74), 123(80), 34(95), 96(125), 51(235), 91(280), 129(290), 150(300), 93(340)

Bolivina barbata Phleger & Parker 51(235), 129(280), 104(700), 108(730)
Bolivina lanceolata Parker 100(34)
Bolivina subspinescens Cushman 149(850)
Bolivina tortuosa Brady 109(890)
Bolivina truncata Finlay 100(34)
Bulimina aculeata d'Orbigny 109(890)
Bulimina affinis d'Orbigny 129(290), 128(350), 127(360), 106(410), 137(420), 75(500), 108(730)
Bulimina alazzanensis Cushman 137(430), 105(480), 80(560), 56(580), 77(620), 108(730), 149(850), 109(890), 155(980)
Bulimina spicata Phleger & Parker 93(340), 128(350), 127(360), 31(420), 105(480), 75(500), 56(580), 77(620), 149(850)
Burseolina intermedia (Palmer) 150(300), 127(360), 106(400), 31(420), 75(500), 56(580), 149(850)

Cancris oblongus (Williamson) 86(61), 125(80), 79(84), 34(95), 51(235), 129(290), 150(300), 93(340), 128(350), 127(360), 106(410), 80(560)
Cancris sagrai d'Orbigny 40(24), 55(39), 72(41), 83(41)
Caribbeanella polystoma Bermúdez 102(16), 46(21), 98(22), 99(24), 65(24), 50(35), 125(80)
Carpenteria monticularis Carter 96(125), 106(410)
Carpenteria utricularis Carter 65(24)
Carterina caribbeana Hofker 83(41)
Cassidulina laevigata d'Orbigny 128(350), 127(360), 75(500)
Cassidulina scabra Cushman 96(125), 91(280), 129(290), 150(300), 93(340), 35(340), 106(410), 31(420), 80(560), 112(600), 77(620), 104(700), 159(730), 149(850), 109(850), 155(980)
Cassidulina subglobosa Brady 123(70), 79(84), 34(95), 31(410), 108(730), 149(850)
Cassidulinoides tenuis Phleger & Parker 108(730), 109(890)
Chilostomella ovoidea Schwager 56(580), 109(890)
Cibicides antillanus Phleger & Parker 96(125), 150(300), 104(700)
Cibicides concentricus (Cushman) 123(70)
Cibicides deprimus Phleger & Parker 47(74)
Cibicides io Cushman 112(600), 108(730)
Cibicides mollis Phleger & Parker 51(235), 129(290), 128(350), 127(360), 106(410) 77(620), 108(730)
Cibicides pseudoungerianus Cushman 96(125), 51(235), 91(280), 93(340), 128(350), 31(420), 137(430), 104(700)
Cibicides robertianus (Brady) 129(290), 128(350), 127(360), 31(420), 80(560), 56(580), 149(850)

Cibicides robustus (Phleger & Parker) 96(125), 51(235), 91(280), 93(340), 128(350), 31(420), 137(430), 104(700), 108(730)
Cibicides umbonatus Phleger & Parker 51(235), 91(280), 129(290), 150(300), 128(350), 127(360), 105(480), 56(580), 108(730)
Cornuloculina inconstans (Brady) 129(290), 150(300), 128(350), 56(580)
Cornuspiroides foleaceus (Philippi) 51(235), 128(350), 127(360), 56(580), 112(600), 149(850)
Cribrogenerina parkerea Andersen 34(95), 129(290)
Cribrostomoides bradyi Cushman 31(420), 80(560), 149(850)
Cushmanella browni (d'Orbigny) 99(24), 123(70), 34(95)
Cyclammina cancellata Brady 80(560), 56(580), 104(700), 108(730), 149(850), 109(890), 155(980)
Cylindroclavulina bradyi (Cushman) 51(235), 91(280), 129(290), 31(420), 80(560)

Dentalina communis d'Orbigny 51(235), 127(360), 104(700), 108(730), 129(350)
Dentalina obliquistriatula nov. spec. 96(125), 106(410)
Dendritina elegans (d'Orbigny) 120(5-15), 144(16), 67(20), 98(22), 74(23), 99(24), 100(24), 44(24), 116(27), 111(28), 89(30), 146(30), 50(35), 59(37), 60(39), 55(39), 72(41), 69(44)
Dimorphina peregrina (Schwager) 51(235), 150(300), 128(350), 127(360), 106(410), 112(600), 77(620), 108(730), 149(850), 109(890), 155(980)
Discammina compressa (Goës) 31(420), 137(430), 80(560), 56(580), 104(700), 108(730), 149(850)
Discogypsina vesicularis (Parker & Jones) 46(21), 55(39), 69(44), 123(70), 97(74)
Dorothia caribaea Cushman 51(235), 91(280), 129(290), 39(340), 128(350), 127(360), 105(480), 80(560), 77(620)
Dorothia curta (Cushman) 105(480), 77(620), 108(730)
Dusenburyana procera (Goës) 123(70), 79(84), 34(95)
Dyocibicides biserialis Cushman & Valentine 86(61), 123(70)

Eggerella bradyi Cushman 112(600), 108(730), 109(890), 155(980)
Ehrenbergina falcata Bermúdez 93(340), 56(580)
Ehrenbergina spinea Cushman 51(235), 129(290), 128(350), 127(360), 106(410), 75(500)
Ehrenbergina trigona Goës 150(300), 128(350), 127(360), 106(410), 31(420), 137(430), 75(500), 56(580), 108(730)
Elphidiononion discoidale (d'Orbigny) 120(5-15), 46(21), 66(22), 65(24), 146(30), 39(37), 55(39), 69(44), 134(49)

Elphidiononion mexicanum (Kornfeld) 102(16), 67(20), 66(22), 59(37), 55(39)
Elphidiononion poeyianum (d'Orbigny) 46(21), 99(24), 116(27), 126(36), 60(39), 55(39), 125(80), and many small specimens in deeper samples
Elphidium advenum (Cushman) 86(61), 123(70)
Elphidium lanieri (d'Orbigny) 83(41), 133(42), 87(49)
Eponides regularis (Phleger & Parker) 128(350), 56(580), 108(700), 149(850), 109(890)
Eponides repandus (Fichtel & Moll) 69(44), 87(49), 134(49), 86(61), 123(70), 97(74), 97(84), 34(95), 91(280)
Eponides umbonatus (Reuss) 106(410), 137(430), 149(850), 109(890), 155(980)
Euuvigerina flintii (Cushman) 51(235), 91(280), 129(290), 150(300), 93(340), 128(350), 127(360), 106(410), 137(400), 105(480)
Euuvigerina parvula (Cushman) 150(300), 128(350), 127(360), 137(430), 77(620)
Euuvigerina peregrina (Cushman) 129(290), 93(340), 128(350), 127(360), 137(430), 77(620)

Fischerina dubia (d'Orbigny) 34(95)
Fissurina formosa (Schwager) 80(560)
Fissurina orbignyiana Seguenza 108(730), 149(850)
Fissurina wiesneri Barker 109(890)
Frondicularia sagittula Vandenbroeck 51(235), 91(280), 93(340), 35(340), 128(350), 31(420), 108(730), 149(850)

Gaudryina atlantica (Bailey) 129(290), 150(300), 80(560), 56(580), 77(620)
Gaudryina convexa (Karrer) 96(125), 129(290), 80(560), 112(600)
Gaudryina flintii Cushman 128(350), 127(360), 108(730), 155(980)
Gaudryina parvula (Cushman) 31(420), 80(560), 56(580), 149(850)
Gavelinonion affine (Reuss) 102(16), 50(37), 60(39), 55(39), 72(41), 125(80), 51(253), 129(290), 106(410), 75(500), 77(620), 104(700)
Glandulina laevigata (d'Orbginy) 149(850)
Glandulina torrida Cushman 109(890)
Globobulimina aperta Hofker 109(890), 155(980)
Gyroidina altiformis Stewart & Stewart 129(290), 128(350), 127(360), 106(410), 31(420), 80(560), 77(620), 104(700), 108(730)
Gyroidina orbicularis d'Orbigny 91(280), 80(560), 104(700), 108(730), 109(890), 155(980)

Hanzawaia concentrica (Cushman) 50(35)
Haplophragmoides bradyi (Robertson) 79(84), 31(700)
Hauerina bradyi Cushman 120(5-15), 102(16), 40(24), 72(41), 133(42)
Hauerina ornatissima (Karrer) 99(24), 100(24), 60(39), 87(49), 134(49)
Heterostegina antillarum d'Orbigny 120(5-15), 144(16), 66(22), 100(24), 40(24), 111(28), 146(30), 59(37), 55(39), 72(41), 69(44), 87(49), 123(70), 34(95), 96(125)
Hoeglundina elegans (d'Orbigny) 79(84), 51(235), 91(280), 129(290), 150(300), 93(340), 128(350), 127(360), 106(410), 31(420), 137(430), 105(480), 75(500), 56(580), 77(620), 104(720), 108(730), 149(850), 109(890), 155(980)
Homotrema rubrum (Lamarck) 46(21), 40(24), 146(30), 123(70), 97(74)
Hormosina spiculifera Hofker 149(850)
Hyperammina distorta Cushman 149(850)
Hyperammina friabilis Brady 109(890)
Hyperammina laevigata 108(730), 149(850)
Hyperammina (Saccammina) caribbeana Hofker 104(700), 108(730), 109(890)

Karreriella bradyi Cushman 51(235), 129(290), 128(350), 127(360), 106(410), 137(430), 80(560), 104(700), 108(730)

Lamarckina atlantica Cushman 111(28), 89(30), 50(35), 72(41), 83(41), 86(61), 123(70), 97(74), 125(80), 79(84), 34(95), 96(125), 51(235), 91(280), 129(290), 150(300), 35(340), 128(350), 127(360), 31(420), 75(500), 56(580), 108(730), 149(850)
Laticarinina bulbrooki Cushman & Todd 31(420), 75(500)
Laticarinina pauperata (Parker & Jones) 137(430), 75(500), 80(560), 56(580), 108(730)
Lenticulina albatrossi (Cushman) 149(850)
Lenticulina calcar (Linnaeus) 96(125), 51(235), 91(280), 129(290), 128(350), 127(360), 106(410), 31(420), 105(380), 75(500), 80(560), 77(620), 149(850)
Lenticulina crepidula (Fichtel & Moll) 96(125), 91(280), 129(290), 128(350), 127(360), 106(410), 31(420), 56(580), 104(700)
Lenticulina falcifer (Stache) 150(300)
Lenticulina formosa Cushman 127(360)
Lenticulina iota (Cushman) 51(235), 93(340), 128(350), 127(360), 106(410), 31(420), 105(480), 75(500), 80(560)
Lenticulina lucida Cushman 112(600)

Lenticulina novangliae (Cushman) 129(290), 75(500), 149(850), 109(890)
Lenticulina subaculeata Cushman 96(125), 51(235), 91(280), 150(300), 127(360), 75(500), 77(620)
Lenticulina submamilligera (Cushman) 35(340)
Lenticulina thalmanni Hessland 56(580)
Lenticulina vortex (Fichtel & Moll) 96(125), 129(290), 150(300), 127(360), 56(580)
Liebusella flintiana (Cushman) 137(430), 75(500), 80(560), 56(580)
Liebusella polyphragma (Goës) 129(290), 128(350), 127(360), 137(430)
Liebusella soldanii (Jones & Parker) 123(70), 97(74), 51(235), 91(280), 129(290), 150(300), 93(340), 128(350), 127(360), 31(420), 75(500), 80(560)
Lingulina seminuda (Reuss) 137(430), 80(560)

Marginulina glabra d'Orbigny 80(560)
Marginulina multicamerata Cushman & Stainforth 140(300)
Marsipella cylindrica Brady 128(350), 56(580), 104(700), 109(890)
Marsipella rustica (Heron-Allen & Earland) 104(700), 140(850), 109(890), 155(980)
Martinottiella antillarum (Cushman) 51(235), 129(290), 93(340), 137(430), 105(480), 75(500)
Martinottiella nodulosa (Cushman) 128(350), 127(360), 80(560), 56(580), 104(700), 108(730), 149(850)
Massilina crenata (Wiesner) 55(30), 86(61), 123(70)
Massilina inaequalis Cushman 83(41), 133(42), 123(70)
Miliola tricarinata (d'Orbigny) 120(5-15), 144(16), 40(24), 55(39), 87(49), 123(70), 97(74)
Miliolinella circularis (Bornemann) 144(16), 100(24), 50(35), 87(49), 134(49), 123(70)
Miliolinella labiosa (d'Orbigny) 120(5-15), 102(16), 144(16), 46(21), 80(30), 59(37), 69(44)
Miliolinella suborbicularis (d'Orbigny) 102(16), 67(20), 100(24), 111(28), 146(30), 87(49), 123(70), 34(95)
Miliolinella subrotunda (Montagu) 120(5-15), 46(21), 74(23), 100(24), 50(35), 126(36), 59(39), 123(70)
Mississippina concentrica (Parker & Jones) 51(235), 129(290), 130(300), 93(340), 106(410), 31(420), 75(500), 56(580), 149(850)

Neoalveolina pulchra (d'Orbigny) 120(5-15), 102(16), 74(23), 99(24), 111(28), 144(16), 89(30), 146(30), 90(32), 60(34), 83(41)

Neocarpenteria candei (d'Orbigny) 86(61), 123(70), 125(80)
Neoconorbina orbicularis (Terquem) 102(16), 67(20), 98(22), 65(24), 89(30), 50(35), 59(37), 60(39), 72(41), 69(44), 79(70)
Neoeponides antillarum (d'Orbigny) 66(22), 44(24), 140(30), 50(35), 60(39), 55(39), 74(41), 83(41), 69(44), 86(61), 123(70), 125(80), 34(95), 96(125), 51(235), 91(280), 93(340), 106(410), 103(480), 80(500), 56(580)
Nodobacularia tibia (Jones & Parker) 55(39)
Nodosaria albatrossi Cushman 96(125), 51(235), 129(290), 150(200), 35(340), 128(350), 105(480), 75(500), 112(600)
Nodosaria emaciata (Reuss) 91(280), 150(300), 35(340), 128(350), 127(360), 80(560)
Nodosaria filiformis d'Orbigny 96(125), 51(235), 129(290), 150(300), 35(340), 128(350), 135(480), 75(500), 80(560), 112(600)
Nodosaria flintii Cushman 56(125)
Nodosaria glanduliniformis Dervieux 80 (560)
Nodosaria obliqua (Linnaeus) 96(125), 51(235), 129(290), 35(340)
Nodosaria semirugosa d'Orbigny 75(500), 80(560)
Nodosaria subsoluta Cushman 56(580), 77(620), 104(700), 108(730), 149(850)
Nonionella grateloupi (d'Orbigny) 120(5-15), 102(16), 67(20), 46(21), 98(22), 99(24), 100(24), 40(24), 65(24), 116(24), 90(32), 59(37), 60(39), 55(39), 72(41), 83(41), 69(44), 134(49), 86(61), 123(70), 125(80)
Nubeculina chapmani Cushman 123(70), 34(95)
Nummuloculina irregularis (d'Orbigny) 150(300), 128(350), 127(360), 31(420), 105(480), 56(580), 112(600), 77(620), 104(700), 108(730), 149(890) 155(980)

Orbitolites (Amphisorus) hemprichii (Ehrenberg) 120(5-15), 102(16), 144(16), 67(20), 98(22), 99(24), 116(27), 89(30), 90(32), 133(42)
Orectostomina camachoi Seiglie 123(70)
Osangularia culter (Parker & Jones) 128(350), 106(410), 31(420), 105(480), 75(500), 109(890), 155(980)

Paradentalina caribbeana Hofker 75(500)
Paromalina semipunctata (Bailey) 35(340), 31(420)
"*Physalidia*" (= embryo of *Sporadotrema*) 44(24), 23(70)
Planispirinoides bucculentus (Brady) 108(730), 149(850)
Planorbulina acervalis Brady 120(5-15), 102(16), 49(21), 66(22), 40(24), 116(27)

Planorbulina caribbeana Hofker 55(39), 125(80)
Planorbulina mahabethi Said 67(20), 66(22), 98(22), 99(24), 116(27), 111(28), 90(32), 60(39), 134(49), 86(61), 123(70)
Planulina ariminensis (d'Orbigny) 51(235), 129(290), 150(300), 128(350), 127(360), 106(410), 137(430), 105(480), 75(500), 80(560), 56(580), 77(620), 109(890), 155(980)
Planulina exorna Phleger & Parker 102(16), 67(20), 55(39), 83(41), 69(44), 87(49), 134(49), 86(61), 123(70), 97(84), 34(95)
Planulina foveolata (Brady) 96(125), 51(235), 91(280), 129(290), 150(300), 93(340), 128(350), 127(360), 106(410), 31(420), 137(430), 105(480), 75(500), 56(580), 77(620), 104(700)
Planulina wuellerstorfi (Schwager) 108(730), 109(890)
Plectina apiculata (Cushman) 108(730)
Polystomammina nitida (Brady) 40(24), 79(84), 34(95)
Pseudoclavulina mexicana Cushman 51(235), 129(290), 50(300), 93(340), 128(350), 127(360), 106(410), 31(420), 137(430), 105(480), 75(500), 56(580), 77(620), 149(850)
Pseudonodosaria comatula (Cushman) 91(280), 150(300), 93(340), 35(340), 128(350), 127(360), 106(410), 31(420), 105(480), 75(500), 80(560), 77(620), 104(700), 108(730)
Pseudopyrgo eburnea (d'Orbigny) 83(41)
Pseudopyrgo subsphaerica (d'Orbigny) 46(21), 74(23), 100(24), 40(24), 146(30), 50(35), 55(39), 72(41), 83(41), 69(44), 134(49), 86(61), 123(70), 97(74), 79(84), 34(95)
Pseudotretomphalus millettii (Cushman) 99(24), 100(24), 40(24), 90(32), 60(39)
Pseudotretomphalus planus (Cushman) 120(5-15), 46(21), 66(22), 100(24), 65(24), 111(28), 72(41), 38(41), 86(61)
Pullenia bulloides (d'Orbigny) 51(235), 91(280), 129(290), 150(300), 128(350), 127(360), 106(410), 105(480), 75(500), 56(580), 77(620), 104(700), 108(730), 149(850)
Pullenia quinqueloba Reuss 109(890)
Puteolina bradyi (Cushman) 120(5-15), 102(16), 67(20), 98(22), 74(23), 99(24), 100(24), 65(24), 44(24), 111(28), 90(32), 126(36), 59(37), 55(39), 72(41), 83(41), 69(44), 143(49), 86(61), 123(70), 125(80), 79(84), 129(290), 105(480), 75(500), 77(620), 104(700)
Puteolina discoidea (Flint) 120(5-15)
Puteolina protea (d'Orbigny) all samples from 5 to 84 m deep
Pyrgo comata (Brady) 104(700)
Pyrgo depressa (d'Orbigny) 112(600), 77(620), 108(730), 149(850), 109(890), 155(980)

Pyrgo elongata d'Orbigny 100(24)
Pyrgo murrhina (Schwager) 96(125), 51(235), 77(620), 149(850)
Pyrgoella sphaera (d'Orbigny) 80(560), 109(890), 155(980)
Pyrgoides denticulatus (Brady) 133(42)
Pyrgoides jugosus (Cushman) 98(22), 74(23), 100(24), 40(24), 111(28), 89(30), 146(30), 90(32), 60(39), 55(39), 72(41), 59(37), 83(41), 133(42), 69(44), 134(49), 123(70)
Pyrgoides striolatus (Brady) 77(620)

Quinqueloculina auberiana (d'Orbigny) 123(70)
Quinqueloculina bidentata d'Orbigny 120(5-15), 144(16), 46(21), 40(24), 116(27), 55(39), 69(44)
Quinqueloculina carinata (d'Orbigny) 120(5-15), 144(16), 46(21), 100(24), 44(24), 116(27), 111(28), 50(35), 55(39), 72(41)
Quinqueloculina garrettii (Howe) 150(300), 93(340)
Quinqueloculina lamarckiana d'Orbigny 120(5-15), 144(16), 67(20), 46(21), 49(24), 40(24), 140(30), 126(36), 59(39), 83(41), 133(42), 134(49), 80(61), 123(70), 125(80), 91(280)
Quinqueloculina occidentalis Cushman 100(24), 40(24), 89(30), 50(35), 55(39), 123(70)
Quinqueloculina poeyiana d'Orbigny 100(24), 89(39)
Quinqueloculina polygona d'Orbigny 100(24), 133(42), 120(70), 125(80), 34(95)
Quinqueloculina quadrilateralis (d'Orbigny) 102(16), 144(16), 74(23), 100(24), 40(24), 89(39), 126(36), 72(41), 55(39), 83(41), 133(42)

Rectobolivina advena (Cushman) 106(410), 31(420), 109(890)
Rectobolivina dimorpha (Parker & Jones) 149(850), 109(890)
Reophax compressus Goës 123(70), 97(74), 125(80), 34(95), 96(125), 51(235), 129(290), 150(300), 93(340), 128(350), 127(360), 106(410), 31(420), 80(560), 104(720), 149(850)
Reophax guttifer Brady 125(80)
Reophax scorpiurus Montfort 125(80), 31(420), 108(730), 149(850)
Reussella aculeata (Cushman) 87(49), 134(49), 123(70)
Reussella atlantica Cushman 86(61), 123(70), 125(80)
Reussella mortenseni Hofker 99(24), 89(30), 90(32), 60(39), 55(39), 72(41), 133(42), 69(44), 134(49), 86(61), 123(70), 125(80), 79(84)
Rhabdammina abyssorum Carpenter 149(850)
Robertina subcylindrica (Brady) 109(890)
Robertinoides bradyi (Cushman & Parker) 129(290), 127(360), 75(500), 80(560), 56(580), 104(700), 149(850), 109(890), 155(980)

Rosalina floridana (Cushman) 102(16), 67(20), 98(22), 65(24), 50(35), 59(37), 60(39), 69(44), 134(49), 125(80)
Rosalina floridensis (Cushman) 97(74), 129(290), 150(300), 93(340), 35(340)
Rotorbinella barbadosensis Hofker 86(61), 123(70), 34(95)
Rotorbinella mira (Cushman) 120(5-15)
Rotorbinella miraeformis nov. spec. 133(42), 87(49), 134(49), 86(61)
Rotorbinella rosea (d'Orbigny) 120(5-15), 46(21)

Saracenaria caribbeana Hofker 51(560), 149(850)
Saracenaria italica Defrance 134(49), 91(280), 129(290)
Saracenaria latifrons (Brady) 80(560)
Saracenaria mexicana Cushman 104(700)
Schlumbergerina occidentalis (Cushman) 40(24), 123(70)
Septigerina floridana (Cushman) 123(70), 79(84), 34(95), 96(125), 91(280), 150(300), 93(340)
Sigmoilina schlumbergeri Silvestri 51(235), 35(340), 106(400), 31(420), 75(500), 80(560), 112(600), 108(730)
Sigmoilina sigmoidea (Brady) 51(235), 129(290), 150(300), 93(340), 128(350), 127(360), 31(420), 105(480), 75(500), 80(560), 112(600), 108(730), 149(850)
Sigmoilopsis arenata (Cushman) 120(5-15), 134(49), 123(70), 91(280)
Sigmoilopsis flintii (Cushman) 91(280), 75(500)
Siphogenerina costata Schlumberger 86(61), 79(84)
Siphonina bradyana Cushman 66(22), 40(24), 146(30), 55(39), 133(42), 69(44), 87(49), 134(49), 86(61), 97(80), 79(84), 34(95), 128(350), 127(360), 105(480), 56(580)
Siphonina pulchra Cushman 51(235), 93(340), 128(350), 75(500), 56(580), 112(600), 149(850)
Siphoninella soluta (Brady) 34(95), 150(300)
Siphotextularia catenata (Cushman) 83(41), 123(70), 125(80), 91(280), 56(580), 112(600), 108(730), 149(850), 155(980)
Siphotextularia concava (Schwager) 51(235), 129(290), 128(350), 31(420), 105(480), 75(500), 80(560), 77(620), 149(850)
Sphaerogypsina globulus (Reuss) 116(27), 111(28), 55(39), 34(95)
Sphaeroidina bulloides d'Orbigny 129(290), 128(350), 127(360), 80(560), 56(580), 77(620), 104(700), 108(730), 149(850), 104(890)
Spiroloculina antillarum d'Orbigny 120(5-15), 144(16), 46(21), 49(24), 100(24), 40(24), 44(24), 116(27), 89(30), 146(30), 50(35), 126(36), 72(41), 133(42), 69(44), 87(49), 86(61)

Spiroloculina ornata d'Orbigny 123(70), 125(80), 91(280)
Spiroloculina planulata (Lamarck) 129(290), 150(300), 128(350), 56(580)
Sporadogenerina proteiformis (Flint) 127(360), 149(850)
Sporadotrema mesentericum (Carter) 127(70), 34(95), 96(125)
Sporadotrema rubrum (d'Orbigny) 144(16), 67(20), 74(23), 100(24), 44(24), 50(35), 72(41), 83(41), 133(42), 69(44), 134(49), 123(70), 79(84)

Textularia conica d'Orbigny 99(24), 90(32), 60(34), 55(39), 72(41), 133(42), 134(49), 86(61), 123(70), 79(84), 35(84), 35(95), 96(125), 91(280), 150(300), 93(340), 31(420)
Textularia cuneiformis d'Orbigny 111(28), 89(30), 87(49), 125(80)
Textularia curta Cushman 129(290), 128(350), 127(360), 31(420), 80(560), 56(580), 104(700), 49(850)
Textularia luculenta Brady 106(410), 31(420), 105(480), 75(500), 80(560), 56(580), 77(620), 108(730), 149(850)
Textulariella barrettii (Parker & Jones) 51(235), 31(420), 75(500), 80(560), 112(600), 104(700), 108(730), 149(850)
Tretomphalus bulloides (d'Orbigny) 67(20), 100(24), 65(24), 59(37), 55(39), 72(41), 69(44), 86(61), 97(74), 79(84), 35(95)
Trifarina pauciporata Hofker 106(410), 31(420), 105(480), 56(580), 77(620), 109(890)
Triloculina gracilis d'Orbigny 100(24)
Triloculina gualtieriana d'Orbigny 67(20), 55(39), 72(41), 134(49)
Triloculina linneiana d'Orbigny 120(5-15), 102(16), 67(20), 46(21), 98(22), 66(22), 99(24), 116(27), 146(30), 126(36), 55(39), 72(41), 69(44)
Triloculina oblonga Montagu 120(5-15), 144(16), 67(20), 48(22), 66(22), 74(23), 100(24), 116(27), 146(30), 59(37), 72(41)
Triloculina oblongoides Hofker 55(39), 72(41)
Triloculina rotunda d'Orbigny 120(5-15), 102(16), 144(16), 74(23), 99(24), 44(24), 69(44)
Tritaxilina atlantica Cushman 51(235), 149(850)
Tritaxilina yassicaensis Bermúdez 123(70), 96(125), 129(290), 128(350), 105(480)
Trochammina coronata Brady 112(600), 155(980)
Trochammina globigeriniformis (Parker & Jones) 79(84), 34(95), 104(720), 149(850), 155(980)
Trochammina irregularis Cushman & Bronnimann 89(30)

Vaginulina insoluta (Schwager) 34(95)

Valvotextularia candeiana (d'Orbigny) 120(5-15), 102(16), 57(20), 98(22), 66(22), 74(23), 99(24), 100(24), 65(39), 87(49)
Valvotextularia oceanica (Cushman) 124(700)
Valvulineria candeiana (d'Orbigny) 102(16), 67(20), 98(22), 66(22), 74(23), 100(24), 65(24), 60(39), 87(49)
Vertebrasigmoilina mexicana (Cushman) 67(20), 40(24), 116(27), 59(37), 72(41), 133(42), 97(74)
Virgulina advena Cushman 125(80), 129(290), 77(620), 104(700)
Virgulina compressa (Bailey) 123(70)
Virgulina mexicana Cushman 83(41)

Wiesnerella auriculata (Egger) 123(70)

Displaced Foraminifera

At some stations on the steeper slopes around the Saba Bank scattered recent displaced Foraminifera were found. They belong to the following species: *Archaias angulatus* (Fichtel & Moll) (St. 123, 125), *Articulina lineata* Brady (St. 125 and some deeper stations), *Articulina sagrai* d'Orbigny (St. 86, 79), *Asterigerina carinata* d'Orbigny (many stations), *Caribbeanella polystoma* Bermúdez (St. 125), *Archaias compressus* (d'Orbigny) (St. 123, 97, 125, 79, 34), *Elphidiononion poeyianum* (d'Orbigny) (St. 125 and many deeper stations), *Miliolinella suborbicularis* (d'Orbigny) (St. 123, 43), *Puteolina bradyi* (Cushman) (St. 125, 97, 129, 105, 75, 77, 104), *Archaias annulatus* (Hofker) (St. 123, 79), *Quinqueloculina lamarckiana* d'Orbigny (St. 123, 125, 91), *Vertebrasigmoilina mexicana* (Cushman) (St. 97). In most cases observed the displaced specimens in this reworked condition are rather small for the species concerned, and they never form more than 2% of the fauna. They all belong to recent species also found on the bank itself and it is obvious that whole faunas never were carried down the deep slopes surrounding the Saba Bank. Most of these species have thin walls and, after having been filled with gas after death, floated away from the flat bank itself. Turbulence seems not to occur in this area, probably since the bank itself is mainly formed by hard rock of volcanic origin, as some larger grains from the deeper sea-floor around the Saba Bank seem to point out. Moreover, the neighbouring islands Saba, St. Martin, St. Kitts and St. Eustatius all are of volcanic origin too.

At some deeper localities of the Saba Bank (depths from 70-90 m) some species occur, often rather commonly, which cannot have lived at such depths, since they are known to possess zooxanthellae and the light could not penetrate so deep when the surface of the sea rose to the recent level after the last glacial era. They have to be considered sub-fossil occurrences. To these Foraminifera belong the genera *Asterigerina, Archaias, Puteolina,* some Miliolids and *Amphistegina.* They are not considered by me here. They were not displaced.

THE VERTICAL DISTRIBUTION OF SOME BENTHIC FORAMINIFERA

At the southern side of the Saba Bank the sea-floor goes steaply down towards the south, whereas at the north side of the Bank the sea-floor is more shallow, forming a strip of several km breadth with a depth of 70-90 m along the NW coast; the sea around the Bank has a depth varying between 200 and 980 m.

The floor of the Bank itself slopes from E to W at the east side of the Bank, the sea-floor slopes from 15 m in the East to a depth of 30 m in a line running from 17°35′ N 63°21′ W to 17°15′ N 63°38′ W. West of this line the sea-floor slopes down till a depth of about 50-70 m is reached.

One has to bear in mind, that the water above the Bank itself is very clear so that at least to a depth of 50 m the sunlight reaches the sea-floor. Plants (Algae) were thus found down to a depth of 49 m, and corals were detected down to the same depth. It will be obvious that on the Saba Bank itself conditions of light (Foraminifera adhering to plants, Foraminifera possessing zooxanthellae) and of temperature (a constant temperature of about 22° C, see Phleger & Parker, 1951: 24, fig. 18) are practically constant.

Foraminifera found in the tidal waters of the Caribbean Sea (Hofker 1964, 1971, 1976) will be found on the sea-floor of the Bank itself also. They are *Rotorbinella mira* (Cushman), *Rotorbinella rosea* (d'Orbigny), *Puteolina discoidea* (Flint), *Planorbulina acervalis* Brady, *Orbitolites hemprichii* (Ehrenberg), *Hauerina brady* Cushman, *Neoalveolina pulchra* (d'Orbigny), *Triloculina rotunda* d'Orbigny, *Asterigerina carinata* d'Orbigny, *Dendritina elegans* (d'Orbigny), *Triloculina oblonga* (Montagu), *Quinqueloculina carinata* (d'Orbigny), *Triloculina linneiana* d'Orbigny, *Miliolinella labiosa* (d'Orbigny), *Quinqueloculina bidentata* d'Orbigny, *Elphidiononion discoidale* (d'Orbigny), *Pseudotretomphalus planus* (Cushman), *Anticulina mucronata* (d'Orbigny), *Puteolina bradyi* (Cushman), *Valvotextularia candeiana* (d'Orbigny), *Caribeanella polystoma* Bermúdez, *Valvulineria candeiana* (d'Orbigny), *Elphidiononion mexicanum* (Kornfeld), *Quinqueloculina quadrilateralis* (d'Orbigny).

A second group can be followed slightly deeper at the northern slope. They continue to a depth of 95 m; it will be obvious that in depths from 70-95 m the light begins to fail, and the temperature may fall down to slightly less than 20° C. To this group belong *Spiroloculina antillarum* d'Orbigny, *Triloculina lamarckiana* d'Orbigny, *Puteolina bradyi* (Cushman), *Nonionella grateloupi* (d'Orbigny), *Miliola tricarinata* (d'Orbigny), *Puteolina protea* (d'Orbigny), *Amphistegina gibbosa* d'Orbigny, *Archaias angulatus* (Fichtel & Moll), *Heterostegina antillarum* d'Orbigny, *Rosalina floridana* (Cushman), *Tretomphalus bulloides* (d'Orbigny), *Pseudopyrgo subsphaerica* (d'Orbigny).

A third group is not found in the tidal zone but starts deeper, at 21 to 24 m; several of them continue deeper than 95 m, thus showing that they are not dependent on light. To this group belong *Pseudopyrgo subsphaerica* (d'Orbigny), *Neoeponides antillarum* (d'Orbigny), *Pyrgoides jugosus* (Cushman), *Textularia conica* d'Orbigny, *Sphaerogypsina globulus* (Reuss), *Lamarckina atlantica* Cushman, *Siphonina bradyiana* Cushman.

Some species are restricted to depths between 44 and 100 m, or slightly deeper; they are *Rotorbinella miraeformis* nov. spec., *Eponides repandus* (Fichtel & Moll), *Reussella mortenseni* Hofker, *Reussella aculeata* Cushman, *Rotorbinella barbadosensis* Hofker, *Sporadotrema mesentericum* (Carter), *Tritaxilina yassicaensis* Bermúdez.

The next group begins to appear at a depth of about 100 m and continues down to 800-1000 m; this group obviously is wholly independent on temperature and light, since from 100 m down to 1000 m temperature falls from 20° C to 5° C. To this group belong *Gavelinonion affine* (Reuss), *Nummuliculina irregularis* (d'Orbigny), *Siphotextularia catenata* (Cushman), *Cancris oblongus* (Williamson), *Angulogerina occidentalis* (Cushman), *Hoeglundina elegans* (d'Orbigny), *Siphonina pulchra* Cushman, *Planulina foveolata* (Brady), *Cibicides robustus* (Phleger & Parker), *Lenticulina calcar* (Linnaeus), *Textulariella barrettii* (Parker & Jones), *Euuvigerina flintii* (Cushman), *Planulina ariminensis* (d'Orbigny), *Pseudonodosaria comatula* (Cushman).

In this group of Foraminifera of the deeper sea-floor, there are also species, which, obviously, are more sensitive to decreasing temperatures. Here belong those species which are restricted to the upper part of these depths; they are *Bigenerina irregularis* Phleger & Parker (70-340 m), *Septigerina floridana* (Cushman) (61-340 m), *Tritaxilina yassicaensis* Bermúdez, *Reophax compressus* Goës (70-500 m), *Liebusella soldanii* (Jones & Parker) (70-560 m), *Rosalina floridensis* (Cushman) (74-340 m), *Cylindroclavulina bradyi* (Cushman) (125-580 m), *Lenticulina iota* (Cushman) (235-360 m), *Liebusella polyphragma* (Goës) (290-430 m).

Other species are typical of the greater depths and the lower temperatures: *Trifarina pauciporata* Hofker (360-890 m), *Textularia luculenta* Cushman (410-850 m), *Discammina compressa* (Goës) (420-580 m), *Bulimina alazanensis* Cushman (420-980 m).

One group of species is restricted to the deepest regions with the lowest temperatures: *Anomalina flintii* Cushman, *Cyclammina cancellata* Brady, *Nodosaria subsoluta* Cushman, *Pyrgo depressa* (d'Orbigny), *Marsipella rustica* (Heron-Allen & Earland), *Globobulimina aperta* Hofker, etc.

As the pressure at great depths is of no influence on Foraminifera but the temperature is, it is obvious that within this small area of the Saba Bank and its environments the enormously high number of species with their restricted distributions is mainly due to the different temperatures found at the sea-floor of this area. However, the spreading of species is not only caused by temperature; the amount of algae and *Gorgonia* in the middle and southern parts of the shallowest eastern part of the Saba Bank gives rise to a peculiar fauna of sessile Foraminifera, such as *Rotorbinella mira, Planorbulina acervalis, Orbitolites* (*Amphisorus*) *hemprichii, Dendritina elegans, Tretomphalus* and *Pseudotretomphalus* spec., *Articulina mucronata, Articulina lineata, Archaias angulatus, Heterostegina antillarum, Caribeanella polystoma, Articulina sagrai, Valvulineria candeiana, Sporadotrema rubrum, Archaias annulatus, Planorbulina mahabethi, Homotrema rubrum, Discogypsina vesicularis*, etc. This fauna, here characterized by the abundant occurrence of *Articulina lineata*, is certainly typical of this environment.

Another remarkable community of Foraminifera is found in the deeper parts of the area north to the Bank proper; here, in the localities 323, 137, 129, 235, 129, 128, 127, 149, we find large numbers of specimens of *Liebusella polyphragma* and *Frondicularia sagittula*, and in the deeper samples (149, 185, 56, 135) *Cyclammina cancellata*. It seems that here the muddy environment plays a role. Remarkable is the occurrence of large quantities of *Archaias compressus* in the more western and deeper parts of the Bank at depths from 35-95 m, since this species is found also in shallow coralline parts of the Caribbean Sea, possible the translucency of the water plays a role in this case.

ON THE VERTICAL DISTRIBUTION OF SOME CLOSELY ALLIED SPECIES

Remarkable is the distribution of the *Cancris*-species; there are two species occurring in the Saba Bank region, *Cancris sagrai* d'Orbigny and *Cancris oblongus* (Williamson). *Cancris sagrai* is found, always in single or few specimens per sample, at depths of 24, 39 and 41 m on the flat sea-floor of the Bank, whereas *Cancris oblongus* was collected at depths of 70, 80, 84, 95, 235, 290, 300, 340, 350, 360, 410, 560, 620, 700, 850 m. *Cancris sagrai* was mentioned by Cushman from Florida at shallow depths, also from Tortugas, whereas *C. oblongus* (Cushman (1931: 72) believed it to be identical with *C. auriculus* (Fichtel & Moll)) was found by Cushman at 123 and 135 m off

Florida (Cushman, 1931: 72-75). Phleger & Parker (1951: 20) did not distinguish between the two species in their tables and call both *C. oblongus*; so the distributions mentioned by them cannot be used. The oblong form was found by me at a depth of 200 m W of Barbados (Hofker, 1969: 94); I described and analyzed many specimens of *Cancris auriculus* (Montfort), which really is *C. oblongus*, from W of St. Croix, close to the Saba Bank, from a depth of 800 m. However, Williamson (1857: 52) described this species as *Rotalia oblonga* from Guernsey, Cork, Rossily, Swansea, Caswell Bay, Tenby, Eddystone, all from shallow water. Nörvang (1945: 40), recording this species as *C. auricula* (Fichtel & Moll), found it from 30 to 1000 m; but we have to bear in mind, that at the English coast as well as at the coast of Iceland temperatures are always relatively low. The finding here of *C. sagrai* at temperatures of about 22° C and of *C. oblongus* at temperatures of 20°-25° C shows that it is the temperature and not the depth that separates the two species.

Four species of the genus *Planulina* were found in the Saba Bank region: *Planulina exorna* Phleger & Parker, *P. ariminensis* (d'Orbigny), *P. foveolata* (Brady) and *P. wuellerstorfi* (Schwager). *P. exorna* was found at two localities at depths of 16 and 20 m and at another series of localities at depths of 39-95 m; this species is clearly adapted to relatively high temperatures of 22°-19° C; *P. foveolata* was found at depths of 125-620 m, corresponding with temperatures of 18°-7° C; *P. arimensis* occurred in the Saba Bank region at depths from 235-980 m, with average temperatures of 16°-5° C; *P. wuellerstorfi* was found in samples at depths of 730 and 890 m with a temperature of about 5° C. This shows that *P. foveolata* and *P. ariminensis* resist higher and lower temperatures, whereas *P. wuellerstorfi* is found only at real deep-sea temperature of about 5° C. *P. wuellerstorfi* thus is adapted to very low temperatures and does not occur at higher temperatures; it was found very abundantly in St. 119, Ingolf Exped., North Atlantic, 67°53′ N 10°19′ W, at a depth of 1902 m with a sea-floor temperature of −1° C. Three species of the genus *Ehrenbergina*, *E. spinea* Cushman, *E. trigona* Goës, and *E. falcata* Bermúdez occur in the Saba Bank area. *E. spinea* was found at depths of 235-560 m, which corresponds with 18°-08° C, *E. trigona* at depths of 300-730 m, corresponding with 14°-06° C, and thus these distribution and temperature ranges partly overlap; *E. falcata* occurs at depths of 340 and 580 m.

Drooger & Kaasschieter (1958: 37) described and figured a small species of *Burseolina* as *Cassidulina palmerae* Bermúdez & Acosta from W of Tobago at depths ranging from 70-150 m; another species, larger and more oval, with a small but deep honeycomb structure, occurred in the samples from the slopes of the Saba Bank; I could identify it with *Burseolina intermedia* (Palmer). It occurs at depths from 300 to 850 m. So here we have a case of two closely allied species, which are restricted to different depths and temperatures; the species described by Drooger & Kaasschieter at temperatures of about 20°-15° C, the other, *B. intermedia*, of 13°-08° C.

The genus *Siphonina* occurs in the Saba Bank region with two species, *Siphonina bradyana* Cushman, found at depths of 22-300 m, with its commonest occurrences in samples from depths of 42-290 m, thus showing that this species is adapted to temperatures from 22°-10° C, and *Siphonina pulchra* Cushman at depths ranging from 74-850 m and adapted to temperatures of 18°-05° C. In this case the differences in vertical occurrence and in temperature range are striking.

Even more striking are the occurrences of the species belonging to the genus *Rotorbinella*. *Rotorbinella mira* and *Rotorbinella rosea* are typical species of the tidal zone, though they may occur slightly deeper. But here another species occurs, closely allied to *R. mira* and which I called *Rotorbinella miraeformis*, in samples from greater depths, viz. 44-61 m; at these depths the temperatures are slightly lower, 18°-20° C. Also another species possibly belonging to this genus, *Rotorbinella barbadosensis* Hofker, collected for the first time at a depth of 100 m (Hofker, 1969: 83), was found in the Saba Bank area at depths of 70-235 m (18°-13° C). All species of this genus thus show very restricted occurrences as to depths and temperatures; *R. mira* and *R. rosea* are restricted to a temperature of at least 22° C, *R. miraeformis* to 18°-20° C, *R. barbadosensis* to 18°-13° C.

It is well known that the species *Neoeponides antillarum* (d'Orbigny) is often found in two forms (see Andersen, 1961: 103, pl. 23 figs. 4, 5). When studying the whole range of this species in the Saba Bank area I found that specimens from 20-95 m deep all belong to the flat form, in which the dorsal side is somewhat higher domed than the ventral one, the latter not showing much of the typical thickening at the umbilical sutures which is characteristic for *Neoeponides*. But as soon as the specimens are found in samples from greater depth, the ventral side becomes much higher domed than the dorsal one and the characteristic thickenings appear at this side. Do we have two species here, or is the change due to the lower temperature? Temperatures in the first 100 m do not differ much from those found at the surface of the sea; but from 100 m onwards the temperature gradually falls from about 20° C to 5° C. *Eponides* (or *Neoeponides*) *antillarum* is found at depths of 20 m to 580 m, where the temperature is 14° C.

The genus *Eponides* is represented by three species; *Eponides repandus* (Fichtel & Moll) occurs in the samples from 44 to 280 m, most abundantly

TABLE 3

Concise list of some of the most dominant species and their vertical spreading in a region with very clear sea-water.

Rotorbinella mira	5-15 m
Puteolina discoidea	5-15 m
Planorbulina acervalis	5-27 m
Asterigerina carinata	5-44 m
Dendritina elegans	5-44 m
Puteolina bradyi	5-84 m
Nonionella grateloupi	5-41 m
Puteolina protea	5-84 m
Amphistegina gibbosa	5-84 m
Archaias compressus	5-95 m
Valvulineria candeiana	16-24 m
Articulina lineata	16-41 m
Neoeponides antillarum	22-560 m
Pyrgoides jugosus	22-70 m
Cancris sagrai	24-42 m
Syphonina bradyiana	39-580 m
Reussella mortenseni	39-95 m
Sphaerogypsina globulus	30-95 m
Rotorbinella miraeformis	42-61 m
Eponides repandus	44-280 m
Septigerina floridana	70-340 m
Gavelinonion affine	70-620 m
Bigenerina irregularis	70-340 m
Lamarckina atlantica	70-730 m (small in 38-42 m)
Cancris oblongus	70-850 m
Tritaxilina yassicaensis	70-480 m
Liebusella soldanii	70-560 m
Hoeglundina elegans	80-980 m
Siphonina pulchra	84-850 m
Planulina foveolata	125-600 m
Cassidulina scabra	125-980 m
Lenticulina calcar	125-850 m
Textulariella barrettii	235-850 m
Euuvigerina flintii	235-850 m
Sigmoilina sigmoidea	235-850 m
Pseudoclavulina mexicana	235-850 m
Planulina ariminensis	235-980 m
Pseudonodosaria comatula	235-850 m
Ehrenbergina trigona	300-730 m
Burseolina intermedia	300-850 m
Gyroidina altiformis	350-730 m
Euuvigerina auberiana	350-980 m
Textularia luculenta	410-850 m
Trufarina pauciporata	410-890 m
Bulimina alazanensis	430-980 m
Nodosaria subsoluta	580-850 m
Anomalina flinti	580-980 m
Pyrgo depressa	600-980 m
Planulina wuellerstorfi	700-980 m
Cyclammina cancellata	700-980 m

so at 70 and 95 m; the temperatures to which this species is adapted range from 22°-18° C; *Eponides regularis* Phleger & Parker is found from 350 to 890 m, thus at temperatures of 15°-05° C; *Eponides umbonatus* (Reuss) occurred at only two localities, at depths of 850 and 890 m, respectively, with a temperature of about 5° C. Once again three related species occurring at three different temperatures.

Other examples are found in *Textularia* and related genera. *Textularia cuneiformis* d'Orbigny is found in the Saba Bank area from 30-70 m deep. *Textularia conica* d'Orbigny occurs between 32 and 700 m. *Textularia curta* Cushman shows up between 350 and 700 m depth. *Textularia luculenta* Cushman is found at depths of 410-850 m.

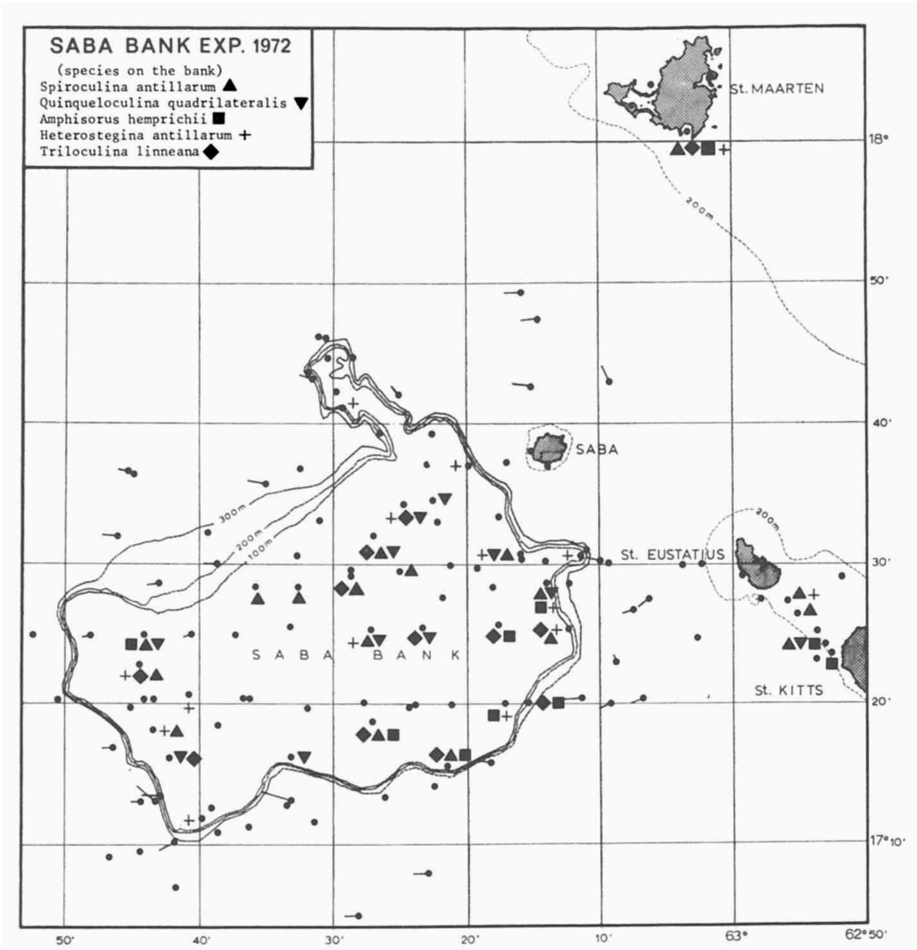


Fig. 4. Horizontal distribution of some Foraminifera found on the Bank.

Septigerina floridana (Cushman) is found at depths of 70-340 m. *Valvotextularia candeiana* (d'Orbigny) occurs between 0 and 44 m. *Bigenerina irregularis* Phleger & Parker is found at 70-340 m depth. *Siphotextularia catenata* (Cushman) occurs from 16 to 290 m. *Siphotextularia concava* (Schwager) is found 350-850 m deep.

So in many of these agglutinated species the depths and thus the temperatures are typical for the species (see table 3).

THE HORIZONTAL DISTRIBUTION OF SOME FORAMINIFERA (figs. 4-10)

Spiroloculina antillarum d'Orbigny is found on the bank itself, and is never common; *Quinqueloculina quadrilateralis* (d'Orbigny) on the whole

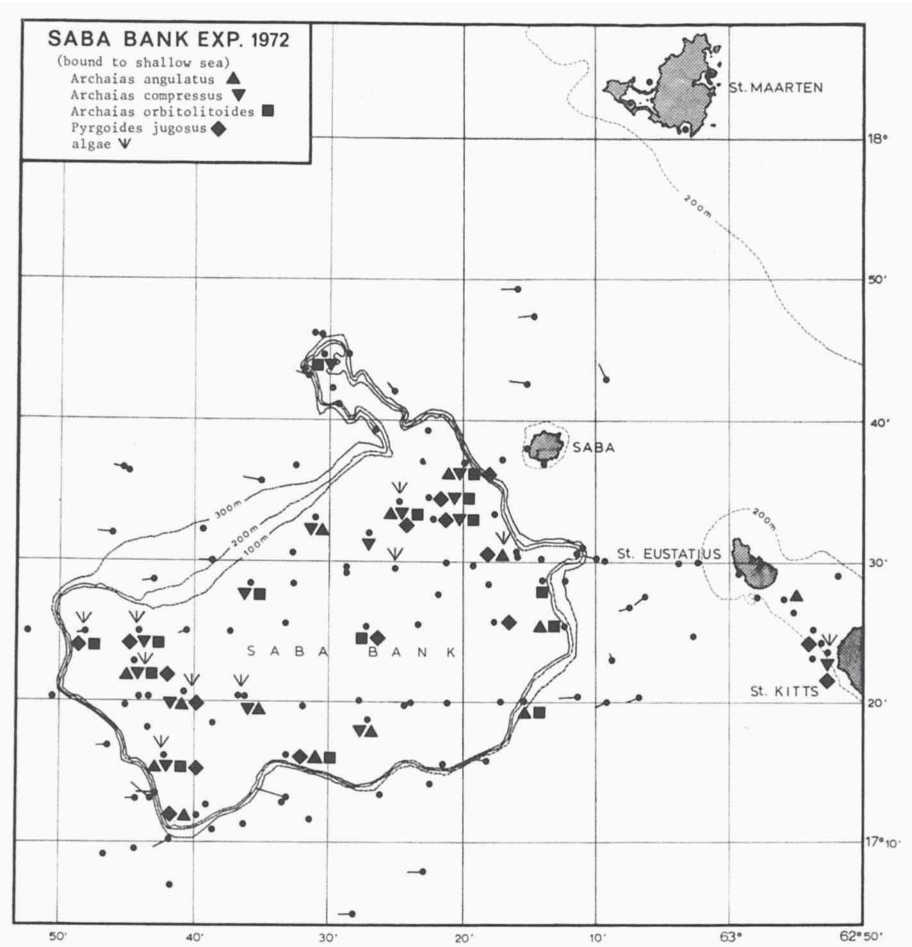


Fig. 5. Horizontal distribution of some Foraminifera found on the Bank.

bank, in scattered specimens; *Orbitolites (Amphisorus) hemprichii* (Ehrenberg) on the bank, mostly at shallow places; *Heterostegina antillarum* d'Orbigny on the bank, the shallower places near St. Maarten and between St. Eustatius and St. Kitts; *Triloculina linneiana* d'Orbigny on the whole bank (fig. 4).

Archaias angulatus (Fichtel & Moll) is found in shallow localities near St. Eustatius, St. Maarten, and on the bank always near its brink, often in localities with corals; *Archaias compressus* (d'Orbigny) has a similar distribution; *Archaias annulatus* (Hofker) occurs over the whole bank, *Pyr-*

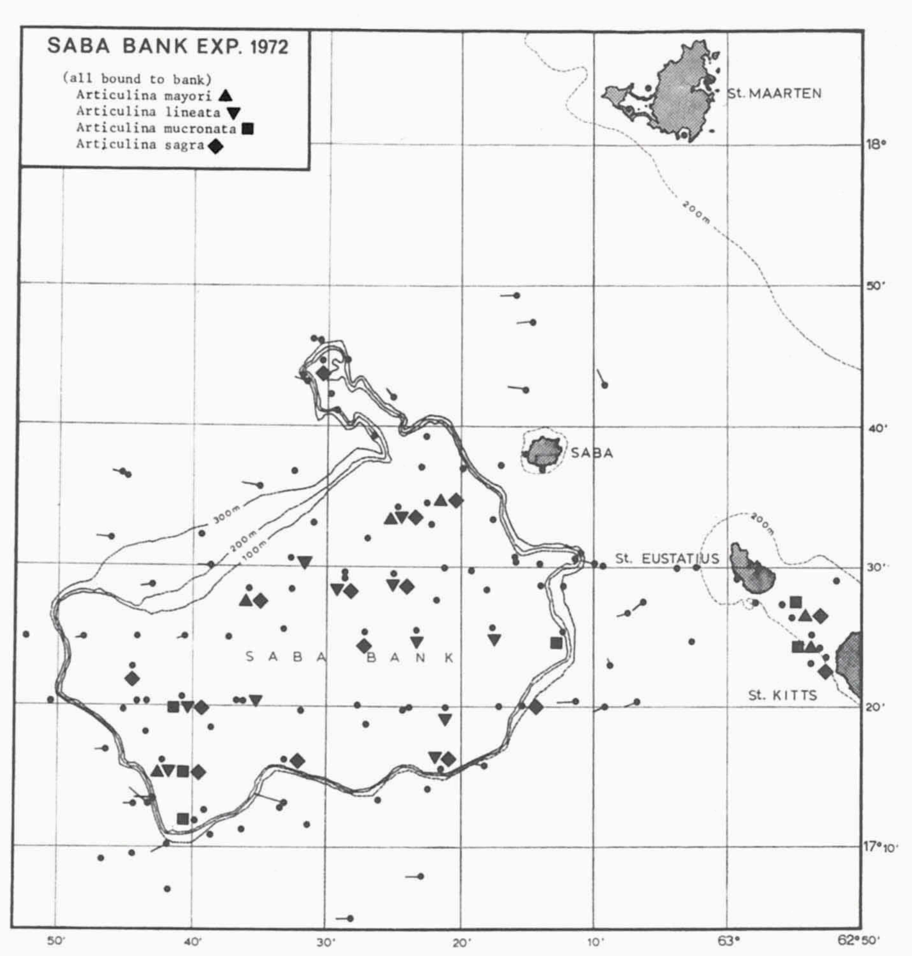


Fig. 6. Horizontal distribution of some Foraminifera found on the Bank.

goides jugosus (Cushman) over the whole bank and near St. Kitts, especially where algae are found (fig. 5).

Textularia conica d'Orbigny occurs over the whole bank and between St. Eustatius and St. Kitts, mostly in deeper localities (slope); *Neoeponides antillarum* (d'Orbigny) on the deeper parts of the bank (ventrally flat form) and on the slope (form with ventral dome); *Siphonina bradyiana* and *Siphonina pulchra* only on the slopes and *bradyiana* Cushman is also found in the deeper localities (N and W) of the bank, *Lamarckina atlantica* Cush-

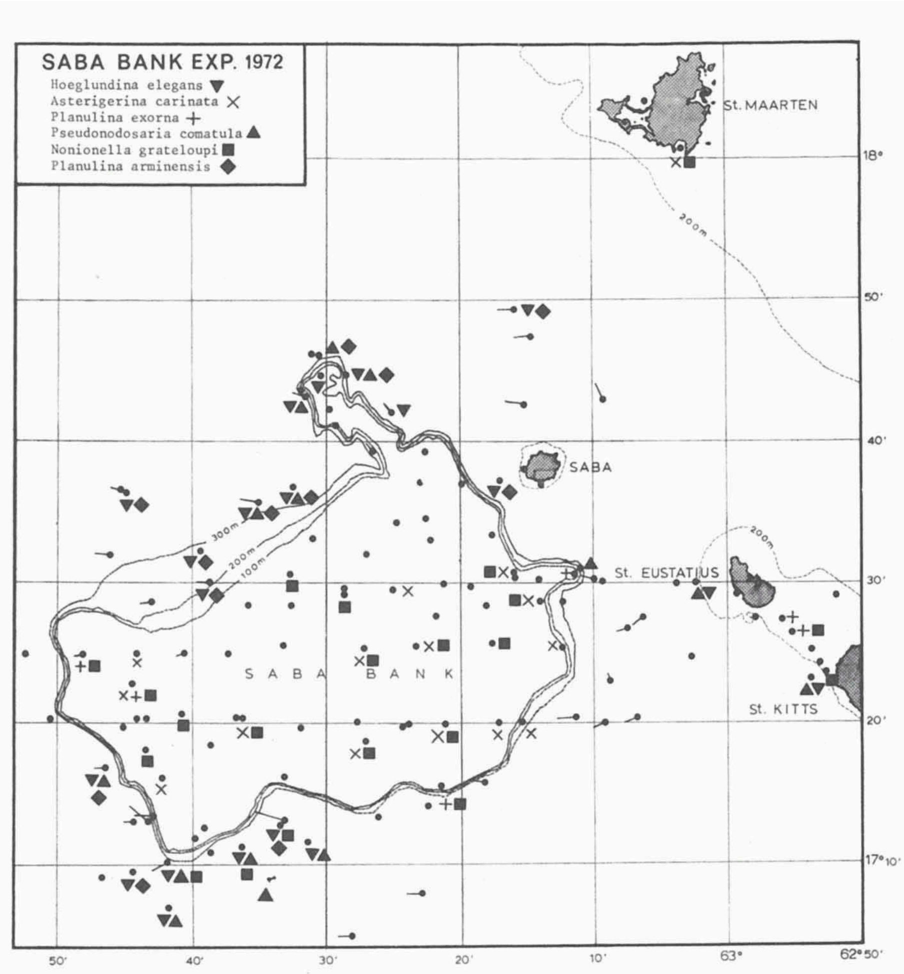


Fig. 7. Saba Bank, horizontal distribution of Foraminifera occurring on the Bank and on its slopes.

man in the deeper localities of the bank (W and N) and on the slopes, also between St. Eustatius and St. Kitts (fig. 6).

Liebusella flintiana (Cushman) was found, rarely, on the slopes; *Liebusella polyphragma* (Goës) only in the former bay of the submerged island (NW slope); *Liebusella soldanii* (Jones & Parker) W of St. Eustatius and St. Kitts; *Cyclammina cancellata* Brady only on the deeper parts of the slopes (fig. 9).

Hoeglundina elegans (d'Orbigny) is confined to the slopes, *Asterigerina carinata* d'Orbigny to the whole flat of the bank and the shallow bay of St.

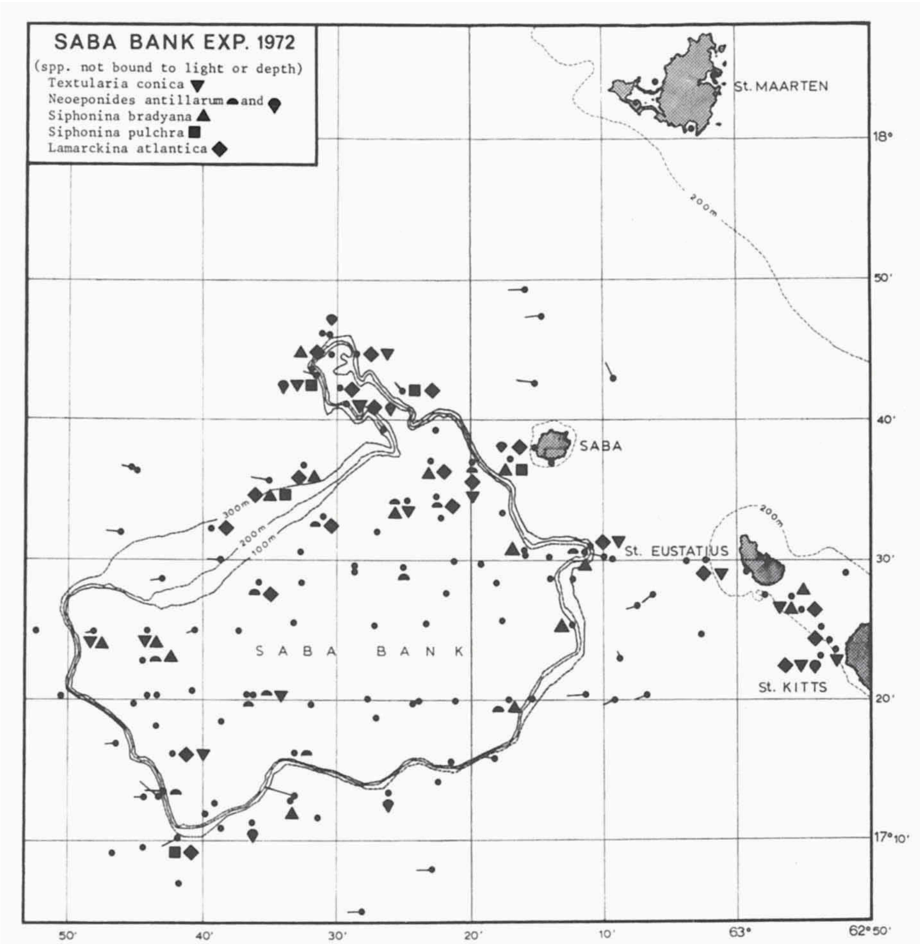


Fig. 8. Saba Bank, horizontal distribution of Foraminifera occurring on the Bank and on its slopes.

Maarten; *Planulina exorna* Phleger & Parker to the brink of the bank and the inner slope; *Pseudonodosaria comatula* (Cushman) to the slopes; *Nonionella grateloupi* (d'Orbigny) is spread over the whole bank and the shallow water of St. Maarten, St. Eustatius and St. Kitts (displaced, it is also found on the slopes as small specimens); *Planulina ariminensis* (d'Orbigny) is confined to all slopes around the bank (fig. 7).

The species of *Articulina* are found all over the bank, *A. lineata* Brady more confined to the central part, *A. mucronata* (d'Orbigny) near the brink of the bank and at shallower localities near the smaller islands, often where algae are found, as is *A. sagrai*; *A. mayori* Cushman is rare (fig. 6).

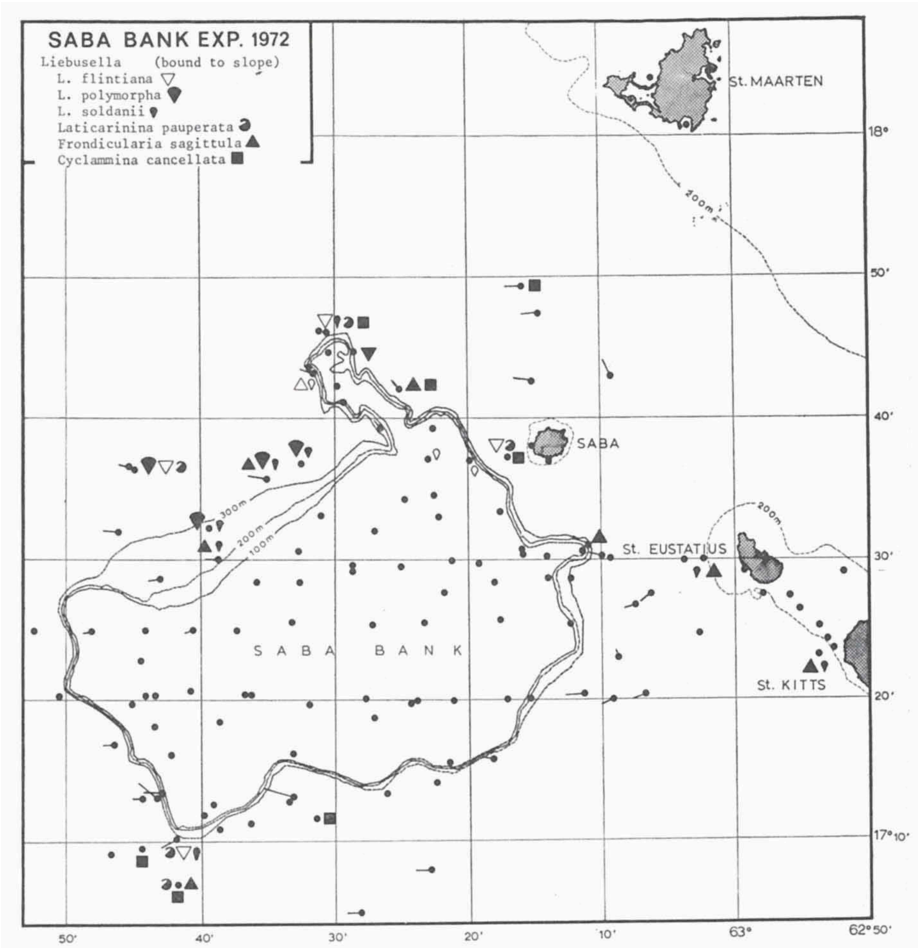


Fig. 9. Foraminifera distribution on the slopes of the Saba Bank.

Trifarina pauciporata Hofker is common on the S-slope, in the deeper parts of the slopes between Saba and the bank and W of St. Eustatius; *Textularia luculenta* Cushman N and S of the bank and W of St. Eustatius, always in deeper water; *Sigmoilina schlumbergeri* Silvestri and *S. sigmoidea* (Brady) N and S of the bank and W of St. Eustatius; *Pullenia bulloides* (d'Orbigny) all around the bank on the deeper slope and W of St. Kitts; *Planulina foveolata* (Brady) N and W of the bank on the slope, W of Saba and W of St. Kitts (fig. 10).

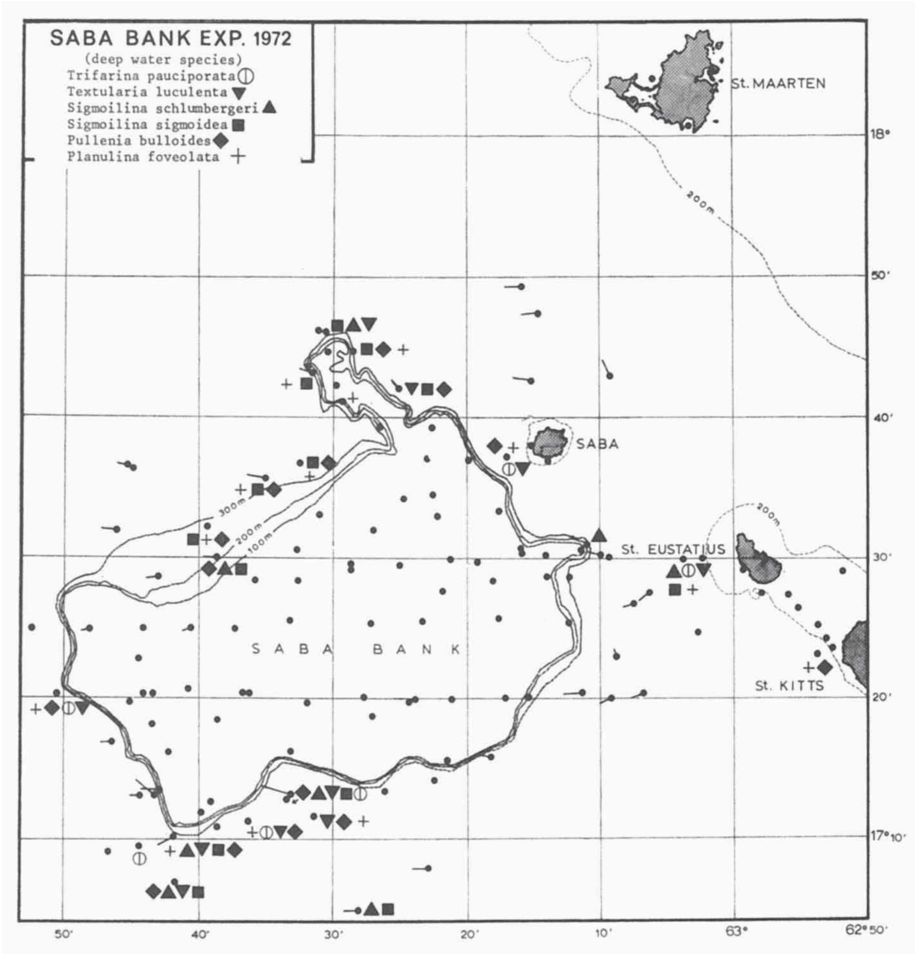


Fig. 10. Foraminifera distribution on the slopes of the Saba Bank.

Planktonic Foraminifera (table 4)

The present author studied the planktonic Foraminifera from the samples W of Barbados (1969) and from samples W of St. Croix (Virginia Islands) (1956). The changes in coiling directions of some planktonic species were studied by me on the former occasion (1969: 100, fig. 266). Detailed data about the structures of many species were given.

The sea-floor may form a trap for the suspended planktonic specimens when living slightly above this floor. Moreover, we know that many planktonic species thicken their tests when living nearer to the sea-bottom. Specimens trapped in plankton nets near the surface mostly have thin tests, but the tests are found to have thickened at the outside when sampled lower.

In the Saba Bank area the sea floor was sampled at various levels from 5 to 980 m, and an analysis of the samples makes it clear that at different levels different species were trapped. Between 5 and 15 m depth no planktonic Foraminifera were collected. Thin-shelled specimens of several species were often found at the shallowest depths in which the species occur. From a depth of 16 m onwards, two species are trapped, viz. *Globigerinoides ruber* (d'Orbigny) and *Globigerinoides trilobus* (Reuss), in some localities even with their spines preserved. From 16 to 26 m only these two species were found. One specimen of the outgrown form of *G. trilobus* (Reuss), known as *G. sacculiferus* (Brady), was found, with spines, in Sta. 85 (depth 26 m), but this form was found abundantly from 95 m onwards, so that this find is exceptional. *Neogloboquadrina eggeri* (Rhumbler) begins to appear at 32 m. *Orbulina universa* d'Orbigny begins to appear at 32 m, though it becomes common in the deeper samples from about 61 m. The same can be said about *Globigerinoides conglobatus* (Brady), *Globorotalia menardii* (d'Orbigny) and *Globorotalia fimbriata* (Brady); they all are more common from 70 m onwards. The first appearance of *Sphaeroidinella dehiscens* (Parker & Jones) and *Globorotalia truncatulinoides* (d'Orbigny) is at 150 m, and from thereon they remain common species. *Pulleniatina obliquiloculata* (Parker & Jones), *Globorotalia tumida* (Brady) and *Candeina nitida* d'Orbigny begin to appear at 340 m; *Globigerina calida* Parker is more common from 700 m onwards. *Globorotalia punctulata* (d'Orbigny), *Globoturborotalita rubescens* (Hofker), *Globigerinita glutinata* (Egger) and *Hastigerina pelagica* (d'Orbigny) appear for the first time at 360-420 m, all with thin hyaline tests, whereas the deepest first appearance, at about 620-700 m, is of *Globigerina calida* Parker and *Turborotalia humilis* (Brady), both species with thin tests also.

A list of planktonic species, trapped by the sea-floor at different depths and occurring in the Saba Bank area, is given in table 4.

TABLE 4

Distribution of the planktonic Foraminifera on the Saba Bank and on its slopes in correlation with depths and temperatures (x = with secondary thickened walls, X = with thin walls, X' = with rests of spines, . = no specimens found).

samples depths	*Globigerinoides ruber*	*Globigerinoides trilobus*	*Neoloboquadrina eggeri*	*Globigerinoides conglobatus*	*Globigerinoides sacculifer*	*Orbulina universa*	*Globigerina aequilateralis*	*Globorotalia menardii*	*Globorotalia fimbriata*	*Sphaeroidinella dehiscens*	*Globorotalia truncatulinoides*	*Pulleniatina obliquiloculata*	*Globorotalia tumida*	*Candeina nitida*	*Globorotalia punctulata*	*Globoturborotalita rubescens*	*Globigerinita glutinata*	*Hastigerina pelagica*	*Globigerina calida*	*Turborotalita humilis*	Bottom-temperatures according to Phleger & Parker, 1952
102(16)	X	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22°C
144(16)	X	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
67(20)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
143(21)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
66(22)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
142(22)	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
44(22)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
46(22)	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
88(22)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
74(23)	x	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
100(24)	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
40(24)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
64(26)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
85(26)	x	X'	.	.	X'	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
115(26)	X'	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
111(28)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
146(30)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
90(32)	x	X	x	X	.	X	x	X	.	.	.	.	.	.	.	.	.	.	.	.	
136(34)	x	x	X	.	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	20°C
49(34)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
50(35)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
126(36)	x	x	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
59(37)	x	x	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	
55(39)	x	x	x	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
60(39)	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
22(41)	X'	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
83(41)	x	x	X	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	
133(42)	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
69(44)	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
93(44)	x	X'	X	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	
132(47)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
87(49)	x	x	.	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
86(61)	x	x	X	.	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	
123(70)	x	.	x	X	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	
97(74)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
125(80)	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
34(95)	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	18°C
96(125)	x	.	x	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	
94(150)	x	.	x	.	.	.	x	x	x	X	X	.	.	.	.	.	.	.	.	.	14°C
51(235)	x	x	x	x	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	
129(290)	x	x	x	x	x	x	x	x	.	x	X	x	.	.	.	.	.	.	.	.	
145(300)	x	.	x	.	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	12°C
92(320)	x	.	.	x	x	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	
93(340)	x	.	x	x	x	x	.	x	x	x	x	x	X	x	.	.	.	.	.	.	
35(340)	x	x	.	.	x	.	.	x	.	x	.	.	X	.	.	.	.	.	.	.	
128(350)	x	x	x	x	x	x	x	x	.	.	x	x	.	.	.	.	.	.	.	.	
140(350)	x	x	.	x	.	.	x	x	.	x	.	.	.	.	.	.	.	.	.	.	
68(360)	x	.	x	x	x	x	.	x	.	x	.	x	X	.	.	.	.	.	.	.	
127(360)	x	x	x	x	x	x	x	x	x	x	.	x	.	.	.	X	X	x	.	.	11°C
137(420)	.	.	.	x	x	x	.	x	.	x	x	x	x	x	.	.	.	.	.	.	
31(420)	x	.	.	x	.	.	.	x	x	.	x	x	x	.	X	X	.	.	.	.	
118(440)	x	.	x	x	x	x	.	x	.	.	.	.	x	x	.	.	.	.	.	.	9°C
75(500)	x	.	x	x	x	x	.	x	.	x	.	x	x	x	X	.	.	.	.	.	
76(500)	x	.	.	x	x	x	x	x	x	.	x	.	.	.	.	.	.	.	.	.	
112(600)	x	.	x	x	.	x	.	x	x	x	x	x	x	x	.	X	x	X	.	.	7°C
77(620)	x	.	x	.	x	x	.	x	x	.	x	x	x	x	.	.	.	X	.	X	
30(680)	x	.	.	.	x	.	.	.	x	.	x	.	.	.	X	X	x	.	.	.	
104(720)	x	.	x	x	x	x	x	.	.	.	x	x	x	x	.	.	.	.	X	X	
108(730)	x	.	x	x	x	x	x	x	x	x	x	x	x	x	x	X	x	X	x	X	6°C
149(850)	x	.	x	x	x	x	x	x	x	x	x	x	x	x	X	X	x	X	x	X	
169(890)	x	x	x	x	x	x	x	x	x	x	x	x	.	x	.	.	.	.	x	X	5°C
155(980)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	.	X	x	X	x	X	4°C

In the area of the Saba Bank tropical submergence phenomena are improbable, as this sunken island is relatively small. Such phenomena occur at the W-coast of Africa, from where I saw typical globigerine-oozes at depths of about 20 m. In the area of the Saba Bank real oozes are found in deep water only. Though occurrences such as *G. sacculifera* at 26 m and *G. fimbriata* at 34 m may be the result of uplifting, table 4 shows that the main occurrences of these species lie much deeper.

However, if the trap-theory outlined above is true, remarkable inconstancies in coiling direction, as ascertained by several authors for a number of species, may be understood by realizing that in warmer seas the different strata of living have much lower temperatures than the sea surface. At all depths *G. menardii* was found coiling to the left, as is the case in *G. fimbriata*; both species seem to live in not too deep water with a temperature of 20° C; *G. tumida*, though living in deeper water (temp. 11° C) also coils to the left; obviously these species are not so susceptable to temperature. *G. truncatulinoides* is susceptable to temperature (Hofker, 1969: 100, fig. 266); in colder water this species coils to the right, in warmer water to the left; yet, in the Saba Bank area there seems to be a tendency to coil to the right; it was found living at a depth where the water temperature lies between 18 and 14° C. All specimens found of *G. eggeri* are coiling to the right, which is typical for this species in warm water; it was found living in depths with temperatures of 20 to 18° C. *G. trilobus* and *sacculifer* (the outgrown deeper-water form of *trilobus*) originate from shallow water with a temperature of 22°-18° C; all specimens observed, also including those found in deep water, show right and left coiling, as is found everywhere, but here with a tendency to left coiling dominance. The deep-sea forms *G. rubescens*, *G. glutinata* and *T. humilis* are cold-water species; *G. rubescens* coils to the right, *G. glutinata* more to the right than to the left; *G. humilis* more to the left than to the right. It will be obvious that such deep-sea forms in tropical water may live in more shallow habitats in a cooler climate. Since *G. truncatulinoides* is found in the Saba Bank at 150 m and deeper, it will be obvious that in reality it is a temperate species that also occurs in temperate regions with cooler seas. We may end this chapter with a citation from Boltowskoy & Wright (1976: 188): "Summarising, we can say that apparently a vertical stratification of foraminiferal planktonic species does exist". But they continue: "...and the correlation of the presence or absence of spines with surface or subsurface water layers appears to be valid". This is only partly true for the Saba Bank area. The species *Globigerinoides ruber*, *G. trilobus-sacculifer*, *Orbulina universa*, *Globigerinella aequilateralis*, *Sphaeroidinella dehiscens* have spines but *Globoquadrina eggeri*, and the *Globorotalia* species have not, nor has *Candeina nitida*; many of the latter species start deeper. But *Globoturborotalita rubescens*, *Hastigerina pelagica* and *Turborotalita humilis* do have spines, though they are typical species of deep water; on the other hand, *Globigeninita glutinata* does not bear spines, whereas *G. calida* does. So, there are exceptions to the rule that typical surface species have spines and sub-surface species have no spines. The deep-water species *Hastigerina pelagica* has spines only on the ends of the chambers; these spines show a triangular transverse section and peculiar thorns on the sides of the spines; obviously these spines serve to fasten the gelatinous vesicules with which this species is covered when alive. The spines of *Globoturborotalita rubescens* and *Turborotalita humilis* are extremely fine and in the latter species they are placed mainly on the top of the last-formed chamber; their function is unknown. *Candeina nitida*, also a deep-water species, and *Globigerinita glutinata* do not have spines and both show bullae in deeper water, whereas the test walls are extremely thin.

Systematic part

Reophax guttifer Brady (fig. 13a)

Reophax guttifer Brady, 1884: 295, pl. 31 figs. 10-15; Cushman, 1920: 13.

Test consisting of 4-6 chambers in a straight line, distinctly separated from each other by neck-like sutures. Chambers globular to slightly pyriform, with coarse and irregular agglutination of calcareous grains. Grains in one single layer; aperture small, rounded, on top of the last-formed chamber. The necks in between the chambers may be thickened by more layers of finer grains. Proloculus rounded. Colour yellowish. Brady and Cushman mention it from greater depths; it was found by me in the Bay of Naples (Ammontatura), 250 m deep (Hofker, 1832: 81). It was never mentioned from the Caribbean Sea. The species occurred commonly at St. 125, depth 80 m.

Polystomammina nitida (Brady) (fig. 13b)

Trochammina nitida Brady, 1884: 339, pl. 41 figs. 3-6.
Polystomammina nitida (Brady); Seiglie, 1965c: 54, pl. 1 figs. 7, 8.

The test on first sight are resembling some normal *Trochammina* with, at the end of their growth, the last-formed chambers more elongate. All chambers visible from the dorsal side, in about 2½ convolutions, only about 10 chambers visible from the ventral side, the chambers ending with pointed tena near the umbilical hollow, which is always open. Walls very thin, with very fine agglutination consisting of fine rounded sand grains and fine broken spicules in a brownish cement. Sutures on both sides slightly rounded backward, depressed. The whole test distinctly depressed with rounded margin; periphery lobulate. Each chamber with an aperture below the pointed end in the open umbilicus, and a second aperture in the form of a narrow slightly curved slit on the marginal face, visible in the last-formed chamber wall; this slit is similar to that found in *Arenoparrella.* Some species of this genus may have been described as *Arenoparrella,* because the small openings into the umbilical hollow are difficult to find, but *Arenoparrella* does not have the open umbilicus nor the umbilical foramina.

The species was found, never commonly, in St. 40 (depth 24 m), St. 79 (84 m) and St. 34 (95 m). Seiglie found it at Los Testigos, on the Venezuelan coast, at depths from 39 to 70 m, which agrees with the finds in the Saba Bank area.

Orectostomina camachoi Seiglie (fig. 13c)

Orectostomina camachoi Seiglie, 1965b: 70, pl. 8 figs. 1, 2.

Seiglie described this species as having a planospiral initial part, but with the planispiral sometimes covering the proloculus. As to this detail his description seems to be slightly erroneous: the spiral part at one side shows the whole spiral, whereas at the other side the later chambers of the spiral are more or less overlapping; thus the genus must belong to the Trochamminidae. In a clarifyer the apertures of the chambers in the spiral part are situated on a short neck and are areally placed. After the spiral some biserially arranged chambers are formed, all slightly longer than broad, with foramina in the shape of a transverse, areal slit with a protruding lip around it. The walls are extremely thin, formed by one single layer of the agglutination which consists of very fine irregular and thin grains with some fine broken spicules in between. *Orectostomina camachoi* Seiglie was found in a single specimen at St. 123, depth 70 m. Seiglie found it near Los Testigos, coast of Venezuela, at depths of 29 and 33 m. It seems to be a rare species.

Carterina caribbeana Hofker (fig. 13d)

Carterina caribbeana Hofker, 1979: 5, fig. 4.

Of this species, always very rare in samples from the Caribbean Sea and possibly only occurring in the northern part, a single specimen was found at St. 83 at a depth of 41 m. I described it fully in another paper (1979). This specimen was filled with protoplasm, but the last formed chamber was empty; the protoplasm of this chamber obviously filled the umbilical part of the specimen. As in other specimens from the region, the ventral walls of the chambers are formed by small spicules, whereas the dorsal walls consist of an inner layer of such small spicules and an outer one of much larger spicules; however, in the specimen from the Saba Bank the dorsal wall of the last-formed chamber consisted of large spicules only while the inner layer was missing; it is possible that this inner layer of finer spicules is formed later and thus did not yet occur in the last formed chamber. As described earlier, the spicules on the ventral side (only small spicules) are directed radially, whereas those at the dorsal side are arranged parallel to the periphery.

Hansen & Grönlund (1977: 147-154) described specimens from the Key Islands, Pacific; they found structures that differ from my Caribbean specimens in that the spicules were not fusiform but blunt, and apparently they also did not find the two different kinds of spicules and the two different layers in the dorsal walls. Angell (1978: 182-185) believed that the spicules found in *Carterina* were derived from another foraminiferal species, *Trichosphaerium sieboldi*; Angell described a *Trochammina* which, possibly, got its spicules from this *Trichosphaerium*; I know of such a species of *Trochammina*, from the Caribbean, which also possesses these spicules in its walls, derived from sponges or from other sources. However, these spicules greatly differ from those of *Carterina*, which, according to Hansen & Grönlund, have an inner structure that is never found in the spicules of sponges and spiculate Foraminifera.

Textularia curta Cushman (fig. 13e)

Textularia flintii Cushman var. *curta* Cushman, 1922: 14, pl. 2 figs. 2, 3.
Textularia agglutinans Flint (part), 1897: 284.
Textularia rugosa; Bagg, 1908: 131.
Textularia flintii Cushman, 1911: 21.

Test elongate triangular, with flat sides and nearly invisible sutures caused by the extremely rough agglutination, consisting of irregular calcareous grains. Last-formed chamber slightly bulbous with apertural slit along the apertural suture. In the megalospheric generation the initial part is rounded, as the marginal sides of the initial chambers have thickened walls formed by several layers of relatively fine grains. Inner walls of chambers thin, consisting of a single layer of grains.

The microspheric generation is rare with more triangular form and its initial part sharply pointed; in this generation the large and irregular grains are restricted to the last-formed chambers only, whereas the larger part of the test is covered by finer grains; here, too, the side of the test is flat.

This small *Textularia* is restricted to deep water; Cushman found it only in the Caribbean region between 222 and 896 fathoms; in the Saba Bank region is was found from 290-850 m.

Textularia luculenta Brady (fig. 13f-h)

Textularia luculenta Brady, 1884: 364, pl. 43 figs. 5-8.

Tests elongate, in the microspheric generation gradually tapering to the apertural end and with pointed initial end, in the megalospheric generation with blunt initial end, then rapidly becoming broader and, from the middle part onward, with nearly parallel sides. Test strongly compressed with blunty rounded margins. Sutures distinctly oblique but indistinct in the flat broad side, often nearly invisible. Periphery slightly lobulate; chambers with a distinct shoulder distally of the aperture, which is a simple narrow slit with its narrow part on the suture. Walls consisting of larger irregular calcareous grains between much finer material, smoothly finished with the surface. Chamber-walls relatively thin. It may be that there are three generations, as some of the megalospheric tests show a very large proloculus, whereas others have a much smaller one; the microspheric proloculus is very small.

Numerous specimens were observed at stations with depths from 410 to 850 m.

Loeblich & Tappan (1955: 8) at several stations in the Caribbean region found specimens ending with somewhat inflated chambers and one or more rounded areal apertures. In the many specimens observed by me, — with flat sides and without any inflated end-chambers, though they seem to be fully grown out (microspheric specimens with 18 biserial rows of chambers, megalospheric ones with 11-14 rows of chambers) — these areal openings were not found, and I do not believe that the specimens with such inflated chambers belong to *Textularia luculenta* Brady. Loeblich & Tappan made *T. luculenta* the type-species of the genus *Planctostoma*. Their (abnormal) specimens may belong to a different species; or these specimens were specimens of *T. luculenta* forming microspores; or, if they were specimens of the microspheric generation (which some of the figures given by Loeblich & Tappan might suggest), they were forming plasmodiospores and the inflated chambers with abnormal apertures are brood-chambers. However, as all the figures given by Loeblich & Tappan are at the same scale (× 17), the differences between the normal specimen figured and the much robuster abnormal specimens suggest that the latter belong to quite a different species.

Liebusella polyphragma (Goës) (fig. 11)

Valvulina triangularis d'Orbigny var. *polyphragma* Goës, 1882: 87, pl. 11 figs. 390-400.

This species, well-described and figured by Goës, seems to have escaped the attention of other investigators of the Caribbean Foraminifera, or it is of very restricted distribution.

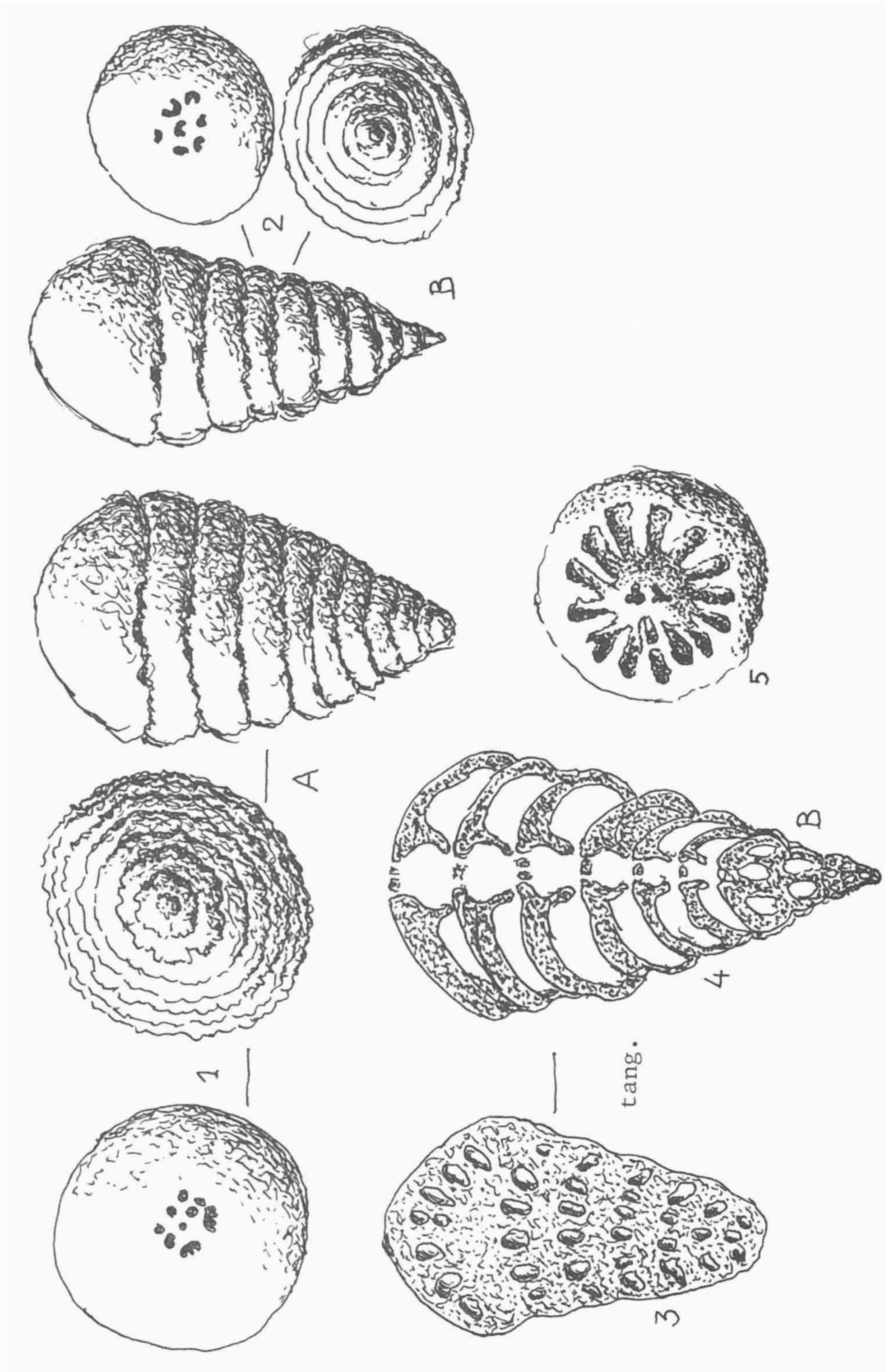


Fig. 11. ***Liebusella polyphragma*** (Goës), St. 127 (360 m), the two generations A and B, and sections, × 25.

The tests are large for the genus, up to 7 mm long, larger breadth 3 mm. It is of balloon-like shape and circular at cross-section. Typical are the smoothly finished surfaces of the chambers, the very fine agglutination and the distinct sutures between the successive chambers. In the megalospheric tests the initial end is somewhat truncate, in the microspheric specimens the whole test is more slender and the initial end sharply pointed. Each chamber shows a central hollow from which many secondary elongate hollows radiate toward the periphery; these secondary hollows are separated from the central hollow by a partition hanging down from the roof of the chamber and leaving an opening at the chamber floor towards the central hollows. The aperture or the foramina between the chambers are formed by somewhat irregular openings in the centre of the roof. Many of these openings are moon-shaped. The initial end is formed by several series of 4-5 chambers in each whorl. *Liebusella polyphragma* is distinguished from the commoner Caribbean *Liebusella soldanii* Jones & Parker, the type-species of this genus by the larger tests, the finer agglutination, and the much more distinct sutures.

This species is extremely common in some of the samples; all stations at which it was found are situated on the slope in the former north-western bay of the Saba Bank. Goës found it to the east of the Lesser Antilles.

Pyrgoides jugosus (Cushman) (fig. 13i)

Pyrgo jugosus Cushman, 1935: 6, pl. 2 figs. 9-11; Seiglie, 1965b: 72, pl. 9 figs. 4, 5.

Test oval, with crenulate marginal keel, often with distinct pointed denticles (denticulate). Outer chambers with distinct keel lengthwise in the middle. Cross-sections show that all former chambers do not have this central keel, and consequently young specimens are similar to *Pyrgoides denticulatus* (Brady).

As the specimens begin with a triserial arrangement of the chambers, the species belongs to *Pyrgoides* and not to *Pyrgo*.

Common on the Saba Bank proper from 22 to 70 m; Cushman found it on the shelf of Puerto Rico and Seiglie on the shelf of Venezuela.

Dendritina elegans (d'Orbigny) (fig. 13j)

Peneroplis elegans d'Orbigny, 1839: 61, pl. 7 figs. 1, 2.
Dendritina elegans (d'Orbigny); Hofker, 1951: 228, figs. 3-5; 1964: 56, figs. 149-155.
Dendritina antillarum (not d'Orbigny); Le Calvez: 1977a: 39, figs. 1, 2.
Peneroplis pertusus (not Forskål); Lévy: 1977: 399, pl. 1 figs. 11.

There exists great confusion as to this species in the literature. d'Orbigny described it as "Coquille comprimée, très fragile, transparente, sa spire non embrassante, se montrant à moitié dans un large ombilic, son pourtour...

légèrement anguleux". The figures of d'Orbigny very clearly show the open umbilicus. The specimens described and figured by Le Calvez do not show this open umbilicus and they cannot belong to this species. The specimen called *Peneroplis pertusus* by Lévy clearly is *Dendritina elegans* (d'Obigny); *Peneroplis pertusus* has a closed umbilicus, since in this species the chambers are wholly overlapping; *P. pertusus* does not occur in the Caribbean region.

However, the description by d'Orbigny goes on: "Ouvertures rondes, au nombre de six ou sept, sur lignes au millieu de la largeur de la dernière loge". In our specimens the apertures are quite different in different individuals; some have 3 to 5 rounded openings, others have several openings with a dent on the lower border, or the openings fuse and a dentate border of the aperture is formed. In some specimens the last formed chambers enroll and a circle of openings appears at the last-formed chamber as in some *Spirolina arietina* (cf. Hofker, 1964: 58, figs. 147-154). But all these different shapes and apertural conditions are also found in many other peneropline species, as Dreyer (1898) has pointed out for *Peneroplis*.

The test wall is ornamented with fine elongate ribs consisting of lines of very fine elongated lenses. As there are not many species of Peneroplidae which show these ribs of lenses, this character is of diagnostic value. To get an overall idea of the apertural conditions, I studied the available specimens from the Saba Bank, where it is found scattered over the area.

Genus **Archaias** De Montfort, 1808

The type-species of *Peneroplis* De Montfort, 1808, is *Nautilus planatus* Fichtel & Moll, 1798, a striate evolute planispiral species; to the same genus belongs *pertusus* Forskål, a species which is striate, involute and planispiral; no one will put these two species in different genera because the one is evolute, the other involute. The same holds true for other Peneroplidae, such as the involute *Puteolina protea* (d'Orbigny), and the evolute *Puteolina bradyi* (Cushman), both having hyaline lenses or pustules on their surfaces. Here, the test being evolute or involute is not considered to be of diagnostic value on the generic level.

As to the inner structure of tests, the present author believes that differences in structure, which have obviously developed in order to strengthen the chambers and are present as partition-walls, pilars, etc., cannot be of generic importance, since they are always formed in connection with narrow (without partitions) or broader (with partitions) chambers.

In all the species here placed in the genus *Archaias* two fundamental characters can be observed; one, supra-generic, feature is that the walls show lenses on the surface of the chambers, which lenses seem to have been developed to direct light beams on the zooxanthellae. The other character concerns the chambers; following the proloculus they are typically peneropline, broadening gradually following their growth, and, in later stages of development or in certain generations of the species, encircling the whole initial test or becoming spirally arranged around the initial part; though the later chambers may be more or less divided into a kind of chamberlets, the chamber itself is characteristically peneropline, i.e. strongly broadening in a plane perpendicular to the axis of coiling. In this way one row of chamberlets forms one peneropline chamber, or said otherwise, each chamber, peneropline, spirally arranged or forming in the end rings around the more initial part, is more or less divided into chamberlets by radially placed partitions, each partition having one or more openings in order to allow of communication with the other chamberlets; thus the protoplasm may stream through the whole chamber. Moreover, the peneropline structure of the tests is completed by rows of rounded openings at the margin; there may be one row in strongly compressed species, two in species with a thicker test, or even more than two rows of openings in yet thicker tests, as is clearly seen in *Peneroplis*

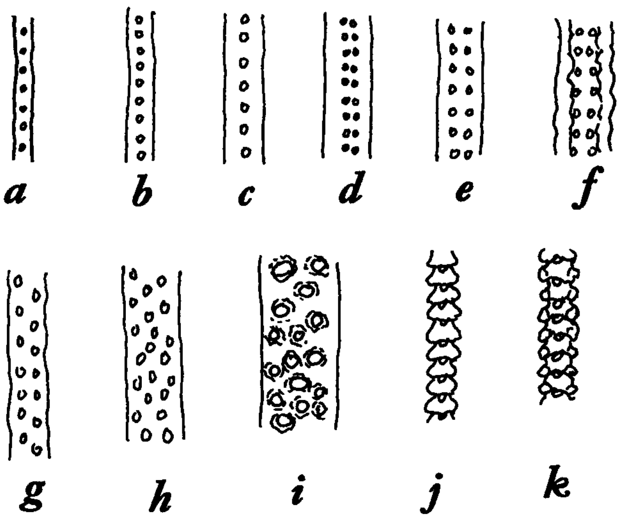


Fig. 12. The situation of the apertures on the margins of species of *Archaias* and *Amphisorus*. a, *Archaias orbitolitoides* (Hofker), W of St. Croix (800 m); b-c, *Archaias annulatus* (Hofker); b, St. 73 (35 m); c, St. 132 (47 m); d-f, *Archaias compressus* (d'Orbigny); d, St. 132 (47 m); e, St. 129 (47 m); f, microspheric, St. 58 (49 m); g-i, *Archaias angulatus* (Fichtel & Moll); g, small flaring specimen, St. 58 (43 m); h, large, megalospheric, St. 45 (25 m); i, large microspheric, St. 49 (34 m); j-k, *Amphisorus hemprichii* Ehrenberg; j, small, St. 90 (32 m); k, large, megalospheric, Cuba, Habana (10 m). All × 10.

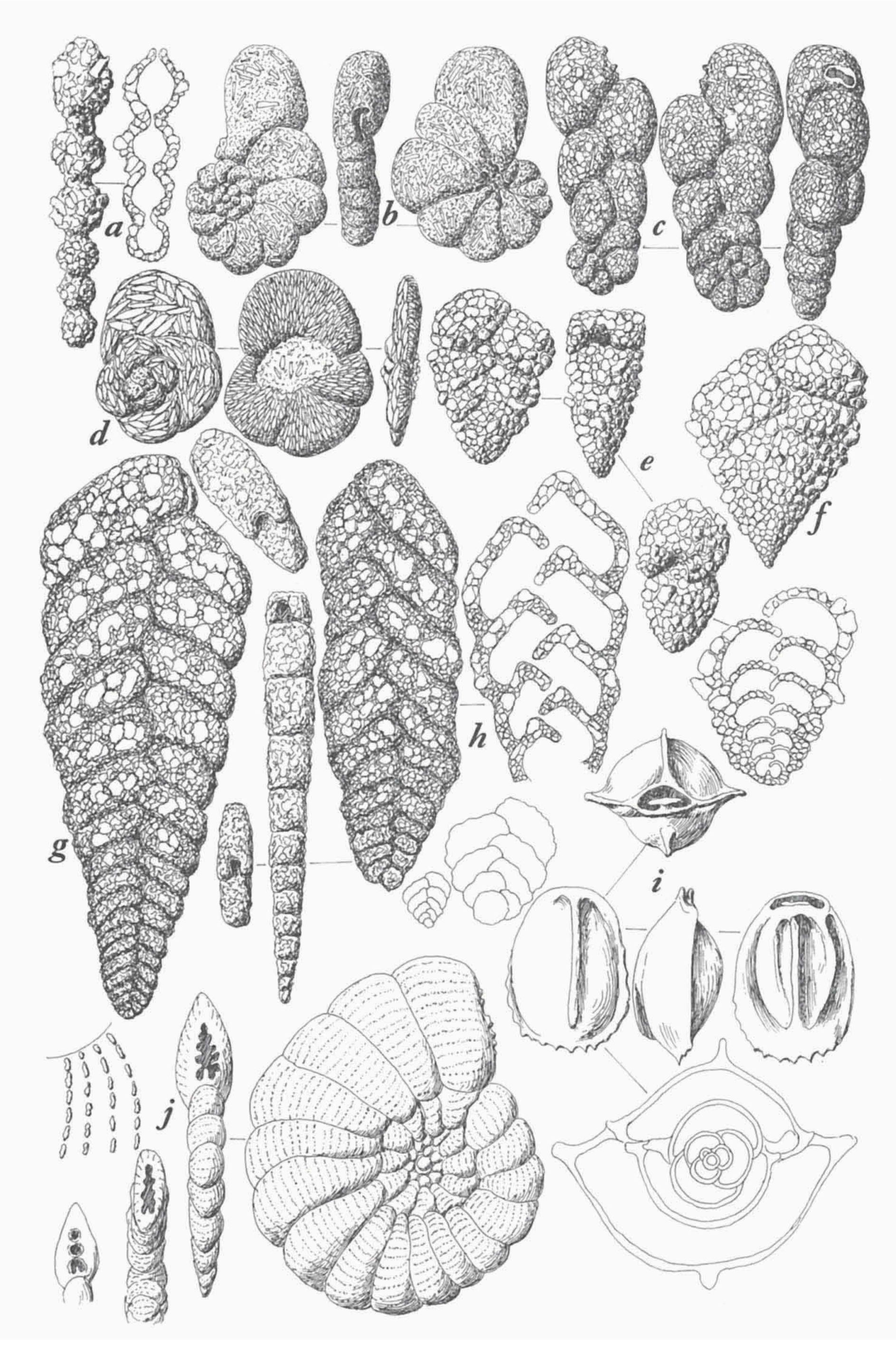
and in *Puteolina* (from which primitive form all the species of the genus *Archaias* seem to have developed) (see textfigure 12).

So we may conclude, that all species with the general characteristics mentioned above must belong to one genus, and that the recognition of several genera within this group has no real meaning and ought to be suppressed; such "genera" are *Helenis* Montfort, *Ilotes* Montfort, *Orbiculina* Lamarck, *Puteolina* (*Archaias*) Hofker (though this name points to the ancestral group of species), *Cyclorbiculina* Silvestri, *Broeckina* Munier-Chalmas (Cretaceous and not related to the Tertiary and Recent species of the group) and *Androsina* Lévy.

Short description of the genus *Archaias* Montfort

Tests always puteoline at their surfaces; proloculus peneropline with neck-chamber in the megalospheric generations, without neck-chamber in the microspheric one; initial chambers peneropline without any trace of partitions or pillars, later chambers in a flaring spiral, often followed by encircling chambers; these later chambers may have formed partitions, in some cases broken into pillars; each chamber connects with the next one by one or more rows of foramina at the margin, the last formed chamber opens into the outer world through these; when partitions are formed, they show one or more openings allowing communication with the next chamberlets; in very much compressed species these openings may be very large, since the partition-walls are practically unnecessary; initial parts may be evolute or involute (in the first case the proloculus is seen from the outside, in the second the proloculus is covered by involute later chambers).

Fig. 13. a, *Reophax guttifer* Brady, St. 125 (80 m), whole individual and section, × 66. b, *Polystomammina nitida* (Brady), St. 79 (84 m), from three sides, × 66. c, *Orectostomina camachoi* Seiglie, St. 123 (70 m), from three sides, × 66. d, *Carterina caribbeana* Hofker, St. 83 (41 m), from three sides, with protruding protoplasm at ventral side, × 66. e, *Textularia curta* Cushman, St. 80 (560 m), megalospheric specimen, three sides, and longitudinal section, × 33. f, *Textularia curta* Cushman, St. 80 (560 m), microspheric specimen, × 33. g, *Textularia luculenta* Brady, St. 31 (420 m), microsperic specimen, two sides, × 66. h, *Textularia luculenta* Brady, St. 31 (420 m), megalospheric specimen, three sides, × 66; part of longitudinal section, × 80, with schematic drawings of the initial parts of the two generations. i, *Pyrgoides jugosus* (Cushman), St. 90 (32 m) from four sides, × 33; transverse section, × 66. j, *Dendritina elegans* (d'Orbigny), St. 90 (32 m), outgrown specimen from two sides, × 66; straight part of another specimen, apertural face of young specimen, × 66; part of surface with ornamental structure, × 200.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Archaias orbitolitoides (Hofker) (figs. 12a, 14a)

Praesorites orbitolitoides Hofker, 1930: 149, pl. 55 figs. 8, 10, 11; pl. 57 figs. 4, 6; pl. 58; pl. 61 figs. 3, 14.
Orbitolites orbitolitoides (Hofker); Hofker, 1952: 105; 1971: 52.
Not *Sorites orbitolitoides* Lehmann, 1961: 645; Hottinger, 1977: 99.
Not *Broeckina orbitolitoides* (Hofker); Lévy, 1977: 423.

This is the only species which is restricted to deep water; it has the most compressed tests, the thinnest outer walls and consequently strongly built partitions with relatively small openings to adjacent chamberlets. Typical is the long spiral of initial peneropline chambers without partitions; in the B-form 17 of these primitive chambers are found, in the A_1-form 10, in the A_2-form 5. Though there cannot be question of zooxanthellae at depths of 800 m and more, the lenses on the thin outer chamber-walls remain.

Not found in the material around the Saba Bank, but common in a sample from off St. Croix, at about 800 m, in the neighbourhood of the Saba Bank.

Archaias annulatus (Hofker) (figs. 12b, c, 14b-f)

Orbitolites annulatus Hofker, 1952: 103, fig. 52.
Sorites marginalis; Cushman (not Lamarck), 1930: 49, pl. 18 figs. 1-4.
Broeckina orbitolitoides; Lévy (not Hofker), 1977: 423.

Tests annular as in *A. orbitolitoides*, compressed, but with thicker outer walls and thicker tests, not so hyaline, and the spirals of initial chambers less numerous; undivided chambers in the B-form about 17, in A_1 5, A_2 never more than 2. In some localities the initial part partly covered by secondary chalk. In the B-form (which is very rare) brood-chambers without visible partitions, but no embryos found as yet. As the outer walls are relatively thick, the partitions could be reduced to two half-moon-shaped parts on either side, with a very large opening towards the adjacent chamberlets. The lenses on the surface of the side-walls are distinct but small.

Many specimens found in many localities on te bank.

Archaias compressus (d'Orbigny) (figs. 12d-f, 15a-d)

Orbiculina compressa d'Orbigny, 1839: 73, pl. 8 figs. 1, 2.
Archaias compressus (d'Orbigny); Cushman, 1930: 48.
Cyclorbiculina compressa (d'Orbigny); Silvestri, 1937: 88.
Puteolina (Archaias) compressa (d'Orbigny); Hofker, 1952: 457; 1971: 47.

This species forms thicker tests than the two foregoing species, though the outer walls remain relatively thin. Since in outgrown specimens the tests, especially in the B-form, get diameters of 5 mm and more, and since the evolute initial part as found in *A. orbitolitoides* and *A. annulatus* easily may be broken away if tests grow larger — and thus must have a longer lifetime to reach this dimension — the initial parts become involute in this and in

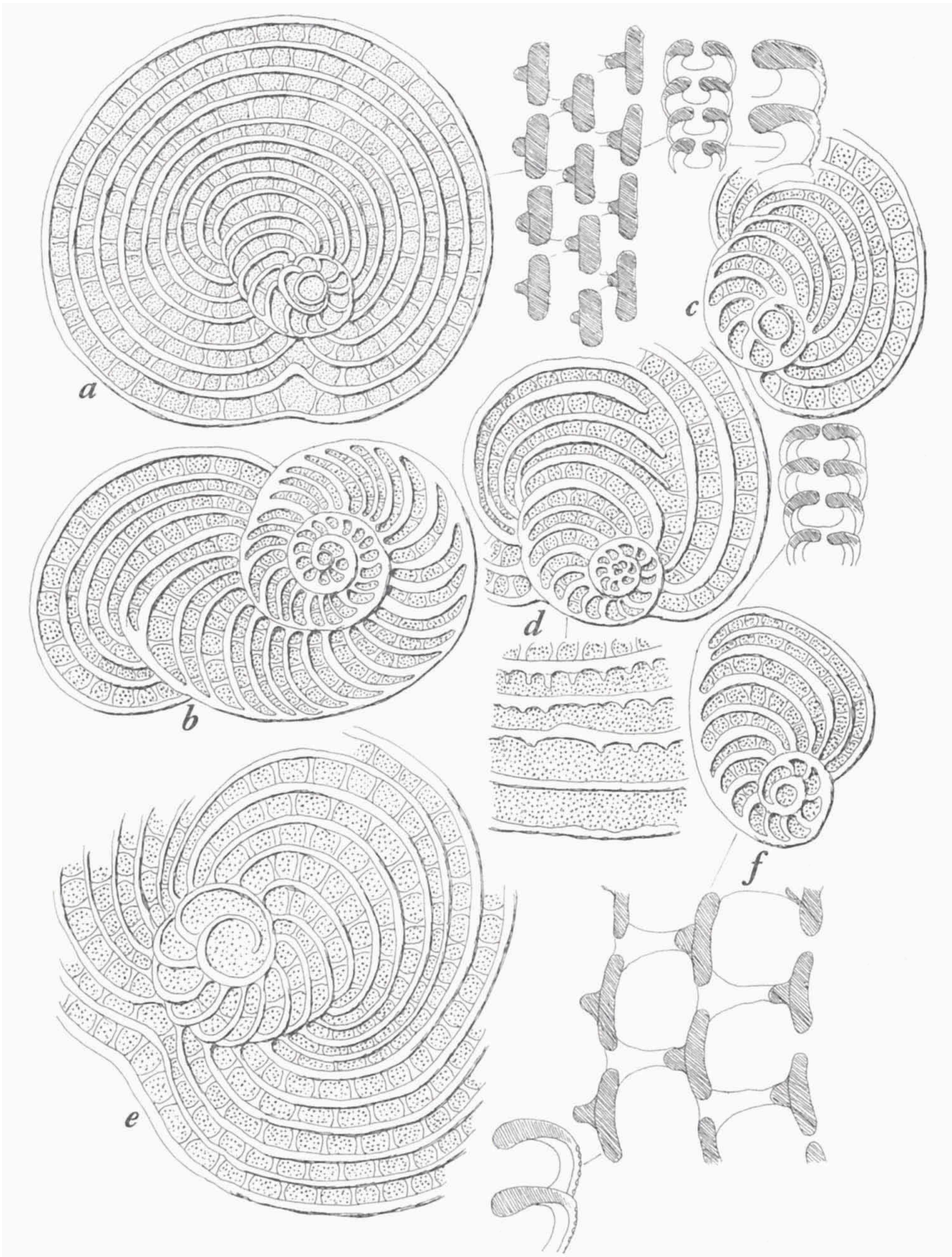

Fig. 14. a, *Archaias orbitolitoides* (Hofker), W of St. Croix (800 m), central part, × 66; with horizontal section, × 200 and transverse sections, × 66 and × 200. b-f, *Archaias annulatus* (Hofker); b, St. 123 (70 m), central part of microspheric specimen, × 66; c, St. 132 (47 m), central part of megalospheric specimen, × 66; d, St. 132 (47 m), central part and periferal broodchambers, × 66; e, St. 132 (47 m), central part of megalospheric specimen, × 66; with horizontal section, × 200, and transverse sections, × 66 and × 200; f, St. 129 (47 m), specimen, central part, with very large proloculus, × 66.

the following species in order to strenghten the initial part. Moreover, the last-formed chambers become progressively broader and consequently the partitions between the chamberlets get more openings and pillars to compensate this. Smouth & Eames (1958: 222) described this in the following way: "Subepidermal partitions can be seen very clearly and in some cases there seems to be a central zone with pillars". In outgrown specimens in both generations the chambers always become circular or cyclical, though flabelliform specimens occur under less favorable conditions. In the microspheric generation the small globular proloculus is followed by nine peneropline chambers and from there onwards the spiral chambers with partitions start. In the megalospheric specimens only three peneropline chambers follow the neck-chamber. Large microspheric specimens develop a series of broodchambers in which megalospheric embryons may be found which have larger diameters than the proloculus of the mother-animal shows.

The species was common in many localities on the Saba Bank, from 5 to 95 m deep, and most commonly at St. 43 (43 m), with many microspheric specimens. Specimens found deeper than 60 m may be sub-fossil.

Archaias angulatus (Fichtel & Moll) (figs. 12g-i, 15e, f)

Nautilus angulatus Fichtel & Moll, 1798: 112, pl. 21 (young specimens as *N. orbiculus* and *N. aduncus*).
Archaias spirans Montfort, 1808: 190.
Ilotus rotalitus Montfort, 1808: 199.
Helensis spatiosus Montfort, 1808: 195.
Orbiculina adunca (Fichtel & Moll); Lamarck, 1816: 468.
Orbiculina angulata (Fichtel & Moll); Lamarck, 1822: 609.
Archaias angulatus (Fichtel & Moll); Cushman, 1930: 46.
Puteolina (*Archaias*) *angulata* (Fichtel & Moll); Hofker, 1952: 461; 1971: 47.

This species has the thickest tests of the group and consequently the broadest chambers near to the margin. It will be obvious that its initial part is strongly involute, that the voluminous chambers do not reach the circular state but end in incomplete spirals, and that the partitions in the later chambers show three or four openings towards adjacent chamberlets and are

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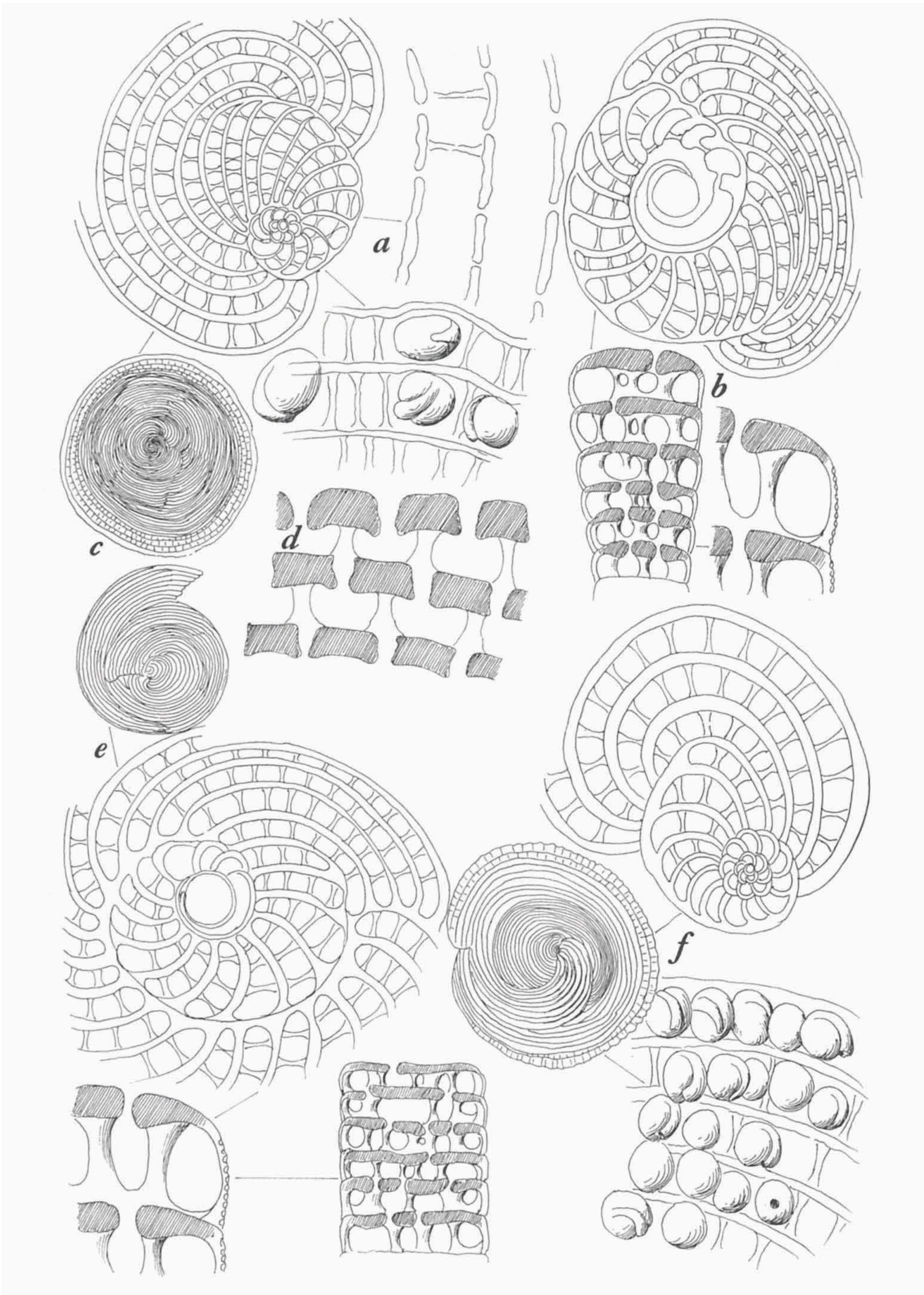
Fig. 15. a-d, *Archaias compressus* (d'Orbigny); a, St. 58 (43 m), microspheric specimen, horizontal section through initial part, × 66; with section through peripheral brood chambers, × 66 and brood chambers with embryons, × 66; b, St. 45 (25 m), horizontal section through initial part, × 66; transverse section showing septa and pillars, × 66 and × 200; megalospheric specimen. c, specimen of fig. a, × 6; d, horizontal section, × 200. e-f, *Archaias angulatus* (Fichtel & Moll); e, St. 45 (25 m), outgrown megalospheric individual, × 5; horizontal section of initial part, × 66; transverse section with septa and pillars, × 66 and 200; f, St. 49 (34 m), microspheric specimen, horizontal section of initial part, × 66; test of outgrown specimen with brood chambers, × 5; brood chambers with embryos, × 66.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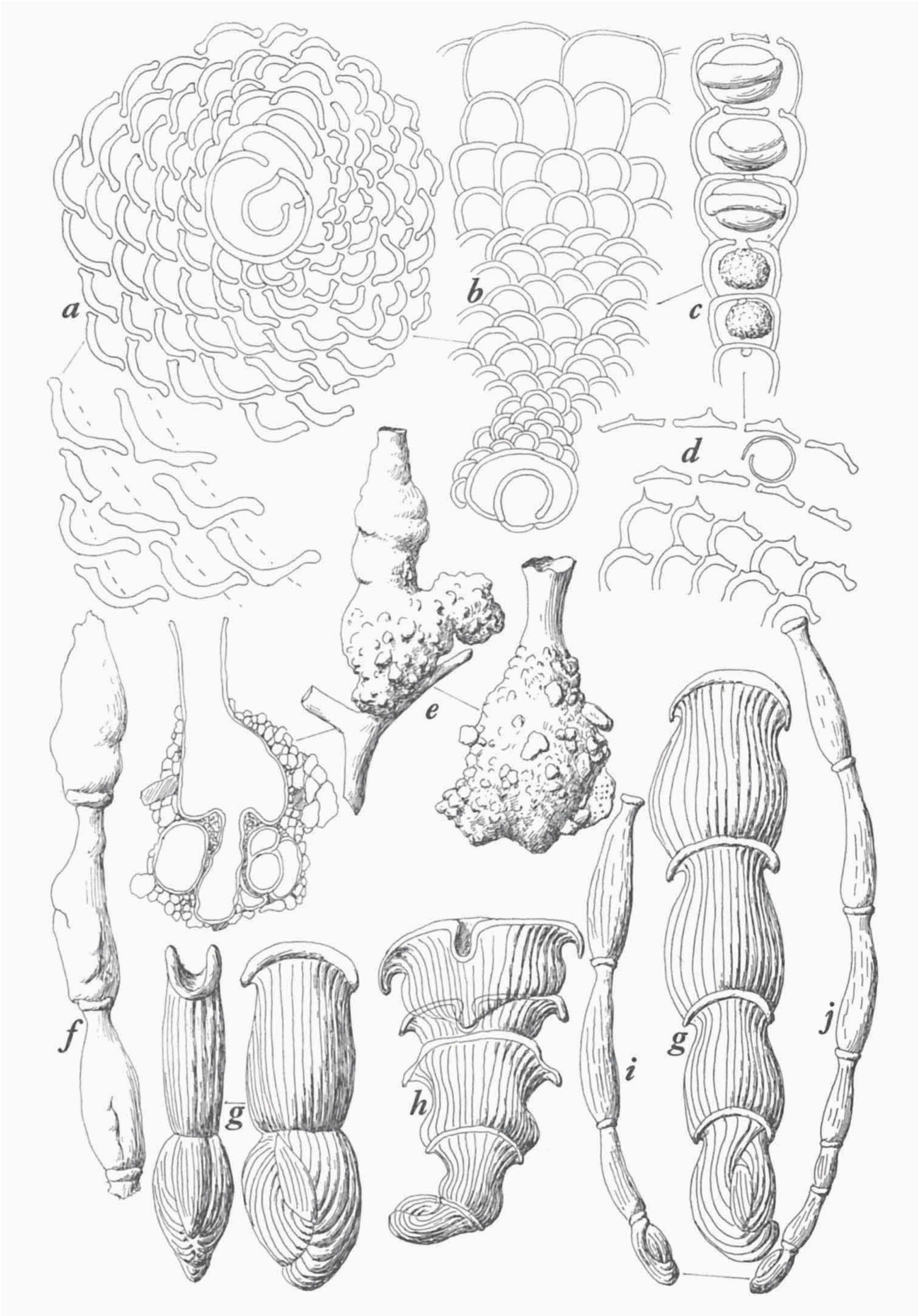
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broken into pillars, though at the outer walls these pillars clearly are remains of mural partitions. However, we already saw that pilars are not restricted to this species, but that they also occur in later chambers of *A. compressus*. Large, outgrown megalospheric specimens show the abruptly broken, spiral-shaped end-chambers, which are very prominent in microspheric, very large specimens where the end of the spiral may crumple up over the former part of the tests. Microspheric specimens may form broad brood-chambers in the end, often filled with embryos, especially in deeper water (34 to 43 m). The microspheric globular proloculus is followed by 20 peneropline chambers, and after that by the short spiral with partitions in the chambers; in the megalospheric generation only three peneropline chambers are found.

This species was very common at St. 45 (25 m) and St. 49 (34 m). At these depths the fully outgrown specimens with large diameters were found. Specimens found deeper than 70 m may be sub-fossil.

Orbitolites (Amphisorus) hemprichii (Ehrenberg) (figs. 12j, k, 16a-d)

Amphisorus hemprichii Ehrenberg, 1839: 134; Bermúdez, 1935: 192; Lévy, 1977: 428.
Orbitolites duplex Carpenter; Flint, 1897: 305.
Orbitolites (Amphisorus) hemprichii (Ehrenberg); Hofker, 1976: 137.
Sorites marginalis (Lamarck); Lévy, 1977: 426.

In the whole Caribbean region only one species is found of the *Orbitolites*-group. It is, moreover, the most primitive (reduced) species of this group. The group apparently arose in the Eocene with *Orbitolites complanata* Lamarck with its complex inner structure (Hofker, 1964: 53), after which we find a reduction in the number of layers of chambers via such forms as *Marginopora vertebralis*, *Orbitolites duplex* Carpenter and *Orbitolites duplex* to *Orbitolites (Amphisorus) hemprichii* (Ehrenberg), with only one layer of chambers.

Many authors believe that the West-Indian species has tests with two layers of chambers, but a thorough study after many sections revealed that it has only one layer of chambers.

Fig. 16. a-d, *Amphisorus hemprichii* Ehrenberg; a, St. 120 (5-15 m), horizontal section of megalospheric specimen, central part, × 66; b, St. 120 (5-15 m), part of megalospheric specimen seen in clarifyer, with at the periphery the brood chambers, × 66; c, St. 120 (5-15 m), transverse section of peripheral chambers, in some chambers embryos without test walls, in the more peripheral chambers with test walls (proloculus with neck chamber), × 66; d, St. 120 (5-15 m), horizontal section with brood chambers and sectioned embryo, × 66. e, *Nubeculina chapmani* Cushman, St. 123 (70 m), two specimens and longitudinal section, × 66. f, *Nodobacularia tibia* (Jones & Parker), St. 55 (39 m), end-part of specimen, × 66. g, *Articulina lineata* Brady, St. 65 (24 m), one individual from two sides, the other with three rectilinear chambers, × 66. h, *Articulina mucronata* d'Orbigny, var., St. 87 (49 m), abnormal specimen, the two last formed chambers with a nozzle, × 33. i, j, *Articulina mayori* Cushman, St. 72 (41 m), two individuals, × 66.

Contrarily to the *Archaias*-group, no species of the *Orbitolites*-group does form partitions in peneropline or annular chambers, but each "cell" is formed by a chamber, and in transverse sections we do not look on partitions but to the side-walls of the chambers.

In the megalospheric tests larger or smaller proloculi, often with a somewhat irregular form, are partly surrounded by a voluminous neck-chamber. In the very rare microspheric generation the small globular proloculus is surrounded by one set of small chambers after which a more irregular chamber-growth follows. In the megalospheric generations (which often give rise to megalospheric embryos), one or two peneropline chambers follow the neck-chamber and then an irregular growth of small chambers starts. Later, the chambers becoming larger, they are arranged in a clockwise—counterclockwise pattern. Then may follow broader and higher chambers, and these chambers gradually pass into irregularly formed brood-chambers in which embryos may be observed. In many cases these brood-chambers have not lost their side-walls. Intercalated rows of chambers always begin with a chamber, in which in the middle a secondary foramen is formed.

The chambers are connected with the chambers of a next row by one or two foramina which, seen from the margin of the test, occur in a single median row; in the later chambers and especially in the brood-chambers, where the test becomes thicker, two or even three rows of foramina may be observed. It is very probable that these multiple rows of foramina have lead to the supposition that this species has two layers of chambers, and this may have lead to the confusion of this species with *Orbitolites duplex* Carpenter; the latter has two layers of chambers, but does not occur in the Caribbean area.

The species is common in shallow water in the Caribbean Sea, but is not common on the Saba Bank; obviously it is restricted mainly to the tidal zone, the floor of the Saba Bank being too deep for the species.

Remark. — In the Caribbean region there exists only one species of the *Orbitolites*-group; I gave it the name which was given to it by Bermúdez in 1935, *Amphisorus hemprichii* Ehrenberg. It is not clear what Ehrenberg meant with this name. Lévy and also Cushman, finding it abundantly in the Bahamas, believed to deal with two quite different species, *Sorites marginalis* (Lamarck) and *Amphisorus hemprichii* Ehrenberg. Not wholly outgrown megalospheric and the microspheric forms show tests composed by one layer of chambers and with foramina in one median line at the margin; outgrown specimens with brood-chambers, however, may become more irregular, so that a sort of double layer of chambers appears at the end of the growth and more than one row of foramina are found at the margin. Authors, therefore, may have been inclined to call the one-layered form *Orbitolites duplex* and place the form with two layers of chambers in *Amphisorus*.

Nubeculina chapmani Cushman (fig. 16e)

Nubecularia divaricata (not Brady); Chapman, 1901: 168.
Nubeculina chapmani Cushman, 1932: 49, pl. 11 fig. 7.

Test consisting of a large proloculus followed by several irregular chambers and ending with a pyriform chamber with an aperture on a neck. The larger part of the test which consists of thin calcareous walls is concealed by an agglutination of relatively fine, irregularly placed chalk grains. The animals are fastened on shells or other substrates. The aperture is rounded and its neck does not have the agglutination; there are also specimens which lack the agglutination on the larger part of the last-formed chamber. Most specimens found have a total length of about 1-1.2 mm. Cushman measured 0.8 mm. Cushman's description of the outer test agrees with the diagnosis; the species until now had only been recorded from the Pacific; this is the first time that it is found in the Caribbean: St. 123 (depth 70 m) and St. 34 (depth 95 m).

Nodobacularia tibia (Jones & Parker) (fig. 16f)

Nubecularia tibia Jones & Parker, 1860: 455, pl. 20 figs. 48-51.
Nodobacularia tibia (Jones & Parker); Rhumbler, 1906: 38; Cushman, 1929: 87, pl. 21 fig. 5.

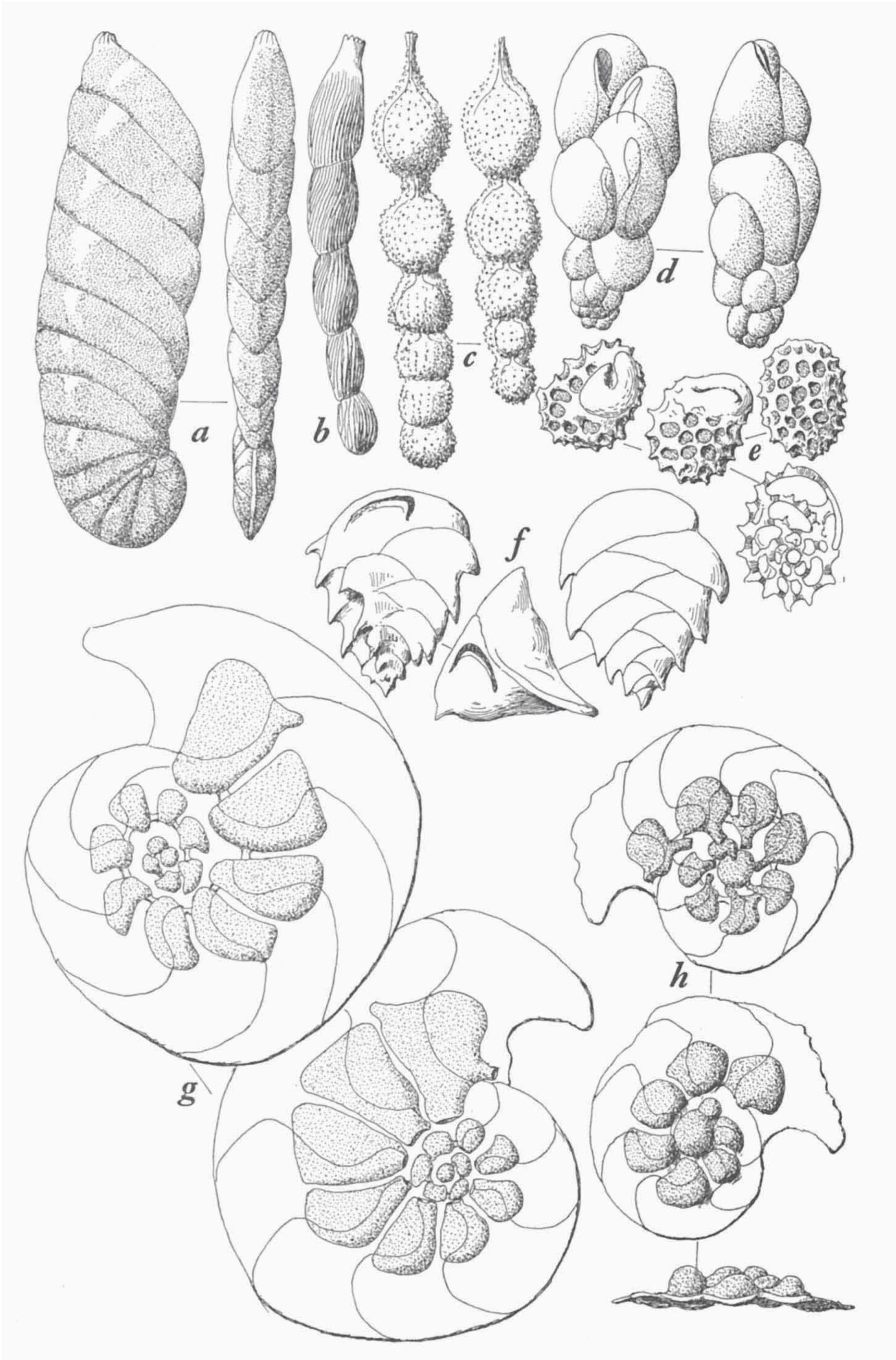
Test consisting of a proloculus with neck-chamber and a series of about three elongate pyriform chambers with very thin calcareous walls.

Only one specimen found, without the proloculus (as is often the case): St. 55 (39 m), Saba Bank.

Genus **Articulina** d'Orbigny

Of this genus the author described already *Articulina mucronata* (d'Orbigny), *Articulina sagrai* d'Orbigny and *Articulina paucicostata* Cushman from the tidal zone in the Caribbean Sea (Hofker: 1964: 32-36). In the Saba Bank area *A. mucronata* was found in the stations 120, 111, 89, 146, 59, 72 and 87, at depths from 5-49 m; *A. sagrai* was more common, as it occurred in St. 102, 67, 46, 74, 100, 44, 116, 90, 50, 59, 55, 72, 83, 69, 86 and 79, at depths from 16-84 m. Two other species were collected, which were not yet described by the author from this region.

Articulina begins with a quinqueloculine or triloculine initial part, which is followed by a set of more or less elongate, rectilinearly arranged chambers. The chambers are compressed or have a rounded transverse section and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always end with an aperture with thickened border without any trace of a tooth.

Two more species are described here that, obviously, are not found in the tidal zone. A peculiar specimen of *Articulina mucronata* is also described.

Articulina lineata Brady (fig. 16g)

Articulina lineata Brady, 1884: 183, pl. 12 figs. 19-21; Cushman, 1929: 52.

Test consisting of a triloculine strongly developed initial part and a series of 1-3 rectilinear chambers, which are distinctly compressed; aperture an elongate opening with distinct lip-like border. Initial part and rectilinear chambers ornamented by longitudinal costae.

Length up to 1.2 mm, thickeness 0.12 mm.

Found on the sea-floor of the bank itself at depths from 16 to 80 m, often very commonly; scattered specimens were found on the slopes of the Saba Bank, but these may have been displaced.

Articulina mayori Cushman (fig. 16 i, j)

Articulina mayori Cushman, 1922: 71, pl. 13 fig. 5; 1929: 52, pl. 12 fig. 5.

Test beginning with an inconspicuous initial part, which is trilocular and scarcely broader than the rest of the test; the test consists of a slightly curved series of elongate slender chambers with thickened lips at the apertures; transverse section rounded, chambers slightly pyriform, faintly longitudinally striate. Test walls very thin, hyaline. Number of rectilinear chambers 3 to 6. Length of tests up to 1.4 mm.

Never common, found at the stations 89, 50, 55, 72, 83 and 86, at depths from 30 to 61 m.

Fig. 17. a, *Marginulina multicamerata* Cushman & Stainforth, St. 140 (350-600 m), from two sides, × 33. b, *Dentalina obliquistriatula* nov. spec., St. 106 (410 m), × 33. c, *Amphicoryna rugosa* (d'Orbigny), St. 108 (730 m) and Sta 104 (700 m), × 66. d, *Virgulina advena* Cushman, St. 104 (700 m), specimen from two sides, × 66. e, *Burseolina intermedia* (Palmer), St. 150 (300 m), specimen from three sides and longitudinal section, × 66. f, *Ehrenbergina falcata* Bermúdez, St. 56 (580 m), specimen from three sides, × 33. g, *Laticarinina pauperata* (Parker & Jones), St. 108 (730 m), specimen from two sides, at the ventral side the aperture of the last formed chamber and the protoforamina directed toward the centre as narrow slits, × 66. h, *Laticarinina bullbrooki* Cushman & Todd, St. 75 (500 m), specimen from three sides; at the ventral side the aperture of the last formed chamber and the protoforamina on short necks directed toward the centre, × 66.

Articulina mucronata (d'Orbigny), var. (fig. 16h)

Vertebralina mucronata d'Orbigny, 1839: 52, pl. 7 figs. 16-19.
Articulina mucronata (d'Orbigny); Cushman, 1944; Hofker, 1964: 33.

In the material of St. 87 (49 m) a well-developed specimen of this species was found. It has four rectilinear chambers, the third chamber has a nozzle at one of the broad sides, overgrown by the fourth chamber, which once again shows such a nozzle in a comparable place; the latter nozzle is open towards the main aperture. In my opinion the repetition of nozzles observed concerns a variety that deserves our attention and for that reason is mentioned here.

Marginulina multicamerata Cushman & Stainforth (fig. 17a)

Marginulina sublituus (Nuttal) var. *multicamerata* Cushman & Stainforth, 1945: 23, pl. 3 figs. 6, 7.

This species is distinctly compressed with enrolled initial part ("*Marginulinopsis*" Silvestris), has many chambers in the straight part with oblique sutures parallel to each other, has apertures at the dorsal side and the enrolled part and ventral side keeled, and the later chambers not ventrally directed to the enrolled part. It was described by Cushman & Stainforth from the "Oligocene" of Trinidad, Cipero marl, which is now stated to be Miocene. The specimen, found at St. 140 (300-600 m) has a Recent appearance; length 2.1 mm, thickness up to 0.3 mm, so it is distinctly compressed.

Remark.—The degree of enrolling of the initial part, the main difference between *Marginulina* and *Marginulinopsis*, is rather a function of the size of the proloculus more than a diagnostic generic character. Many species described from the Cipero Marl and the "Oligocene" (= Miocene) of the Dominican Republic (Bermúdez, 1949) also occur in the Recent at the deeper stations of the Saba Bank area. Examples are *Vulvulina spinosa, Textulariella barrettii, Karreriella bradyi, Martinottiella antillarum, Tritaxilina yassicaensis, Hauerina occidentalis, Quinqueloculina lamarckiana, Articulina lineata, Lenticulina calcar, Lenticulina iota, Lenticulina subaculeata, Saraceneria latifrons, Nodosaria* sp., *Frondicularia sagittula, Pseudonodosaria comatula, Elphidium lanieri, Elphidium discoidale, Euuvigerina flintii, Neouvigerina auberiana, Trifarina pauciporata, Rosalina floridana, Rosalina floridensis, Rotorbinella mira, Ammonia parkinsoniana, Ammonia tepida, Lamarckina atlantica, Siphonina pulchra, Eponides antillarum, Eponides repandus, Eponides umbonatus, Hoeglundina elegans, Gyroidina altiformis, Cancris sagrai, Asterigerina carinata, Cymbaloporetta squammosa, Pseudotretomphalus atlanticus, Tretomphalus bulloides, Cassidulina subglobosa, Burseolina intermedia, Ehrenbergina falcata, Cushmanella browni,* *Chilostomella mediterranensis, Pullenia bulloides.* To this group also belongs *Marginulina multicamerata.*

Dentalina obliquistriatula nov. spec. (fig. 17b)

Only two specimens were found. Chambers oval with slightly oblique and not much depressed sutures, the whole test slightly curved. Chambers very gradually increasing in size. Walls of chambers ornamented by very fine obliquely arranged striae, aperture radiate. Length of test 1.7 mm, thickness of last-formed chamber 0.23 mm.

The species was found in St. 96 (depth 125 m) and St. 106 (depth 410 m).

Amphicoryna rugosa (d'Orbigny) (fig. 17c)

Nodosaria rugosa d'Orbigny, 1839: 13, pl. 1 figs. 2-3.

Test elongate with 4-5 chambers closely following each other without much depressed sutures in between; followed by one chamber separated from the others by a more indentated suture and in that case ending with a more pyriform chamber often provided with a very thin neck ending in the minute rounded aperture; there occur specimens without such pyriform chambers. Characteristic are the very narrow foramina through which the chambers communicate, as at the sutures the walls are much thicker than at the sides of the chambers. Whereas in *Nodosaria hirsuta* d'Orbigny and in *N. hispida* d'Orbigny the wall is provided with distinct and often elongate spines, especially at the basal parts of the chambers, *Amphicoryna rugosa* shows very fine and densely placed pustules, which in some specimens are situated in elongate lines at the surfaces of the initial chambers.

The whole structure of the tests points to the genus *Amphycoryna,* though I cannot find microspheric specimens to prove this.

This species was discarded by Le Calvez (1977b: 50), as she could not find the holotype in the collection of d'Orbigny; I believe this compact species to be identical with the figure given by d'Orbigny. It was found, never commonly, at stations 129 (290 m) and 128 (350 m), and also at stations with depths from 500 to 850 m. If the last-formed chamber is broken off, the specimens strongly resemble that figured by d'Orbigny (who found it in shore sand of Cuba) where the last-formed chamber with its thinner neck with the former chamber easily may have been broken off.

Virgulina advena Cushman (fig. 17d)

Virgulina advena Cushman, 1922: 120, pl. 25 figs. 1-3.

This small and hyaline species with bluntly rounded initial end and inflated chambers at first sight seems to be a *Bulimina.* However, the last-formed chambers tend to become biserially arranged, and the long comma-like aperture with its simple toothplate point to the genus *Virgulina*. The length is up to 0.6 mm, which is in agreement with the statement by Cushman. It occurred at station 104 (700 m) in many specimens, and more rarely at 125(80), 129(290) and 77(620).

Burseolina intermedia (Palmer) (fig. 17e)

Cassidulina palmerae Bermúdez & Acosta var. *intermedia* Palmer, 1941 : 282, pl. 28 fig. 2.

Though Palmer believed that this species has less deep and smaller reticulations than the fossil species described by her as *C. intermedia*, the differences are so small that I am inclined to identify the Recent form with that species; it is clear that the small-sized species with globular shape and large but very shallow reticulations found by Drooger & Kaasschieter (1958: 37, pl. 1 fig. 15) W of Tobago at depths from 70 to 150 m and recorded as *Cassidulina palmerae* Bermúdez & Acosta does not belong to this species, which is found in much deeper water in the Saba area.

Test small, greatest length about 0.25 mm, elongate globular, last-formed chamber without reticulations in the apertural face, aperture a curved slit with slender toothplate within. Reticulations obscuring the sutures and with very fine pores between the reticulations. Longitudinal section shows it to be a true *Cassidulina* with two whorls of pairs of chambers around the proloculus. Walls granular.

Burseolina intermedia occurs in many samples at depths from 300-850 m; in many samples it was common, but it may have escaped earlier investigators because of its small size.

Ehrenbergina falcata Bermúdez (fig. 17f)

Ehrenbergina falcata Bermúdez, 1949: 271, pl. 20 figs. 41-43.
Ehrenbergina sp.; Phleger & Parker, 1951 : 28, pl. 15 figs. 2, 3.

Test large for the genus, dorsal side elongate triangular with distinct biserial chambers, ending at the periphery with short spines directed towards the initial end. At the ventral side the later chambers end in a distinct claw formed at the junctions of two chambers, giving the test a strongly triangular appearance when seen from the apertural side. Aperture a curved slit on the apertural face of the last-formed chamber with the toothplate forming the proximal border of this aperture. Length of outgrown tests about 0.8 mm, largest breadth 0.6 mm.

Bermúdez described it from the "Upper Oligocene" (rather middle Miocene) of the Dominican Republic. It was found by Phleger & Parker in the Mexican Gulf.

It was collected in several specimens at the Saba Bank Stations 93 (340 m) and 56 (580 m). For Miocene species, which are also living in the Recent, see my remarks on *Marginulina multicamerata.*

Laticarinina pauperata (Parker & Jones) (fig. 17g)

Pulvinulina repanda var. *menardii* subvar. *pauperata* Parker & Jones, 1865: 395, pl. 16 figs. 50, 51.
Laticarinina pauperata Wiesner, 1931: 136; Cushman & Todd, 1942: 15, pl. 4 figs. 1-6; Hofker, 1951: figs. 283, 284; 1978: 52, pl. 7 fig. 7.
Laticarinina halophora (Stache); Finlay, 1940: 468; Stache, 1865: 248, 250.

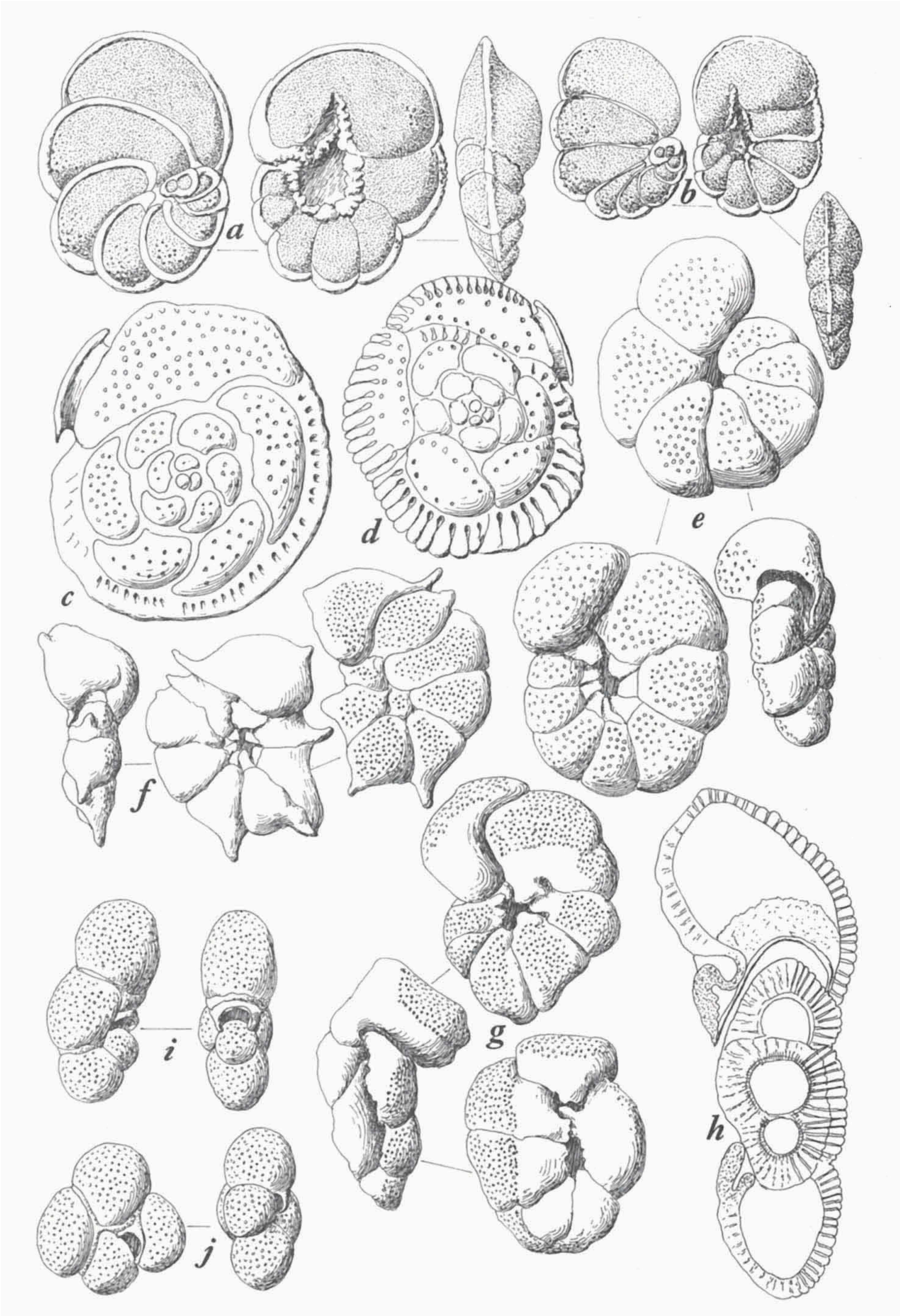
This species, commonly known as *Laticarinina pauperata,* according to the Rules of Zoological Nomenclature should be called *Laticarinina halophora* (Finlay, 1940). It occurred with many specimens at several stations, from 430 to 730 m. I described it in full in 1951 and showed the wide carina to be formed by o toothplate. However, at that time I could not find the protoforamina which should be connected with this toothplate which is running to the deuteroforamen and further on forming the carina-part of each chamber. In the material from the Saba Bank area these protoforamina could be detected as very narrow slits at the inner umbilical elongated parts of the ventral last-formed chambers; the ventral part of the last-formed chamber forms the deuteroforamen as a protruding neck on the carina, where it opens with a moon-shaped slit. In a clarifier with transmitted light the foramina connecting the former chambers are also seen at the dorsal side; they develop from the foramina.

Laticarinina bullbrooki Cushman & Todd (fig. 17h)

Laticarinina bullbrooki Cushman & Todd, 1942: 19, pl. 4 figs. 8, 9.

Specimens small with flat ventral side and distinctly inflated chambers at the dorsal side. At the ventral side the chambers end with centrally directed tubes, which open with the small protoforamina. Inside the tubes the toothplates begin, run through the chamber and then partly divide the two halves of the chambers and extend into the chamber part of the broad carina. These tubiform protoforamina resemble those found in the Pacific *Laticarinina altocamerata* (Heron-Allen & Earland), described by me elsewhere (1978: 54). The dome-shaped chambers of the chamber-parts of the dorsal side of *L. bullbrooki* also resemble those of *L. altocamerata*; but the latter does not have the broad carina, and the openings of the protoforamina are larger.

L. bullbrooki was found at St. 31 (420 m), St. 80 (560 m) and at St. 75 (500 m). It was first described from the Miocene, but seems also to be present in the Recent.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Lamarckina atlantica Cushman (fig. 18a, b)

Lamarckina atlantica Cushman, 1931: 35, pl. 7 fig. 7; Hofker, 1956: 105, pl. 13 figs. 5-15; 1969: 79, figs. 224-230.

Tests variable in size and texture; in samples in which the species is abundant some tests are broadly oval, with the last-formed chamber at the ventral side nearly occupying half the test, as described by Cushman. In other samples, where the species is less common, the tests are more elongate, much smaller, with the last formed chamber at the ventral side occupying only one-third of the test. These specimens are more like *Lamarckina scabra* (Brady), as described and figured by Brady and Cushman (Cushman, 1931: 35, pl. 7 fig. 6). Most tests found of either category have pustules only on the marginal part of the dorsal walls, and this sculpturing seems not to be of any specific value. I believe that they belong to one single species but give rise to two different phenotypes, viz. *atlantica*, when growing under more favourable conditions, and *scabra*, when living in less favourable environments. I found the following forms in the samples, arranged according to their depths:

St. 111	(28 m)	*scabra*-type	St. 51	(235 m)	*scabra*-type
St. 89	(30 m)	*scabra*-type	St. 91	(280 m)	*scabra*-type
St. 50	(35 m)	*scabra*-type	St. 129	(290 m)	*scabra*-type
St. 22	(41 m)	*scabra*-type	St. 150	(300 m)	*scabra*-type
St. 83	(41 m)	*scabra*-type	St. 35	(340 m)	*scabra*-type
St. 86	(61 m)	*atlantica*-type	St. 128	(350 m)	*scabra*-type
St. 123	(70 m)	*atlantica*-type	St. 127	(360 m)	*scabra*-type
St. 97	(74 m)	*atlantica*-type	St. 31	(420 m)	*scabra*-type
St. 125	(80 m)	*atlantica*-type	St. 75	(500 m)	*scabra*-type
St. 79	(84 m)	*atlantica*-type	St. 56	(580 m)	*scabra*-type
St. 34	(95 m)	*atalntica*-type	St. 108	(730 m)	*scabra*-type
St. 96	(125 m)	*scabra*-type	St. 149	(850 m)	*scabra*-type

Fig. 18. a, b, *Lamarckina atlantica* Cushman; a, St. 34 (95 m), specimen from three sides, showing the large and broad form, × 66; b, St. 35 (340 m), specimen showing the small form, possibly identical with *Lamarckina scabra* (Brady), × 66. c, *Siphonina bradyiana* Cushman, St. 145 (300-350 m), dorsal side of test, × 66. d, *Siphonina pulchra* Cushman, St. 104 (700 m), dorsal side of test, × 66. e-h, *Paromalina semipunctata* (Bailey); e, St. 35 (340 m), young specimen from three sides, showing on ventral and dorsal sides the pores, × 66; f, St. 31 (420 m), outgrown specimen from three sides, at the ventral side the lips over the apertures visible and the pores closed by secondary calcareous matter, × 33; g, St. 31 (420 m), very large specimen in which the last formed chambers and rotated so that the porous dorsal side has become marginal, as in *Paromalina bilateralis* Loeblich & Tappan, from three sides, × 33; h, transverse section showing the closed pores at the ventral side, the granular lips over the apertures, and the fine protopores in the first chambers, × 66. i, so-called *Physalidia earlandi* Bermúdez, in reality the embryo of a megalospheric specimen of *Sporadotrema mesentericum* (Carter), St. 114 (24 m), from two sides, × 33. j, another specimen of the same "species", St. 123 (70 m), × 33.

If one would prefer to maintain the two species found in the Caribbean Sea, it would lead to the observation that *Lamarckina scabra* (Brady) occurs at depths of 28 to 41 m and at depths of 125-850 m, whereas *Lamarckina atlantica* occurs at depths of 61 to 95 m. But we then would have to bear in mind that *atlantica* occurs abundantly, whereas *scabra* is rare or very rare in the respective samples. In my opinion the two forms developed according to the environmental conditions.

Le Calvez (1977b: 111) discovered a specimen in the d'Orbigny-collection with only the ventral side visible and badly preserved; it is the specimen described and figured by d'Orbigny (1839: 274, pl. 4 figs. 9-11) as *Rotalina deformis*. It is quite possible that this specimen represents the large and broad form described by Cushman as *Lamarckina atlantica*; however, the figures given by d'Orbigny fail to show the typical large chamber on the ventral side, and, moreover, the specimen figured by Le Calvez (1977b: fig. 1) shows large and distinct pores, whereas all specimens of *Lamarckina* have extremely fine pores. According to Le Calvez the species should be transferred to *Lamarckina*; if her decision is correct, *Lamarckina atlantica* Cushman is a younger synonym of *L. deformis* d'Orbigny.

The species of **Siphonina** Reuss, 1849 (fig. 18c, d)

Cushman (1931: 68, 69) described two species from the Caribbean Sea, viz., *Siphonina pulchra* Cushman and *Siphonina bradyana* Cushman. I found a third species in the material from off St. Croix, described earlier (1956: 120) as *Siphonina primitiva* Hofker, but this species did not turn up in the material of the Saba Bank area. It has very fine pores, whereas the two other species show coarse pores. *Siphonina pulchra*, as described and figured in 1931 by Cushman, shows a distinct flange in which, at either side, pores open at the base where they form distinct gutters over the flange to the periphery; *Siphonina bradyana*, on the other hand, is stouter, has a less pronounced flange at the margin and the pore-gutters do not reach the periphery. There are several other characters, which distinguish the two Caribbean species: *S. bradyana* is thicker and stouter and has an opaque wall, distinctly granular in structure, and at the dorsal side the chambers show pores over their entire walls; *S. pulchra* is much more hyaline and has the pores on the chamber walls clearly distributed in rows, one at the sutures toward the centre, the other parallel to the marginal border of the walls; a second line of pores penetrates the flange. The middle parts of the chamber walls are always poreless. These differences are so clear-cut that they allow the two species to be easily separated.

Siphonina bradyana was found in the samples of the Saba Bank Expedition at depths from 22 to 580 m, *Siphonina pulchra* from 235 to 850 m.

Paromalina semipunctata (Bailey) (fig. 18 e-h)

Rotalina semipunctata Bailey, 1851 : 11, figs. 17-19.
Anomalina polymorpha Costa, 1856: 252, pl. 21 figs. 7-9; Cushman, 1931: 106; Brady, 1884: 676, pl. 97 figs. 3-7; Barker, 1960: 200.
Truncatulina vermiculata d'Orbigny, 1839: 39, pl. 6 figs. 1-3.
Anomalina vermiculata (d'Orbigny); Barker, 1960: 200.

Test planispiral, chambers of last-formed whorl often overlapping at both sides. At the dorsal side 7 or 8 chambers visible with some of the chambers of the last but one visible at the umbilicus; at the ventral side the umbilicus is wider but in most cases nearly totally covered by the peculiar thick lips of the chambers. In young and small specimens this ventral side shows large pores but for the lips, or the pores are more or less confused by secondary calcareous coverings. In older tests the chambers of the last-formed whorl often form a kind of spine. Periphery lobulate at least in the last-formed chambers, and margin strongly rounded, especially in the last-formed, much inflated chambers. On transverse section the walls are very thick with distinct pores at the dorsal side, whereas the pores on the ventral side are filled up by the thickenings of secondary calcareous material; however, in most cases the pores remain visible on section. Therefore, pores are also found at the ventral side in young specimens but not in older specimens. The aperture is a marginal slit which continues under the ventral lips. These lips are remarkable, as they form a fold of granular material which then leads to the lip proper. Characteristic structures of this kind are also seen in *Paromalina bilateralis* Loeblich & Tappan (cf. Hofker, 1970: 88, pl. 32 figs. 16, 17). Most other characters of *semipunctata* also point to its belonging in *Paromalina*, not in *Anomalina*. One of these characters are the fine pores in the initial walls, whereas the later pores are much coarser.

The species was found on the Saba Bank at St. 35 (340 m) and St. 31 (420 m), where it was abundant. Cushman & Brady found the species from 118 to 504 fathoms and from 210 to 410 fathoms.

Paromalina semipunctata (Bailey) is very closely related to *Paromalina bilateralis* Loeblich & Tappan (the type-species of *Paromalina*), as was detected in a very large specimen of *P. semipunctata* from St. 31; here the last formed chambers rotate with their axes, so that the porous fields of their dorsal sides shift toward the margins and a poreless field is developed on their dorsal sides, whereas near the dorsal umbilicus peculiar extra tena are formed, just as is the case in *Paromalina bilateralis*. In *Paromalina bilateralis* this torsion of the chambers is found in all later chambers; that this torsion actually takes place in *P. bilateralis* may also be deducted from the direction of the coiling axis of the initial chambers, this axis forming an angle with the coiling axis of the later chambers (see Hofker, 1970, sections pl. 32 figs.

15, 16). It is probable, that *Paromalina semipunctata* is the form that occurs in more shallow water (temperature about 10° C), whereas *Paromalina bilateralis* is the cold-water form, found along the Atlantic coast of America and in deeper water near Mallorca in the Mediterranean (5° C). If these two forms actually belong to one species, it has to be named *Paromalina semipunctata* (Bailey). Both have initial chambers with fine protopores.

Remark. — Mediali & Scott (1978), studying the genus *Discanomalina* Asano, come to a more or less similar conclusion. They propose the synonymy of *Rotalina semipunctata* Bailey, *Anomalina polymorpha* Costa, *Anomalina coronata* Parker & Jones, *Discanomalina japonica* Asano and *Paromalina bilateralis bilateralis* Loeblich & Tappan, and bring all these names under *Discanomalina semipunctata* (Bailey).

On the "genus" **Physalidia** Heron-Allen & Earland (fig. 18h, i)

This taxon is characterized by the possession of only four chambers, arranged in an elongate to rounded, short spiral and always beginning with a very large proloculus, apertures bordered by distinct poreless lips, tests mostly being described as reddish or pinkish, and distinctly porous walls. Two specimens belonging here were found in the material of the Saba Bank Expedition, one at St. 44 (24 m), the other at St. 123 (70 m). The original description by Heron-Allen & Earland (1910) of *Physalidia simplex* is the more elongate form; the elongate form was described by Bermúdez (1935: 212, pl. 14 figs. 1-3) from the coast of Cuba as *Physalidia earlandi* and once again by Seiglie (1965a: 12, figs. 2, 3) after a somewhat smaller form and as *Rugidia minuta* after more rounded tests.

All these descriptions and figures clearly refer to the same form and characteristics. They certainly are Foraminifera, but the large proloculi and the presence of only four chambers in all forms have led me to the conclusion, that the genus *Physalidia* (with *Rugidia* Seiglie as younger synonym), are nothing but the embryos of some reddish coloured species or species-group. Analysing again the Homotremidae (Hofker: 1970: 80-94), I notice that several of the species mentioned by me in that group show a reddish or pinkish colour and that the megalospheric specimens of several species of this group begin with a four-chambered initial part (see for instance my figs. 3a, pl. 51 of 1970) and also the following illustrations in the first part of the Siboga monograph (Hofker, 1927): pl. 9 fig. 2 (*Sporadotrema cylindricum*), pl. 10 figs. 1 and 3 (*Sporadotrema cylindricum*), pl. 12 fig. 4 (*Miniacina miniaceum*), pl. 12 fig. 5 (*Miniacina miniaceum*), pl. 13 figs. 1 and 4 (*Miniacina miniaceum*) and pl. 15 fig. 5 (*Homotrema rubrum*). In the Saba Bank region two species are found with red colour and with the said "raspberry-type" initial parts in the A_2-generation: *Homotrema rubrum* (Lamarck) and *Sporadotrema mesentericum* (Carter). The small *Rugidia minuta* Seiglie is wholly identical with the free-creeping embryon of *Homotrema rubrum,* whereas the larger form, found by Bermúdez and me, certainly is such an embryo of *Sporadotrema mesentericum*; both species have a reddish colour. *Physalidia simplex* Heron-Allen & Earland came from the Kerimba region where *Miniacina miniaceum* is very common.

I would, therefore, like to conclude that the genus *Physalidia* has no generic status and is a mere assemblage of the megalospheric embryos of several red-coloured sessile species. These embryos creep about freely to seek a good place to settle, as far as possible from the motheranimal. In this free-living stage they can be trapped and these are the specimens which have been taken for the genus *Phisalidia* or *Rugidia* from 1928 onwards, when Heron-Allen and Earland found them in the Kerimba Archipelago. *Rugidia corticata* (Heron-Allen & Earland) very likely is the embryonic megalospheric (A_2-generation) of *Biarritzina proteiformis* (Goës) (see Hofker, 1969: 148, fig. 484); these embryos recorded as *Rugidia* do not have the reddish colour and *Biarritzina proteiformis* is colourless and often shows the rough surface typical for *Rugidia.* The four chambers, characteristic for these two "genera", are also typical for the embryos of the A_2-generations of the entire group of the Homotremidae. Both "genera" should be delated from our foraminiferal system.

Planulina exorna Phleger & Parker (fig. 19a-d)

Planulina exorna Phleger & Parker, 1951 : 32, pl. 18 figs. 5-8.

Tests flat on both sides, periphery slightly lobulate in later chambers, margin subacute to rounded and lacking pores. About 10 chambers form the last coil. Sutures on both sides slightly curved backward, filled up with secondary calcareous material, which at one side forms an irregular ornamentation over the initial whorls. At the ventral side, where the chambers are slightly overlapping and towards which the marginal aperture extends, the pores in the walls are distinctly visible; at the opposite side finer pores are only visible in the last-formed chambers, as in all former chambers the pores are filled with secondary chalk and thus have become invisible. This side is here called dorsal, though the coiling is rather planispiral. Aperture and foramina between chambers provided with a thickened lip, which is clearly seen in horizontal section; in transverse section the foramina are distinctly bent to the ventral side. The septa are rounded backward and consist of one granular lamella, whereas the walls of the margin are distinctly doubled by means of secondary granular material. Length of the slightly oblong tests up to 0.5 mm, thickness 0.1 mm. The species was found, often commonly, at depths from 16 to 95 m, whereas the three other species of the genus *Planulina* occur in much deeper water.

Possibly *Rosalina edwardsiana* d'Orbigny is the same species; it was transferred to *Planulina* by Le Calvez (1977b: 88); the description of this species by d'Orbigny and the figure given by Cushman (1931: 103, pl. 19 fig. 4) strongly resemble this species; *Planulina exorna* Phleger & Parker then would be a younger synonym. However, the description and figures by d'Orbigny (1839: 101, pl. 6 figs. 8-10) are too indefinite to give certainty. Cushman's material came from Tortugas.

Caribeanella polystoma Bermúdez (fig. 19e, f)

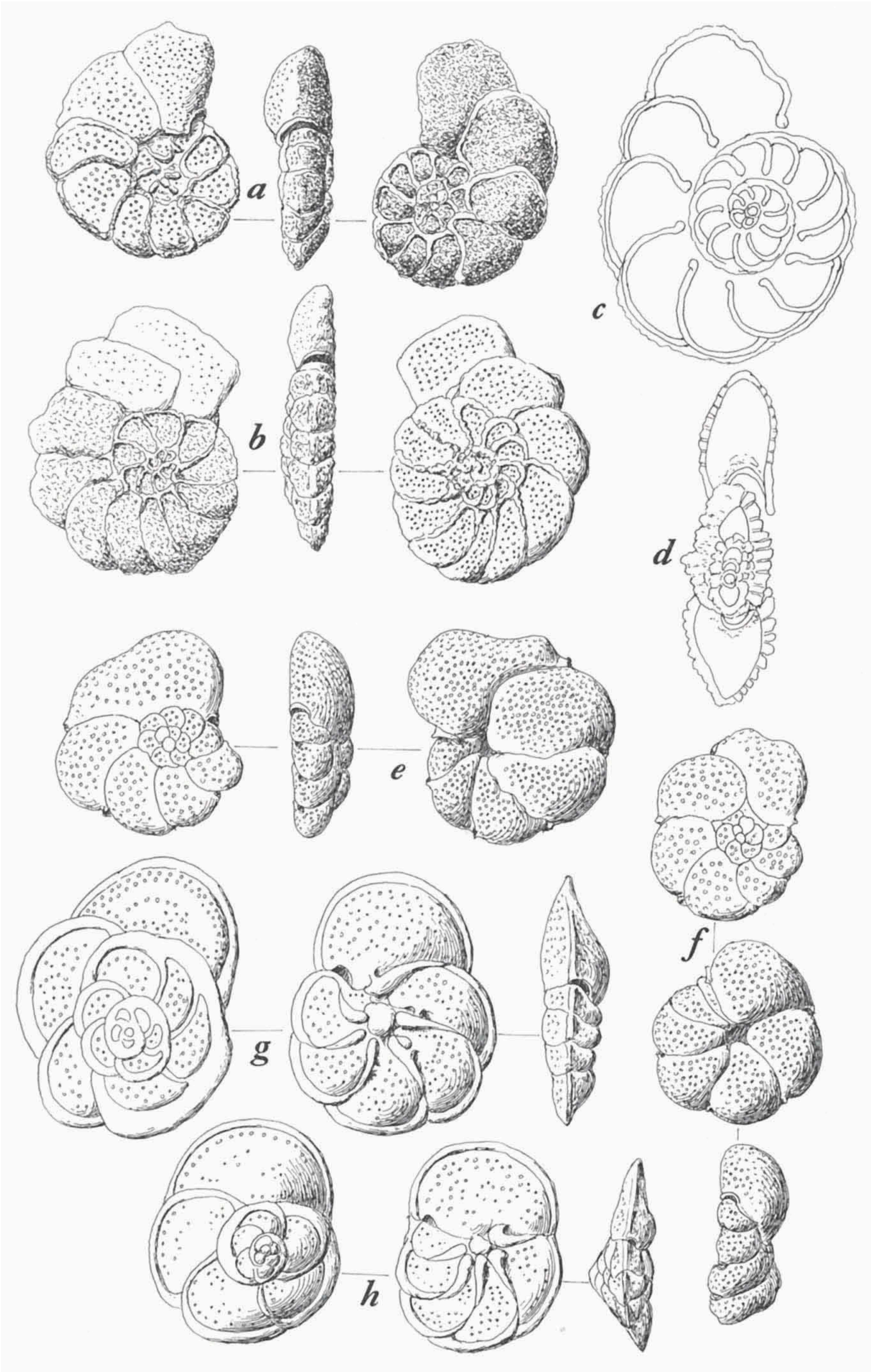
Caribeanella polystoma Bermúdez, 1952: 121, pl. 28 fig. 18; Schnitker, 1969: 67, 68, pl. 14 figs. 1-12; Hofker, 1970: 39-41, pl. 36 figs. 1-5.

This species was described more accurately by Schnitker (outer structures) and Hofker (inner structures). It shares so many characteristics with *Planorbulina* that it has to be placed into the Planorbulinidae and not in the Cibicidae, as did Loeblich & Tappan (1964: 688); Bermúdez correctly placed it in the Planorbulinidae.

Bermúdez found it abundantly in the Bahamas, at 7.5 fathoms deep; Schnitker mentioned it from the shelf of North Carolina; I received it, through Bermúdez, from the north coast of Cuba; it was found, often abundantly, on the Saba Bank in samples from 16 to 24 m deep, and, rarely, at 35 and 80 m deep.

It is very probable that the specimen of *Truncatulina advena* in the collection of d'Orbigny, described by him (d'Orbigny, 1839: 87, pl. 6 figs 3-5) and transferred to *Cibicides* by Le Calvez (1977b: 122), belongs to this species; the retrogade foramina are often difficult to observe, but are visible in the electromicrograph of this specimen made by Le Calvez (fig. 2). If my assumption is correct, the species should be named *Caribeanella advena* (d'Orbigny).

Fig. 19. a-d, *Planulina exorna* Phleger & Parker; a, St. 86 (61 m), from three sides, × 66; b, St. 123 (70 m), from three sides, × 66; c, horizontal section, × 80; d, transverse section, showing that at the dorsal side the pores are filled up with secondary calcareous matter, × 80. e, f, *Caribeanella polystoma* Bermúdez, St. 46 (21 m), two individuals from three sides, × 66. g, *Rotorbinella miraeformis* nov. spec., St. 87 (49 m), test from three sides, × 66. h, *Rotorbinella mira* (Cushman), St. 120 (5-15 m), test from three sides, × 66.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Rotorbinella miraeformis nov. spec. (fig. 19g)

Test oval, dorsal side flat, never conical, ventral side slightly more inflated. At the dorsal side all chambers visible, spiral with relatively broad flange without pores, sutures flush with the surface, distinct, strongly rounded backward. Pores distinct, all over the chamber walls. Margin acute with poreless carina. Periphery lobulate in the last-formed chambers. At the ventral side only six chambers visible, leaving the umbilical area free, this filled up by a distinct knob. Free ends of toothplates running from the umbilical border of the distinct protoforamina toward the perifery and covering the larger parts of the sutures, which are slightly impressed; chamber walls distinctly inflated. Deuteroforamen a narrow crescent-shaped slit with short tenon at its umbilical side. Sutures slightly rounded backward, passing into the poreless carina. Chamber walls distinctly porous, pores over the entire walls. The test have a shining surface. Greater length of tests up to 0.6 mm, thickness 0.12 mm.

The species was found in samples from depths of 42 to 61 m.

The species differs from *Rotorbinella mira* (Cushman) (fig. 19h) in its larger tests, the lack of a dome-shaped dorsal side, the more inflated chambers on the ventral side, the broader marginal keel and the pores which are equally distributed over the dorsal walls. Moreover, *Rotorbinella mira* is typical for the tidal zone, whereas the new species occurs in a narrow but deeper zone (50-60 m). Whereas other species of *Rotorbinella*, except *Rotorbinella barbadosensis* Hofker, occur in the tidal zone, this species is found slightly deeper, though not so deep as *barbadosensis*, which in the Saba area was found at depths of 70 to 125 m. It is worth mentioning that *Rotorbinella granulosa* (Heron-Allen & Earland), found especially in the northern part of the Caribbean Sea, was lacking in the Saba area material; obviously, the sea floor was too deep.

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