CORALLINE ALGAL MICROATOLLS NEAR COZUMEL ISLAND, MEXICO

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ABSTRACT: Microatolls of coralline algal encrustations were discovered during a reconnaissance study of environments around Cozumel Island, 14 miles off the northeast coast of the Yucatan Peninsula. One-hundred-sixteen of them were counted in one small area along the northeastern shore in a belt approximately 100 feet wide, 150 yards offshore, and parallel to shore. The microatolls are roughly circular with diameters between 12 and 25 feet. The outer margin of each is outlined by an algal ridge several inches wide and a few inches above sea level. This rim, enclosing a shallow "lagoon", is especially prominent because it supports a luxuriant growth of upright, non-calcareous algae.

Many of the microatolls are within 15 feet of one another; the deepest passages observed between them are 14 feet deep. The microatolls form the upper rims of cylindrical structures with vertical to slightly overhanging sides. The sides are covered by coralline algae including *Goniolithon solubile*, *Archaeolithothamnium episporum*, *Lithothamnium sejunctum*, *Epilithon membranaceum*, *Lithophyllum* sp., and *Lithoporella* sp. Living coral colonies cover only a small percent of the vertical sides, but most samples show coral beneath the algal encrustation. The origin of the microatoll foundations is speculative.

INTRODUCTION

Fossil algal biostromes and bioherms of various geologic ages have been described from many areas. Most of these are stromatolitic and are thought to have been built primarily by blue-green algae. In the seas of today, the coralline red algae seem to be the most important plant group creating *in situ* deposits of calcium carbonate. Studies of recent reefs have emphasized their importance as contributors to the reef frame, both through addition of their carbonate crusts to the overall mass and through their activity of welding debris to the frame as a result of their encrusting mode of growth.

Kornicker and Boyd (1962) have noted their importance in these respects in Alacran Atoll in the Gulf of Mexico, but the coralline algae have received most of their publicity from investigations of Pacific reefs. Here, the crest of the seaward margin of the reef is commonly dominated by coralline algae (Wells, 1957, p. 615). The resulting linear carbonate deposit rises a few feet above the adjacent reef flat and is exposed at low tide. This distinctive topographic feature, usually called the algal ridge, or the *Lithothamnion* ridge, has not been reported to our knowledge in the Gulf of Mexico or Caribbean Sea. It is the purpose of this paper to describe microatolls in the Caribbean with rims which appear to have been built to water level and above by red algae.

The microatolls were observed by Kornicker and Boyd during a reconnaissance study of near-shore environments around Cozumel Island (Pl. 1). This island, some 27 miles long and 9 miles wide, is 14 miles off the northeast coast of the Yucatan Peninsula of Mexico. The long axis of the island trends north-northeast parallel to the peninsula shore. According to local fishermen, the prevailing water currents run northward on both sides of the island.

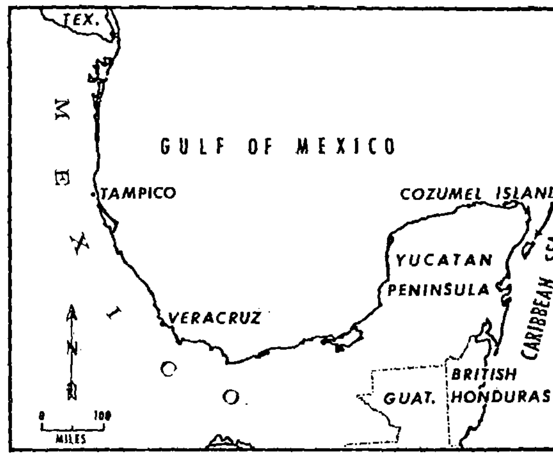

Plate 1. Location of Cozumel Island

ENVIRONMENTAL SETTING

The unique algal deposits were found in only one area, along the northeastern shore of the island (Pl. 2). There are no obvious differences in environment between this area and various other localities along the Cozumel shore. Much of the island shore is characterized by a platform cut into limestone bedrock and now 2 to 5 feet above sea level. Evidence was observed at one locality along the west shore of another erosion surface about 8 feet below present sea level. The sub-aerial platform is greatly dissected by solution in some areas, exhibiting as much as 3 feet of relief from upper surface to bottom of deepest solution pits. Collapse of bedrock, apparently caused by subsurface solution, has produced depressions occupied by small lakes near the west-central coast and has influenced shoreline configuration in the same region.

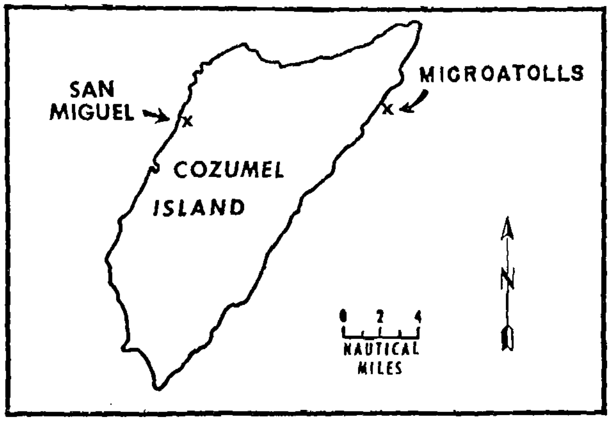

Plate 2. Location of microatolls

Storm-built ramparts of boulders and cobbles rest on the platform along parts of the shore. The most impressive rampart slopes from water edge to a height of 20 feet on the east coast not far south of the algal locality. Sand beaches are found at several places around the island and the north shore has shallow lagoons and mangrove swamps. Cozumel Bank is a shallow-water area off the north end of the island, but elsewhere around the coast shallow water is restricted to a narrow belt along shore with abrupt increase in depth to several hundred feet a few hundred yards offshore. Where shallow bottom was observed along the east coast, it consisted of rock rather than loose sediment. Scattered corals and alcyonarian sea whips and sea fans live here, but no coral reefs were observed. By contrast, the shallow-water belt along the west coast has extensive areas of rippled sand bottom, and thriving patch reefs are common in some areas between shore and deep water. Some of these rise from depths of 50 feet, with tops of corals about 7 feet below sea level. The largest one observed is 3 to 4 hundred feet offshore.

Reef corals on the west side of the island, as well as those forming scattered colonies on the east side, are familiar genera common to reefs of the West Indies. They include *Acropora* , *Diploria* , *Montastrea* , and *Porites* , among others.

Reconnaissance of shallow water along the Yucatan coast opposite Cozumel indicated predominantly rock bottom and scattered patch reefs with the same corals noted previously. Here some coralline algal encrustation was observed on rock and coral.

CHARACTERISTICS OF THE MICROATOLLS

Scarcity of coralline algae in areas thus far described makes the algal deposits illustrated in Plate 3, figures 1 and 2 all the more puzzling. Although apparently limited to one locality along the northeastern Cozumel shore, 116 of the circular rims were counted in that area. They form a belt approximately 100 feet wide with its long axis parallel to shore and about 150 yards offshore.

Each structure attracts attention because its outer edge is formed by a raised rim of coralline algae. The rim is about 5 inches wide and rises some 3 inches above sea level (Pl. 3, fig. 3). The ridge is especially prominent because it supports a luxurious growth of non-calcareous algae, especially the genus *Turbinaria* . Each rim is roughly circular and resembles a large hoop floating in the water. Most diameters are 12 to 25 feet. The distinctive rims are so numerous and close spaced, some are within 15 feet of one another, that the observer first suspects them to be man-made phenomena.

In plan view (Pl. 4) the outer rim surrounds a pavement from 1 to 4 feet wide just below water level. It is densely populated by a variety of non-calcareous algae growing on pink carbonate crust. Several holes about 2 inches in diameter and each occupied by a regular echinoid were observed in the platform illustrated in Plate 4. The platform is bathed by water spilling over the rim as swells cross the structure, and by water coming through the rim by way of "blow holes" - small surge channels which have been roofed over by coralline algae. The platform surrounds a lagoon, up to 20 inches deep in the example shown in Plate 4, in which scattered colonies of the coral *Porites asteroides* are growing. Other organisms in the lagoon are the non-calcareous alga *Dictyota* and the bushy green alga *Halimeda* , an important loose sediment contributor.

The circular rims outline the upper margins of cylindrical structures whose sides descend precipitously to horizontal surfaces at various depths. Origin of these surfaces, whether primarily constructional or destructional, is uncertain; they are covered with algal encrustations and have the same appearance as the vertical sides of the cylindrical features. The deepest passages between cylindrical forms studied were 14 feet deep. The upper few feet of the cylinder sides are vertical or slightly overhanging surfaces. Coral colonies of *Porites* , *Diploria* , *Agaricia* , *Favia* , and *Colpophyllia* are growing on the sides but were estimated to cover less than 5 percent of the surface. Most of these colonies are less than a foot in diameter, although a much larger *Diploria* colony is shown just outside the rim in Plate 4. The bushy green alga *Halimeda* , the large echinoid *Diodema* , and abundant alcyonarian sea whips characterize algal-encrusted underwater surfaces around the structures.

Plate 3. Microatolls and a thin section

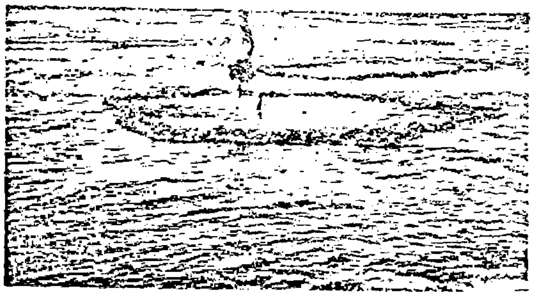

Figure 1. Microatoll; enclosed "lagoon" is shallow, but surrounding water depth is as much as 14 feet. Other microatolls appear in background, and part of rim of another is at lower margin of picture.

Figure 3. Part of rim of one microatoll; "lagoon" on right and deep water on left. Outer edge of rim supports dense growth of non-calcareous alga *Turbinaria* . Snorkel, about one foot long, rests on platform surrounding "lagoon".

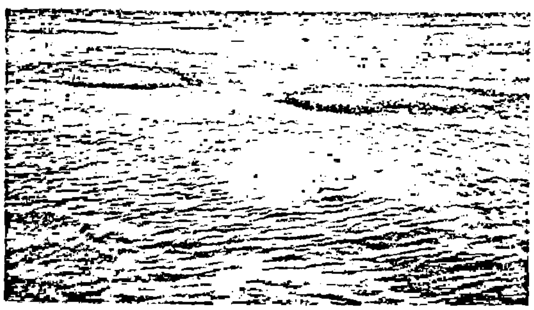

Figure 2. View eastward across microatoll belt.

Figure 4. Thin section of *Archaeolithothamnium episporum* from side of microatoll; reference line is 1 mm long.

Samples were collected from the side of the structure shown in Plate 4, but those from the raised rim were subsequently lost. Our remaining samples were taken from depths of 4, 5, 6, and 10 feet. Six species of coralline algae were identified from this suite of samples. *Goniolithon solubile* is found at 4 feet and at 5 feet. In the latter sample, it is accompanied by *Archaeolithothamnium episporum* (Pl. 3, fig. 4) and *Lithoporella* sp. The sample from 6 feet contains *Lithothamnium sejunctum* and *Lithophyllum* sp. and at 10 feet, *Epilithon membranaceum* and *Lithoporella* sp. are found. A noteworthy depth zonation is indicated by the finding of only 2 genera in more than one sample in the vertical traverse.

It is a matter of observation that encrustations of coralline algae form the distinctive hoop-like rims of the microatolls and dominate the sides of the structures. However, all our samples from the sides include varying amounts of coral debris. Three possibilities for the origin of the cylindrical form beneath each algal rim must be considered. First, the entire structure may represent an algal bioherm. In this case, the coral material beneath the algal crusts in our samples is explained by assuming that samples were unconsciously biased by being selected from projections representing locations of encrusted coralla. Second, the structures may represent coral bioherms recently covered by encrusting algae. In this case, corals

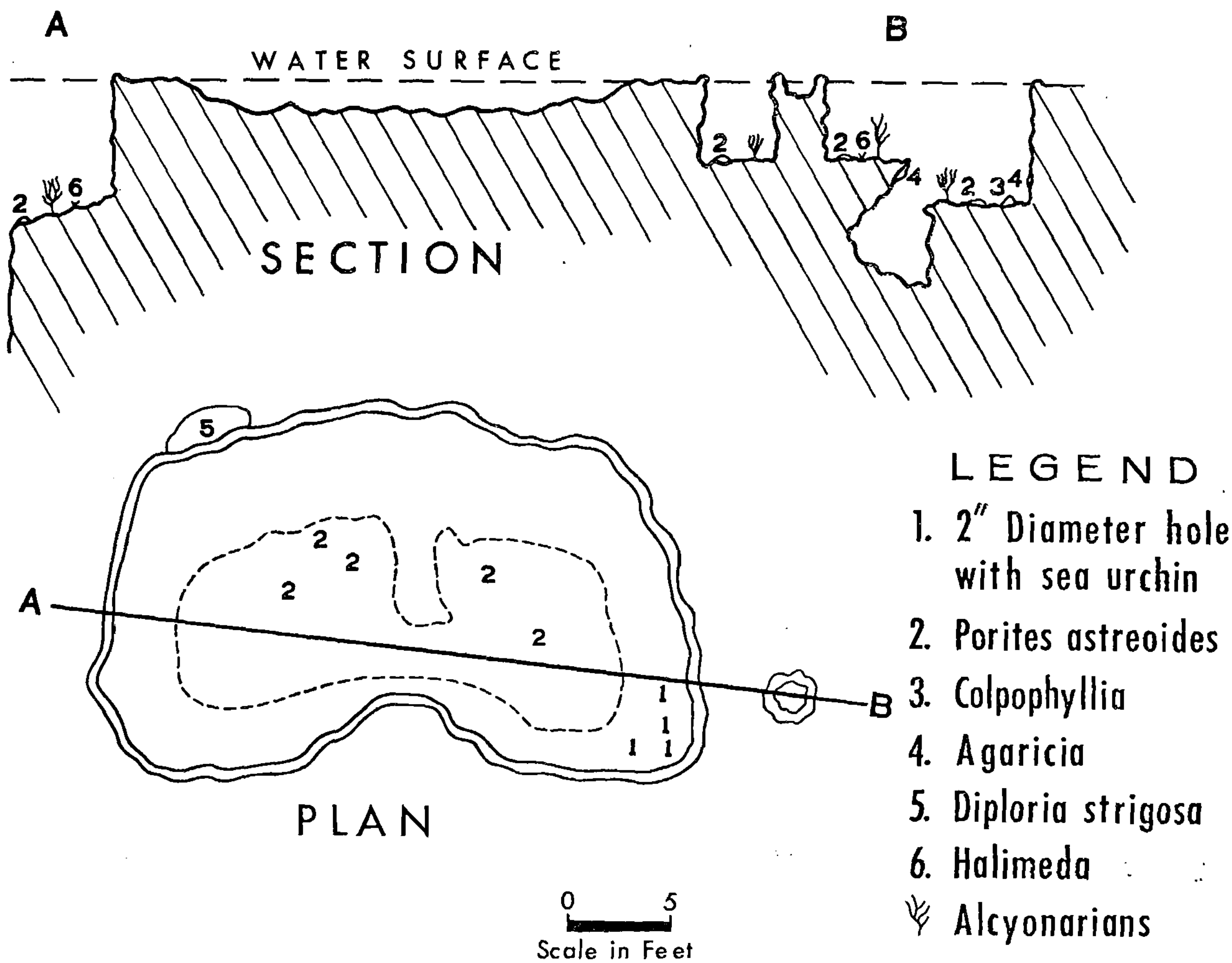

Plate 4. Plan view and profile of one microatoll and adjacent features. No vertical exaggeration.

were more important contributors to the structures during their earlier history than they are at present. Third, foundations of the microatolls may represent pillars of bedrock.

Time limitations permitted subaqueous observations on only a few microatolls. A more leisurely investigation might resolve the foundation question from observations of structures in different stages of construction or destruction. However, samples obtained by drilling into the interiors of the structures may be required before the question can be answered.

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