The CORAL REEFS of BROWARD COUNTY

written and photographed by Bill Raymond

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INTRODUCTION

Prior to 1967, the coral reefs of Broward County might well have been called "mystery reefs." All that was known about them was their surface topography. In 1967 a set of charts was prepared by Ocean Science and Engineering, Inc., in which the bathymetry and subsurface topography were mapped from the shoreline area to a distance of one nautical mile offshore. Two years later, the United States Army Coastal Engineering Research Center (1969) conducted a study from Palm Beach to Miami of the sediments and reefs in which the latter were described as marginal edge reefs capping three step-like marine terraces.

There have been several publications which describe the geology of the reefs and provide an analysis of their formation. This author published the first in 1972. Later that year, Courtenay et al. described the biology of the reefs in Pompano,Dania and Hallandale. In 1977,Lighty described in detail the outer reef at a trench cut for a sewer outfall in Pompano Beach. Lighty's study represented the first confirmation of Raymond's speculation that the third reef had been created by elkhorn coral (Acropora palmata) at a lower sea level, although no trace of live elkhorn coral exists today on the third reef.

The information presented in the following article was obtained during monitoring and reef damage surveys for beach restoration projects in which offshore sediments were utilized to renourish eroding beaches. As a result of the engineering studies of these sediments and surveys of the reefs, one can only be dismayed to discover their current state of crisis.

AN HISTORICAL OVERVIEW OF THE REEFS

During the ice ages, large volumes of water were siphoned out of the sea to form thick glaciers over the high latitude continents, leaving the level of the sea considerably lower than it is today. Sub-marine sea level features indicate that the sea level has been as low as -400 feet (Curray,1965).Apparently,conditions were not favorable for coral reef growth during this time because no remains of reefs have been detected at those depths.

The original beaches were stranded high above the water during the ice ages, forming a series of inland beach ridges on the exposed sea floor. Terrestial vegetation grew over the beach ridges and established roots in the sandy soil. Eventually, the sand ridges became cemented by acidic rain water and formed fossil beaches by preserving their seaward sloping strata, root casts, ridge profiles and inlet gaps.

The most prominent ridge has been named the Hillsboro Ridge because it is a submerged extension of the coastal ridge under Hillsboro Beach. Because the sea

level has risen since the last ice age, a water-cut cliff has formed at the seaward edge of the Hillsboro Ridge, a half mile offshore from Fort Lauderdale and Pompano Beach. Finally, these ice age beachrock ridges have evolved into submerged, reef-like ridges on which a coral cap has grown.

The most prominent coral cap is the marginal reef at the seaward edge of the series of beachrock ridges,two-thirds of a mile offshore, where a high profile spur-and-groove coral reef was built by elkhorn coral 2,500 years ago.

Seaward of the beachrock ridges and the coral cap at the outer edge are true coral reefs. These grew on shallow hard grounds during low sea level positions between 7,000 and 9,000 years ago (Lighty, 1977). Geologically speaking, they are not alive now,but neither are they old enough to be classified as fossil reefs because they are less than 10,000 years old.

At that time sea level was 80 feet lower than at present and was rising (Blackwelder,et al.,1979). During this time, a massive barrier reef grew along the east coast of Florida and extended as far north as Cape Hatteras, North Carolina (Macintyre and Milliman,1970).

This reef continued to grow rapidly until 4,500 years ago (Raymond,1978).Then, it suddenly died and the sea level rose 45 feet to its present elevation.It is not fully understood why the growth of the reefs did not keep pace with rising sea level. Perhaps, at first, the rise was sudden, submerging the reefs to depths below the elkhorn zone. Slower growing surviving corals would not have been able to match the subsequent rise of the ocean to its present level during the last 4,000 years (Scholl and Stuiver,1967).

Coral geologists do not agree on what killed the reefs (Goldberg, 1979; Lighty, and Macintyre, 1979; Braithwaite, 1979). Moreover, they do not even agree on the date. Although some have reported a date of 7,000 or 8,000 years ago (Lighty,1977; Adey,et al.,1977), recent information suggests that the event may have occurred as recently as 4,500 years ago (Raymond, 1978). Evidence of the more recent reef growth in other study areas may have been erased by subsequent erosion of the reef after its death. In any case, there is mounting evidence that all the reefs in the West Indies were killed by some unknown catastrophe between 4,000 and 7,000 years ago (Braithwaite,1979).

Some geologists have cited a drop in sea temperature as the reason (Vaughan, 1916, 1918; Goldberg, 1979). Others have suggested sedimentation and turbidity resulting from the erosion of land sediments as the sea level rose and flooded the coastal areas (Adey,et al.,1977). Another possible cause is the world wide flood, recorded in historic literature (Genesis 6-8).

Whatever the cause of death, the third reef was built by elkhorn coral between 4,000 and 9,000 years ago. Minor reef building star,starlet and brain corals continue to populate the reef to this day but have not added significantly to its structure.

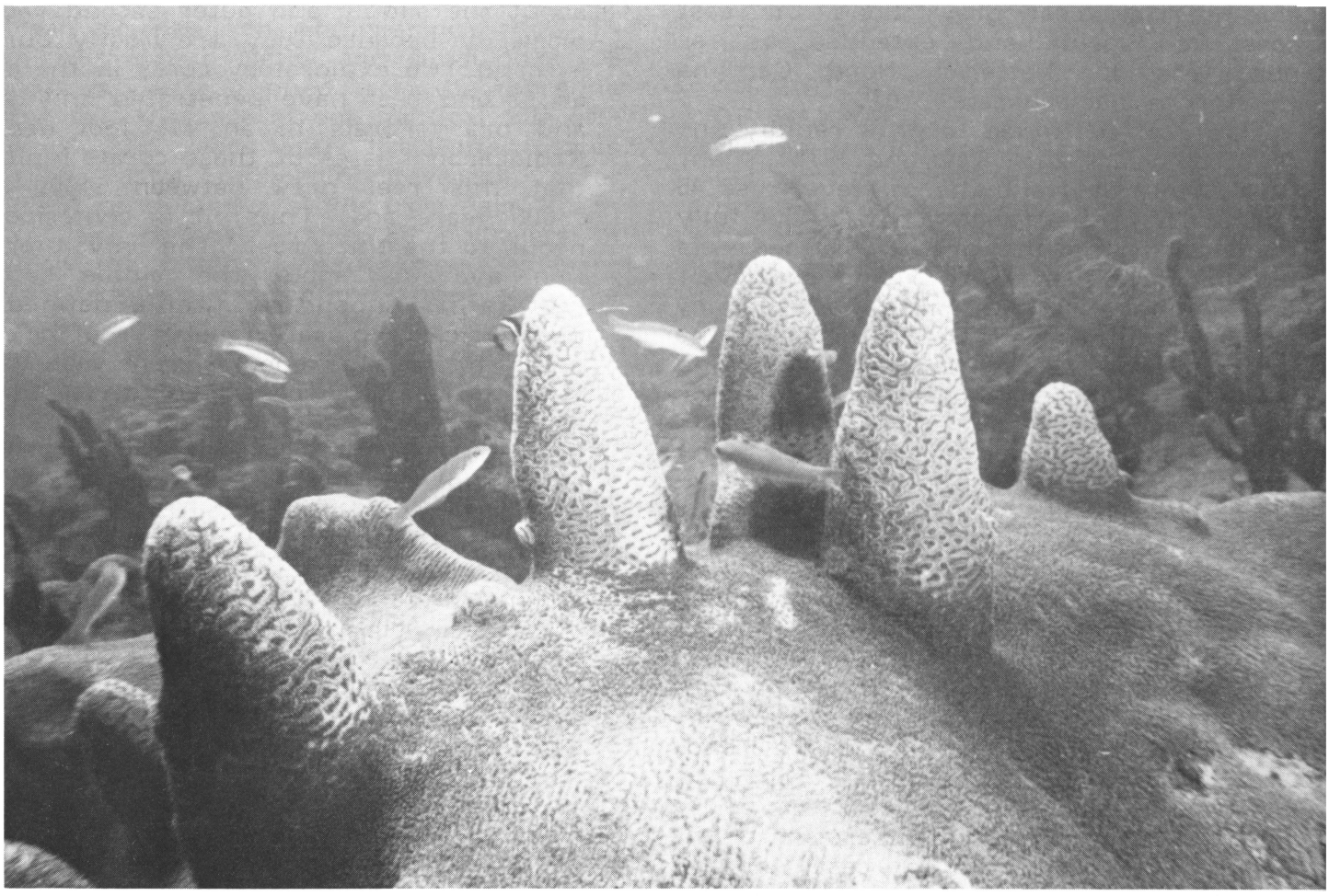
The second reef is actually composed of three reefs,if one includes the most landward coral reef cap that lies on the outer edge of the beach ridge complex. Geologically, this reef cap may be considered a part of the first reef.Very little is known about the middle and outer second reefs, primarily because they are mostly buried in sand.Two exploratory cores in the outer second reef have penetrated only star and brain corals to an 11½ foot depth. Radiocarbon dates of these corals indicate that this reef grew between 3,000 and 7,000 years ago. Thus, it is contemporaneous to the third reef. The only information available about the middle second reef is its subsurface profile defined in geophysical exploration surveys of borrow areas for beach renourishment materials.

As the sea level continued to rise,flooding the nearshore continental shelf,a reef grew and flourished landward of the second and third reefs, just seaward of a prominent sub-marine cliff. This reef, which may be considered part of the first or second reefs, as noted before, grew from about four to six feet high during the last 4,000 years. There, a few surviving stands of elkhorn coral and pillar coral exist even today.

ELKHORN CORAL

The third (outer) reef in Broward County was built of elkhorn coral (Acropora palmata), a rapidly growing reef building coral which is common today in the Florida Keys and among the West Indies reefs.

TOP: (fig.A) A small trumpet fish hangs suspended at the edge of a cave in the coral cap reef at -22' off Ft.Ld. Eroded clam-and-sponge-encrusted remains of elkhorn coral are clearly visible on the walls of the cave. A fragment of this coral was carbon-14 dated at 2500 B.C. BOTTOM (fig.B) Ten inch pillars on a large pillar coral 3/4's of a mile off Ft.Ld. The long furry polyps have retracted and show the skeletal structure of the live coral. Pillars grow to be several feet in height on reefs in the Florida Keys. Stubby, short pillars in Broward County may be the result of turbid water.



In shallow depths and exposed to high wave energy, this coral forms massive labyrinthine barriers of sharp spired stems. These are oriented obliquely shoreward and sometimes resemble a stack of rifles pointed at a 45° angle on the seaward face of a reef. In depths of -15 to -20 feet and in shallow protected areas, its growth form is more of a broad-blade moosehorn shape, sometimes resembling a giant orange four leaf clover. Elkhorn coral does not grow well below -20 feet and is rarely found below -30 feet, apparently because of insufficient light at those depths.

Elkhorn coral is probably the most important coral in coral reefs. Wherever it grows, reefs are considered "alive." Its prolific growth rate and regenerative capability are factors which enable reefs to grow in high energy environments. Slower growing corals cannot keep pace with the destructive forces at the reef front where waves expend their force. Thus, the elkhorn coral serves as an energy absorbing buttress and provides shelter for the star and brain coral heads. Elkhorn coral grows diagonally upward to the level of mean sea level, exposing its branches out of the water during low tide. During a rising sea level, an elkhorn reef can grow upward as fast as one inch per year.

BROWARD REEF ECOLOGY

Today, only a minimal number of isolated individual stands of elkhorn coral exist on the reefs of Broward County. On the nearshore beachrock ridges, live corals cover less than 5% of the surface area, the remainder is covered by fleshy algae, sponges and other simple life forms.

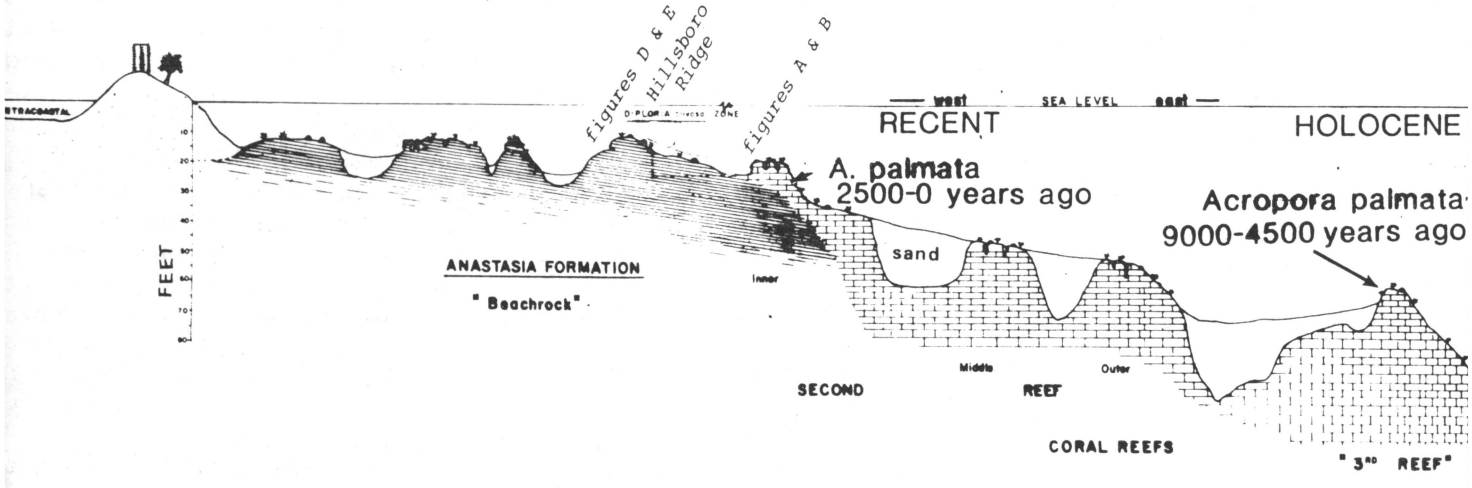
Soft corals occur in approximately equal numbers to the hard corals (D.E. Britt Assoc., Inc., 1981). Low profile, encrusting forms dominate the coral species living on the reefs. Coral species that form tall, columnar hemispherical or domed shapes in the Keys tend to develop encrusting or massive shapes in Broward County until they grow to a height above bottom which frees them from storm sedimentation.

The Hillsboro Ridge forms a sill or submerged barrier, trapping nearshore sediments that had been agitated by the storm waves. Cold water, which can be lethal to branching corals, also tends to get trapped behind this barrier. The branching staghorn coral (Acropora cervicornis) grows most prolifically on the seaward face of this ridge at a depth of -20 feet.

Stony corals are best formulated on the first coral reef, east of the ridge, two-thirds of a mile offshore in -20 to -25 foot depths. This is because of the reef's shallow depth and high profile and the protection provided it by the Hillsboro Ridge between it and the shore.

The diversity of the coral species also reaches its peak on this reef. Of the 41

CONTINENTAL SHELF EAST OF BAHIA MAR, Ft.LAUDERDALE



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iment damage to the reefs in the vicinity of Port Everglades in Fort Lauderdale and Dania, apparently related to previous harbor dredging projects. The beach restoration projects of the 1970s have accelerated this decline.

One million cubic yards of sand have been dredged in Pompano; 400,000 in Hallandale; 1.1 million in Fort Lauderdale; and, just recently, three million cubic yards in Hollywood and Hallandale. Each of the beaches built in these projects is expected to last only 10 years. Thus, one can expect to witness a repeat of this level of dredging in the 1980s and in every subsequent decade.

Can the reefs tolerate this continual bombardment of unusual sedimentation? Until recently, it appeared that they could. In 1976 sediment damage from a closely monitored dredging project was minimal, despite the heavy amount of sedimentation that fell on the reef. The tentative official posture was that, because dredging only slightly injured the reefs and did not destroy them, it was therefore assumed tolerable. That is, the reefs would replenish themselves after dredging projects had been terminated.

These two facts are known. Heavy environmental stress is applied to our coral reefs during dredging projects and the reefs off Fort Lauderdale have continued to decline since formal monitoring studies began. Now, five years after dredging, for reasons yet to be determined, those reefs continue to decline rather than recover. Is this a result of the 1976 dredging project? Could the 1979 Hollywood-Hallandale project have affected Fort Lauderdale's reefs so adversely?

Perhaps the cause is not even the beach restoration project. Regardless, before another dredging project is launched caution should prevail until these matters have been resolved. Hopefully, this trend will be reversed before the reefs undergo a total eco-collapse as the Hens & Chicken Reef did in 1970 in Key Largo (Thomas, 1979).

FOOTNOTES

Adey, Macintyre, Stuckenrath & Dill, "Relict Barrier Reef System off St. Croix, Western Atlantic," Proc. 3rd Int'l Coral Reef Symp.,(1977)15.

Barnes,D., "Growth in Colonial Scleractinians,"BULLETIN OF MARINE SCIENCE,(1973) 23, 2, 280-298.

Blackwelder,B., Pilkey,O. & Howard, J., "Late Wisconsin Sea Levels on the SE US Atlantic Shelf Based on Inplace Shoreline Indicators," SCIENCE,(1979) 204, 618-620.

Braithwaite,"Holocene Reef Growth on the Edge of the Florida Shelf," NATURE, (1979) 278, 281-282.

Courtenay,W.,Herrema,D., Thompson, M., Azzinaro,W., and van Montfrans, J., "Ecological Monitoring of Two Beach Nourishment Projects in Broward County, Florida," SHORE & BEACH, (1972) 40, 2, 8-13.

Curray, "The Quaternary of the US; In NW Gulf of Mexico," PRINCETON UNIV. PRESS, (1965) 723.

Duane,D. & Meisburger, E., "Geomorphology & Sediments of the Nearshore Continental Shelf, Palm Beach to Miami," CERC TM, (1969) 29.

Goldberg, "The Ecology of the Coral-Octocoral Communities off the SE Florida Coast," BULLETIN OF MARINE SCIENCE, (1973) 23, 465-488.

Goldberg,W.,"Shelf Temperatures and Reef Growth on the SE Coast" (a discussion),NATURE,(1979) 278,669-670.

Hoffmeister,J. & Multer, H., "Growth Rate Estimates of a Pleistocene Coral Reef of Florida," BULLETIN GEOL. SOC. AMER.,(1964) 75, 353-358.

Lighty, R., "Relict Shelf-Edge Holocene Coral Reef: SE Coast of Florida," PROC.3rd INT'L.CORAL REEF SYMP., (1977) 2, 215.

Lighty,R.,Macintyre,I.& Stuckenrath, "Reply" (a discussion),NATURE,(1979) 278, 670.

Macintyre,I. & Milliman,J.,"Physiographic Features on the Outer Shelf and Upper Slope, Atlantic Continental Margin, SE US," GSA BULLETIN, (1970) 81, 2577-2598.

Marshall,S. & Orr, A., "Sedimentation of Low Isles Reef and its Relation to Coral Growth, Great Barrier Reef Expedition," SCI. REP. BRIT.MUS. (NH) (1931) I, 5, 94-133.

Raymond,B., "Marine Geology of Broward County," (final report to Broward County Erosion Prevention District, 1972) FSU master's thesis, 92p.

Raymond, B., "Reef Damage Survey: An Interim Report," Broward County Erosion Prevention District,(1978) 51p.

Scholl,D. & Stuiver,M., "Recent Submergence of Southern Florida: A Comparison with Adjacent Coasts & Other Eustatic Data," GSA BULLETIN, (1967) 78, 437-454.

Shinn,E., "Spur-and-Groove Formation on the Florida Reef Tract," JOUR. SED. PET., (1963) 33, 291-303.

Thomas, L., "Who's Killing the Corals?," SPORT DIVER, (1979) 69-76.

Vaughan,T., PROC. NAT'L. ACAD. SCI. USA, (1916) 2, 95-100.

Vaughan,T., "The Temperature of the Florida Coral Reef Tract," CARNEGIE INSTITUTE OF WASHINGTON, (1918) 213, 321-339.

Wells, J., "New and Old Scleractinian Corals from Jamaica," MARINE SCIENCE, (1973) 23, 1, 16-58.