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Occurrence and Distribution of Stony Corals (Anthozoa and Hydrozoa) in the vicinity of Santa Marta, Colombia

By

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With 1 figure and 3 plates

Resumen

Un reconocimiento en los alrededores de Santa Marta, Colombia, realizado en Enero y Febrero de 1971, resultó con 33 especies de corales scleractinias. Se determinaron distribución y abundancia relativa de las especies a lo largo de transectos. En estos se recolectaron también los especimenes, en cada caso desde el limite inferior de la presencia de corales (existencia más profunda en 30 ms) hasta el eulitoral. La ausencia de verdaderos arrecifes puede ser la consecuencia de afloramiento de aguas frias.

Zusammenfassung

Eine Untersuchung in der Umgebung von Santa Marta, Kolumbien, im Januar-Februar 1971, erbrachte 33 Arten von scleractinen Korallen. Verteilung und relative Häufigkeit der Arten wurde entlang von Transekten festgestellt. Hier wurde auch die Aufsammlung der Arten durchgeführt, und zwar jeweils von der Tiefengrenze des Korallenvorkommens (tiefster Fundort 30 m) bis zur Gezeitenzone. Das Fehlen echter Riffstrukturen dürfte auf Fluktuationen der Wassertemperatur zurückzuführen sein.

Summary

During a survey in January-February 1971 in the area of Santa Marta, Colombia, 33 species of Scleractinia were found. The distributions and relative abundances of species were recorded along transects. Subsequently all transects were sampled from the depth limit of coral (deepest occurrence 30 m), into the subtidal zone. The lack of prominent reef structures is believed to be a consequence of cold upwelling.

Introduction

A detailed survey of occurrence and distribution of stony corals in Venezuela made it desirable to extend this survey over the entire south coast of the Caribbean Sea. Due to the outstanding working facilities at the Instituto Colombo-Alemán, Santa Marta was chosen as one of the Colombian sites of this project. Following a reconnaissance visit in March-April 1970, a faunistic and ecological survey was undertaken in January—February 1971, at: 1. Punta de Betín, 2. Morro Grande and Morrito and 3. Bahía de Concha. All collected specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D. C.

Species occurrence and distribution were observed by diving with SCUBA outfit along established transects that were subsequently sampled

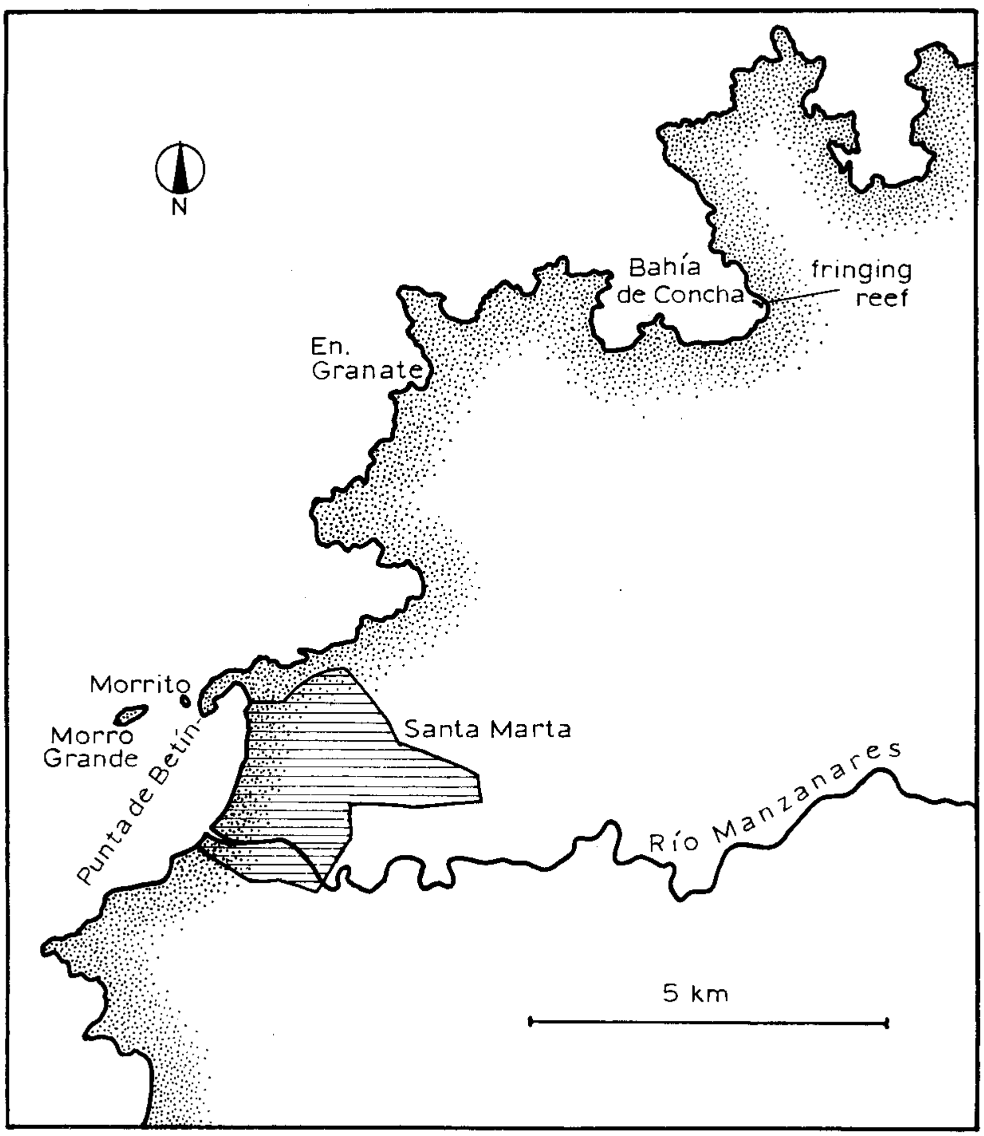

Figure 1. Map of Santa Marta, showing the location of the surveyed sites.

from deepest to shallowest limits of coral growth. Heavy sample loads were carried over long distances in a fabric bag tied to an empty gasoline tank. Distribution patterns along transects were documented by a movie camera (Eumig Vienette 3 — Submarine).

The Santa Marta locality lies southwest of the Peninsula de La Guajira at the foot of the Sierra Nevada de Santa Marta, the world's highest coastal mountain ridge. The rocky slopes of the Sierra dominate not only the Santa Marta coast, but also the area eastward up to about the small village of Dibulla. Within this coastal area, occurrance and distribution of coral species were not expected to vary significantly, owing to similar substratum conditions throughout. Therefore the results of the present survey probably are characteristic of most of the 100-km coastline between Santa Marta and Dibulla. Individual survey sites are described in the pertinent chapters.

List of species

Classification according to WELLS (1956)	Occurence at		
	Punta de Betín	Two Morros	Bahía de Concha
Class Anthozoa EHRENBERG 1834			
Subclass Hexacorallia HAECKEL 1896			
Order Scleractinia BOURNE 1900			
Suborder Astrocoeniina VAUGHAN & WELLS 1943			
Family Astrocoeniidae KOBY 1890			
1. *Stephanocoenia michelinii* MILNE-EDWARDS & HAIME	×	×	×
Family Pocilloporidae GRAY 1842			
2. *Madracis decactis* (LYMAN)	×		
3. *Madracis mirabilis* (DUCHAISSING & MICHELOTTI)			×
Family Acroporidae VERRILL 1902			
4. *Acropora cervicornis* (LAMARCK)			×
5. *Acropora palmata* (LAMARCK)		×	
Suborder Fungiina VERRILL 1865			
Superfamily Agariciicae GRAY 1847			
Family Agariciidae GRAY 1847			

Classification according to WELLS (1956)	Occurence at Punta de Betín	Two Morros	Bahía de Concha
6. *Agaricia agaricites* (LINNAEUS)			
forma *humilis*	×	×	×
forma nova (see footnote on page xxx)	×		
7. *Agaricia fragilis* DANA	×		
8. *Agaricia lamarcki* MILNE-EDWARDS & HAIME	×		
9. *Helioseris cucullata* (ELLIS & SOLANDER)	×		×
Family Siderastreidae VAUGHAN & WELLS 1943			
10. *Siderastrea siderea* (ELLIS & SOLANDER)	×	×	×
11. *Siderastrea radians* (PALLAS)	×	×	×
Superfamily Poriticae GRAY 1842			
Family Poritidae GRAY 1842			
12. *Porites astreoides* LESUEUR	×	×	×
13. *Porites porites* (PALLAS)	×	×	×
Suborder Faviina VAUGHAN & WELLS 1943			
Superfamily Faviicae GREGORY 1900			
Family Faviidae GREGORY 1900			
14. *Favia fragum* (ESPER)	×	×	×
15. *Diploria clivosa* (ELLIS & SOLANDER)	×	×	×
16. *Diploria labyrinthiformis* (LINNAEUS)			×
17. *Diploria strigosa* (DANA)	×	×	×
18. *Manicina areolata* (LINNAEUS)			
forma *areolata*			×
forma *mayori*	×	×	
19. *Colpophyllia natans* (MÜLLER)	×	×	×
20. *Cladocora arbuscula* (LESUEUR)	×	×	×
21. *Montastrea annularis* (ELLIS & SOLANDER)	×	×	×
22. *Montastrea cavernosa* (LINNAEUS)	×	×	×
23. *Solenastrea hyades* (DANA) ?		×	
Family Rhizangiidae D'ORBIGNY 1851			
24. *Astrangia solitaria* (LESUEUR)	×	×	×

Family Oculinidae GRAY 1847			
25. *Oculina diffusa* LAMARCK			×
Family Meandrinidae GRAY 1847			
26. *Meandrina meandrites* (LINNAEUS)			
forma *meandrites*	×	×	
forma *danae*			×
27. *Dichocoenia stellaris* MILNE-EDWARDS & HAIME	×	×	×
28. *Dichocoenia stokesii* MILNE-EDWARDS & HAIME	×	×	×
Family Mussidae ORTMANN 1890			
29. *Mussa angulosa* (PALLAS)	×	×	×
30. *Scolymia lacera* (PALLAS)	×	×	×
31. *Isophyllia sinuosa* (ELLIS & SOLANDER)		×	×
32. *Mycetophyllia lamarckana* MILNE-EDWARDS & HAIME		×	×
Suborder Caryophylliina VAUGHAN & WELLS 1943			
Superfamily Caryophylliicae GRAY 1847			
Family Caryophylliidae GRAY 1847			
33. *Eusmilia fastigiata* (PALLAS)	×	×	×
Class Hydrozoa OWEN 1843			
Order Milleporina HICKSON 1901			
Family Milleporidae FLEMING 1901			
34. *Millepora alcicornis* LINNAEUS			×
35. *Millepora complanata* LAMARCK	×	×	×
36. *Millepora squarrosa* LAMARCK	×	×	×

Distribution of Species

1) Punta de Betín

The Punta de Betín is a high, narrow rocky cape, forming the northwestern end of the bay of St. Marta. Its inner (eastern) shore is very sheltered, and the shallow inner shelf consists of boulders interspersed in a gravel-and-sand flat. Scattered coral growth is restricted to rocky surfaces, and is dominated by the hydrocoral *Millepora complanata.* Scleractinians are represented by only 4 species: *Diploria strigosa, Manicina areolata, Siderastrea radians* and *Favia fragum. S. radians* and *F. fragum* tend to form small round heads up to 7 cm in diameter and *M. areolata* f. *mayori* up to 10 cm, whereas *D. strigosa* is more encrusting, reaching 25 cm in diameter.

The outer (western, windward) side of the cape differs in character because the steep rocky slopes plunge to 20 m before they flatten out.

The rocky surface generally disappears under muddy sand flats at the 25 m contour line. Coral species decrease conspicuously on these slopes, from the water surface to the mobile bottom. The total number of species in this locality is represented only in the upper layers of zonation, where every species occurs at least occasionally, but each disappears completely beyond a certain depth. The subtidal zone down to 1 m is a notable exception because *Millepora companata, M. squarrosa,* and *Favia fragum* are abundant, *Siderastrea radians* is scarce, but no other species are represented here.

The seven species noted at the bottom of the zonation, ranging from 25 to 20 m, are, in order of abundance: *Montastrea cavernosa, Agaricia agaricites* forma *humilis* and f. n.[1]), *Agaricia lamarcki, Scolymia lacera, Dichocoenia stellaris* and *D. stokesii, Helioseris cucullata* and *Agaricia fragilis.* At the 20 m level, the number of species increases to 10, with the appearance of *Montastrea annularis, Stephanocoenia michelinii* and *Porites astreoides. Colpophyllia natans, Diploria strigosa* and *Meandrina meandrites* occur at 17 m, and *Siderastrea siderae, Eusmilia fastigiata* and *Mussa angulosa* occur at 15 m. At 10 m, only *Madracis decactis* is new, while *Diploria clivosa* and *Manicina areolata* appear from 5 to 1 m.

Unquestionably dominant in the deep layers of this zone is *Montastrea cavernosa,* although its colonies rarely exceed 1/2 m in diameter. These colonies are mainly flat and encrusting, and show a wide spectrum of color diversity: pink, brown, bright and dark green, grey-green, and even almost black. *Montastrea annularis* is far less abundant, but some specimens grow to sizes unusual in this area. The largest single colony recorded, a free-standing stalk 2.50 m high and 1.50 m in diameter, had a completely smooth and uninterrupted surface, and was alive from top to bottom. Dominant from about 15 m to 4 m are *Colpophyllia natans* and *Diploria strigosa,* both growing to about 1 m in diameter. *Siderastrea siderea, Diploria clivosa* and *Manicina areolata* dominate the uppermost layer, just below the *Millepora-Favia* zone.

S. siderea forms flat heads, *D. clivosa* is encrusting, and both may reach 25 cm in diameter. *Manicina areolata* f. *mayori* grows only to about half this size and tends to form rounded crusts.

2) Morro Grande, Morrito

Both Morros are naked rocky elevations west of the Punta de Betín, Morro Grande being 1 km away and Morrito merely separated by a channel from the mainland. Morro Grande is a high and narrow ridge oriented in a NE—SW direction, about 500 m long, and still representing a proper island, whereas Morrito is no more than a cliff. Despite

[1]) A new form of *Agaricia agaricites,* will be described by J. W. Wells.

their apparent dissimilarity, these two areas are remarkably similar under water. The Morro Grande was investigated to the extreme western point because wave action too strong to anchor a boat and distances too long to swim prevented the inspection of the proper windward side. The small size of the Morrito, however, made a complete survey of this islet possible, including its windward side.

Underwater slopes of both Morros provide a steep rocky surface for coral settlement, except for the landward side of Morrito, where the bottom is just 4 m deep and composed of very coarse gravel. The leeward side of both Morros is coral covered down to 25 m, where the slopes are replaced by sand flats. At the western and northern (windward) side of Morrito, coral growth extends to 30 m — the deepest limit of coral occurrence found during the present survey.

Despite these additional 5 meters depth of coral growth at Morrito, coral distribution at the two Morros is not significantly different. Deepest layers of zonation from 25 or 30 m, up to about 20 m, are dominated by *Montastrea cavernosa* that forms colorful, flat and rather small colonies similar to those observed at Punta de Betín. They may comprise well over 50 % of the living coral surface, while the remaining 50 % are divided between *Agaricia agaricites* f. *humilis*, *Scolymia lacera*, *Isophylla sinuosa* and *Mycetophyllia lamarckana*, the latter covering more space than the others owing to the larger size of its colonies (up to 30 cm in diameter). *Isophyllia sinuosa* and *Scolymia lacera* reach about 10 cm in diameter, *Agaricia agaricites* f. *humilis* hardly half this size. *Dichocoenia stellaris* and *D. stokesii* are scarce in this zone. Nearly all coral colonies in this range occur as flat forms that are either encrusting (e. g. *Montastrea cavernosa)*, or disc shaped (e. g. *Mycetophyllia lamarckana*).

Although the species noted above also occur in the upper layers of the zonation, they are not dominant above the 20 m line. More head-shaped colonies occur. The dominant species above 20 m is *Colpophyllia natans*, which also forms the largest heads, sometimes exceeding 1 m in diameter. Next in size are *Montastrea annularis* and *Stephanocoenia michelinii*, which both form small heads up to about 30 cm. *Diploria strigosa*, *Meandrina meandrites* f. *meandrites* and *Siderastrea sidera* reach about similar size, but are less common. Rather scarce and scattered colonies of *Eusmilia fastigiata* and *Mussa angulosa* grow to 20 and 40 cm high, respectively. *Porites astreoides* is common in shallow depths, including the subtidal layer where *Millepora complanata*, *M. squarrosa* and *Favia fragum* are dominant. A third species, however, could be detected at the Morro grande — an encrusting piece of *Acropora palmata*, not more than 8 cm in diameter[2]). Another extremely rare species,

[2]) This species, which was practically absent in all transects made, occurs in Ensenada de Granate, halfway between Sta. Marta and Bahía de Concha.

believed to be *Solenastrea hyades*, was observed in 30 m depth at the Morrito, but since no sample was taken this finding remains doubtful.

3) Bahía de Concha

The Bahía de Concha is a deep sheltered bay lying 10 km northeast of Sta. Marta. It appears to be the only area in the entire study site where a small fringing reef has developed. The top of this reef is a flat about 10 × 30 m, one side stretching into the intertidal zone of the shore, and its seaward edge about 30 cm deep. From this rim a sandy flat extends down to 2 m. Between 2 and 3 m, the slope becomes increasingly steep, and from 3 m a proper declivity drops to about 8 m. At this depth the slope flattens out again and patches of coral sand become common, gradually changing to mud around the 10 m line. An uninterrupted and continuous mud flat begins at the 15 m isobath.

The mud flat is the depth limit of coral growth. The deepest layer of the zonation, between 15 and 10 m, is patchily inhabited by 8 scattered species: *Dichocoenia stellaris* and *D. stokesii*, *Scolymia lacera*, *Montastrea cavernosa*, *Mycetophyllia lamarckana*, *Isophyllia sinuosa*, *Agaricia agaricites* f. *humilis* and *Helioseris cucullata*. Although the total number of *Dichocoenia* species is generally small in the entire area, they are dominant in Concha Bay towards the depth limit of species distribution. Both species may reach nearly 30 cm in diameter, which is about twice the colonial size found at other sites.

No further species zonation can be observed between 10 m and 2 m depths. In addition to the recorded species, *Diploris strigosa* and *D. labyrinthiformis* occur along with *Montastrea annularis*, *Siderastrea sidera* and *Colpophyllia natans*, all forming head-shaped colonies of considerably greater size than observed at the other localities. They may well exceed 1 m in diameter, with *Diploria strigosa* and especially *Colpophyllia natans* reaching more than 2 m. Also common in this zone, but smaller in size, are colonies of *Stephanocoenia michelinii*, *Meandrina meandrites* f. *danae*, *Porites astreoides* and *Manicina areolata* f. *areolata*. Although large heads and boulders dominate this slope, only a few are in good condition, for only about 30 % (mainly smaller colonies) may be completely uninjured, while about 50 % of all coral heads are at least partly damaged, and 20 % (mainly large one) are completely dead.

The branching forms show less damage than the compact species. *Mussa angulosa*, which is common, has colonies measuring about $^1/_2$ m in either direction. *Eusmilia fastigiata*, also common, reaches half this size. The colonies of *Oculina diffusa* are scarce and very tiny; those of *Madracis mirabilis* are also scarce, but rather extended. In 5 m depths, a dense layer of this species has covered a surface of several square meters, and thus grows over a few large dead coral heads.

Acropora cervicornis was observed only in the rather sandy flat lying between the 2 m contour line and the flat reef-top. The branches reach about 1/2 m in length but never form a coherent layer since distribution is widely scattered. At the edge of the reef flat, in water 50 to 20 cm deep, the densest growth of *Millepora* could be observed, including all three species. However, *M. squarrosa* and *M. alcicornis* are dominant. Deeper down, to about 3 m, only *M. complanata* was noted. The top layer of the reef is a coherent and unbroken flat of *Porites porites*.

Conclusions

The three surveyed localities — Punta de Betín, the Morros and Bahía de Concha — do not show any important differences in species diversity. However, significant differences were observed in growth forms when the exposed sites were compared with the sheltered Bahía de Concha. The mean size of coral colonies in the bay is about twice the size of those at Punta de Betín or the two Morros. On the other hand, coral heads at the exposed sites were noted to be much healthier than those of Concha Bay. In the bay at least 80 % of all coral colonies inhabiting the slope are partly destroyed or completely dead, whereas nearly all corals at Punta de Betín or the two Morros are alive and uninjured. Stronger currents and wave action at the exposed sites may account for these differences. Sediment does not settle long enough on the corals of the exposed sites to cause extensive coral mortality. Furthermore, heads that may have died because of being broken loose during heavy storms apparently do not remain at the slope, but seem to be transported gradually into deeper water to the end of the rocky surface, until they disappear in the mobile substratum.

Because Concha Bay is much more sheltered and rarely experiences heavy storms, coral heads are overthrown by bio-erosion only and are not transported. Bio-erosion usually takes place after coral killing by sedimentation. It seems that sediment, once it has been stirred up here and settles down on the coral colonies, remains long enough to cause considerable damage. Thus, the great number of dead coral heads present in this bay may ultimately be the result of sedimentation. The change of the ratio between live and dead specimens (i. e. increasing percentage of dead specimens towards larger size) might serve as an indicator of the frequency of heavy sedimentary disturbance.

Compared with other areas of the Caribbean Sea, Santa Marta is intermediate with respect to species diversity. Thirty-three species of scleractinian corals have been discovered to date, plus two species, *Madracis asperula* and *Solenastrea bournoni*, from Geyer's (1969) list of species from Bahía de Concha which were not observed during the present survey. One specimen at the Morrito tentatively identified as

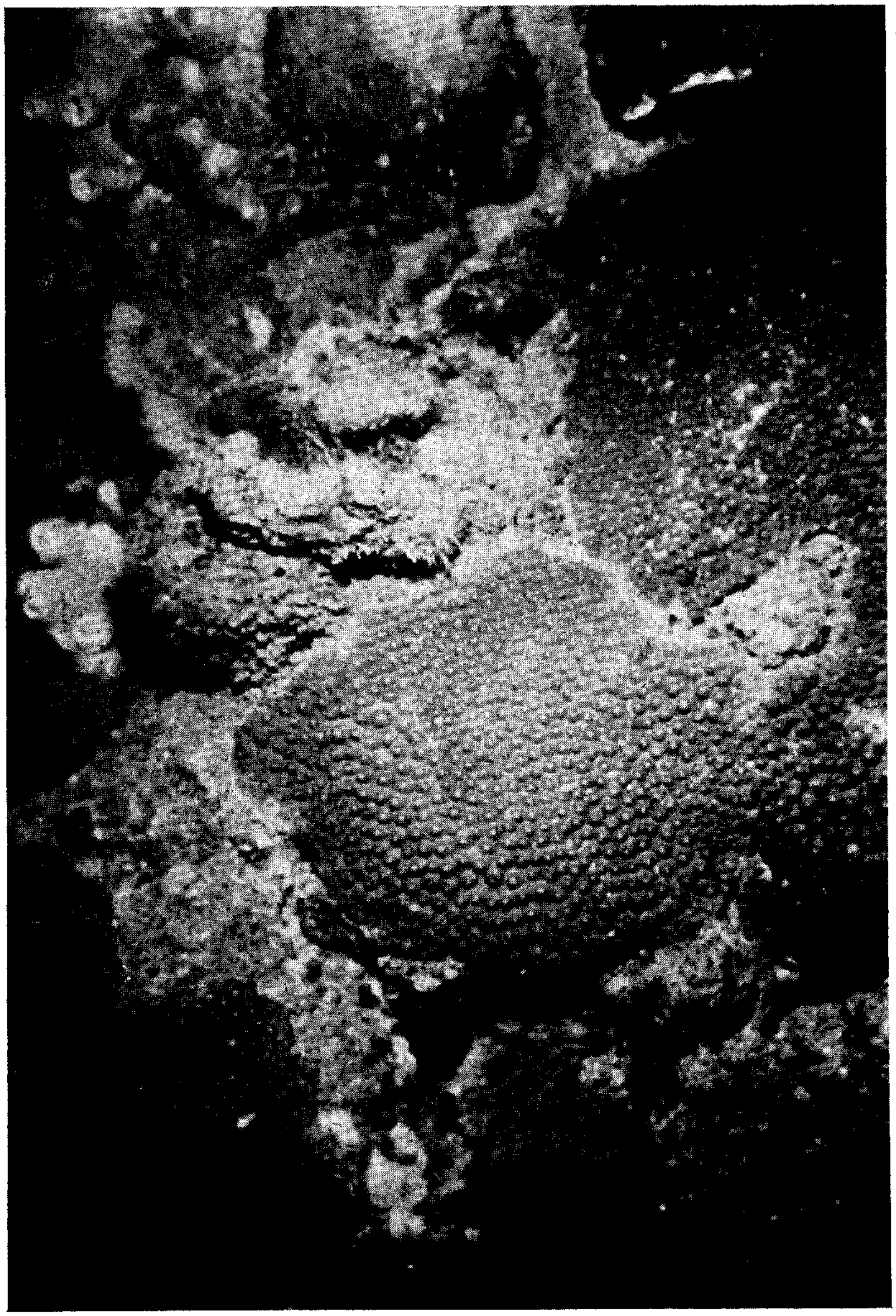

Plate 1. Deep colonies of *Montastrea cavernosa* are flat and encrusting. Morro Grande, 20 m.

Plate 2. Head shaped colonies of *Montastrea cavernosa* in shallow water. Punta de Betín, 4 m.

Plate 3. Colonies of *Montastrea cavernosa* partly killed by sedimentation. Bahía de Concha, 9 m.

S. hyades may, however, be *S. bournoni*. On the other hand, *Madracis* listed by GEYER as *M. asperula* may have been *M. mirabilis, which* definitely occurs in the Bahía de Concha and is difficult to distinguish from *M. asperula,* particularly when only thin parts of branches are available for identification.

Species diversity of Sta. Marta is thus well above other parts of the southern coast of the Caribbean See previously surveyed, especially the large and interesting Gulf of Cariaco in eastern Venezuela which has only 15 species of scleractinians (ANTONIUS, in press). It appears that limiting environmental factors are considerably stronger in the southeastern coastal area of the Caribbean than in the southwestern. Low water temperatures at the eastern part of the Venezuelan coast, related to cold upwelling, which heavily influences this area (FUKUOKA 1965 a, b, 1966), may restrict the number of species and proper reef development. In the Gulf of Cariaco, for example, temperatures as low as 19° C were recorded in the littoral zone (ANTONIUS, in press).

The temperature range favored by hermatypic corals lies between 25°—29° C (VAUGHAN and WELLS 1943). A short exposure to 18.5° will block their growth (MAYOR 1914), while with few exceptions (MACINTYRE & PILKEY 1969), reef corals will die at about 16° (MAYOR 1916). The surface temperature in January—February 1971 at Sta. Marta was 24° C, and no significant decrease was detected with depth. The number of species in this area is therefore surprisingly low considering that this is just 1 degree below the optimum temperature range for reef corals. However, just as the absence of reef development off the entire East Venezuelan coast may be related to cold upwelling (ANTONIUS, in prep.), so the lack of reef construction around Sta. Marta may be the result of at least occasional upwelling. Characteristic for both eastern Venezuela and the Sta. Marta coast is the fact that small fringing reefs exist only at the inner parts of sheltered bays that are less influenced by cold upwelling and show slightly higher mean water temperatures. Consequently, the narrow zonation of species, a result of temperature decrease, is more evident at exposed sites than inside the bay.

The assumption that cool water may hamper coral reef development gains probability if the southern Caribbean coast is compared with immediately adjacent islands which are not influenced by low temperatures. PFAFF's (1969) list of coral species and varieties of the Islas del Rosario off Colombia, for example, contains 48 scleractinians, and during a Venezuelan survey, very similar conditions were found at Los Roques, an atoll off Venezuela (ANTONIUS, in prep.), both islands being well developed and active coral reef structures.

From the next neighboring island, Curaçao, 28 species and varieties were reported (ROOS 1964), 33 from Barbados (LEWIS 1960), 35 from Puerto Rico (ALMY and CARRION-TORRES 1963) and 41 from Cuba

(DUARTE BELLO 1960). These numbers of species, mostly reported from well developed reefs, seem low. The great increase in coral numbers off Jamaica, up to 62 species (GOREAU and WELLS 1967), may be attributed to more detailed investigations rather than to basic distinctions.

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