

ATOLL RESEARCH BULLETIN

NO. 178

**A PRELIMINARY DESCRIPTION OF THE CORAL REEFS OF THE TOBAGO
CAYS, GRENADINES, WEST INDIES**

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**Issued by
THE SMITHSONIAN INSTITUTION
Washington, D.C., U.S.A.**

January 15, 1975

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A PRELIMINARY DESCRIPTION OF THE CORAL REEFS OF THE TOBAGO CAYS, GRENADINES, WEST INDIES

by John B. Lewis^{1/}

INTRODUCTION

The Tobago Cays are composed of four small islands of the Grenadines lying between St. Vincent and Grenada, West Indies at 12°28'N, 61°22'W. They are exposed on a long, narrow submarine bank which stretches southward to Grenada. All are low lying with narrow beaches and rocky coasts and are covered for the most part by scrub vegetation of the type described by Beard (1949) for the Grenadines. The largest island, Petit Bateau, has an elevation of about 45 meters while the smallest, Jamesby is only 20 meters in height. The islands are not populated. They are visited frequently by fishermen from the nearby islands and are politically administered from Grenada.

The Cays are protected on the east by a semicircular coral reef called the Horseshoe Reef. Heavy seas break over the reef during most of the year and strong and variable currents flow across the reef into the central area. A map of the Cays and surrounding reef is shown in Fig. 1.

The distribution of the fauna on Horseshoe Reef and around the Cays was investigated by free divers. Data was recorded on an underwater slate and on photographs with a Nikonos II underwater camera. Three transects across the Horseshoe Reef were studied in detail. Because of the small size of the Cays it was possible to swim around the coast of each one and map the distribution of the shallow water communities. Representative samples of corals and other invertebrates were collected on each dive for subsequent identification.

The work was supported by a grant in aid of research from the National Research Council of Canada. I am grateful to Alan Emery for diving assistance.

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(Manuscript received June, 1972--Ed.)

LIST OF CORALS FOUND AT TOBAGO CAYS

Seriatorporidae:

- Madracis decactis (Lyman)
Madracis asperula Milne-Edwards and Haime

Acroporidae:

- Acropora cervicornis (Lamarck)
Acropora palmata (Lamarck)

Agaricidae:

- Agaricia agaricites (Linnaeus)
Agaricia fragilis (Dana)

Siderastreidae:

- Siderastrea radians (Pallas)
Siderastrea siderea (Ellis and Solander)

Poritidae:

- Porites astreoides Lamarck
Porites porites (Pallas)
Porites furcata Lamarck
Porites divaricata Leseuer

Faviidae:

- Favia fragum (Esper)
Diploria clivosa (Ellis and Solander)
Diploria strigosa (Dana)
Diploria labyrinthiformis (Linnaeus)
Colpophyllia natans (Müller)
Colpophyllia amaranthus (Müller)
Manicina areolata (Linnaeus)
Solenastrea bournoni Milne-Edwards and Haime
Montastrea annularis (Ellis and Solander)
Montastrea cavernosa (Linnaeus)

Trochosmiliidae:

- Meandrina meandrites (Linnaeus)
Dichocoenia stokesii Milne-Edwards and Haime
Dendrogyra cylindrus Ehrenberg

Mussidae:

- Mussa angulosa (Pallas)
Isophyllastrea rigida (Dana)
Mycetophyllia lamarckana (Milne-Edwards and Haime)
Isophyllia multiflora (Verrill)

Cariophylliidae:

- Eusmilia fastigiata (Pallas)

DESCRIPTION OF HORSESHOE REEF

A three dimensional sketch of the zonation across the mid-region of Horseshoe Reef is shown in Fig. 2. Three distinct regions were recognized, an inner zone or back reef, a reef crest and a reef slope or reef front.

1. Back reef

This is an area of relatively flat bottom varying in depth between 1 and 2 meters and in width between 50 and 75 meters. Between the back reef and the Cays the bottom is sandy with meadows of the sea grasses Thalassia testudinum König and Syringodium filiforme Kützing, broken by the presence of clumps of corals, sponges, the sea fan Rhipidogorgia flabellum (Linnaeus) and other alcyonarians.

Sediments in the back reef region are composed of coarse calcareous sands and there are wide areas of flat reef rock pavement. Patches of reef are dominated by low clumps of Montastrea annularis which may be 3-4 meters in diameter at the outer edge of the zone. Large colonies of Siderastrea siderea are also common in this zone, together with Porites astreoides, P. porites, Siderastrea radians, Diploria clivosa, D. strigosa, D. labyrinthiformis, Favia fragum, Agaricia agaricites, Isophyllastrea rigida and Meandrina meandrites. Towards the seaward limit of the zone scattered stunted growths of Acropora palmata occur.

Alcyonarians are very conspicuous on the back reef, especially the sea fan Rhipidogorgia. Other common alcyonarians include Briareum asbestinum (Pallas), Pterogorgia acerosa (Pallas), Eunicia asperula (Milne-Edwards and Haime), Plexaurella dichotoma (Esper), P. grisea (Künze), Plexaura flexuosa (Lamouroux) and Muricepsis flavida (Lamarck).

Patches of Millepora sp. are common in the mid-region of the back reef and towards the reef crest. Both the flat-bladed form and the more fragile branched types (Boschma, 1948) are present.

Other conspicuous invertebrates in this zone include the sea urchins Diadema antillarum (Philippi) on the coral patches and rock pavement, Tripneustes esculentus (Leske) on algae covered bottom, the large sedentary polychaete Sabellastarte magnifica (Shaw) in crevices between colonies of Montastrea annularis, the smaller boring polychaete Spirobranchus giganteus (Pallas) and numerous species of sponges. Near the reef crest zone extensive areas of flat reef rock pavement are densely covered with the yellow zooanthid Palythoa mammillosa (Ellis and Solander).

2. Reef crest

The reef crest zone is dominated by dense growths of the branching Acropora palmata. The water depth in mid-zone is 1-2 meters and the width varies between 10 and 25 meters across. The bottom is covered with broken branches of Acropora or is composed of bare rock pavement encrusted with Millepora or Palythoa and scattered colonies of Porites astreoides and Favia fragum. Narrow channels, a few meters in width, occur at frequent intervals along the reef and are bare of Acropora. The reef crest zone is thus a band of prolific growth of Acropora and is subjected to heavy wave action and water turbulence.

3. Reef front

The reef front may conveniently be considered to begin within the area of turbulence where the water begins to deepen. At the inner edge, clumps of Acropora palmata appear less dense and low mounds of Montastrea annularis are able to colonize the reef rock surface. There are large areas of uncolonized bare rock surface, scattered colonies of Porites porites, P. astreoides and the encrusting zooanthid Palythoa.

The seaward slope drops steeply from the reef crest to depths of 15-20 meters. Its face is dominated by large massive mounds of Montastrea annularis from a depth of about 5 meters down. At the top, Montastrea forms tall pillar-like clumps but then changes to shingle shaped colonies and broad sheets towards the bottom of the slope. There is much destruction of the clumps for a considerable amount of talus-like debris lies at the bottom of the slope or on the sandy bottom.

Mixed with the Montastrea are a number of other corals on the slope face. Acropora palmata is common near the top and there are numerous colonies of Porites porites, P. astreoides, P. furcata, Agaricia fragilis, A. agaricites, Dendrogyra cylindrus, Colpophyllia natans, C. amaranthus, Isophyllastrea rigida, Diploria clivosa, D. strigosa, etc. The sea fan Rhipidogorgia is abundant near the shallower portion of the slopes.

DISTRIBUTION OF SHALLOW WATER COMMUNITIES AROUND THE ISLANDS

The pattern of distribution of shallow water communities around the islands was very similar in each of the four Cays. Maps of the distribution of the major communities around the islands are shown in Figs. 3 and 4.

A prevailing current flows from east to west, across the Horseshoe Reef and past the four Cays. Longshore currents flow

along the east coasts of each of the Cays and are strongest at the northern and southern extremities of the islands. A strong current also flows between Rameau and Bateau Cays. The direction of current flow are shown in Fig. 1.

Each of the Cays is partially surrounded by a narrow reef. Except for Jamesby Cay, reefs are absent on the leeward sides. Between the reefs and the shore are mixed beds of Porites porites, P. furcata and Thalassia on patches of sand or reef rock pavement. At the northern and southern extremities of the islands, where the currents are strongest, there are luxuriant beds of Rhipidogorgia and other alcyonarians. The narrow reefs consist for the most part of low clumps or heads of coral on a sandy bottom which slopes gradually down into a channel. Typical sections of littoral shallow water fringing communities for a leeward and windward coast are shown in Fig. 5.

1. Petit Rameau

The southern coast of Rameau Cay is fringed by a narrow beach with a small patch of mangrove trees (Rhizophora sp.) near the eastern end. The eastern and western extremities are comprised of rocky outcrops.

Between the south coast reef and the beach the bottom is densely covered with a mixture of Porites porites, P. furcata, the turtlegrass Thalassia and the algae of the genera Halimeda and Amphiroa.

Other corals commonly found in this zone include Manicina aereolata, Porites astreoides, Favia fragum and Stephanocoena michelani. The anemones Condylactis sp., and Aiptasia sp., are abundant, as are the sea urchins Tripneustes esculentus (Leske) and Echinometra lucunter (Linnaeus) and the brittle stars Ophiocoma riseii (Lütken) and O. echinata (Lamarck). Several species of sponges including the large Sphaciospongia vesparia (Lamarck) are abundant.

The Thalassia-Porites association develops upon the debris and erect branches of Porites porites and Porites furcata. Sediment from two coralline algae of the genera Halimeda and Amphiroa is abundant throughout the community. Several other species of algae are abundant including the genera Laurencia, Dictyota, Dictyopecteris and Zonaria.

On the slope below about 2-3 meters Thalassia is absent and beds of Porites porites, P. furcata are mixed with low clumps of Montastrea annularis, Porites astreoides, Siderastrea radians, S. siderea, Favia fragum and the hydroid Millepora. Halimeda is still common and the bottom is thickly covered with debris from the calcareous algae and rubble from the branching

Porites species. There are profuse growths of a number of species of algae of the genera Dictyota, Penicillus and Udotea.

At the bottom of the slope and on the inner edge of the channel at about 5 meters a more diverse coral community is present. Montastrea annularis is the most common species and occurs in widely separated clumps. M. cavernosa, Siderastrea siderea, Diploria clivosa, D. strigosa, Colpophyllia natans, Porites furcata, Dichocoenia stokesii, Agaricia agaricites and Millepora are common. Rhipidogorgia and other alcyonarians are also present.

The middle of the channel between the south coast of Petit Rameau and the north coast of Petit Bateau is composed of calcareous sand and varies between 5 and 10 meters in depth.

The west coast of Petit Rameau is comprised of low rocky outcrops, broken by small sandy beaches. In shallow water the bottom is composed of carbonate sand and loose rubble of branching Porites and Acropora. There are small patches of living Porites porites and P. furcata. Mancina aereolata is common and Halimeda is abundant. In general, however, the area does not support a diverse fauna. In a little deeper water a few scattered corals, Favia fragum, Siderastrea siderea, Porites porites, Porites astreoides and Millepora occur down to sandy bottom at a depth of about 4 meters. A few isolated patches of Acropora palmata and Montastrea are present in depths of 4 or 5 meters.

The north and east coasts and the four corners of the island are characterized by low rocky cliffs, heavy wave action and strong currents. Prolific growths of the sea fan Rhipidogorgia develop in these areas, together with massive boulders of Siderastrea siderea and Diploria spp. These are encrusted on a reef rock pavement or upon exposed country rock. Close to shore the rock substrate is bare or secondarily encrusted with Millepora and Palythoa. Rhipidogorgia is found close to low water mark and the tips of the fans are sometimes exposed. Massive mounds of Montastrea annularis are developed in deeper water at 3-4 meters.

At the south west corner of the Cay, where the current is less strong and wave action limited, a more prolific association of corals are found and develops close to the shore. Fewer alcyonarians are found here but the coral community is much more diverse. Montastrea annularis is dominant but a number of species of massive corals are present.

2. Petit Bateau

The distribution of benthic communities around Bateau Cay is similar to that of Petit Rameau. The north coast lies

on the lee side and is protected from wave action. There is a wide beach along most of the coast. The shallow water along the coast is covered by extensive areas of broken coral rubble with a few patches of Thalassia and small colonies of massive corals. This bottom slopes downward to the channel with a sandy bottom at a depth of 4-5 meters. The north-east promontory supports a dense growth of Rhipidogorgia, the boulder corals Siderastrea siderea and Diploria species and Acropora palmata.

On the west side of the island there are steep rocky cliffs with piles of rubble at their bases in shallow water. Sea fans and other alcyonarians are abundant here, especially on the promontories where the current is strongest. There are patches of Acropora palmata, A. cervicornis, dense Millepora and small colonies of Porites porites and P. astreoides. Favia fragum and Siderastrea radians are common. Outside the 3 fathom line the bottom is comprised of sand and rubble with scattered coral patches.

Along the southern and eastern coasts there are sandy beaches with beds of Porites porites and Porites furcata in shallow water. Thalassia is less abundant here than on the southern coast of Petit Rameau. The Thalassia-Porites association lies in a narrow band along the coast down to depths of about 2 or 3 meters. Beyond this depth there are dense coral communities similar to those of Petit Rameau, dominated by Montastrea annularis.

3. Baradal

There is a sand and rubble bottom in shallow water along the south coast of this island and the water is very turbulent close to shore. The marine grasses Thalassia and Syringodium are common but very little Porites occurs here. Manicina aereolata is common and there are numerous loggerhead sponges Spheciospongia and a red encrusting sponge. Tripneustes esculentus is common in the grass beds. A long sand spit is present at the south-east end of the island.

Along the eastern coast there are rather narrow beds of Porites and Thalassia with scattered corals in deeper water. The Thalassia is replaced towards the northern end by scattered patches of reef corals including Acropora palmata, Diploria spp., Siderastrea and Porites. Alcyonarians are abundant at the northern and southern ends of the Cay. The bottom along the western coast is composed of sand and rubble with a heavy growth of green algae of the genera Ulva and Enteromorpha.

4. Jamesby

The shallow water along the western side has flourishing

communities of reef corals and alcyonarians similar to those on the east side of Petit Bateau. The west coast is rocky with much debris in shallow water. The water is turbid and strong currents prevail along this shore. A rather poorly developed Thalassia-Porites association with reef corals in deeper water occurs along the eastern coast.

DISCUSSION

The zonation of corals on the Horseshoe Reef is similar to that described for a number of other Caribbean reefs. The reef front or reef slope zone which is dominated by Montastrea annularis most closely resembles the reef front of Nicaraguan reefs described by Milliman (1969), the Montastrea-Deep-Water Zone at Abaco Island, Bahamas (Storr, 1964) and the outer reef regions on Aruba noted by Roos (1971).

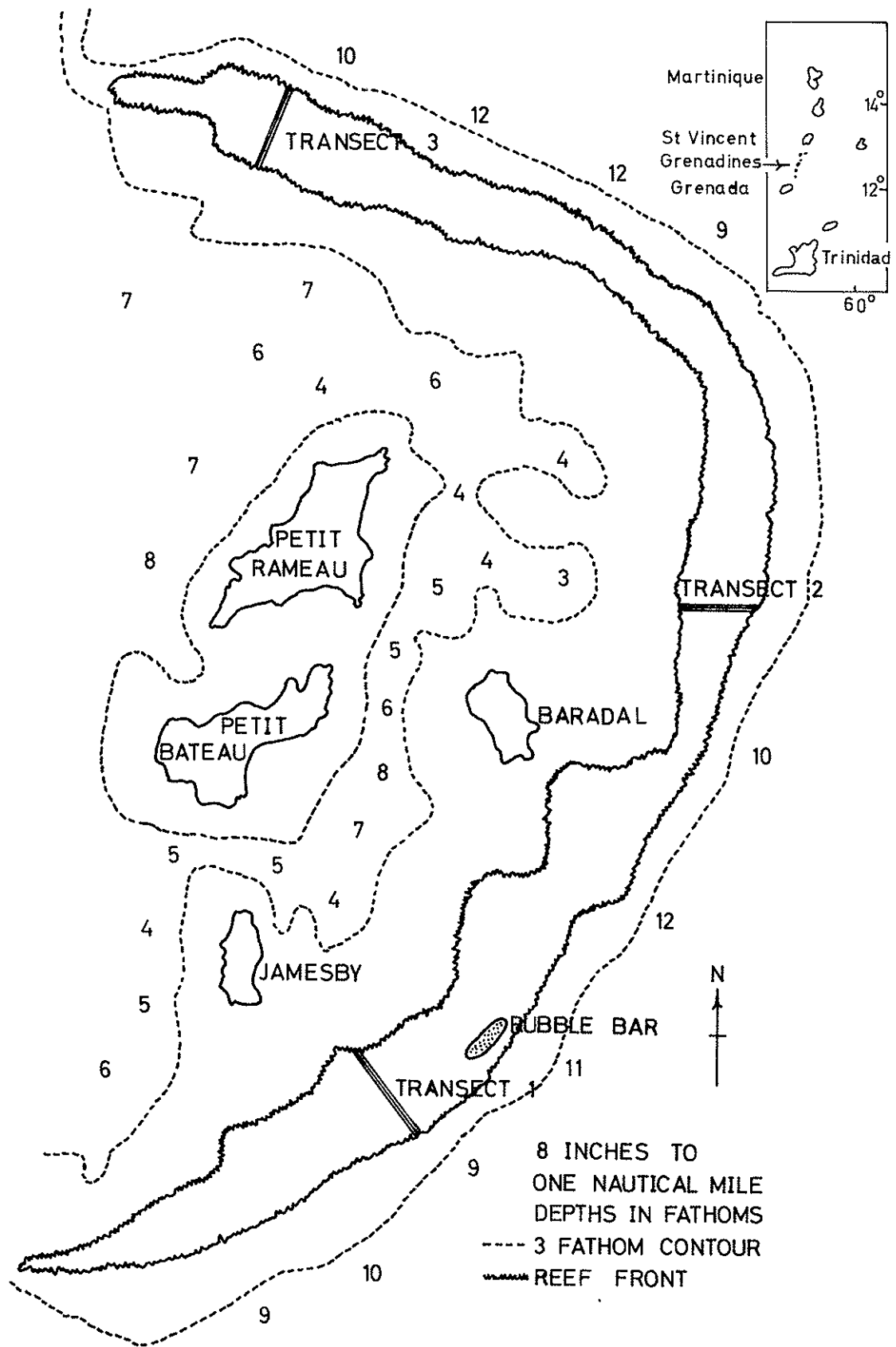
The reef crest with its dense growth of Acropora palmata is a characteristic feature of many Caribbean reefs and exists on the shallow frontal region in Florida (Shinn, 1963), in British Honduras (Stoddart, 1962), Jamaica (Goreau, 1959), Cayman Islands (Roberts, 1971), Curaçao and Aruba (Roos, 1964, 1971) and the Bahamas (Newell et al, 1959 and Storr, 1964). The spur and buttress region described for Jamaican reefs by Goreau (1959) is not present on the Horseshoe Reef although the reef is bisected with channels.

The back reef region resembles the shallow water zones described by Stoddart (1962), Roos (1964, 1971), Goreau (1959) and Milliman (1969) as a patchwork distribution of corals and alcyonarians. The occurrence of Millepora and the colonial zooanthid Palythoa in shallow water is also characteristic of Caribbean reefs and has been reported by Lewis in Barbados (1960), Adams in St. Vincent (1968), Milliman (1969) and Goreau (1959).

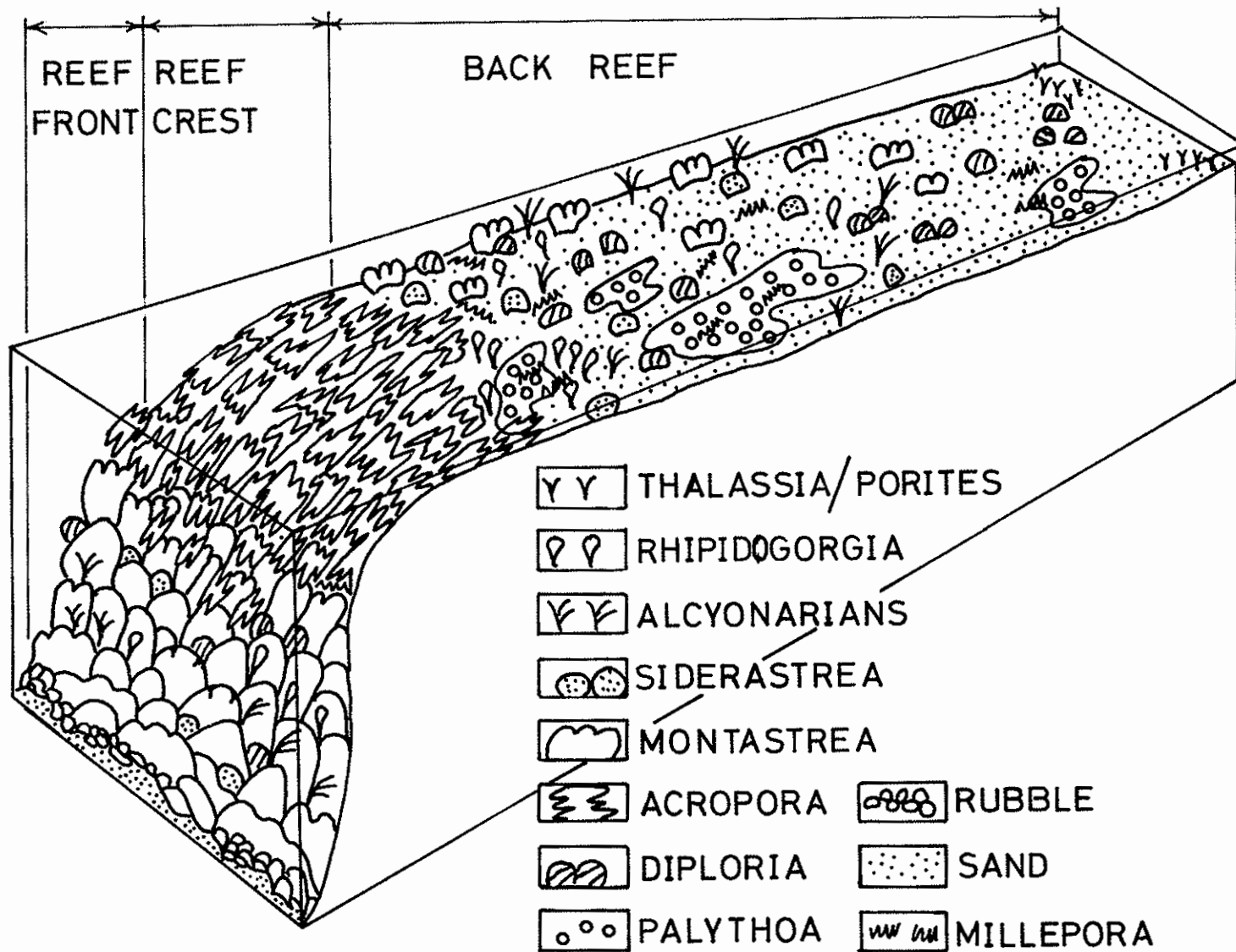
The distribution of shallow water communities around each of the Cays appears to be related to the coastline configuration and to the current velocities. Currents are strongest at the eastern entrance to the channel between Bateau and Rameau, at the north-eastern tip of Petit Rameau, the northern and southern ends of Baradal and along the western side of Jamesby Cay. There are flourishing patches of a number of reef corals in all these areas and dense stands of Rhipidogorgia and other alcyonarians. Thalassia-Porites associations are restricted to the southern coasts of Rameau and Bateau, along the eastern sides of Baradal and Jamesby where the currents are less strong. In deeper water below a few meters the composition of coral species is much the same for each Cay.

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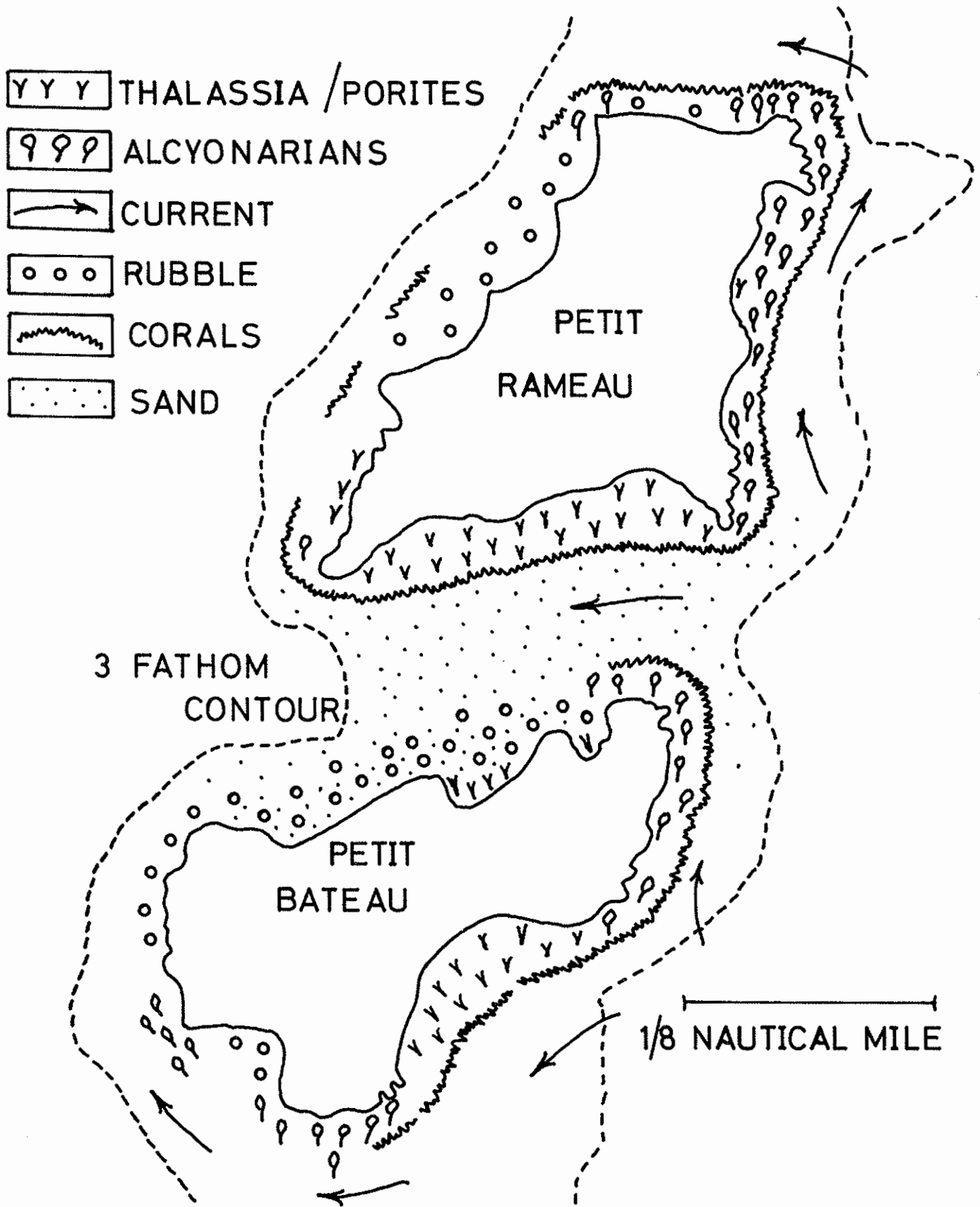
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1 Map of Tobago Cays with inset showing Lesser Antilles and Grenadines.



2 Three dimensional sketch of a generalized transect across the Horseshoe Reef showing zonation. Sketch not to scale. Depth 15-20 meters; horizontal distance approximately 100 meters.



3 Distribution of shallow water communities around Petit Rameau and Petit Bateau, Tobago Cays.

YYY THALASSIA / PORITES

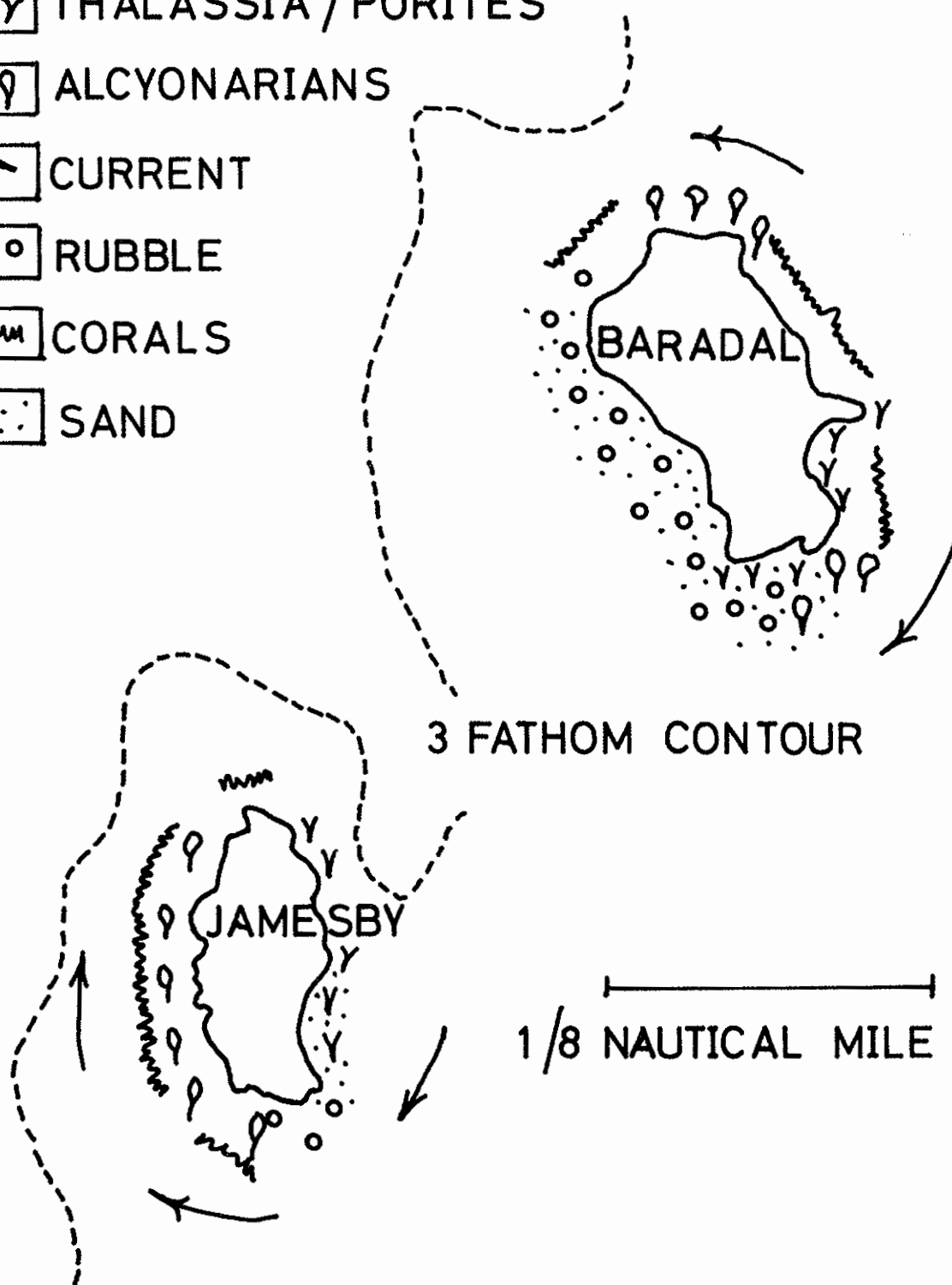
999 ALCYONARIANS

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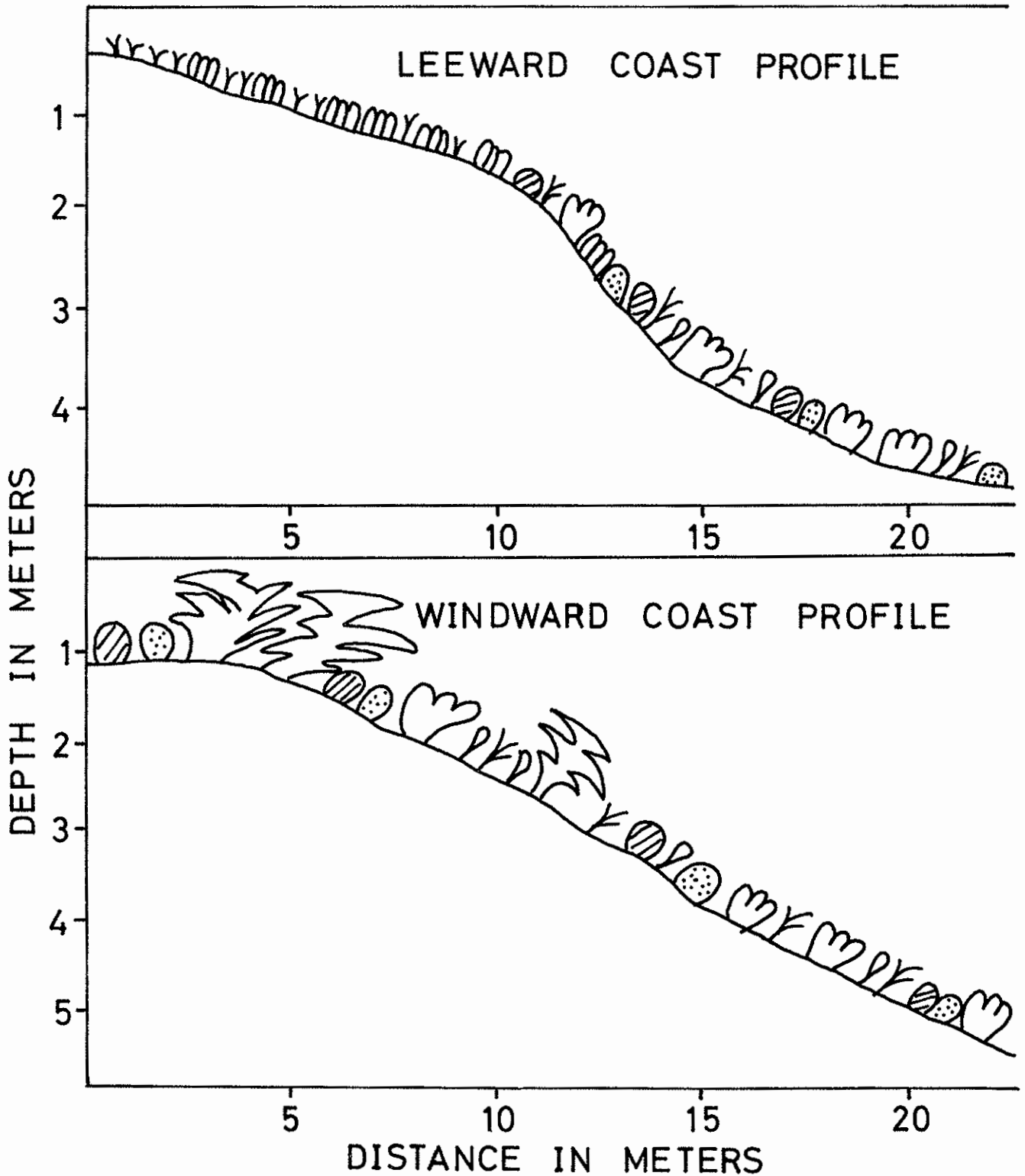
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4 Distribution of shallow water communities around Baradal and Jamesby, Tobago Cays.



|   |            |   |               |   |              |
|---|------------|---|---------------|---|--------------|
| Y | THALASSIA  | m | PORITES       | / | ALCYONARIANS |
| / | DIPLORIA   | . | SIDERASTREA   | S | ACROPORA     |
| M | MONTASTREA | P | RHIPIDOGORGIA |   |              |

5 Profiles of typical shallow-water communities on leeward (sheltered) and windward (exposed) coasts of the Tobago Cays.