

STUDIES ON THE FAUNA OF CURAÇAO AND OTHER CARIBBEAN ISLANDS: No. 81.

THE DISTRIBUTION OF REEF CORALS IN CURAÇAO

by

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INTRODUCTION

About the middle of the eighteenth century, the question whether the corals originally known only from collections of curiosities were animal, vegetable, or mineral was definitely decided in favour of the first of these categories (MARSILLI 1786).

During the second half of the eighteenth and the entire following century, the former *Lithophyta*, as a subdivision of the *Anthozoa*, were an object of study for anatomists, taxonomists and, particularly in the nineteenth century, palaeontologists.

Not until the twentieth century did ecological research into corals, in combination with laboratory investigation, begin to develop. This development had been heralded in the nineteenth century by DANA and DARWIN; as a result of their studies, some general conditions for coral growth became known. At the beginning of the present century, in the laboratory at Dry Tortugas, Florida, VAUGHAN and MAYOR carried out experiments concerning the

influence of various physical factors on the rate of growth and metabolism of reef corals. VAUGHAN studied the composition of the coral fauna of Puerto Rico (1902), and later the ecology of the reef corals of Hawai (1907). MAYOR studied the ecology of the Murray Island reef (1917).

The culmination of ecological research in the Pacific was undoubtedly the Great Barrier Reef Expedition of 1928–1929. During this expedition nearly all aspects of the ecology and physiology of reef corals were investigated (MANTON & STEPHENSON, 1953).

In the nineteen-thirties BOSCHMA (1936), VERWEY (1931) and UMBGROVE (1939) carried out investigations in the Bay of Batavia, and KAWAGUTI (1937) investigated the Palau Islands.

Ecological research before the Second World War was principally restricted to the Pacific and Indian Oceans, little work being done in the Caribbean Sea. This was mainly due to the fact that the Pacific reefs were more easily accessible than those of the Caribbean. The former are mostly dry at low tide, which permits the living reef to be walked over. As a rule this is not the case in the Caribbean.

However, the development of underwater swimming since the Second World War has enabled corals and coral reefs to be explored in the Caribbean too. The investigations of GOREAU (1959b), LEWIS (1960), SCHEER (1960), and SQUIRES (1958) have furnished much information on the corals of Jamaica, Barbados, Bonaire and Bimini (Bahamas) respectively. The systematic work of VAUGHAN (1902) has furnished data on the composition of the reefs of Puerto Rico.

VAN DER HORST's (1924) investigations on Curaçao in 1920 were already carried out with modern methods. Wearing a diving suit, or only a diver's helmet, he walked amidst the corals, and thus was able to study in situ the differences in coral growth between Caracas Baai and Spaansche Water. He realized, however, that his equipment was not perfect.

VAN DER HORST's collecting trip was followed ten years later by a geological expedition from Utrecht University, during which many types of animals were collected, but no corals. One of the participants, WAGENAAR HUMMELINCK, returned in 1936, in 1948, and

again in 1955, and collected marine organisms; but this material was almost entirely limited to what could be gathered in wadable depths (HUMMELINCK, 1951, 1953).

In the meantime, skin diving technique had been developed through the pioneer work of HASS (1941, 1947) and COUSTEAU (1953). The photographic material of HASS's publications – which contain much spectacular information on the Netherlands Antilles – is very interesting; and this also applies to the booklet by HAKKENBERG VAN GAASBEEK (1955). Photography was likewise the main object of the under water investigations of Father VITUS BRENNEKER (pseudonym: VAN VENLO, 1950).

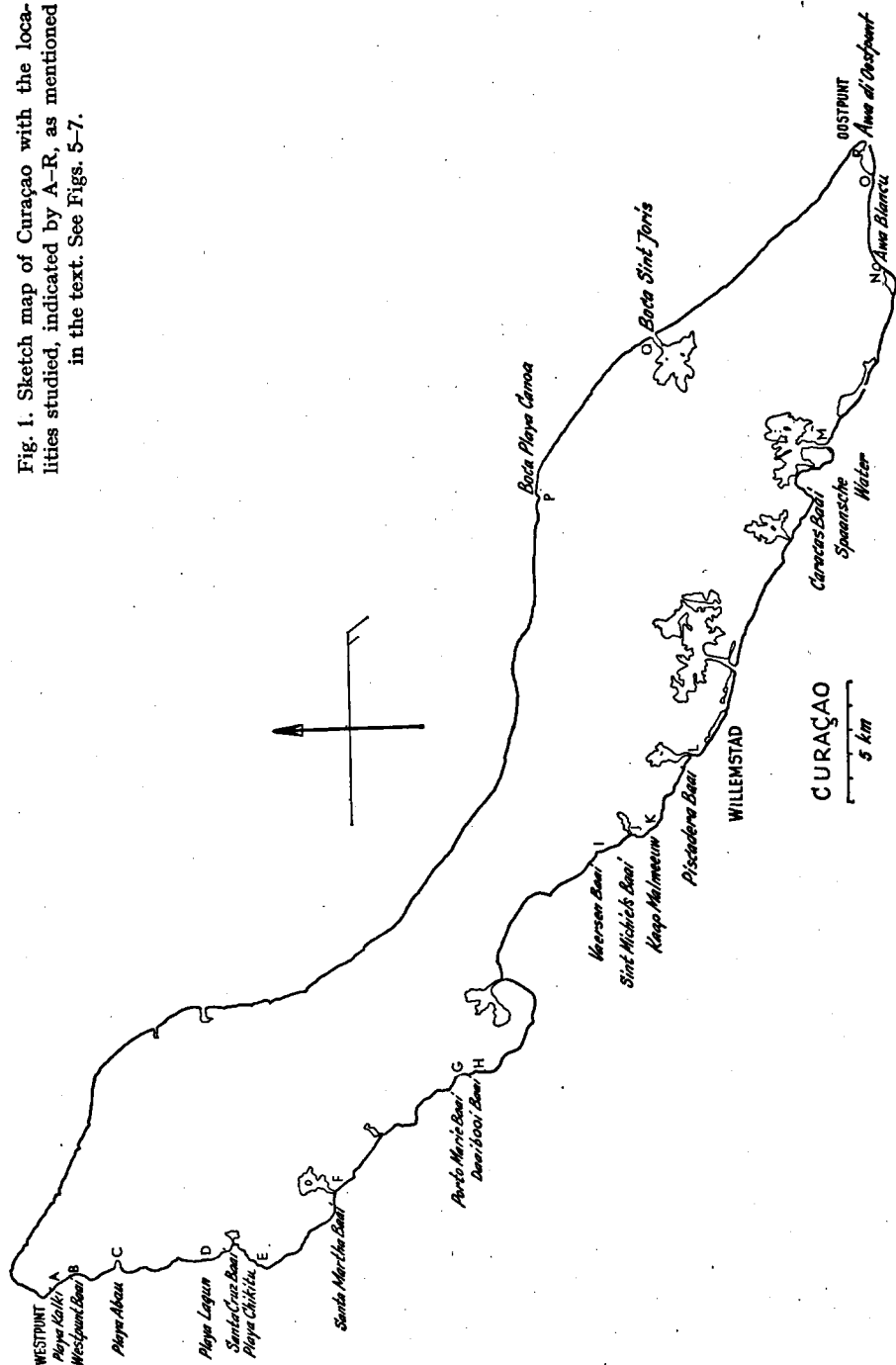
The importance of the popular books mentioned should not be underestimated; they gave the initial impetus to the strong development of skin diving on these islands, which opens up remarkable new prospects, for the biologist as well as others. In this connection, the work done by RAY & CIAMPI (1956) should also be mentioned.

VAN DER HORST knew the underwater conditions in Caracas Baai and Spaansche Water, but only as regards shallow parts. The purpose of the present author was to obtain information on ecological relations throughout the entire living coral reef, but exclusively with respect to the reef-building Scleractinia, from the lowest part of the reef up to the corals between the mangroves in the inner, landlocked parts of the bays.

The results of these investigations, a survey of large sections of the coast of Curaçao, emphasizing distribution and zoning, are published in the present paper. The ecological part of the project, which has not yet been concluded, will probably be published at a later date.

The author's investigations were financed by the "Netherlands Foundation for the Advancement of Research in Surinam and the Netherlands Antilles (WOSUNA)". They were carried out from April to October 1961, as part of his graduation studies in zoology, under the direction of Professor H. ENGEL, Amsterdam. The "Caribbean Marine Biological Institute" at Curaçao (Carmabi) was used as a base. The ready co-operation of the Executive Board of WOSUNA, the Director of the Institute, Dr. I. KRISTENSEN, and its personnel, and the staff of the Zoological Museum, Amsterdam, is gratefully acknowledged. Thanks are also due to Professor A. PUNT of the Laboratory for Animal Physiology, University of Amsterdam, for designing and constructing the photometric apparatus; to Messrs. G. KLAY and R. PRINSEN, Curaçao, for their assistance in sailing and diving; to Messrs. W. FLACHS and M. VAN

Fig. 1. Sketch map of Curaçao with the localities studied, indicated by A-R, as mentioned in the text. See Figs. 5-7.



VELDHOVEN, Curaçao, for their general and technical assistance; to the Royal Netherlands Navy and to the Director of the Zuurstoffabriek (Oxygen Works) in Curaçao, Mr. J. LENDERINK, for the repeated refilling of aqualung cylinders; and to Dr. P. WAGENAAR HUMMELINCK, Utrecht, for his comprehensive help in the preparation of both the fieldwork and this paper.

The photographs and drawings were made by the author, with the exception of Fig. 1 and Plates I, III and XIII, which were made by Dr. P. WAGENAAR HUMMELINCK; and Plate II which was rendered available by KLM Aerocarto.

WORKING PROCEDURE

The position of the island in relation to the prevailing trade winds renders it practically impossible to investigate the north (and northeast) coast. Consequently, most of the work had to be carried out on the south (and southwest) coast. Not all places along the shore are accessible over land. However, with the help of swim fins, mask and snorkel, the whole south and southwest shoreline can be reached from the sea. By means of this simple equipment, corals were studied and collected to a depth of 15 m. For greater depths, self-contained underwater breathing apparatus had to be used. This consisted of air cylinders manufactured by the U.S. Divers Co., Los Angeles, with a Nemrod Snark II two-stage regulator. The combination gave first-rate service to depths of over 60 metres.

The depth was measured with a wrist-model depth recorder.

The corals were collected by means of a small axe; notes were made with a glass pencil on a plastic paper pad, as, also were sketches of corals growing inside a portable wire frame measuring 2×2 m (Figs. 9-15).

Since it was of great importance to identify corals in situ, close familiarity with the living colonies was essential. The corals collected had to be damaged and exposed to the air as little as possible. After being labelled with an aluminium tag with a number, they were placed in an aquarium. When the colony had resumed its normal aspect, the living coral could be studied. The coral was then killed in fresh water, macerated, and identified. In this manner it was possible to get to know the living corals in a short time.

THE CORAL FAUNA OF CURAÇAO

In the following list of corals, the classification of VAUGHAN & WELLS (1943) has been followed for the Scleractinia. In the case of each species, the following data are given:

Name and author.

Number in the P. J. Roos collection in the Zoological Museum, Amsterdam (PJR 1-143). — Localities of these specimens.

Occurrence. — General colour of living colony as observed in daylight.

Remarks on shape and/or nomenclature.

The indication "discoid" is used for corals in colonies which are disc-shaped but are spherical under optimal conditions. This discoid form manifests itself in species when they reach the lower depth limit, and is closely related to the intensity of light (see Plates IX-XI). "Oblique discoid" means that the plane of the disc forms an angle with the horizontal. This is seen in specimens found in caves and niches (Fig. 2).

Class **ANTHOZOA**

Subclass **HEXACORALLIA**

Order **SCLERACTINIA**

Family **Astrocoeniidae**

Stephanocoenia michelini Edwards & Haime

PJR 105 and 137. — Piscadera Baai, from depths of 40 and 1 m respectively.

Probably generally present in exposed waters; not very common. —

Colour brownish.

Family **Acroporidae**

Acropora cervicornis (Lamarck)

PJR 023. — Westpunt Baai.

Not in inner bays; above 8 m depths, beneath the reach of waves. —

Colour white to brown.

Acropora palmata (Lamarck)

PJR 007. — Westpunt Baai.

Not in inner bays, at a higher level than *A. cervicornis*, up to within the reach of waves. — Colour brown with light rims.

All *Acroporas* have been named *A. cervicornis* by me if their branches are round in section, as is the case in large specimens. The *Acropora* with very broad and flat branches, *A. palmata*, generally likewise form large colonies (Pl. IVa, XIII). I found no transitions between these forms.

A very small, finely branching *A. cervicornis* also occurs (Pl. XIIa). In one place, Punta Caballero, it is very common in quiet water, nearer to the surface than *A. palmata*. The upper side of the flat branches of this *A. palmata* carries other branches of exactly the shape as the delicate *A. cervicornis*. This is obviously the sub-variety *surculo-palmata* VERRILL (1902). In bays where only *A. palmata* is present, the very young colonies always have the shape of *A. cervicornis*. It is therefore not impossible that both *Acroporas* belong to one and the same species, as was also assumed by VERRILL.

Family Seriatoporidae

Madracis asperula Edwards & Haime

PJR 003, 058, 063, 092 and 101. — Piscadera Baai and St. Michiels Baai, from 8 to 20 m.

Generally present above 20 m, except in inner bays. — Colour yellow.

Madracis decactis (Lyman)

PJR 062, 078, 138 and 139. — Piscadera Baai, at 40 and 45 m.

Generally present below 20 m, common below 30 m. — Colour purple-brown.

VERRILL (1902) gave the following description of *Madracis decactis*: "... thin crusts, irregularly massive, nodose or lobulated,

and also both in slender, and in short, stout, branched forms." It is evident from this description that he combined two different forms.

The encrusting form was first described by LYMAN (1859) as *Astraea decactis*. The branching form was described by EDWARDS & HAIME (1850) as *Madracis asperula*. The two forms are different not only in shape, but also in habitat. The branching form is mostly present between 5 and 10 m, and the encrusting form at 35 m. It may be concluded that they belong to two different species.

The encrusting form (Pl. VIa) answers the description of LYMAN (1859), and must be considered to be *Madracis decactis* (Lyman). Of the branching species the young colonies correspond with the description of EDWARDS & HAIME (1850), which, in fact, applies to young colonies. The adult colony is different (Pl. VIb). The branching is dichotomous, with parallel branches of equal length. This type should therefore be named *Madracis asperula* Edwards & Haime.

GOREAU (1959 b) also distinguished *M. decactis* and *M. asperula*, but without indicating differences. From personal correspondence with Dr. GOREAU it appears that his *Madracis* species from Jamaica correspond morphologically and ecologically with those from Curaçao.

Family Agariciidae

Agaricia agaricites (Linnaeus)

Forma *crassa*: PJR 135 and 136; forma *agaricites*: PJR 008, 047 and 085; forma *purpurea*: PJR 041, 121 and 123; transitional forms between f. *agaricites* and f. *purpurea*: PJR 087, 122, 124, 125, 126 and 127. — Piscadera Baai 0.5 m (f. *crassa*); 5–10 m (f. *agaricites*); 15–40 m (f. *purpurea*).

Generally present; f. *crassa* in very shallow water; f. *agaricites* to about 12 m; f. *purpurea* deeper, down to 45 m. — Colour light brown to purple-brown.

Each form is found in a special zone; together, these zones cover the entire area of distribution of the species. In very shallow water the small tuberculous f. *crassa* occurs; in water of about 10 m depth f. *agaricites* occurs, in leaf-shaped colonies, with corallites on both sides; in deeper water f. *purpurea* is found, in colonies consisting of

large vertical scales reaching a diameter of more than half a metre, with corallites on one side only. These forms, which gradually merge into each other, are depicted in Pl. XII*b*.

***Agaricia fragilis* Dana**

PJR 086, 113 and 128. — Piscadera Baai, Lagun.

Sporadic. — Colour brown.

Family *Siderastreidae*

***Siderastrea radians* (Pallas)**

PJR 026, 054 and 082. — Westpunt Baai, St. Michiels Baai, Piscadera Baai.

Common in shallow water, scattered down to a depth of 25 m. — Colour brown, generally darker than the next species.

In shallow water mostly present as small, flat discs.

***Siderastrea siderea* (Ellis & Solander)**

PJR 015. — Boca Spaansche Water.

Generally present above 40 m, common at about 10 m. — Colour light brown.

Spherical in shape.

Family *Poritidae*

***Porites astreoides* Lamarck**

PJR 012, 013, 014, 017, 018, 024, 025, 089, 095, 096 and 099. — Piscadera Baai, Boca Spaansche Water, Westpunt Baai. Discoid from Piscadera Baai, at 25 m.

Common above 25 m. — Colour yellow to brown.

Near its lower depth limit the species is discoid (Pl. IX). In niches along Spaansche Water it is oblique discoid.

This species also occurs encrusting in very shallow water and on

piles. The thecae are then mostly slightly smaller than normal, and the colour is darker. It recalls *P. branneri* (Rathbun). However, neither form or arrangement of the septa, nor the distribution, justifies the establishment of a separate species in this case.

Porites porites (Pallas)

PJR 004, 005, 043, 051, 060, 061, 072, 109, 110 and 134. — Piscadera Baai, Spaansche Water, St. Michiels Baai, Kaap Malmeeuw, Awa di Oostpunt.

Common above 25 m. — Colour white to yellow.

In this paper, all branching *Porites* colonies have been named *P. porites*. No other species or even forms have been distinguished. There is some relation between habitat and mode of branching: in deep, quiet water a hardly branching *Porites* is found, with thick, almost vertical branches. In shallow inner bays, a strong dichotomous branching is observed; the colonies spread laterally and then show some resemblance to *P. furcata* Lamarck.

Family Faviidae

Subfamily Faviinae

Favia fragum (Esper)

PJR 009, 010, 019, 045, 049, 083, 107, 108 and 112. — Piscadera Baai, Boca Spaansche Water, St. Michiels Baai.

Generally present above 15 m. — Colour yellow to dark yellow.

Diploria clivosa (Ellis & Solander)

PJR 001. — Boca Spaansche Water.

Generally present on barren rock, often in the surf. North coast. — Colour white to grey.

Diploria labyrinthiformis (Linnaeus)

PJR 033, 034, 035 and 091. — Sta. Martha Baai, Piscadera Baai.

Above 25 m, not in inner bays. Common at a depth of about 10 m. — Colour yellow to brown.

Diploria strigosa (Dana)

PJR 031, 032 and 059. — Sta. Martha Baai, St. Michiels Baai.

Above 25 m. Common at about 10 m, also in inner bays. — Colour yellow.

Colpophyllia natans (Muller)

PJR 021, 037, 056, 065, 069, 090 and 106. — Piscadera Baai, Westpunt Baai, Sta. Martha Baai, St. Michiels Baai, Kaap Malmeeuw.

Generally present above 35 m. — Colour bright yellow or yellow or brown, with greenish peristome.

Subfamily **Montastreinae****Montastrea cavernosa (Linnaeus)**

PJR 042, 076 and 142. — Piscadera Baai 20 and 40 m, Sta. Martha Baai 5 m.

Less common than the next species. Not occurring in inner bays. More common with increasing depth, down to 45 m. — Colour purple, reddish-brown.

Never discoid, but colonies are smaller at greater depth.

Montastrea annularis (Ellis & Solander)

PJR 016, 027, 036, 048, 055, 067, 070, 088, 094, 131 and 133. — Piscadera Baai, Boca Spaansche Water, Sta. Martha Baai, St. Michiels Baai and the reef at Zaquito.

Very common above 10 m. Not deeper than 30 m. Not in inner bays. — Colour brown, in some cases with red or green peristome.

Spherical or columnar with globular top. Discoid near its depth limit.

Solenastrea bournoni Edwards & Haime

PJR 130. — Piscadera Baai, 20 m.

General below 15 m, where it more or less replaces *Montastrea annularis*. Lens-shaped. — Colour light brown.

Family **Meandrinidae**Subfamily **Meandrininae****Meandrina meandrites** (Linnaeus)

PJR 011, 022, 028, 029, 064 and 103. — Piscadera Baai, Westpunt Baai, reef at Zaquito.

Found everywhere, except in inner bays. Down to 25 m. — Colour yellow to brown, white tentacles at night.

Discoid near its depth limit (Pl. X). Oblique discoid in submarine cave (Fig. 2).

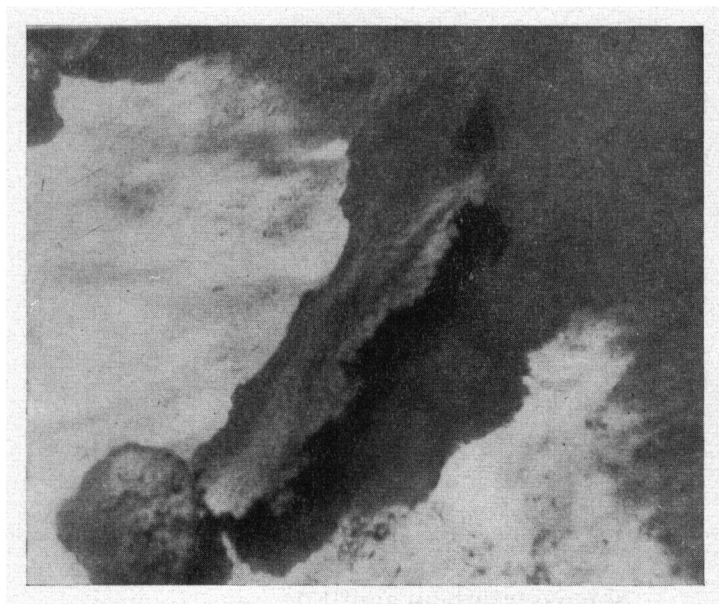


Fig. 2. Slanting discoid *Meandrina meandrites*, in a sub-marine cave near Lagun, Curaçao, 3 m deep. — A colony of *Montastrea cavernosa* is to be seen at the bottom of the picture, at the left.

Subfamily Dichocoeninae

Dichocoenia stokesii Edwards & Haime

PJR 030, 044, 084, 097, 098 and 143. — Piscadera Baai, Westpunt Baai.

Found everywhere above 30 m. — Colour yellow to brown, with yellow corallites.

Discoid from 25 to 30 m.

Dendrogyra cylindrus Ehrenberg

PJR 050 and 075. — St. Michiels Baai, Piscadera Baai.

Above 10 m, but not in landlocked waters, or in front of an inner bay. — Colour brown; tentacles also extended in daytime.

Family **Mussidae****Mussa angulosa** (Pallas)

PJR 038, 079, 100 and 111. — Piscadera Baai, between 10 and 20 m.

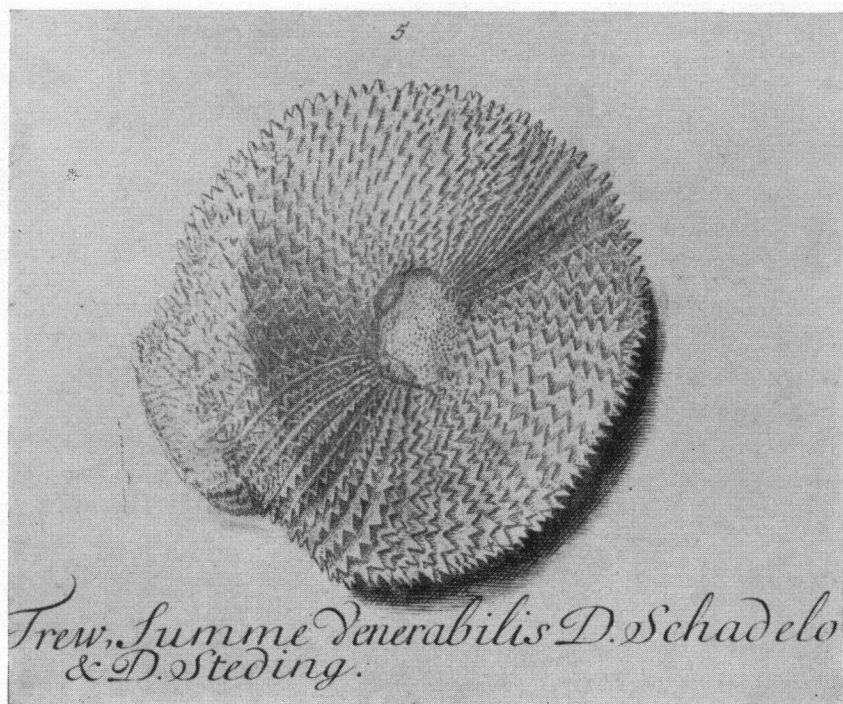
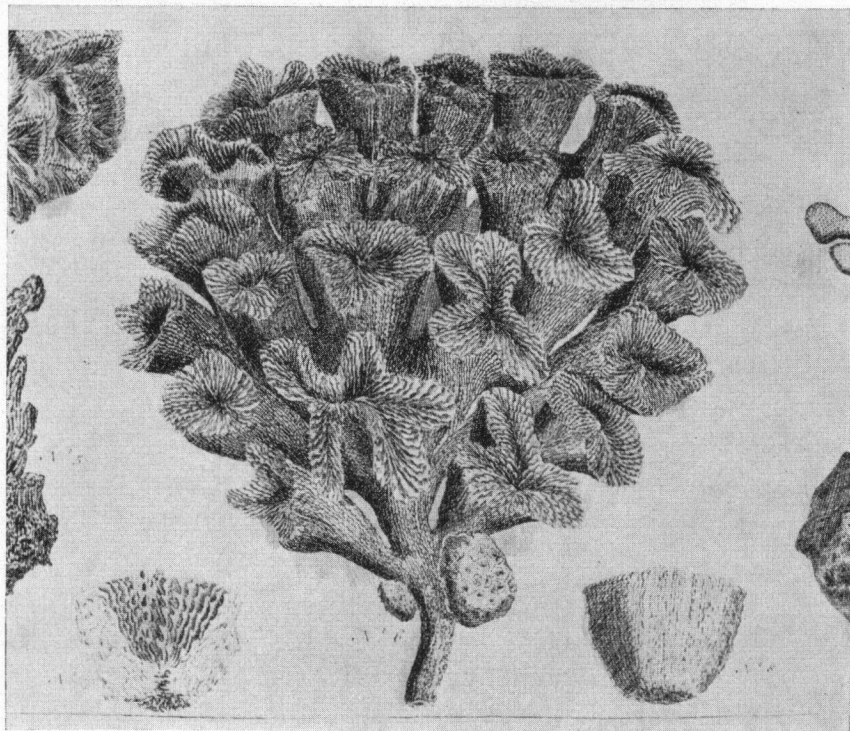
Not rare from 10–25 m in water open to the sea. — Flesh-coloured, pink to purple.

Mussa lacera (Pallas)

PJR 039, 074, 141; 114, 115, 116, 118, 119 and 120. — The first three from Piscadera Baai, 12–45 m, the others from Spaansche Water, 2–3 m.

In open water deeper than 10 m; common and well developed from 20 to 45 m; in Spaansche Water present at very shallow depth. — Colour green in outer water, brown in inner bay.

When in 1928 MATTHAI proposed to restrict the genus *Mussa* Oken, 1815, to the Atlantic species described by PALLAS in 1766 as *Madrepora angulosa*, the number of species of this genus was reduced from twenty to one. Of the twenty species assigned to *Mussa* by EDWARDS & HAIME in 1857, some were transferred to other genera, and the remainder were assigned to *Mussa angulosa* as growth forms, a clean-up which had already been started by VERRILL in 1902.



One of the solitary forms, which MATTHAI considered to be a juvenile specimen of the branching *Mussa angulosa*, was described as *Madrepora lacera* by PALLAS in 1766.

For this description PALLAS used pictures from ALDROVANDI (1648), HEBENSTREIT (1743), KNORR (1754) and SEBA (1758). Comparison of these pictures and the description by PALLAS with recent corals from Curaçao shows that both corals described by PALLAS are present there and answer to the above-mentioned description and pictures.

The description and classifications were based on the study of dead material from collections and museums, and represent the most enlightened views of that time. PALLAS and his contemporaries knew corals only as a diversity of many external forms, and they gave each form a name of its own. EDWARDS & HAIME (1857), VERRILL (1902) and MATTHAI (1928), being experienced taxonomists, distinguished forms not only by their external appearance, and arrived at a much smaller number of species, with a great diversity of forms within the species.

In studying living corals in Curaçao, it became evident that *Mussa lacera* is not to be considered as a not yet branching juvenile specimen of *Mussa angulosa*, as will be explained presently.

The solitary, round or oval *M. lacera* (Pl. VIIb) is found along the entire open coast, from 10 m depth to the lower limit of the living reef at 45 m. There, this coral is mostly bright green, with or without darker spots or concentric rings. In Spaansche Water, in shallow, turbid water on a mud bottom the colour is generally brown, but it has a bright green colour in niches in the cliffs of the little islands and the Kabrietenberg. The light intensity in all these localities is relatively low: less than 60% of the amount of light entering the water.

The branching *M. angulosa* (Pl. VIII), with the angular corallites is pink to brownish-purple, and is found from 6 to 12 m on the open

Fig. 3. Illustration from SEBA, 1758 (Thes. 3, tab. 109 no. 6), referring to *Mussa angulosa*.

Fig. 4. Illustration from KNORR, 1771 (Del. nat., tab. A 8 no. 5), referring to *Mussa lacerata*.

coast, not in the inner bays. In the same depth zone a very small, red and solitary coral of the same genus is sporadically present, probably a young *M. angulosa*.

Both these corals, as living in the CARMABI aquarium, have been depicted in Pl. VIIa.

Corals of one and the same species often differ in appearance and shape in different environments. Transitional forms are also present, as a rule. These are absent, however, between *M. lacera* and *M. angulosa*. It is therefore concluded that they belong to different species. PALLAS (1766) already described these two species accurately. He referred to the following pictures: for *Madrepora lacera*: ALDROVANDI, p. 496; Mus. Richt. (i.e. HEBENSTREIT, 1733) p. 381; SEBA Thes. III tab. 108 (2 and 4), tab. 110 (4 and 6A), tab. 111 (9); KNORR tab. A III fig. 1; and for *Madrepora angulosa*: SEBA Thes. III tab. 109 (2 and 3).

HEBENSTREIT's Museum Richterianum gives a clear drawing of *M. lacera*. ALDROVANDI's indistinct picture is probably *M. lacera*. SEBA's pictures represent the respective species very clearly. PALLAS does not mention fig. 6 of tab. 109 (Fig. 3), a beautiful colony of *M. angulosa*, regarding which SEBA states that the "flowers" are similar to those in figs. 2 and 3. The latter are mentioned by PALLAS under *Madrepora angulosa*.

According to EDWARDS & HAIME, *Mussa lacera* is also depicted in tab. 109 nos. 7 and 8. These concern a single corallite, the species of which is uncertain.

According to PALLAS, KNORR's tab. A III fig. 1 is *Madrepora lacera*. This is clearly a *M. angulosa*, as stated also by EDWARDS & HAIME. These authors, like PALLAS, do not mention the picture of tab. A VIII fig. 5 in the same work, evidently a *M. lacera* (Fig. 4).

***Isophyllastrea rigida* (Dana)**

PJR 129. — Lagun.

Very sporadically observed. — Colour purplish-pink.

Isophyllia sinuosa (Ellis & Solander)

PJR 077. — Westpunt Baai.

Very sporadically observed. — Corallites purplish-blue, coenosarc white.

Mycetophyllia lamarckana (Edwards & Haime)

PJR 066, 073, 104 and 140. — Kaap Malmeeuw at 30 m, Piscadera Baai at 40–15 m. Common between 10 and 35 m. — Colour bluish-purple.

In St. Michiels Baai, one hemi-spherical specimen has been found.

Family **Caryophyllidae**

Eusmilia fastigiata (Pallas)

PJR 002, 020, 040, 053, 068, 071, 080, 081 and 117. — Boca Spaansche Water, Westpunt Baai, Piscadera Baai, St. Michiels Baai, Kaap Malmeeuw, Spaansche Water among *Rhizophora*.

Found everywhere above 35 m, also in inner bays. — Colour bright yellow, with white tentacles.

Family **Dendrophyllidae**

Tubastrea tenuilamellosa (Edwards & Haime)

PJR 046 and 057. — Piscadera Baai, St. Michiels Baai.

Mainly occurring in niches of the open cliff, in some places in full light. — Colour red, with orange tentacles.

Class **HYDROZOA**

Order **HYDROCORALLINAE**

Family **Milleporidae**

Millepora spec. div.

PJR 093 and 102. — Piscadera Baai, Sta. Martha Baai.

Mostly in shallow water, often on dead coral, as crusts on piles, etc.
— Colour yellow to dark brown.

It appeared impossible to distinguish in the field between *M. alcornis* Linnaeus, *M. squarrosa* Lamarck and *M. complanata* Lamarck (BOSCHMA, 1948).

Family **Stylasteridae**

Stylaster roseus (Pallas)

PJR 052. — St. Michiels Baai.

Rather common in niches in the open cliff. — Colour red.

THE CURAÇAO COAST AND THE DISTRIBUTION OF ITS CORALS

The island of Curaçao is situated at latitude 12° 15' north and longitude 69° 0' west, about 70 km from the mainland of Venezuela. It is 60 km long and 11 km wide at its widest point; its narrow middle part is only 4 km across.

The longitudinal axis of the island runs NW-SE. The trade wind, with a yearly average velocity of 12 knots (Beaufort 4.2) from the east, causes heavy surf, and a strong current along the north coast. A strong current also runs in western direction along the south coast.

The tide is mainly diurnal, with only slight differences between high and low tide. The variation, even at spring tide, is not more than 30-40 cm. However, these tidal differences, small as they are, cause strong tidal currents in the narrow mouths of the larger inner bays.

There are no rivers on the island. After heavy showers of rain the water runs off rapidly towards the sea through narrow gullies which are dry at other times. The coastal water is only temporarily polluted by this. More serious and of longer duration is the mud-diness caused by continuous bad weather conditions in the Venezuelan coastal area.

The coast of Curaçao consists for the greater part of a cliff of coral

limestone, interrupted by landlocked bays, natural harbours which in some cases reach far inland. On the south/southwest coast, i.e. on the lee side of the island, ridges of limestone debris are present, and in some places a small sand beach. The landlocked bays are bordered by cliffs, coral debris or beach at the entrance, and by mangrove vegetation further inland. The entrance to the inner part of the bay, with its cliffs, together with the small outer part of the bay enclosed by cliffs, is called a "boca".

The following general description applies to the south and west coasts.

Where, between the bays, no beach or debris ridge is present, the water directly below the cliff is about 3 m deep. Beaches slope gradually, and ridges steeply, towards this depth. There a generally flat sandy plateau is mostly present, which gradually shelves towards a depth of 8–10 m. This depth is reached at about 100 m from the shore, where the bottom slopes very steeply towards the blue open water. For this reason, divers in Curaçao call that point the "blauwe rand" (blue edge). The latter name will be used for the entire area along the top of the slope, in which corals are conspicuously abundant. Beyond the blue edge, the steep slope is heavily eroded and covered with coral limestone, as far down as about 45 m. At that depth a sloping area begins, covered with sand and a few boulders; in Piscadera Baai it goes down to over 60 m. In a few places another plateau about 50 m wide is found at 20 m.

On the north and northeast coasts the cliffs are steep and battered by the surf, as a result of which this side of the island is less accessible than the "south coast". Consequently, little work was done by the present writer on this "north coast", and no observations at all have been made in deeper water there.

On the accompanying maps (Figs. 1 and 5–7), the localities have been indicated by letters and numbers. A capital letter indicates a certain coastal area. If, in such an area, observations are restricted to one place, this letter alone indicates the locality, and is given on the map at the place concerned. In an area with more than one observation, the numbers indicate the localities. A subdivision for the Spaansche Water is given in small letters.

This coding has been applied in the following description of the various coastal areas, i.e. in conformity with the coding on the maps. The terminology of the descriptions is much as possible that of DE BUISONJÉ & ZONNEVELD (1960).

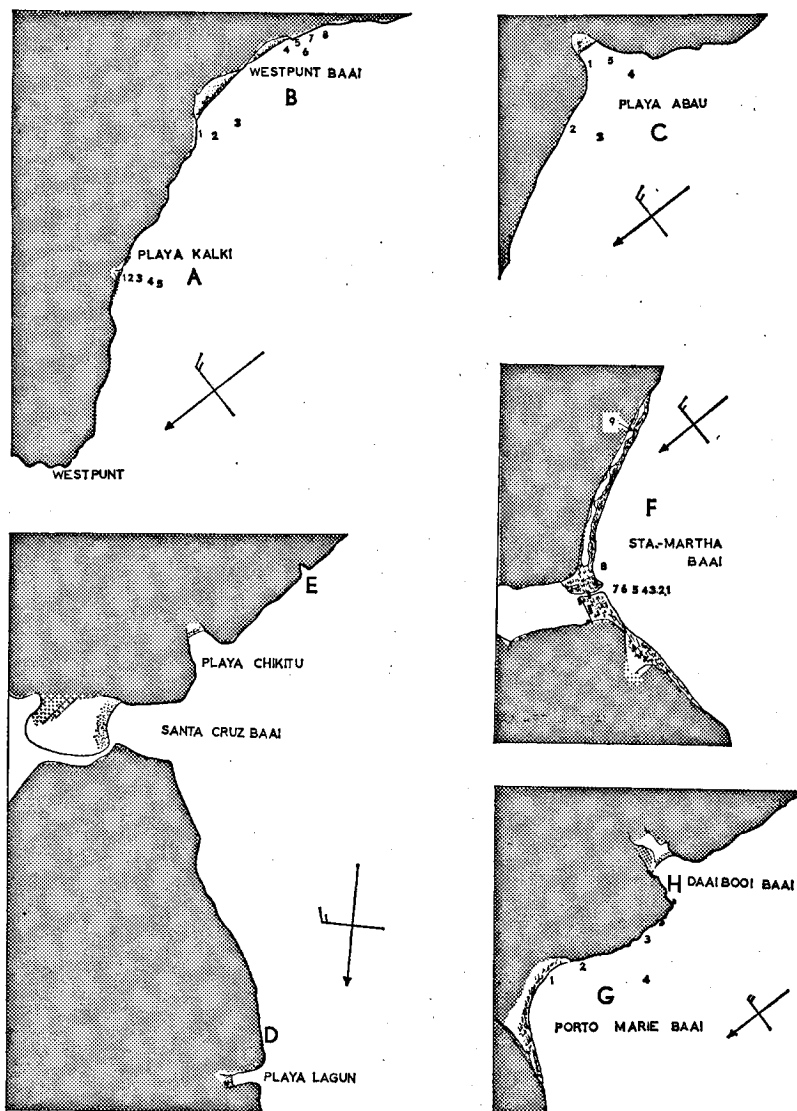


Fig. 5. Coastal areas studied in Curaçao (A-H), with exact indication of localities.

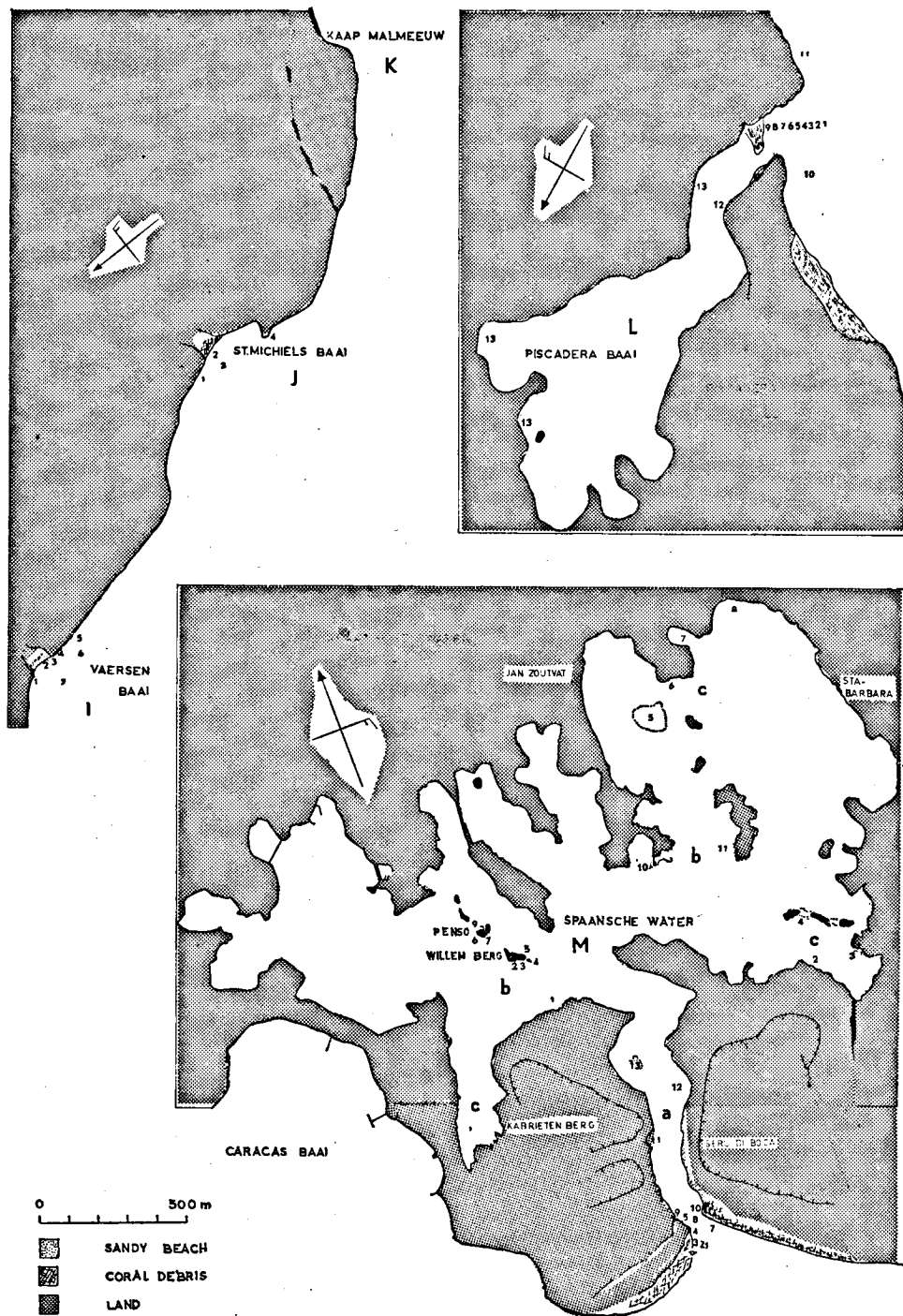


Fig. 6. Coastal areas studied in Curaçao (I-M), with exact indication of localities.

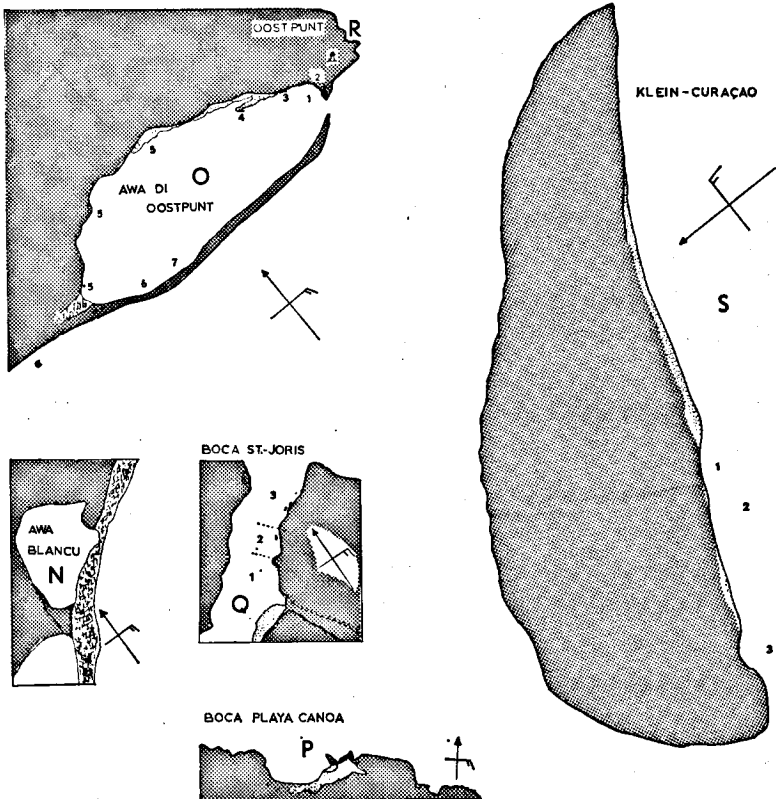


Fig. 7. Coastal areas studied in Curaçao (N-R) and Klein Curaçao (S), with exact indication of localities.

In describing the localities, the names of *Scleractinia* and *Hydrocorallia* have been abbreviated as follows:

<i>Acr. cer.</i>	= <i>Acropora cervicornis</i>	<i>Den. cyl.</i>	= <i>Dendrogyra cylindrus</i>
<i>Acr. pal.</i>	= <i>Acropora palmata</i>	<i>Dic. sto.</i>	= <i>Dichocoenia stokesii</i>
<i>Aga. aga. aga.</i>	= <i>Agaricia agaricites</i>	<i>Dip. cli.</i>	= <i>Diploria clivosa</i>
	f. <i>agaricites</i>	<i>Dip. lab.</i>	= <i>Diploria labyrinthiformis</i>
<i>Aga. aga. cra.</i>	= <i>Agaricia agaricites</i>	<i>Dip. str.</i>	= <i>Diploria strigosa</i>
	f. <i>crassa</i>	<i>Eus. fas.</i>	= <i>Eusmilia fastigiata</i>
<i>Aga. aga. pur.</i>	= <i>Agaricia agaricites</i>	<i>Fav. fra.</i>	= <i>Favia fragum</i>
	f. <i>purpurea</i>	<i>Iso. rig.</i>	= <i>Isophyllastrea rigida</i>
<i>Aga. fra.</i>	= <i>Agaricia fragilis</i>	<i>Iso. sin.</i>	= <i>Isophyllia sinuosa</i>
<i>Col. nat.</i>	= <i>Colpophyllia natans</i>	<i>Mad. asp.</i>	= <i>Madracis asperula</i>

<i>Mad. dec.</i> = <i>Madracis decactis</i>	<i>Por. ast.</i> = <i>Porites astreoides</i>
<i>Mea. mea.</i> = <i>Meandrina meandrites</i>	<i>Por. por.</i> = <i>Porites porites</i>
<i>Mil. alc.</i> = <i>Millepora alcornis</i>	<i>Sid. rad.</i> = <i>Siderastrea radians</i>
<i>Mil. com.</i> = <i>Millepora complanata</i>	<i>Sid. sid.</i> = <i>Siderastrea siderea</i>
<i>Mon. ann.</i> = <i>Montastrea annularis</i>	<i>Sol. bou.</i> = <i>Solenastrea bournoni</i>
<i>Mon. cav.</i> = <i>Montastrea cavernosa</i>	<i>Ste. mic.</i> = <i>Stephanocoenia michelini</i>
<i>Mus. ang.</i> = <i>Mussa angulosa</i>	<i>Sty. ros.</i> = <i>Stylaster roseus</i>
<i>Mus. lac.</i> = <i>Mussa lacera</i>	<i>Tub. ten.</i> = <i>Tubastrea tenuilamellosa</i>
<i>Myc. lam.</i> = <i>Mycetophyllia lamarckiana</i>	

A. PLAYA KALKI

A cliff coast with a small gully, which causes the cliff to retreat there and the debris ridge to form the coastline. A small beach is found on the north side of this lower part. A flat plateau extends to a depth of 10 m; then follows a steep slope.

1. 1.5–3 m depth.

Acr.pal., *Mil.spec.*, *Mon.ann.*, *Dip.str.*, *Por.ast.*, *Fav.fra.*, *Den.cyl.*

2. 3–5 m depth.

Acr.cer., *Mon.ann.*, *Mad.asp.*, *Dip.str.*, *Por.ast.*, *Dip.lab.*, *Mon.cav.*, *Aga.aga.aga.*

3. 5 m depth, on flat sand plateau.

Col.nat., *Por.ast.*

4. Along blue edge 6 m depth.

Sid.sid., *Dip.lab.*, *Dip.str.*, *Mon.ann.*, *Mad.asp.*

5. Blue edge, 7–10 m depth.

Mon.ann., *Aga.aga.pur.*, *Myc.lam.*, *Eus.fas.*, *Dip.lab.*, *Mil.spec.*, *Mus.ang.*, *Mad.asp.*

B. WESTPUNT BAAI

This bay consists of two parts: A northern part and a southern part which are separated by a promontory cliff.

1. North of Westpunt Baai along the cliff as far as the straight stretch to Playa Kalki.

Tub.ten., *Mon.ann.*, *Mon.cav.*, *Dip.lab.*, *Dip.str.*, *Dip.cli.*, *Acr.pal.*, *Por.ast.*, *Iso.sin.*, *Dic.sto.*, *Sid.sid.*, *Sid.rad.*, *Den.cyl.*, *Col.nat.*, *Aga.aga.aga.*

2. Open bay, 3–5 m deep; shallower parts with seaweeds and scanty corals.

Acr.pal., *Acr.cer.*, *Mon.ann.*, *Por.ast.*, *Dip.str.*, *Dip.lab.*, *Sid.sid.*

3. Right in front of the northern part of the bay is a large sandy slope, 60 m wide, beginning at 15 m depth and merging into the sandy slope beyond 45 m depth, which is devoid of corals. The corals on either side are normally zoned (compare Sta. Martha Baai and Piscadera Baai).

4. Cliff along the bay on the south side.

Mil.spec., *Tub.ten.*, *Sid.sid.*, *Por.ast.*, *Dip.str.*, *Dip.lab.*, *Aga.aga.aga.*, *Dic.sto.*, *Fav.fra.*

5. Vegetation along the cliff, down to the sandy bottom at a depth of about 5 m.

Mil.spec., *Den.cyl.*, *Dic.sto.*, *Mon.ann.*, *Aga.aga.aga.*, *Tub.ten.*, *Por.ast.*

6. Boulders and corals on the sand.

Sid.sid., *Por.ast.*, *Dip.str.*, *Dip.lab.*, *Dip.cli.*, *Dic.sto.*, *Mon.cav.*, *Mon.ann.*, *Mea.mea.*

7. Transitional zone towards the exposed cliff, 5-7 m depth.

Por.por., *Eus.fas.*, *Acr.pal.*, *Den.cyl.*, *Dip.cli.*, *Aga.fra.*, *Iso.rig.*, *Sid.sid.*, *Dip.lab.*, *Dip.str.*, *Mon.ann.*

8. Exposed cliff, 5-7 m depth.

Dip.lab., *Dip.str.*, *Mon.cav.*, *Mon.ann.*, *Sid.sid.*, *Den.cyl.*, *Eus.fas.*, *Mil.spec.*, *Por.por.*, *Por.ast.*, *Mad.asp.*

C. PLAYA ABAU

The bay is bordered by cliffs on both sides, and has a flat sandy beach. Some boulders occur at the base of the cliffs under water. A sandy area lies between these boulders and the blue edge.

1. Cliff and boulders west of the boca.

Tub.ten., *Sty.ros.*, *Aga.aga.aga.*, *Por.ast.*, *Mil.spec.*, *Fav.fra.*, *Dip.str.*, *Acr.pal.*, *Por.por.*, *Dip.cli.*

2. Cliff along open coast, down to 6 m depth. The plateau in front of the cliff consists of sand, and is practically devoid of coral.

Den.cyl., *Por.ast.*, *Aga.aga.aga.*, *Fav.fra.*, *Dip.str.*, *Dip.lab.*, *Dip.cli.*, *Sid.rad.*, *Mon.ann.*, *Mon.cav.*

3. Plateau in front of the cliff at a depth of about 8 m, along the very broad blue edge, which lies far away from the shore.

Mon.ann., *Por.ast.*, *Dip.lab.*, *Dip.str.*, *Sid.sid.*, *Mil.alc.*, *Mea.mea.*, *Mon.cav.*, *Eus.fas.*, *Mad.asp.*

4. Plateau right in front of the boca, 6-8 m deep, with scattered coral growth.

Por.por., *Mad.asp.*, *Dip.str.*, *Dip.lab.*, *Mon.ann.*, *Col.nat.*, *Dic.sto.*, *Den.cyl.*, *Acr.cer.*

5. Cliff and boulders east of the boca.

Den.cyl., *Acr.pal.*, *Dip.str.*, *Por.ast.*, *Mea.mea.*, *Tub.ten.*, *Mon.cav.*, *Mon.ann.*, *Dip.cli.*, *Sid.rad.*, *Fav.fra.*, *Mil.spec.*, *Aga.aga.aga.*

D. CAVES NEAR LAGUN

South of Playa Lagun there are a few small caves at or just below the water level. Two of these extend to 15 m horizontally, and have a very narrow opening. Consequently they are very dark, and do not contain corals. The third is very shallow in horizontal direction, and has a very large opening; it is therefore a large cavity in the cliff face rather than a cave.

Mea.mea. oblique discoid, *Mon.cav.*, *Aga.aga.pur.*, *Aga.fra.*

Between these caves and the boca of Playa Lagun *Iso.rig.* has been found at one place.

E. SMALL BOCA SOUTH OF PLAYA CHIKITU

This small bay, only accessible from the sea, has a sandy bottom at the entrance. In deeper places the bottom is calcareous. This calcareous bottom gradually rises until it reaches the surface in the rear part of the boca.

From the sandy bottom up to the surface of the water:

Mon.cav., *Mon.ann.*, *Ste.mic.*, *Acr.pal.*, *Dip.str.*, *Dip.cli.*, *Zoantaria*.

F. STA. MARTHA BAAI

A wide, open outer bay, bordered by a debris ridge, is connected by a narrow channel with a large inner bay. This connection has been altered considerably by human activities. Below a depth of 45 m the bottom is flat and sandy.

1. 45 m depth, on scattered boulders.

Mus.lac., *Mon.cav.*, *Sol.bou.*

2. 45-40 m depth.

Mus.lac., *Mon.cav.*, *Aga.aga.pur.*, *Sid.sid.*, *Sol.bou.*, *Mad.dec.*

3. 40-35 m depth.

Myc.lam., *Eus.fas.*, *Dic.sto.discoïd.*, *Mea.mea.*, *Col.nat.*

4. 35-30 m depth.

Mus.lac., *Mon.cav.*, *Myc.lam.*, *Aga.aga.pur.*, *Dic.sto.*

5. 30-25 m depth.

Aga.aga.pur., *Mea.mea.*, *Eus.fas.*, *Myc.lam.*, *Mon.cav.*, *Mon.ann.*, *Dic.sto.*, *Mus.lac.*

6. 25-20 m depth.

Myc.lam., *Aga.aga.pur.*, *Mon.cav.*, *Mea.mea.*, *Col.nat.*, *Aga.aga.aga.*

7. 20-15 m depth.

Mon.cav., *Mon.ann.*, *Por.ast.*, *Mea.mea.*, *Mus.ang.*

8. Plateau between debris ridge and blue edge, which lies at 10 m depth.

Mil.com., *Acr.pal.*, *Acr.cer.*, *Dip.lab.*, *Fav.fra.*, *Mon.ann.*, *Col.nat.*, *Por.ast.*, *Sid.sid.*, *Mea.mea.*, *Eus.fas.*, *Dip.str.*

9. Small lagoon between cliff and debris ridge.

Sid. rad.

G. PORTO MARIE BAAI

The bay is bordered by coral pebbles with boulders, and has a very flat bottom. East of the bay, low rocks occur in and under water. Between Porto Marie and Daaibooi Baai there is a deep niche in the exposed cliff, just below the waterline.

1. Along the pebble beach, very shallow.

Fav.fra., *Aga.aga.aga.*, *Por.ast.*, *Por.por.*

2. Transitional zone from the pebble beach via boulders to the cliff along the bay.

Fav.fra., *Aga.aga.aga.*, *Por.ast.*, *Por.por.*, *Den.cyl.*, *Dip.lab.*, *Tub.ten.*, *Mil.com.*, *Mon.ann.*, *Dip.str.*, *Dip.cli.*, *Sid.rad.*

3. Detached rocks in front of the cliff, and the cliff proper up to Daaibooi Baai.

Mon.ann., *Por.ast.*, *Acr.pal.*, *Dip.lab.*, *Dip.cli.*, *Dip.str.*, *Fav.fra.*, *Tub.ten.*, *Mil.com.*, *Den.cyl.*, *Mad.asp.*

4. Flat area between cliff and blue edge, at a depth of about 6 m, with many *Thalassia* and gorgonids close to Daaibooi Baai; corals particularly along the blue edge at 8 m.

Dip.lab., *Dip.str.*, *Mon.ann.*, *Dic.sto.*, *Mea.mea.*, *Col.nat.*, *Sid.rad.*, *Mon.cav.*, *Acr.cer.*, *Den.cyl.*, *Mad.asp.*

H. DAAIBOOI BAAI

A bay which is shut in by steep cliffs, with large detached rocks in front of the cliff. A survey has been made only of the north side of the boca.

Acr.pal., *Dip.str.*, *Sid.sid.*, *Mil.com.*, *Fav.fra.*, *Por.ast.*, *Col.nat.*, *Tub.ten.*, *Mea.mea.*, *Por.por.*, *Dic.sto.*, *Acr.cer.*

I. VAERSEN BAAI

An open bay, with a small beach and very flat bottom. Here and there, some rocks are lying below the surface of the water. Some large rocks are found at the transition to exposed cliff east of the bay. The bottom slopes up to the water line near the cliff, with a small sand beach in some places.

1. Boulders under water along the cliff in the western part of the bay.
Dip.str., *Por.ast.*, *Dip.cli.*, *Sid.sid.*, *Fav.fra.*, *Mon.cav.*, *Mon.ann.*, *Por.por.*, *Sid.rad.*, *Col.nat.*, *Acr.spec.*
2. Boulders between the beach and the cliff in the eastern part of the bay. On the bottom many fragments of dead *Acr. cer.*
Dip.cli., *Sid.sid.*, *Fav.fra.*, *Por.ast.*, *Mon.ann.*, *Mil.spec.*
3. Cliff in eastern part of bay.
Mil.com., *Por.ast.*, *Dip.str.*, *Fav.fra.*, *Dip.cli.*, *Mon.ann.*, *Tub.ten.*, *Aga.aga.aga.*, *Por.por.*, *Dic.sto.*, *Den.cyl.*, *Col.nat.*
4. Sandy area between bay and exposed cliff, with much detached seaweed and some gorgonids; also a small reef with well-developed *Scleractinia.*
Por.por., *Por.ast.*, *Dip.cli.*
5. Exposed cliff with boulders in front, some of which are submerged.
Tub.ten., *Mil.com.*, *Mon.ann.*, *Den.cyl.*
6. Plateau in front of the cliff, at 3 m depth, about 250 m from the shore.
Mon.ann., *Sid.sid.*, *Dip.str.*, *Por.ast.*, *Dic.sto.*, *Dip.cli.*, *Dip.lab.*, *Mon.cav.*, *Mea.mea.*, *Mad.asp.*, *Eus.fas.*, *Mus.ang.*, *Aga.aga.aga.*, *Por.por.*, *Den.cyl.*
7. Plateau right in front of bay, with seaweeds down to the blue edge, which lies at a depth of about 8 m.
Mea.mea., *Mon.cav.*, *Dic.sto.*, *Eus.fas.*, *Sid.sid.*, *Dip.str.*

J. ST. MICHIELS BAAI

An outer bay which is rather sheltered, particularly on the south side, is separated from a practically dry inner bay by a debris ridge. In front of the cliff north of the bay, a flat rocky plateau; in front of the cliff south of the bay, sand with boulders. Beyond the blue edge a plateau at about 20 m depth.

1. Plateau about 500 m NW of bay. In front of the steep cliff, a flat sandy bottom with many gorgonids.
Sid.sid., *Dip.str.*, *Den.cyl.*, *Fav.fra.*, *Mon.ann.*
2. North side of bay, above the blue edge. Along the cliff a shallow rocky plateau with many *Sid.rad.*; in front of the bay a barren open plateau with scattered corals.
Sid.rad., *Fav.fra.*, *Dic.sto.*, *Mon.ann.*, *Mon.cav.*, *Sid.sid.*, *Aga.aga.aga.*, *Por.ast.*, *Por.por.*, *Dip.lab.*, *Dip.str.*, *Col.nat.*, *Acr.cer.*, *Mus.ang.juv.*

3. Beyond the blue edge at 10–15 m, i.e. above the second plateau, which lies at 20 m.

Eus.fas., *Mea.mea.*, *Mon.ann.*, *Mon.cav.*, *Mad.asp.*, *Aga.aga.aga.*, *Por.por.*, *Col.nat.*, *Col.nat.discoid*, *Mus.lac.*, *Mus.ang.juv.*, *Myc.lam.*, *Den.cyl.*, *Dic.sto.*, *Sid.sid.*, *Ste.mic.*, *Dip.lab.*

4. Cliff south of bay, with sandy bottom in front, bearing scattered corals.

Tub.ten., *Sty.ros.*, *Col.nat.*, *Mad.asp.*, *Por.por.*, *Dip.str.*, *Mon.ann.*, *Eus.fas.*

K. KAAP MALMEEUW

Explorations were carried out only along the deep side of a plateau at 20 m depth.

Dip.lab., *Dip.cli.*, *Dip.str.*, *Dic.sto.*, *Col.nat.*, *Aga.aga.aga.*, *Aga.aga.pur.*, *Por.ast.discoid*, *Mon.ann.discoid*, *Mea.mea.*, *Myc.lam.*, *Eus.fas.*, *Por.por.*

L. PISCADERA BAAI

An open outer bay, connected with a strongly polluted inner bay. The inner bay and the outer bay are separated by a ridge of coral debris, particularly on the east side. The inner bay is surrounded by mangroves, in the places where the cliff does not reach the water. On the east side, the outer cliff ends abruptly in the debris between inner and outer bay. The same is found on the west side, but there the cliff is higher.

1. 45–40 m depth.

Aga.aga.pur., *Mad.dec.*, *Mon.cav.*, *Mus.lac.*, *Ste.mic.*

2. 40–30 m depth.

Mon.cav., *Aga.aga.pur.*, *Ste.mic.*, *Mad.dec.*, *Mus.lac.*, *Mea.mea.discoid*.

3. 30–25 m depth.

Sol.bou., *Myc.lam.*, *Mon.cav.*, *Mad.dec.*, *Eus.fas.*, *Mus.lac.*, *Mea.mea.*, *Sid.sid.*

4. 25–20 m depth.

Mea.mea., *Sol.bou.*, *Eus.fas.*, *Aga.aga.pur.*, *Myc.lam.*, *Mon.cav.*, *Mus.lac.*

5. 20–15 m depth.

Mea.mea., *Mon.cav.*, *Sid.sid.*, *Sol.bou.*, *Myc.lam.*, *Fav.fra.*, *Aga.aga.aga.*, *Aga.fra.*, *Dic.sto.*, *Eus.fas.*

6. 15–10 m depth.

Eus.fas., *Aga.aga.pur.*, *Por.ast.discoid*, *Mus.ang.*, *Por.por.*, *Dip.cli.*, *Mad.asp.*, *Por.ast.*, *Mon.ann.*, *Mon.cav.*

7. 10–5 m depth.

Mea.mea., *Mon.ann.*, *Aga.aga.aga.*, *Aga.aga.pur.*, *Eus.fas.*, *Mad.asp.*, *Fav.fra.*, *Col.nat.*, *Dip.str.*, *Sid.sid.*

8. 5–3 m depth.

Mon.cav., *Dip.str.*, *Dic.sto.*, *Mea.mea.*

9. 3–0 m depth.

Fav.fra., *Sid.sid.*, *Aga.aga.cra.*, *Por.ast.*, *Ste.mic.*, *Mea.mea.*, *Mil.com.*, *Dic.sto.*, *Dip.str.*, *Mon.ann.*, *Tub.ten.*

10. West of bay.

Many gorgonids, and between them well-developed *Den.cyl.*; at 20 m depth, *Mea.mea.* discoid.

11. East of bay.

Sid.sid., *Mon.cav.*, *Dic.sto.*, *Col.nat.*, *Mea.mea.*, *Dip.str.*, *Eus.fas.*, *Den.cyl.*,
Por.ast., *Por.por.*, *Mon.ann.*, *Dip.cli.*, *Fav.fra.*

12. Below the cliff, along west side of inner bay.

Sid.rad., *Por.ast.*

13. Rear part of inner bay and along the entire east side of it; along cliffs and between mangroves.

Sid.rad.

M. SPAANSCH WATER

This is a large, hand-shaped inner bay, connected with the sea by a long, narrow channel. On the sea side this connection has a sill, the top of which lies at a depth of about 12 m. Behind the sill the water is warm and turbid; it runs off in a brown current over the sill, following a small gully approximately 1 m wide and 0.3 m deep. The cool and clear open water is found above it. The northern slope of the sill consists of sandy mud, like the rest of the bottom of the inner bay. The bottom outside the sill, to the south, lies as deep as 30–50 m, even in the mouth of the bay, and consists of sand with a few corals, including an occasional *Cirripathes*. The gully, through which this specifically heavier, warm and muddy inner water runs off, is devoid of any coral growth.

The bay has been subdivided into three parts: Ma (= boca), Mb (= central part) and Mc (= peripheral part).

Ma. Entrance and narrow part (= boca)

The narrow part is bordered on the west by a steep cliff, which is replaced towards the outside by a debris ridge, separated from the cliff by a strip of mangrove vegetation.

In front of the debris and the mangroves is a broad plateau, at a depth of half a metre. On the east side, the cliff passes into a long sandy beach (Santa Barbara Beach), and further out into a debris ridge, which extends as far as Fuik Baai.

1. Outside the sill, western slope, 30–20 m depth.

Myc.lam., *Mon.ann.*, *Mon.cav.*, *Aga.aga.aga.*, *Aga.aga.pur.*, *Mus.lac.*, *Mad.dec.*,
Mus.ang., *Sid.rad.*, *Ste.mic.*, *Sid.sid.*, *Eus.fas.*, *Dic.sto.* discoid, *Col.nat.*, *Mea.mea.*

2. Outside the sill, western slope, 20–10 m depth.

Mad.dec., *Mon.cav.*, *Sid.sid.*, *Aga.aga.pur.*, *Mus.lac.*, *Col.nat.*, *Mea.mea.*,
Mad.asp.

3. Outside the sill, western slope, 10–0 m depth.

Acr.pal., *Acr.cer.*, *Por.por.*, *Dip.cli.*, *Dip.str.*, *Eus.fas.*; *Por.ast.*, *Por.ast.* discoid
between *Acr.pal.*, *Sid.sid.*, *Fav.fra.*

Acr.pal. from 0–4 m depth, *Acr.cer.* from 4–7 m depth.

4. Above sill, west side. With the exception of *Acropora* all species of 3, including large colonies of *Sid.sid.* and *Dip.str.*

5. Shallow plateau, at 0.5 m depth, west side.

Por.por., *Dip.str.*, *Dip.cli.*, *Sid.sid.*, *Sid.rad.*, *Fav.fra.*, *Acr.pal.*, *Por.ast.*,
Mil.com., *Mon.ann.*

6. Very shallow plateau along Punta Caballero.

Under the lee of *Acropora palmata* of 3, very many, very finely branching *Acropora* occur (sub-variety *surculo-palmata* cf. p. 7). Many *Zoantharia*, a few *Por.ast.*

7. Outside sill, east side, 20 m depth.

Ste.mic., *Mus.lac.*, *Col.nat.*, *Sid.sid.*, *Mon.cav.*, *Dic.sto.*, *Mea.mea.*, *Myc.lam.*, *Mus.ang.*, *Fav.fra.*, *Por.por.*, *Aga.aga.pur.*, *Por.ast.discoid.*

8. In the middle and on top of the sill, and along its outer slope, as far down as 17 m.

Col.nat., *Dic.sto.*, *Mea.mea.*, *Sid.sid.*, *Mon.cav.*, *Aga.aga.aga.*, *Mil.alc.*, *Eus.fas.*, *Mus.lac.*, *Mus.ang.*, *Dip.lab.*, *Ste.mic.*, *Mon.ann.*, *Mad.asp.*

9. North of sill (only the west side surveyed).

On boulders of dead coral:

Aga.aga.pur., *Aga.fra.*, *Ste.mic.*

Closer to the surface:

Eus.fas., *Mea.mea.*, *Mus.lac.*, *Col.nat.discoid.*, *Sid.sid.*

10. East side before the sill, a very steep, bare sandy slope with roundstones; scanty *Scleractinia*.

Dic.sto., *Dip.str.*, *Mus.ang.*

11. In front of the cliff, sandy bottom at 0-1 m depth, with *Thalassia*. Corals on the deep side.

Sid.sid., *Mon.ann.*, *Mad.asp.*, *Dip.str.*, *Dic.sto.*, *Tub.ten.*, *Aga.aga.aga.*, *Aga.aga.pur.*

12. Halfway along the narrow part on the east side, a shallow, broad sandy flat with *Thalassia*. Corals on the steep slope towards deeper water.

Por.por., *Sid.sid.*, *Sid.rad.*, *Col.nat.*, *Eus.fas.*, *Aga.aga.aga.*, *Dip.str.*

13. Shallow in the northern portion of narrow part.

Sid.sid., *Mon.ann.*, *Dip.lab.*, *Por.por.*, *Por.ast.*, *Aga.aga.aga.*, *Dic.sto.*

Mb. Central part

This area comprises the entire middle part of the Spaansche Water, including various islets, a section of cliff and a centrally located creek.

1. At the foot of Kabrietenberg.

Sid.sid., *Sid.rad.*, *Dip.cli.*, *Por.por.*, *Por.ast.* oblique discoid.

2. South side of the small island of Willem Berg; flat shallow plateau.

Por.por., *Por.ast.*, *Aga.aga.aga.*, *Dip.str.*

3. Sloping plateau, deeper than 2 m.

Sid.sid., *Aga.aga.aga.*, *Dic.sto.*, *Por.por.*, *Por.ast.*, *Fav.fra.*, *Sid.rad.*

4. Around small rock, SE of Willem Berg.

Fav.fra., *Por.por.*, *Por.ast.*, *Dip.str.*, *Aga.aga.aga.*, *Aga.aga.pur.*, *Por.ast.* oblique discoid, *Mil.com.*, *Sid.rad.*

5. East side of Willem Berg.

Mil.com., *Sid.sid.*, *Dip.str.*, *Por.por.*, *Por.ast.*, *Aga.aga.aga.*

6. West side of island of Penso.

Sid.rad., *Sid.sid.*, *Por.por.*, *Col.nat.*, *Fav.fra.*, *Aga.aga.aga.*, *Por.ast.*, *Dip.str.*, *Dic.sto.*, *Mil.com.*, *Mus.lac.*, *Aga.aga.pur.*

7. South side of Penso; very flat, shallow shoal towards Willem Berg, with scattered *Scleractinia*.

Por.ast., *Sid.rad.*, *Dic.sto.*, *Por.por.*

8. East side of Penso.
Por.ast.oblique discoid, *Mus.lac.*, *Dip.str.*, *Dip.cli.*, *Aga.aga.aga.*, *Por.ast.*, *Col.nat.*, *Por.por.*, *Sid.rad.*
9. North side of Penso, deeper and muddier than other localities around this island.
Only on mangrove roots: *Aga.aga.cra.*
10. Outermost point south of Jan Zoutvat.
Between mangroves: *Sid.rad.*
On mangrove roots: *Fav.fra.*
In open water: *Sid.rad.*, *Sid.sid.*, *Por.por.*, *Por.ast.*
11. West side of largest island in eastern part of Spaansche Water, 0.30–1.50 m depth. Above 0.30 m, only *Sid.rad.*; deeper than 1.50 m only mud, sand and *Thalassia*.
Dip.lab., *Sid.sid.*, *Fav.fra.*, *Mus.lac.*, *Aga.aga.aga.*, *Dic.sto.*, *Col.nat.*, *Por.ast.*

Mc. Peripheral part

This part comprises the mangrove vegetation around the inner part of Spaansche Water, the remote coves and a few small islands.

1. Kabrieten Baai.
0–0.5 m depth, only *Sid.rad.*; below 3 m, no corals.
Sid.sid., *Por.por.*, *Aga.aga.aga.*, *Fav.fra.*, *Por.ast.*, *Dip.str.*, *Dic.sto.*, *Col.nat.*, *Mus.lac.*
2. Mangroves below Seru di Boca, mud with *Thalassia*; above 0.5 m *Sid.rad.*, below this depth the other corals.
Sid.rad., *Sid.sid.*, *Col.nat.*, *Por.ast.*, *Mus.lac.*
3. Opposite 2, landing-place "Newhaven"; mud with *Thalassia* and *Sid.rad.*
Between 2 and 3 the bay is about 6 m deep and has a muddy bottom without vegetation.
4. Central island in front of Seru di Boca.
Sid.rad., *Sid.sid.*, *Fav.fra.*, *Aga.aga.aga.*, *Eus.fas.*, *Col.nat.*
5. Shallow place north of the most northwesterly island, at a depth of about 0.5 m. Many *Thalassia*, Porifera and Ascidia. At more than 2 or 3 m depth, only sand. *Por.por.* only to 1 m, the other corals above this depth.
Por.por., *Por.ast.*, *Aga.aga.aga.*, *Mus.lac.*, *Fav.fra.*
6. Open shore between Jan Zoutvat and Sta.Barbara.
Por.por., *Aga.aga.aga.*, *Sid.sid.*, *Por.ast.*, *Mus.lac.*, *Fav.fra.*, *Sid.rad.*
7. Small cove between Jan Zoutvat and Sta.Barbara.
Sid.rad., *Sid.sid.*
8. Open space in mangrove vegetation between Jan Zoutvat and Sta.Barbara, where rock is exposed at the surface. No corals among or near the mangroves.
Por.ast., *Por.por.*, *Col.nat.*, *Fav.fra.*

N. AWA BLANCU

A lagoon, entirely separated from the sea by a bar of debris, deepened in places by digging for sand. A dense *Thalassia* layer, no corals.

O. AWA DI OOSTPUNT

This bay is separated from the south coast by a long, narrow spit of land consisting of solid rock. On the north side, the bay is bounded by a low cliff and in a few places a small beach. The opening of the bay is towards ESE, and is thus more or less protected against the waves. In the rear part of the bay, in particular, the water is turbid.

1. Northern, inner side of entrance.

Por. por., *Por. ast.*, *Mil. com.*, *Dip. str.*

2. Shallow pool on little land spit north of entrance, washed by practically every wave.

Fav. fra., *Por. ast.*, *Por. por.*, *Mil. spec.*

3. Small beach, about 100 m inside bay, corals in front of it.

Fav. fra., *Por. por.*, *Mil. spec.*

4. Sand spit along north side. Between spit and shore *Por. por.*, *Por. ast.* and *Mil. com.*. In front of the sand spit a flat, hard bottom about 20 m wide, steeply sloping towards 10–12 m depth on inner side of bay. All over the plateau *Sid. rad.*, and deeper a few *Sid. sid.*

5. Along north and west sides a few scattered *Por. por.*

6. Inner side land spit on south coast, about 100 m from the beginning. A few *Por. spec.*

7. Inner side of land spit, 50 m beyond 6, with steep, firm slope.

Por. ast.; *Por. por.*, *Fav. fra.*, *Sid. rad.*

P. BOCA PLAYA CANOA

One of the few bays with a beach on the north coast. On the east side is a shallow, flat, rocky plateau.

Scleractinia occur particularly in hollows in this plateau, which, although it is somewhat protected by a few isolated rocks, is constantly exposed to the heavy breakers.

Por. ast., *Por. por.*, *Dip. cli.*

Q. ST. JORIS BAAI

The mouth of St. Joris Baai is fully exposed to the trade wind. The violent movement of the breakers on the north coast is transformed here into strong movements of water lengthwise down the narrow boca. These movements do not extend far into the boca, and hence the transition from inner bay to north coast takes place over a rather short distance. The strong water movement in the outer part of the boca, caused by the topography of the bay, proves to be of great influence on the shape of the *Acropora* colonies.

1. Inner part of entrance.

Sid. rad. and a few specimens of *Sid. sid.*

2. Transition to boca.

Sid. rad., *Sid. sid.*, *Por. ast.*, and very low *Por. por.*

3. Boca.

Sid. rad., *Sid. sid.*, *Por. ast.*, *Por. por.*, *Dip. cli.*, *Dip. str.*, *Acr. pal.*

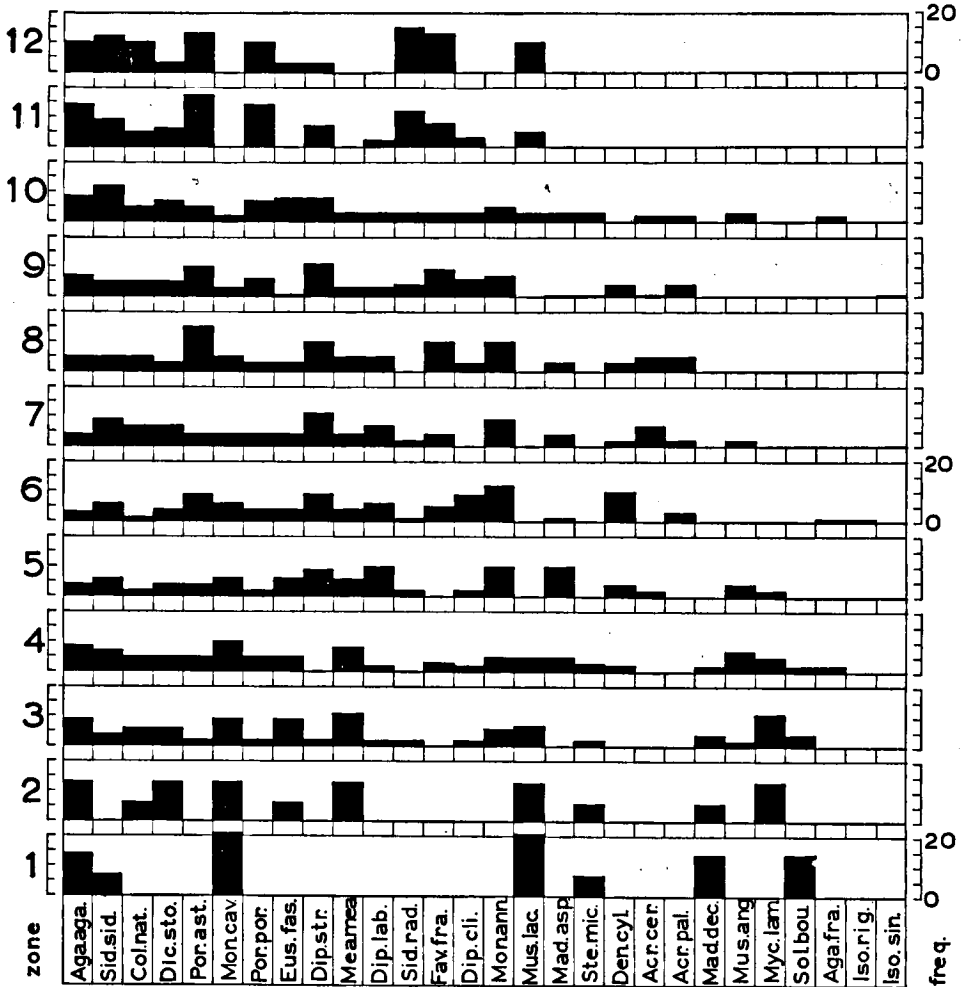


Fig. 8. Graphic representation of the relative frequencies of occurrence (in percentages) of reef corals along the south coast of Curaçao. The species have been arranged according to the number of localities in which they occur; their names are abbreviated as indicated on pages 22 and 23. The different zones 1–12 are explained in the text.

The last-mentioned coral is only found encrusting in shallow water, but is free in deeper water, where it is also very distinctly streamlined in the direction of the longitudinal axis of the bay (Fig. 16).

R. OOSTPUNT

NW of Oostpunt, a series of slight indentations in the cliff on the north coast begins. The first of these has been investigated. The cliff, which at this place is only a few metres above sea level, continues vertically to the barren bottom, at a depth of about 5 m. From there a plateau slopes down to about 8 m. At about 20 m from the shore it plunges steeply towards unknown depth.

Along the cliff, *Tub.ten.* and *Dip.cli.* On the bottom, *Mil.spec.* and *Acr.pal.* The latter is found in the middle of the recess in the cliff, and is spirally rounded off (Fig. 16). *Por.ast* and *Dip.str.* occur in crevices in the sea bed.

S. KLEIN CURAÇAO

This island is located SE of Curaçao, is elongate egg-shaped, and has a length of 2.5 km. A landing-place is situated in the middle of the west side. Here a low cliff grades into a beach which occupies the remaining, southern part of this side of the island.

The north and east coasts consist of cliffs, which are battered by strong breakers. Owing to the sharp elliptical shape of the island, it has no south coast. Consequently only the west coast has been surveyed. Apart from the beach already mentioned, the entire shoreline consists of low cliffs. The island proper is completely flat, with barren and sharp lapies in the NE part. The southern part is covered with a dense and uniform herbaceous vegetation.

1. Landing-place. On the sand in front of the houses and on the beach, no corals. *Scleractinia* only along the cliff and on submerged rocks near the landing place.
Fav.fra., *Dic.sto.*, *Sid.rad.*, *Por.por.*, *Por.ast.*, *Dip.cli.*, *Dip.str.*
2. Along cliff north of landing-place. Same corals, and also *Mon.ann.*, *Sid.sid.* and *Dip.lab.* Many fragments of dead *Acr.cer.*
3. Northern part of west coast and in front of cliff.
Sid.rad., *Por.ast.*, and *Dip.cli.* The other corals scattered on a slightly sloping plateau at 4-6 m depth.
Sid.rad., *Por.ast.*, *Dip.cli.*, *Mon.ann.*, *Mon.cav.*, *Dip.str.*, *Aga.aga.cra.*, *Acr.cer.*, *Col.nat.*, *Fav.fra.*, *Dic.sto.*, *Ste.mic.*

In order to obtain a comprehensive general view of the distribution and the horizontal and vertical zonation of the Curaçao reef corals, the localities mentioned have been classified into the following twelve zones.

1. Steep slope below 40 m depth, F1, F2, L1.
2. Steep slope from 40 to 30 m depth, F3, F4, L2.
3. Steep slope from 30 to 20 m depth, F5, F6, K, L3, L4, Ma1.
4. Steep slope from 20 to 10 m depth, F7, J3, L5, L6, Ma2, Ma7.

5. Blue edge in front of exposed cliff, A4, A5, C3, G4, I6.
6. Exposed cliff and plateau directly in front of it, B5, B6, B7, B8, C2, G3, I4, I5, J1, L11.
7. Blue edge in front of an inner bay, B2, C4, I7, J2, L7.
8. Shallow plateau in front of a very low coast, A1, A2, A3, F8, G1, I2, L8.
9. Protected cliff along a small boca, B1, B4, C1, C5, G2, H, I1, I3, J4, L9.
10. Mouth of a large landlocked water, Ma3, Ma4, Ma8–Ma13.
11. Central part of a large landlocked water, L12, Mb1–Mb11.
12. Peripheral part of a large landlocked water, L13, Mc1–Mc8.

The data available from the north coast are too scanty for inclusion in such a subdivision. Awa di Oostpunt occupies a different, somewhat intermediate position, and is also left out of account; the same applies to the small lagoons near Sta. Martha and a few localities in the mouth of the Spaansche Water, which likewise can not be fitted into a general scheme.

The number of times a coral has been mentioned as occurring in a certain zone in the foregoing discussion of the Curaçao coast and the distribution of the coral is a rough measure of the frequency of that coral within that zone. The sum of all frequencies within each zone has been fixed at 100%. The relative frequencies in percentages are given in the following table, in which the corals have been arranged according to the number of localities in which they occur. The most widely distributed species are listed at the top of the list, those with the most restricted distribution at the bottom. In Fig. 8 these frequencies are depicted graphically, and the corals are given in the same order as in the table. The species names have been abbreviated as indicated on pages 22 and 23.

At the top of the list, those species are given which are very generally distributed and which, with the exception of *Agaricia*, are only absent, or almost so, in the deepest water: *Agaricia agaricites*, *Siderastrea siderea*, *Colpophyllia natans*, *Dichocoenia stokesii* and *Porites astreoides*.

TABLE 1

RELATIVE FREQUENCIES OF CORALS IN THE TWELVE ZONES

Zone	1	2	3	4	5	6	7	8	9	10	11	12
<i>Agaricia agaricites</i>	14	13	9	8	4	3	4	5	7	8	14	10
<i>Siderastrea siderea</i>	7	—	4	7	6	6	9	5	5	12	9	13
<i>Colpophyllia natans</i>	—	6	6	5	2	1	7	5	5	5	5	10
<i>Dichocoenia stokesii</i>	—	13	6	5	4	4	7	3	5	7	6	3
<i>Porites astreoides</i>	—	—	2	5	4	9	4	15	10	5	17	13
<i>Montastrea cavernosa</i>	21	13	9	10	6	6	4	5	3	2	—	—
<i>Porites porites</i>	—	—	2	5	2	5	4	3	6	7	14	10
<i>Eusmilia fastigiata</i>	—	6	9	5	6	4	4	3	1	8	—	3
<i>Diploria strigosa</i>	—	—	2	—	9	9	11	10	11	8	7	3
<i>Meandrina meandrites</i>	—	13	11	8	6	4	4	5	3	3	—	—
<i>Diploria labyrinthiformis</i>	—	—	2	2	10	6	7	5	3	3	2	—
<i>Siderastrea radians</i>	—	—	2	—	2	1	2	—	4	2	12	15
<i>Favia fragum</i>	—	—	—	3	—	5	4	10	9	3	8	13
<i>Diploria clivosa</i>	—	—	2	2	2	8	—	3	6	3	3	—
<i>Montastrea annularis</i>	—	—	6	5	10	12	9	10	7	5	—	—
<i>Mussa lacera</i>	21	13	7	5	—	—	—	—	3	5	10	—
<i>Madracis asperula</i>	—	—	—	5	10	1	4	3	1	3	—	—
<i>Stephanocoenia michelini</i>	7	7	2	3	—	—	—	—	1	3	—	—
<i>Dendrogyra cylindrus</i>	—	—	—	2	4	10	2	3	4	—	—	—
<i>Acropora cervicornis</i>	—	—	—	—	2	—	7	5	1	2	—	—
<i>Acropora palmata</i>	—	—	—	—	—	3	2	5	4	2	—	—
<i>Madracis decactis</i>	14	6	4	2	—	—	—	—	—	—	—	—
<i>Mussa angulosa</i>	—	—	2	7	4	—	2	—	—	3	—	—
<i>Mycetophyllia lamarckiana</i>	—	13	11	5	2	—	—	—	—	—	—	—
<i>Solenastrea bournoni</i>	14	—	4	2	—	—	—	—	—	—	—	—
<i>Agaricia fragilis</i>	—	—	—	2	—	1	—	—	—	2	—	—
<i>Isophyllastrea rigida</i>	—	—	—	—	—	1	—	—	—	—	—	—
<i>Isophyllia sinuosa</i>	—	—	—	—	—	—	—	—	1	—	—	—

The corals at the bottom of the list are of limited distribution.

The following species are already present below 10 m, i.e. below the blue edge, but they are definitely absent in the landlocked waters: *Montastrea cavernosa*, *Meandrina meandrites*, *Madracis asperula* and *Dendrogyra cylindrus*. A distinction must be made between *Montastrea cavernosa* and *Meandrina meandrites*, which belong to the very-deep-water corals, and *Madracis asperula* and *Dendrogyra cylindrus*, which are confined to the coastal plateau.

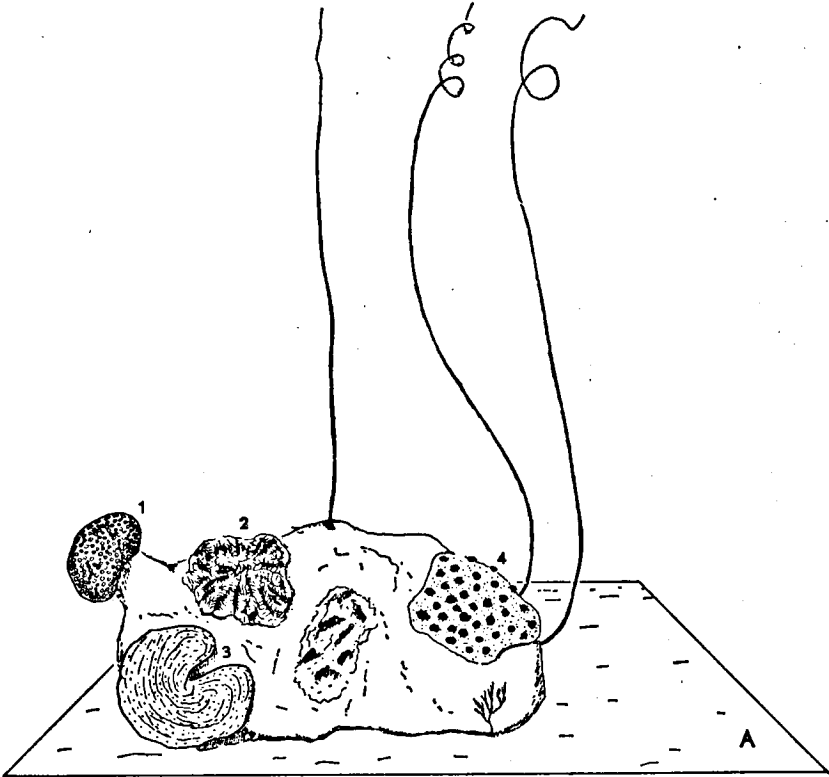


Fig. 9. Coral growth in Piscadera Baai, at a depth of 40 metres, as sketched under water, within a wire frame of 2×2 metres. — 1 *Solenastrea bournoni*, 2 *Meandrina meandrites*, 3 *Agaricia agaricites*, 4 *Montastrea cavernosa*.

Dendrogyra is also absent in front of inner bays, which might be explained by the fact that this is the only coral which has its tentacles completely expanded in daytime, and consequently is more susceptible to pollution than other species.

One group of corals is restricted to certain depths: *Madracis decactis*, from 50 m to below the blue edge; *Mycetophyllia lamarckiana*, from 35 m up to and into the blue edge; and *Solenastrea bournoni*, from 50 m to about 15 m depth. It is noteworthy that *Mycetophyllia*, in particular, occupies a very specific zone; within this zone it is conspicuous, but it does not occur at all outside it. *Solenastrea* is

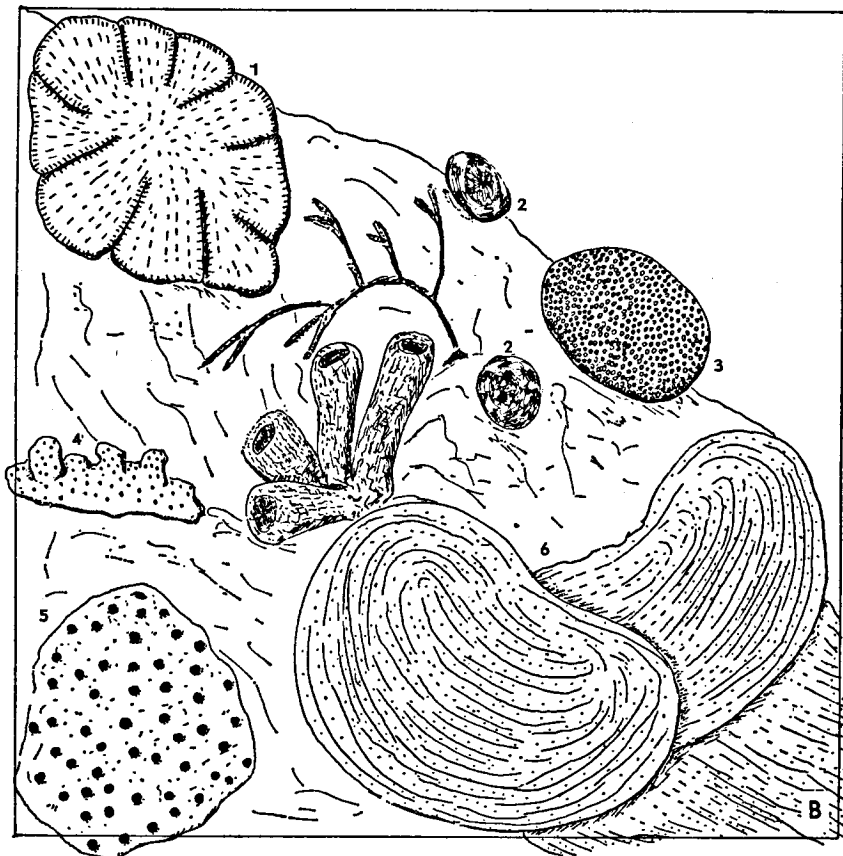


Fig. 10. Coral growth in Piscadera Baai, at a depth of 30 metres, as sketched under water, within a wire frame of 2×2 metres. — 1 *Mycetophyllia lamarckiana*, 2 *Mussa lacera*, 3 *Solenastrea bournoni*, 4 *Madracis decactis*, 5 *Montastrea cavernosa*, 6 *Agaricia agaricites*.

replaced in higher levels by *Montastrea annularis*; these two can only be distinguished under water after some practice. *Madracis decactis* is entirely absent above the blue edge, whereas *Madracis asperula* is restricted to shallower depths.

A remarkable distribution was noticed for *Mussa lacera* and *M. angulosa*. The first is very predominant in deep water and does not occur at all in shallow water, except in the very shallow and muddy

water of the Spaansche Water. *M. angulosa* is found along the blue edge. This is therefore presumed to be a branching form which remains unbranched under non-optimal conditions. The absence of transitional forms, however, prompts the conclusion that these two forms are not only ecologically, but also specifically different.

Both *Acroporas* are restricted to open water above the blue edge. If they occur together, *Acropora palmata* is the upper one, reaching as high as the waves and in some cases projecting above water. *A. cervicornis* is always found in deeper water.

Besides the corals with a general distribution, a few others are present in inner waters. Some of these occur there incidentally, such as *Eusmilia fastigiata* and *Favia fragum*, in which case they will be found even on and between the mangrove roots. In addition to species already discussed, *Porites porites* and *Siderastrea radians* are common in the Spaansche Water, both in very shallow water, but *Porites* occurs on small plateaus in the middle of the bay, whereas *Siderastrea radians* is also found up to the water line right at the back of the bay. It is evident that the latter species is thus exposed to changes in temperature and to fluctuations in pH and salinity as a result of sun radiation, evaporation and showers of rain. The variations in the middle of the bay are much smaller.

Just as the flat forma *purpurea* of *Agaricia agaricites* occurs in deeper water, other corals also show a change in development in deeper water. This applies to various massive corals, which are spherical above the blue edge, in open water, but assume a flat, dish-like shape at a certain depth. They generally have this discoid shape where the light from a certain direction is sufficient for a normal growth of the species concerned, but from all other directions is insufficient. This occurs at considerable depth, but not at very great depth, because of the diffusion of the light, and also in dim niches and caves. In the latter localities the corals are rendered obliquely discoid by the inclined incidence of the light. *Meandrina meandrites*, *Dichocoenia stokesii*, *Porites astreoides*, *Montastrea annularis* and *Colpophyllia natans* are examples of this phenomenon.

Discoid forms of *Porites astreoides* and *Meandrina meandrites* are depicted in Pls. IX and X. Fig. 2 is an under water photograph of an obliquely discoid *Meandrina meandrites*.

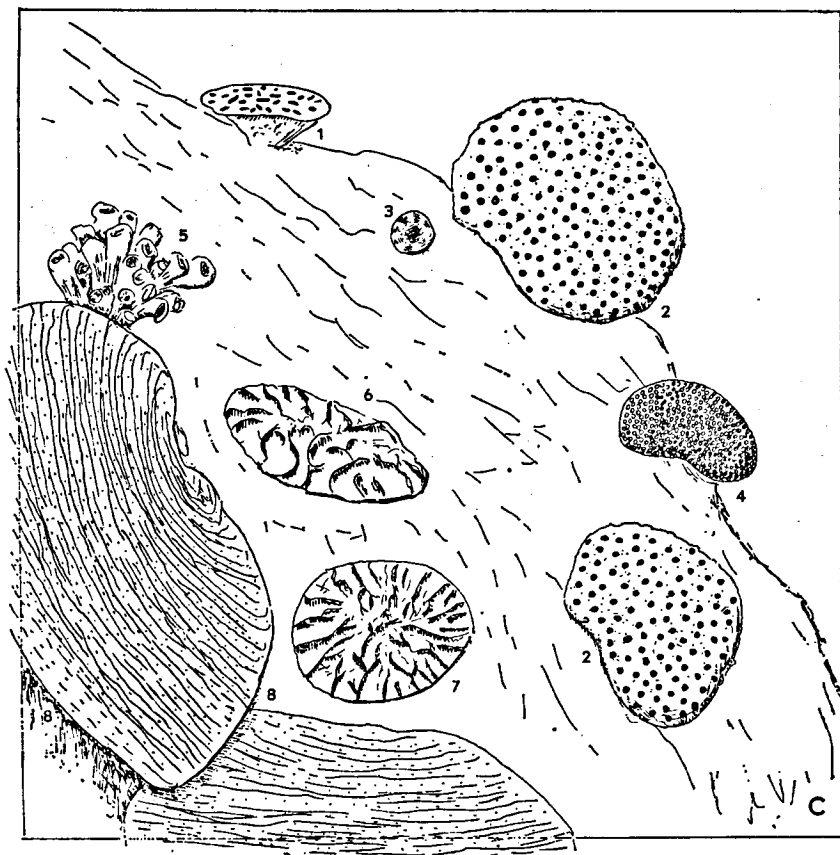


Fig. 11. Coral growth in Piscadera Baai at a depth of 20 metres, as sketched under water, within a wire frame of 2×2 metres. — 1 *Dichocoenia stokesii*, 2 *Montastrea cavernosa*, 3 *Mussa lacera*, 4 *Solenastrea bournoni*, 5 *Eusmilia fastigiata*, 6 *Colpophyllia natans*, 7 *Meandrina meandrites*, 8 *Agaricia agaricites*.

On comparison of the above data with the relative frequencies, the twelve zones of the south coast can be characterized as follows.

1. Below a depth of 40 m, *Montastrea cavernosa*, *Mussa lacera*, *Agaricia agaricites* and *Solenastrea bournoni* occur together, and *Mycetophyllia lamarchkana* is absent.
2. From a depth of 40 m to about 30 m, the following species are

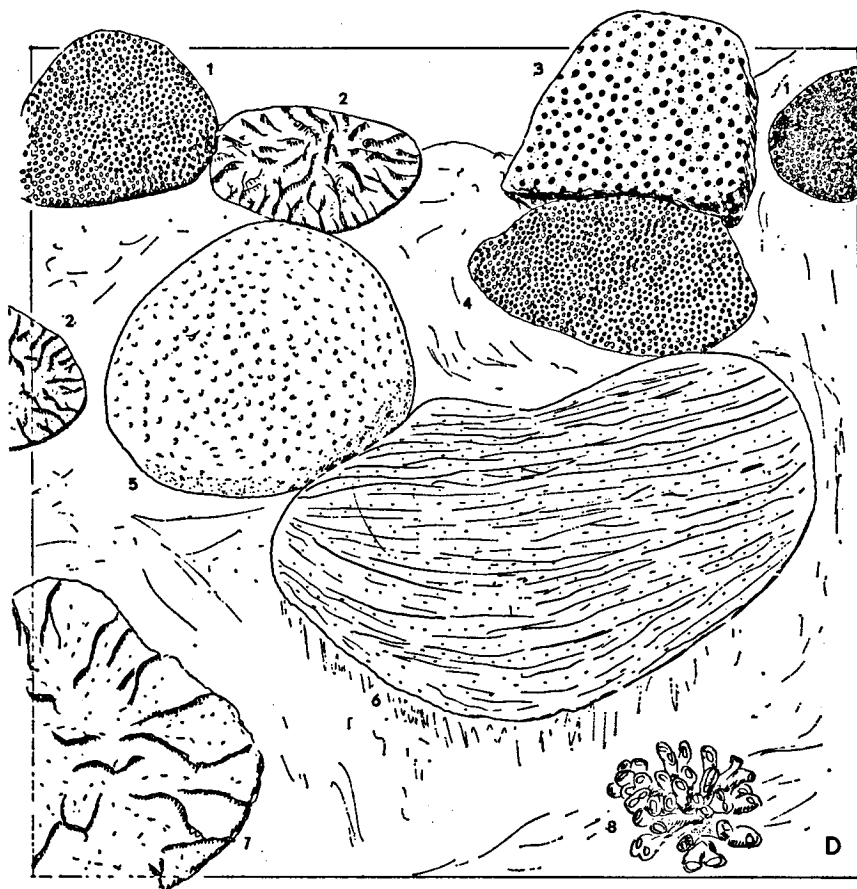


Fig. 12. Coral growth in Piscadera Baai at a depth of 15 metres, as sketched under water, within a wire frame of 2×2 metres. — 1 *Solenastrea bournoni*, 2 *Meandrina meandrites*, 3 *Montastrea cavernosa*, 4 *Montastrea annularis*, 5 *Siderastrea siderea*, 6 *Agaricia agaricites*, 7 *Mycetophyllia lamarckana*, 8 *Eusmilia fastigiata*.

practically all that occur. They are found next to each other: *Montastrea cavernosa*, *Mussa lacera*, *Agaricia agaricites*, *Solenastrea bournoni* and *Mycetophyllia lamarckana*.

3. At a depth of about 20 m, the same corals as in 2 occur together, but *Solenastrea bournoni* is replaced by *Montastrea annularis*, and other species may begin to present.

4. The area just below the blue edge is distinguished from the area along the blue rim by the presence of *Madracis decactis* and the predominance of *Agaricia agaricites* f. *purpurea* over f. *agaricites*.
5. Along the blue edge in front of an exposed cliff coast, *Agaricia agaricites* f. *purpurea* and f. *agaricites* are present in equal numbers. *Montastrea annularis* and *Diploria labyrinthiformis* predominate.
6. The exposed cliff and the plateau in front of it are characterized by the occurrence of *Diploria clivosa* along the cliff and of *Montastrea annularis* next to *Dendrogyra cylindrus* on the plateau.
7. The blue edge in front of an inner bay differs from the environment mentioned under 5 by a relative decrease of *Montastrea annularis* in favour of *Diploria strigosa*.
8. The shallow plateau in a quiet bay is characterized by the occurrence of often large numbers of *Acropora palmata* and *A. cervicornis*. The first is found as far as in the breakers, the latter in deeper water.
9. The sheltered cliff along a boca contains the common species *Montastrea annularis* and *Diploria strigosa*. *Acropora palmata* is frequently present, *Acropora cervicornis* seldom. This area also differs from the other localities located close to the south coast in the almost total absence of *Eusmilia fastigiata*.
10. The entrance to a large landlocked water, in this case the Spaansche Water, is a transitional area, with relatively many *Siderastrea siderea* and few *Montastrea annularis*. The area is possibly characterized by the occurrence together of *Mussa angulosa* and *Mussa lacera*, while *Mycetophyllia lamarckana* is absent.
11. The central part of the Spaansche Water is characterized by relatively many *Siderastrea siderea*, *S. radians*, *Porites porites* and *P. astreoides*, side by side.
12. The peripheral coves contain the same corals as 11, but *Porites porites* is much less common and *Colpophyllia natans* and *Mussa lacera* are common. The extreme periphery of all inner bays is characterized by the exclusive and scattered occurrence of *Siderastrea radians*.

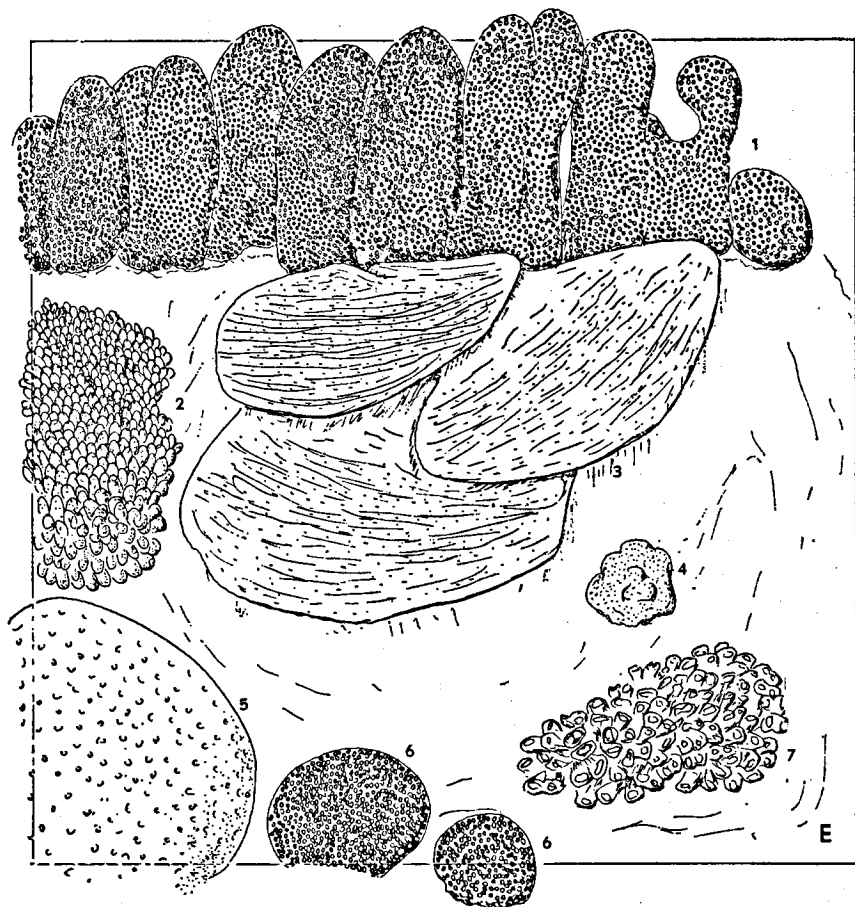


Fig. 13. Coral growth in Piscadera Baai at a depth of 12 metres, as sketched within a wire frame of 2×2 metres. — 1 *Montastrea annularis*, 2 *Madracis asperula*, 3 *Agaricia agaricites*, 4 *Porites astreoides*, 5 *Siderastrea siderea*, 6 *Solenastrea bournoni*, 7 *Eusmilia fastigiata*.

Along the north coast the most important corals in the higher levels are: *Diploria clivosa*, *Porites astreoides*, *Porites porites* and *Acropora palmata*. Of these, *Diploria clivosa* covers the greater part of the steep cliff. Other corals are present on the flat plateau; *Porites porites* and *Acropora palmata* are prominent amongst the species which are deformed under the influence of water movement.

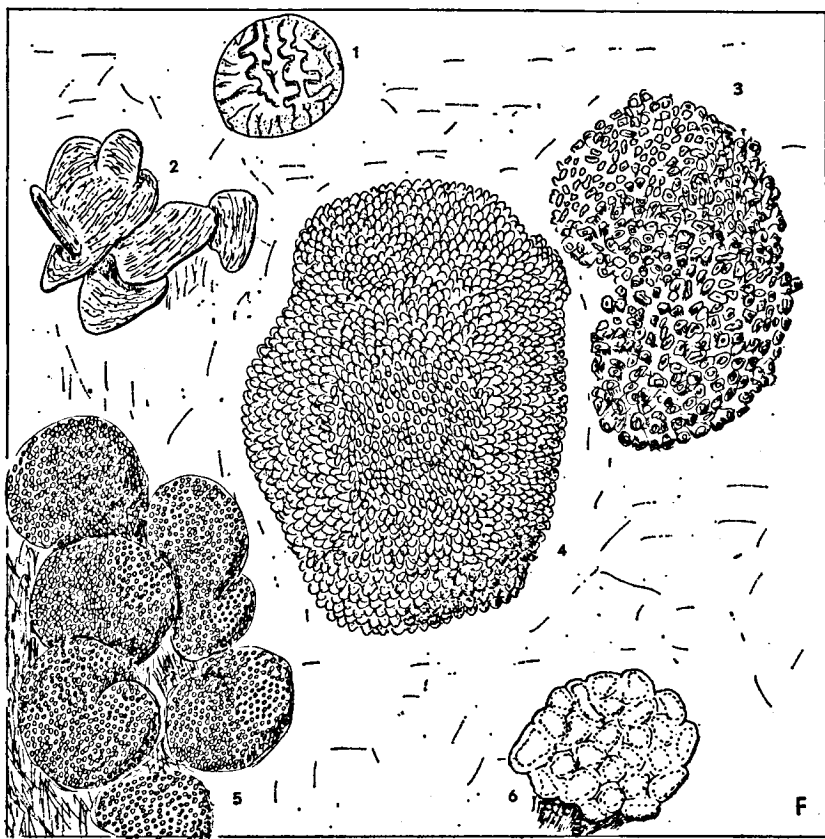


Fig. 14. Coral growth in Piscadera Baai, at a depth of 10 metres, as sketched within a wire frame of 2×2 metres. — 1 *Diploria strigosa*, 2 *Agaricia agaricites*, 3 *Eusmilia fastigiata*, 4 *Madracis asperula*, 5 *Montastrea annularis*, 6 *Mussa angulosa*.

Typical examples of coral growth from various zones in Piscadera Baai have been sketched under water, and are depicted in Figs. 9–15. Plates IVb and Va–b are under water photographs of typical aspects of the shallow part of Piscadera Baai. Pl. IVa is a photograph of an *Acropora palmata* colony at Playa Kalki. Fig. 2 is an obliquely discoid *Meandrina* from a shallow cave at Lagun.

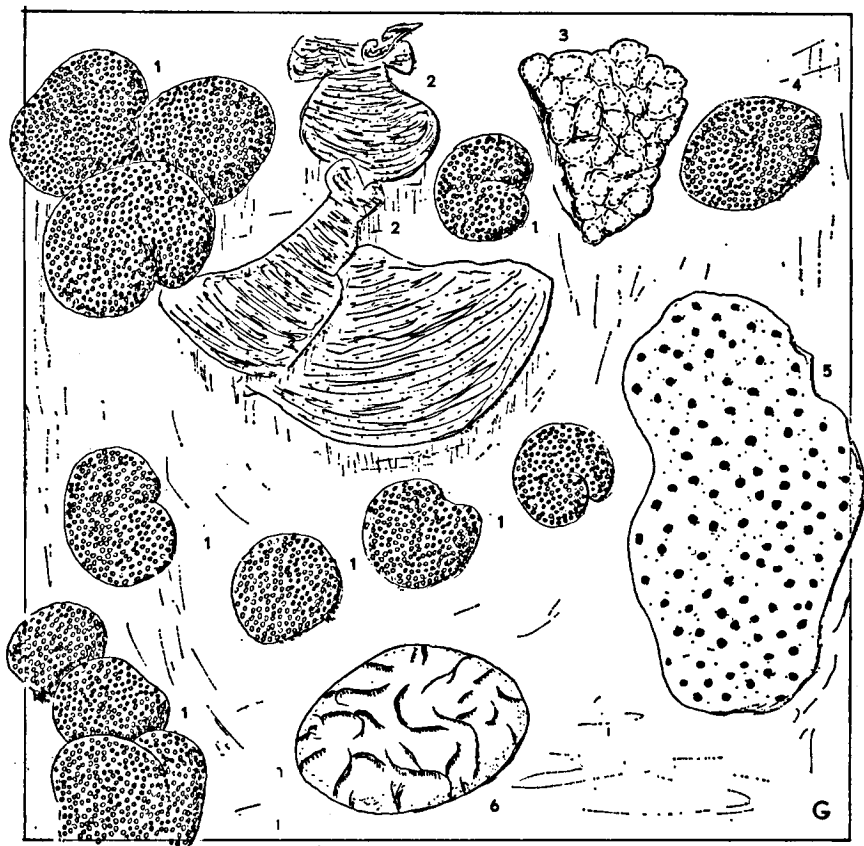


Fig. 15. Coral growth in Piscadera Baai, at a depth of 10 metres, as sketched within a wire frame of 2×2 metres. — 1 *Montastrea annularis*, 2 *Agaricia agaricites*, 3 *Mussa angulosa*, 4 *Solenastrea bournoni*, 5 *Montastrea cavernosa*, 6 *Colpophyllia natans*.

INFLUENCE OF MOVEMENT OF WATER ON FORM AND DISTRIBUTION

The flat, encrusting corals are particularly able to withstand the mechanical force of moving water, branching forms much less. In the surf zone, *Diploria clivosa* and *Siderastrea radians* are almost the only corals found. Accordingly, the first of these is the only species capable of covering large parts of the cliff along the north coast.

The branching *Porites porites* may also be present there, in fissures of the sea bottom — hence, always somewhat protected.

However, its branches remain very short and bludgeon-shaped.

On the south coast the coarsely and widely branching *Acropora palmata* occurs in the surf zone, whereas the more fragile *Acropora cervicornis* remains in lower regions, below the waves. On the north coast *Acropora palmata* occupies that deeper place, although there strong water movements have an influence on this coral at a depth of a few metres.

Fig. 16 shows three different forms of *Acropora palmata*; the letters and figures indicate the localities. On the left is the coral completely developed in a quiet bay on the south coast; the other two pictures represent specimens from the north coast.

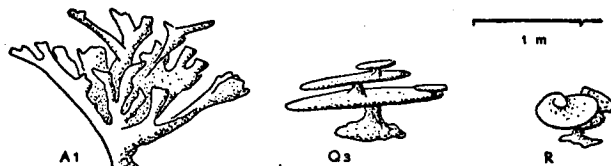


Fig. 16. Three different forms of *Acropora palmata*, as sketched in the field at Playa Kalki (A1), St. Joris Baai (Q3), and Oostpunt (R).

Standing on the cliff looking eastward into the mouth of St. Joris Baai, one sees elongated forms parallel to the mouth of the bay (Q 3). These are highly streamlined specimens of *Acropora palmata*, the shape of which is due to the movement of the water to and fro down the length of the boca.

Another example of shaping by a certain predominant direction of water movement is the third specimen, found at a depth of about 3 m on the flat bottom of an embayment near Oostpunt (R). The turbulence of the water has caused the coral to assume a flat screw shape.

Along the west coast of Klein Bonaire HUMMELINCK found extremely streamlined specimens of *Acropora palmata*, with branches which are almost round in cross section (see Plate XIV), at only about 15 m from other colonies of quite normal appearance.

COMPARISON OF THE CORAL FAUNA OF CURAÇAO WITH THAT OF OTHER WEST INDIAN REGIONS

GOREAU (1959b) has summarized the data from the literature on the subject in his paper on the ecology of the reefs of Jamaica. His outline is given below, supplemented with data for Curaçao (Table 2).

From this Table 2, it may be concluded that Curaçao is not very rich in species. The coral fauna of this island can best be compared with the fauna of Barbados, which is not so strange in view of its geographical situation.

As is stated by GOREAU (1959b) there are no important regional differences within the Caribbean region. On the basis of the data at present available, a maximum number of species appears to occur in the region roughly bordered by Florida, Bahamas, Puerto Rico, Jamaica and Isla de Pinos.

It is much more difficult to compare the zoning in the various areas, as the topography, geology and soil conditions of the coasts described are different. Again, Curaçao can be best compared with Barbados. On that island LEWIS (1960) distinguished a greater number of zones than in Curaçao, on account of the lesser slope of its coasts. By telescoping the zones until the slope is as in Curaçao, the zoning in Barbados is completely comparable to Curaçao.

LEWIS (1960) recognized a "reef-flat zone" close to the island, to a depth of one metre and about 50 m wide, in which only *Siderastrea radians* is generally present. This zone can be found in Curaçao everywhere along the coast and the inner bays where the water is very shallow. In Barbados the next zone is the "Diploria - Palythoa zone", 5-20 m wide and at 60 cm depth, mainly containing *Diploria clivosa* and the zoantharian *Palythoa mammillosa*. During the present survey a similar fauna was observed in Curaçao only in one place, the small boca south of Playa Chikitu. At a depth of half a metre the bottom there is completely covered with beautiful grey *Diploria clivosa*; towards the shores yellow *Palythoa*, and in still shallower parts green and blue *Zoanthus*, are predominant.

The other LEWIS zones can be recognized in Curaçao to a depth of 15 m, although less differentiated.

TABLE 2

DISTRIBUTION OF WEST INDIAN REEF CORALS

Ber = Bermuda, SMITH (1948), VERRILL (1901)

Bah = Bahamas, VAUGHAN (1910 et seq.), SMITH (1948)

Flo = Florida, VAUGHAN (1910 et seq.), SMITH (1948)

Jam = Jamaica, GOREAU (1956), DUERDEN (1902), FONTAINE (1954)

Bar = Barbados, GOREAU (unpublished field notes), BUTCH (1939), NUTTING (1919)

Cur = Curaçao, ROOS (1963)

* not observed by the author, but present in the collections of the Caribbean Marine Biological Institute, Curaçao.

Fam./spec.	Ber	Bah	Flo	Jam	Bar	Cur
Astrocoeniidae						
<i>A. pectinata</i>	—	—	+	—	—	—
<i>S. michelini</i>	+	+	+	+	+	+
Acroporidae						
<i>A. cervicornis</i>	—	+	+	+	+	+
<i>A. palmata</i>	—	+	+	+	+	+
<i>A. prolifera</i>	—	+	+	+	—	—
Pocilloporidae						
<i>M. asperula</i>	—	—	—	+	+	+
<i>M. decactis</i>	+	+	+	+	+	+
Agariciidae						
<i>A. agaricites</i>	—	+	+	+	—	+
<i>A. fragilis</i>	+	—	+	+	+	+
<i>A. nobilis</i>	—	+	+	+	—	—
Siderastreidae						
<i>S. radians</i>	+	+	+	+	+	+
<i>S. siderea</i>	+	+	+	+	+	+
Poritidae						
<i>P. astreoides</i>	+	+	+	+	+	+
<i>P. branneri</i>	—	+	—	—	—	—
<i>P. divaricata</i>	—	—	+	+	—	—
<i>P. furcata</i>	—	+	+	+	—	?
<i>P. porites</i>	+	+	+	+	+	+
Faviidae						
<i>F. fragum</i>	+	+	+	+	+	+
<i>D. clivosa</i>	—	+	+	+	+	+
<i>D. labyrinthiformis</i>	+	+	+	+	+	+
<i>D. strigosa</i>	+	+	+	+	+	+
<i>C. amaranthus</i>	—	+	+	+	—	—
<i>C. natans</i>	—	+	+	+	+	+
<i>M. areolata</i>	—	+	+	+	—	—
<i>M. mayori</i>	—	—	+	—	—	—
* <i>C. arbuscula</i>	—	—	+	—	—	+

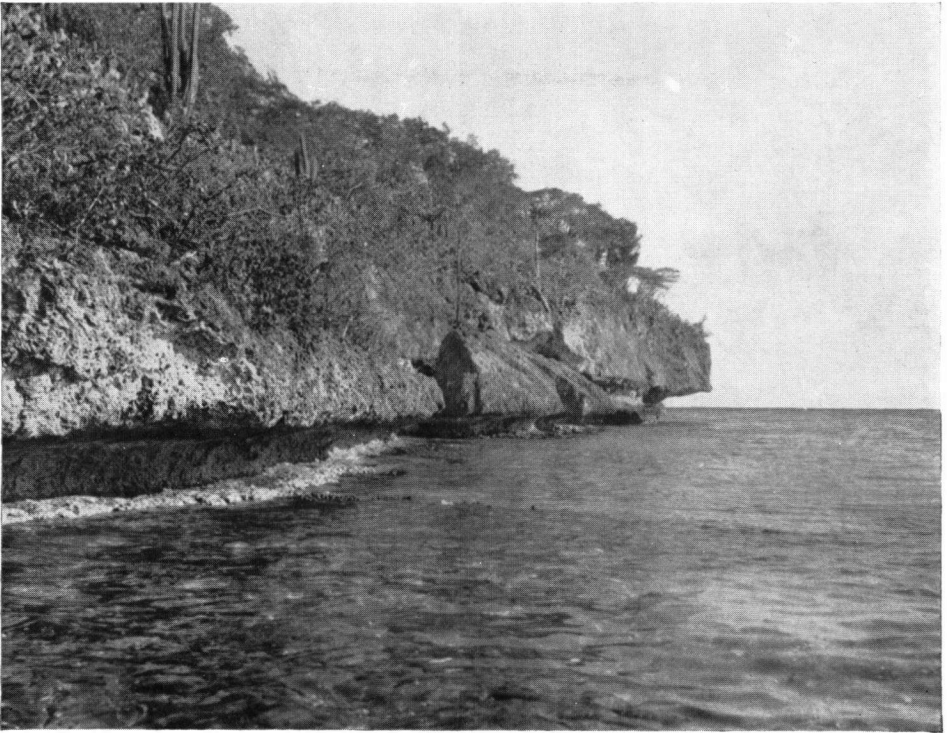
Fam./spec.	Ber	Bah	Flo	Jam	Bar	Cur
<i>M. cavernosa</i>	+	+	+	+	+	+
<i>M. annularis</i>	+	+	+	+	+	+
<i>S. bournoni</i>	—	+	+	—	—	+
<i>S. hyades</i>	—	—	+	+	—	—
Rhizangiidae						
* <i>A. solitaria</i>	+	+	+	+	+	+
<i>P. americana</i>	—	—	+	+	—	—
Oculinidae						
<i>O. diffusa</i>	+	+	+	+	—	—
<i>O. valenciennesi</i>	+	+	—	?	—	—
* <i>O. varicosa</i>	+	—	+	—	+	+
Meandrinidae						
<i>M. meandrites</i>	—	+	+	+	—	+
<i>M. braziliensis</i>	—	+	+	+	+	—
<i>D. stokesii</i>	—	+	+	+	+	+
<i>D. cylindrus</i>	—	+	+	+	+	+
Mussidae						
<i>M. angulosa</i>	—	+	+	+	+	+
<i>Mussa lacera</i>	+
<i>I. rigida</i>	+	+	+	+	—	+
<i>I. multiflora</i>	+	+	+	+	+	—
<i>I. sinuosa</i>	+	+	+	+	—	+
<i>M. lamarckiana</i>	—	+	+	+	+	+
Caryophyllidae						
<i>E. fastigiata</i>	—	+	+	+	+	+
Dendrophylliidae						
<i>T. tenuilamellosa</i>	—	—	—	+	—	+
Total species	19	37	42	41	26	30

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Ia. Limestone cliffs along the West (= leeward) coast of Curaçao, South of Playa Chikitu, showing a distinct niche with projecting bench at low tide.



Ib. Limestone cliffs along the East (= windward) coast of Aruba, showing a projecting bench with many small terraced ponds, each surrounded by a ridge of newly formed inclusions. The bench is undercut and parts of it are broken off during heavy storms.

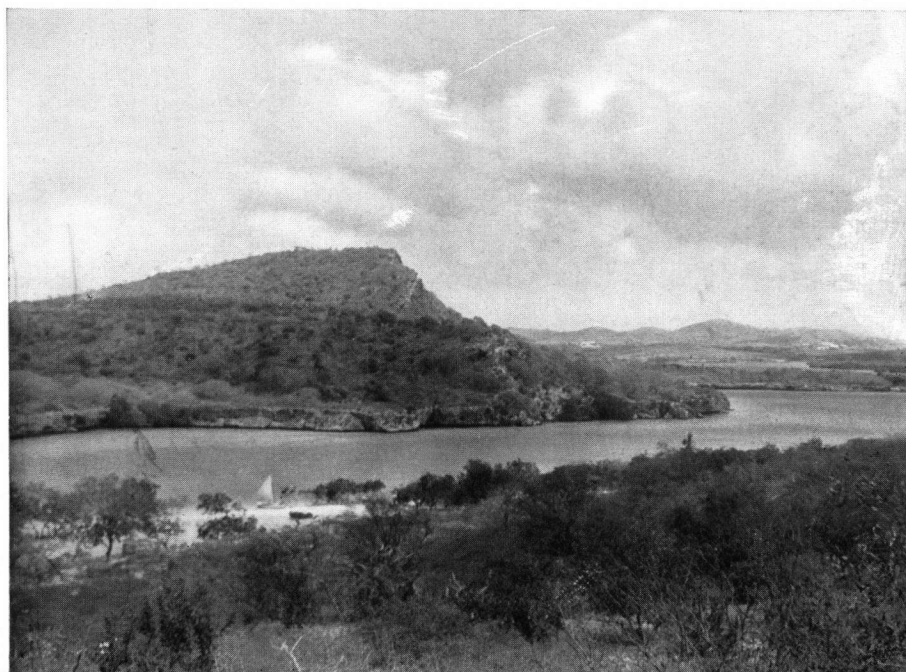
Plate II



Aerial view of the entrance and the narrow part of Spaansche Water (cf. Fig. 5 Ma).
The shallow parts are lighter in colour than the deeper ones.

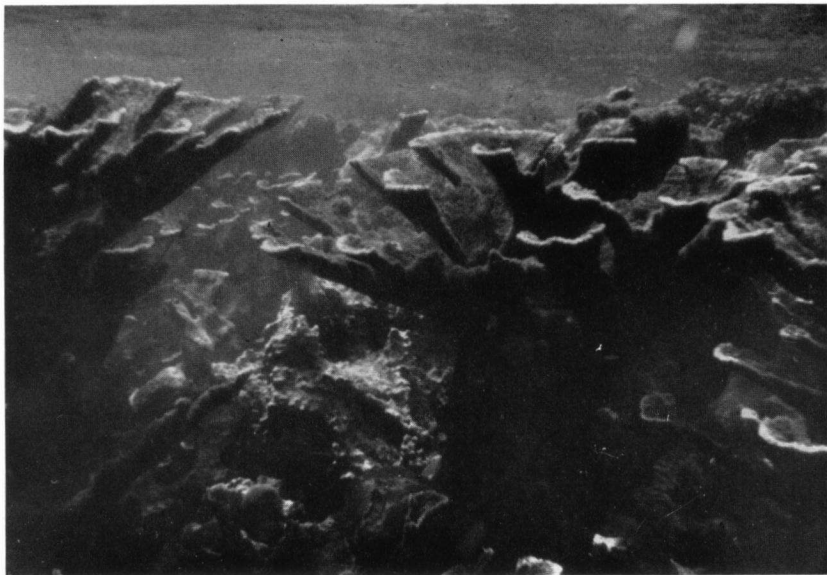


IIIa. Entrance of Spaansche Water, looking southwestward towards Punta Caballero.

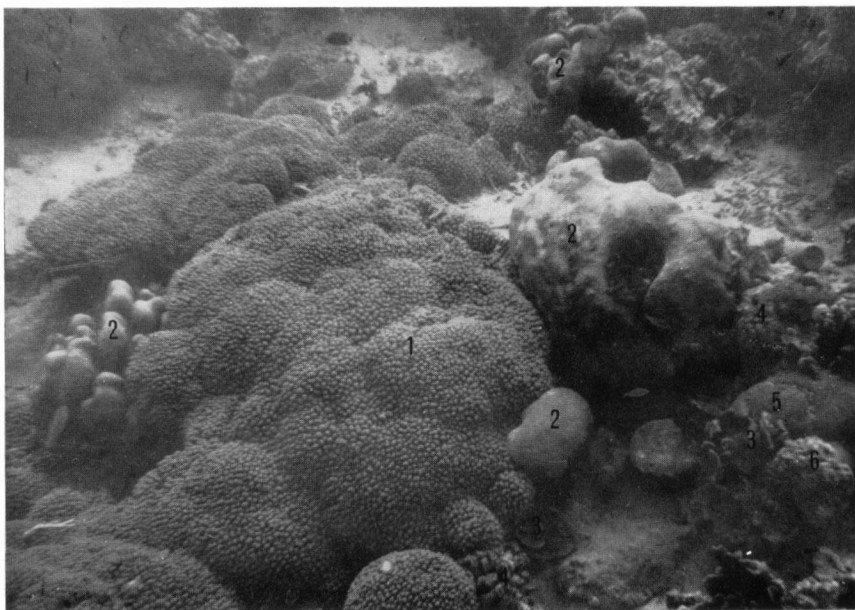


IIIb. Narrow part of Spaansche Water, looking northwestward towards the Kabrietenberg (78 m). The Boca is bordered by a sandy beach at the East, and by a steep limestone cliff with niche at the West.

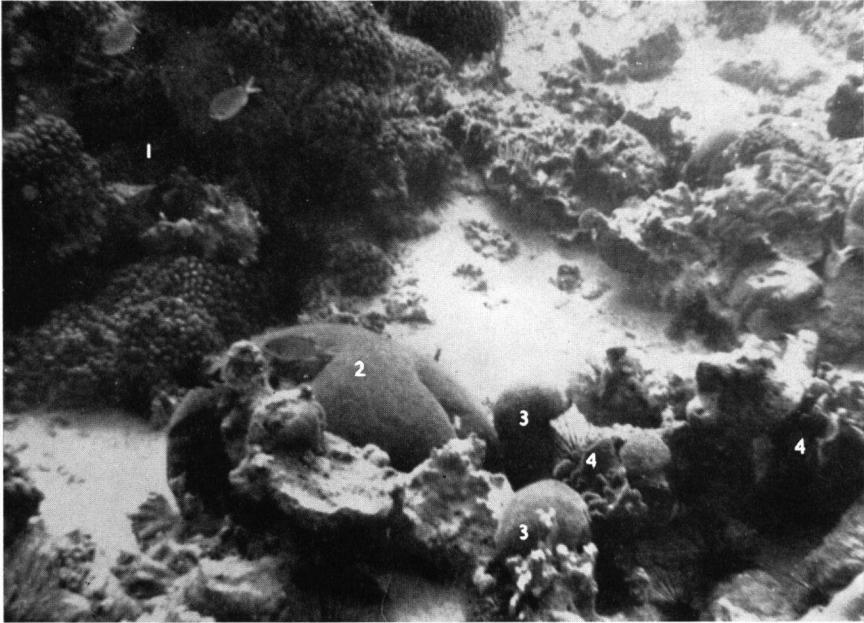
Plate IV



IVa. Playa Kalkie, 1-2 m deep: *Acropora palmata*.



IVb. Piscadera Baai, near entrance of inner bay, 6 m deep: 1 *Madracis asperula*, 2 *Montastrea annularis*, 3 *Agaricia agaricites*, 4 *Eusmilia fastigiata*, 5 *Siderastrea siderea*, 6 *Porites astreoides*.

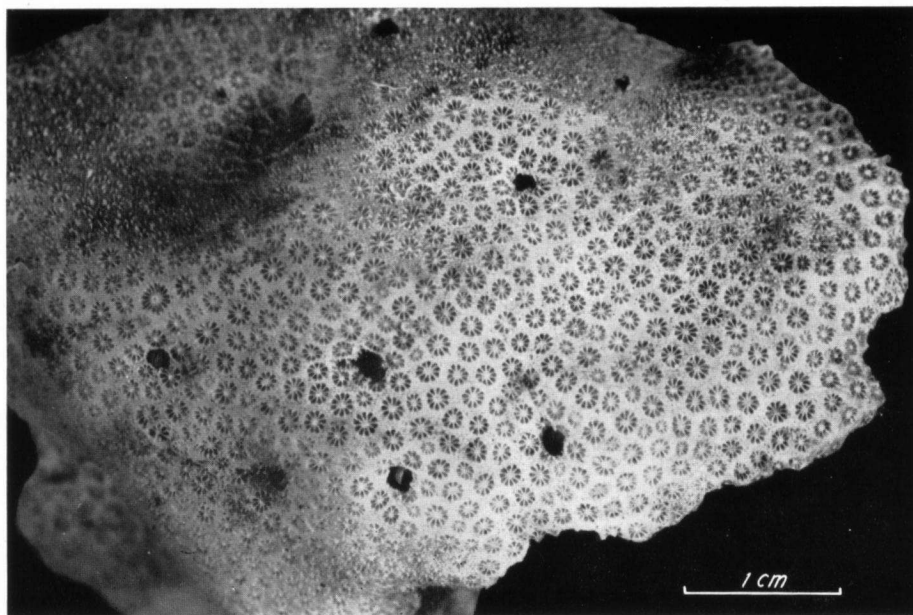


Va. Piscadera Baai, 6 m deep: 1 *Madracis asperula*, 2 *Siderastrea siderea*, 3 *Montastrea annularis*, 4 *Agaricia agaricites*.

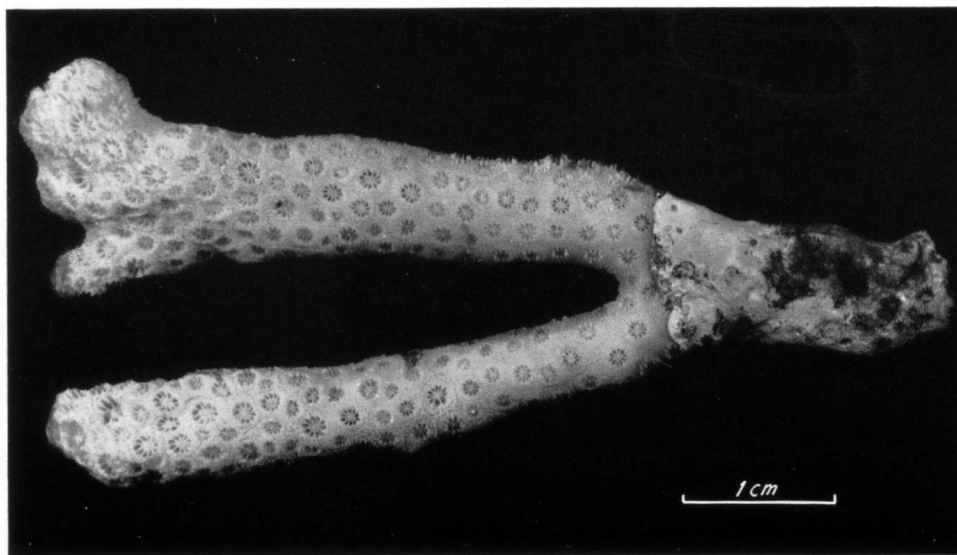


Vb. Piscadera Baai, 8 m deep: 1 *Montastrea annularis*, 2 *Diploria strigosa*, 3 *Eusmilia fastigiata*, 4 *Madracis asperula*, 5 *Agaricia agaricites*.

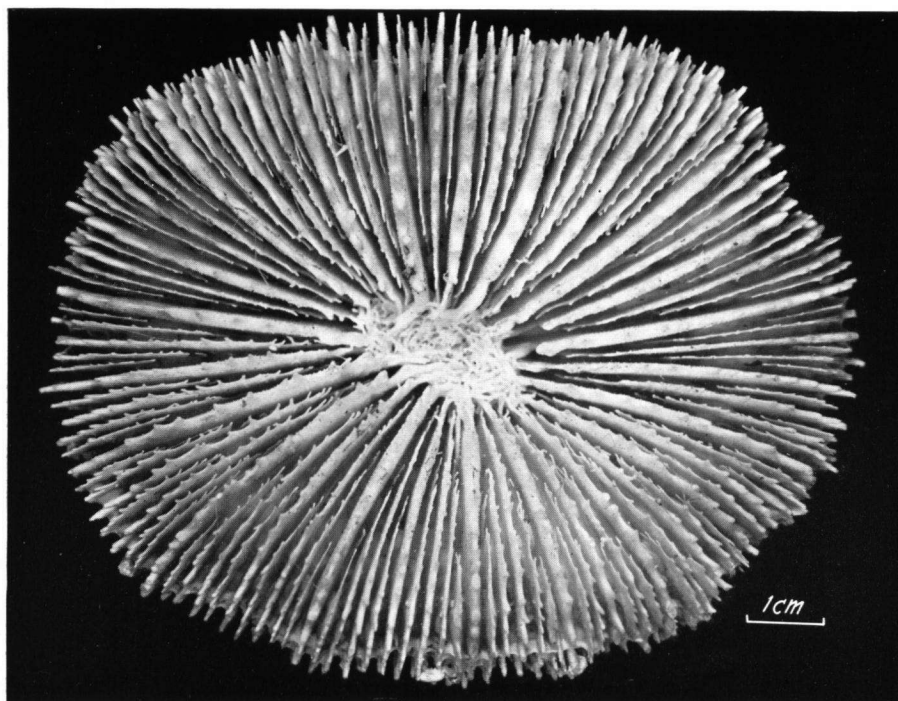
Plate VI



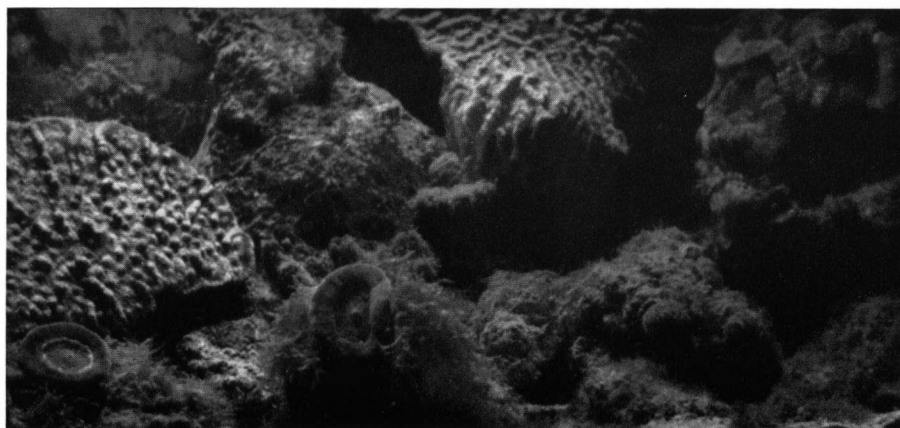
VIa. *Madracis decactis* from Piscadera Baai, 45 m deep. (PJR 139)



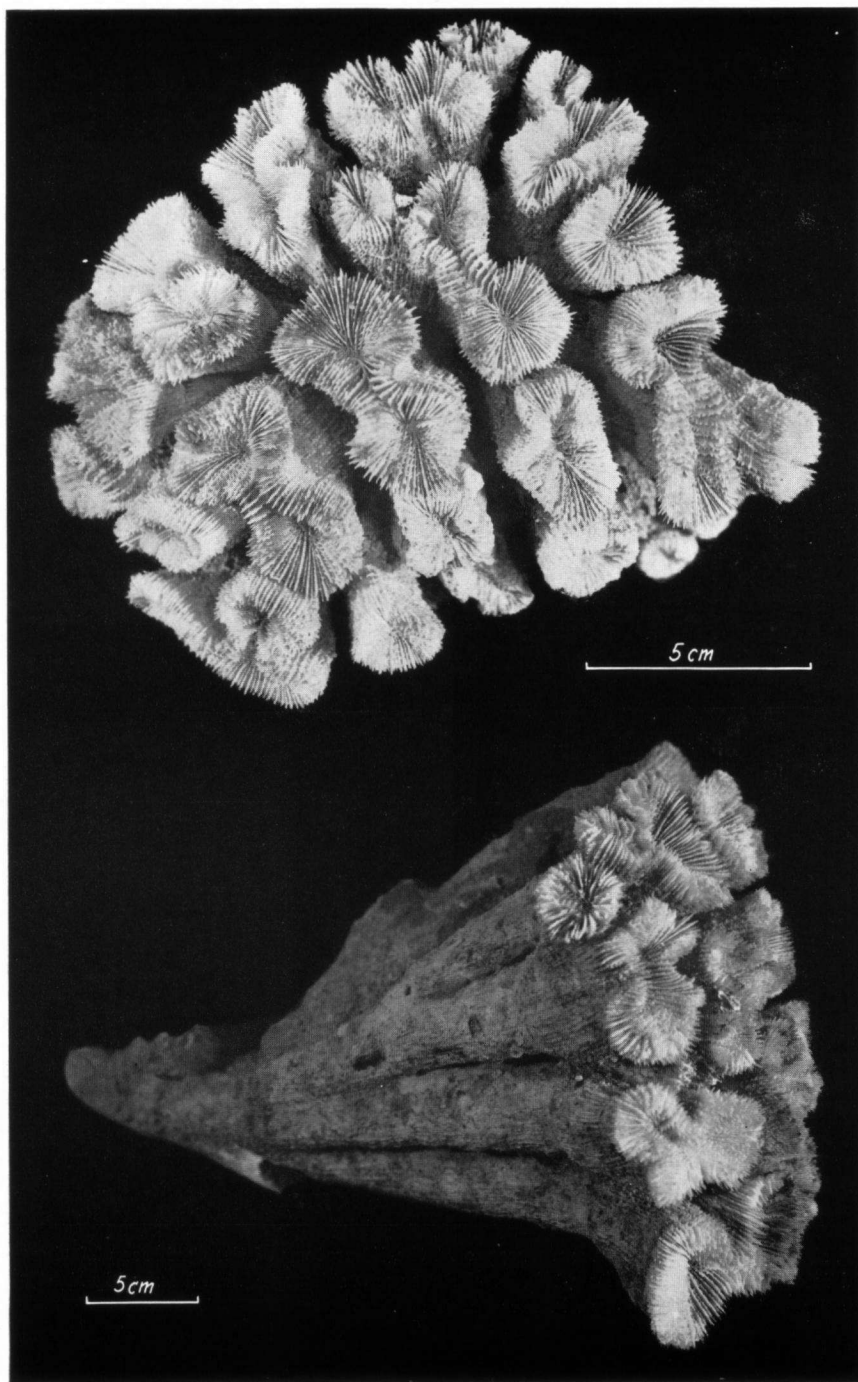
VIb. *Madracis asperula* from Piscadera Baai, 6 m deep. (PJR 101)



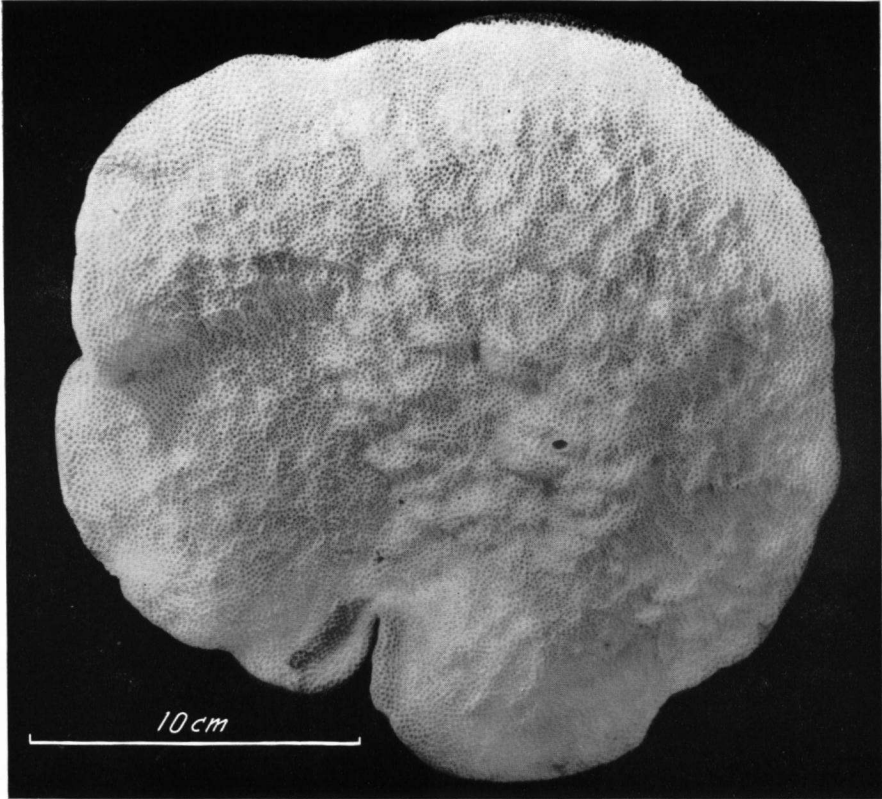
VIIa. *Mussa lacera* from Piscadera Baai, 40 m deep. (PJR 141)



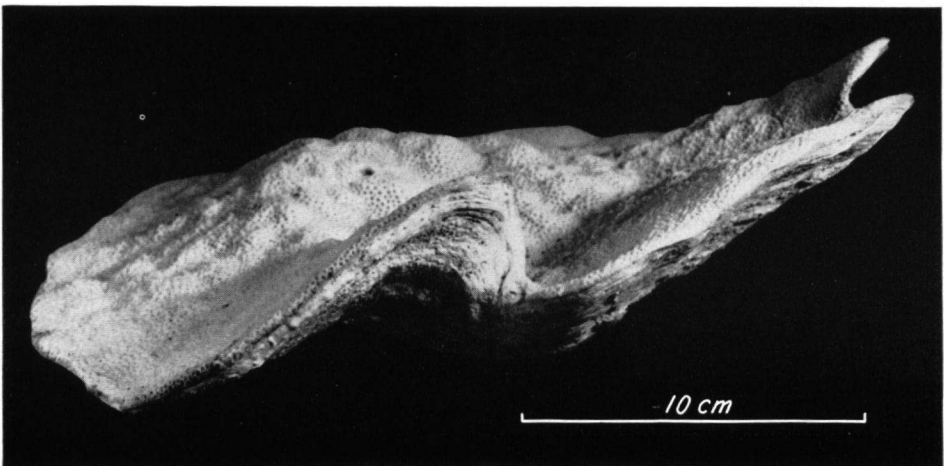
VIIb. Living reef corals from Curaçao at the laboratory of the Caribbean Marine Biological Institute: bottom-left, two bright green solitary *Mussa lacera*; top-right, a brownish-purple colony of *Mussa angulosa*.



Mussa angulosa from Piscadera Baai, 12 m deep, same specimen. (PJR 111)

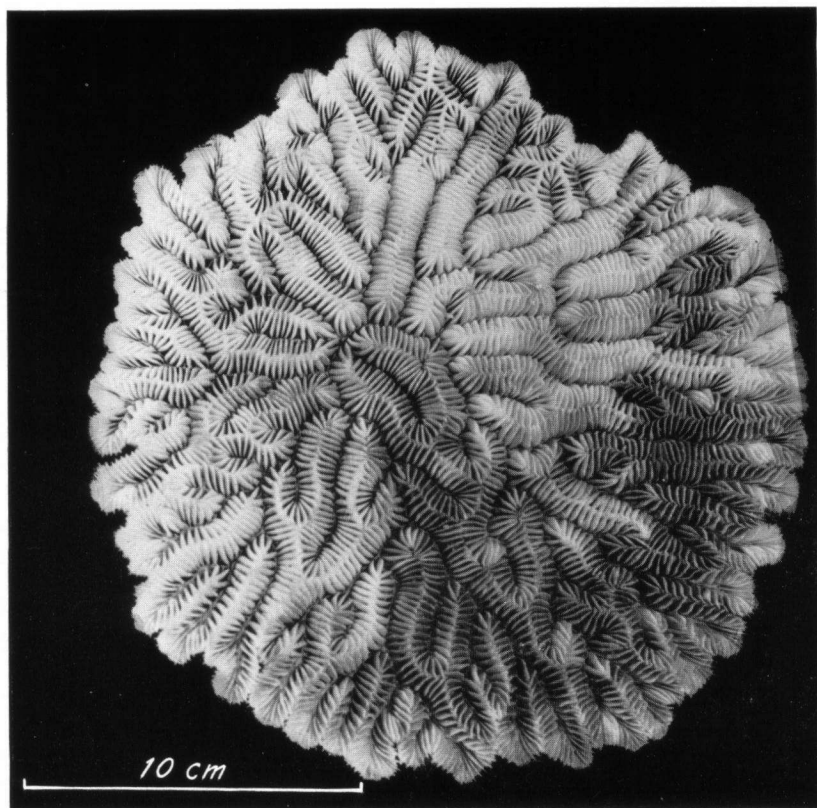


IXa. *Porites astreoides* from Piscadera Baai, 25 m deep. (PJR 95)

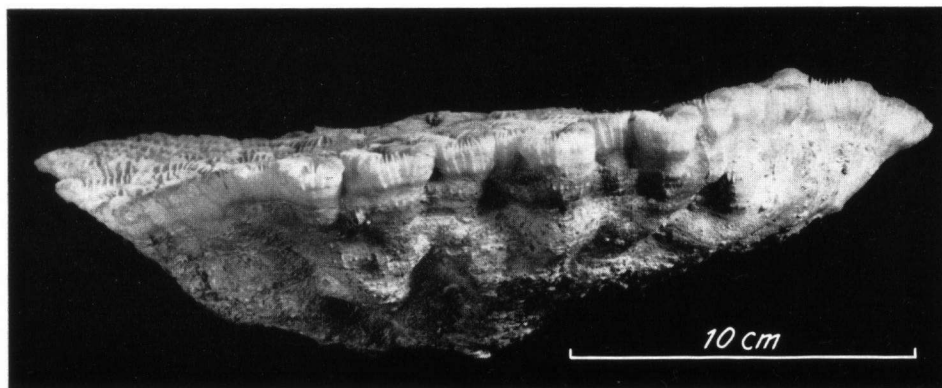


IXb. *Porites astreoides* from Piscadera Baai, 25 m deep. (PJR 95)

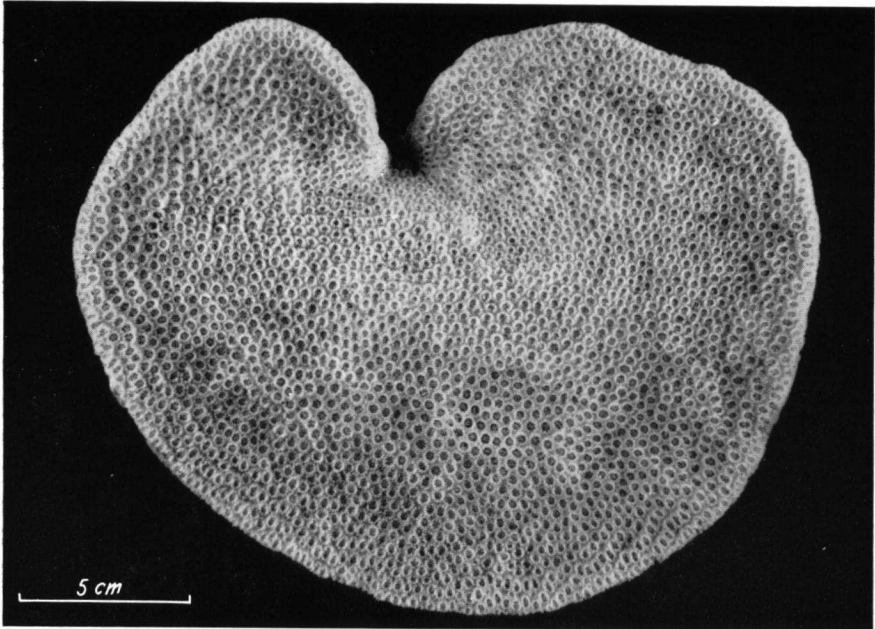
Plate X



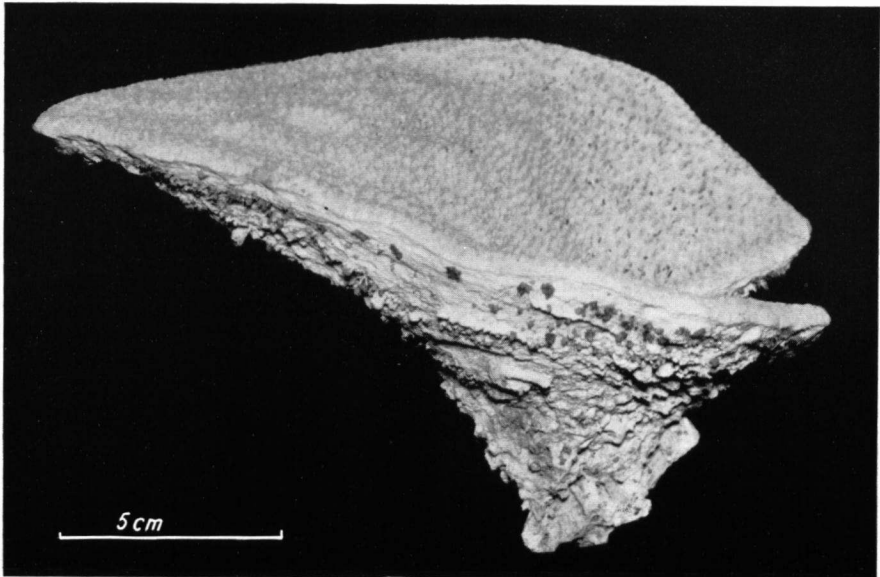
Xa. *Meandrina meandrites* from Piscadera Baai, 25 m deep. (PJR 103)



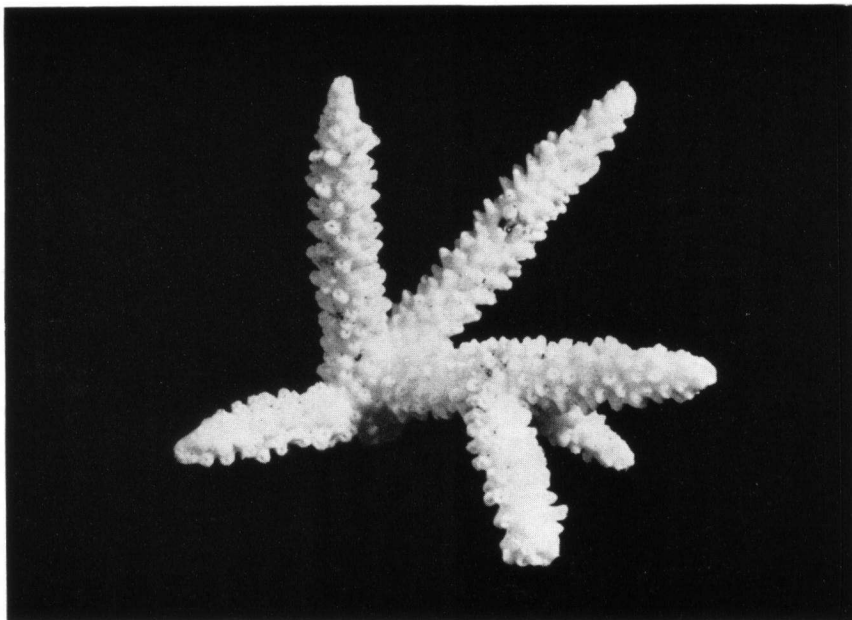
Xb. *Meandrina meandrites* from Piscadera Baai, 25 m deep. (PJR 103)



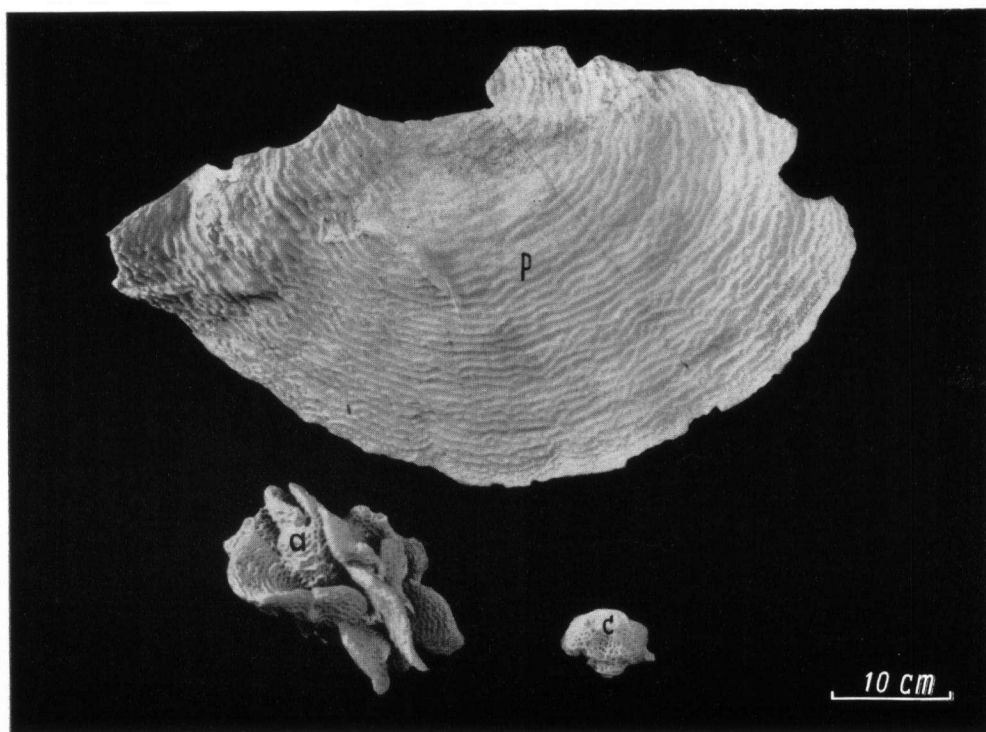
XIa. *Montastrea annularis* from Curaçao. (Zoöl. Lab. Utrecht)



XIb. *Montastrea annularis* from Curaçao. (same specimen)



XIIa. *Acropora cervicornis* from Westpunt Baai, 1 m deep; length of longest sprout from axil 55 mm, width 11 mm. (PJR 23)



XIIb. *Agaricia agaricites* from Piscadera Baai: p = forma *purpurea*, 20 m deep (PJR 121); a = forma *agaricites*, 8 m deep (PJR 47); c = forma *crassa*, $\frac{1}{2}$ m deep. (PJR 136)



XIIIa. *Acropora palmata* from Westpunt, Klein Bonaire, rising above sea level at low tide, and able to withstand surf-zone conditions: colonies of a quite normal appearance.



XIIIb. *Acropora palmata* from Klein Bonaire; extremely streamlined specimens at only a very short distance from the colonies illustrated on Plate XIIIa, at the entrance of a narrow, only 20 m long boca of the rather exposed limestone coast.