Coral Biodiversity and Zonation on a Pleistocene Reef, Southeastern Jamaica

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Introduction
The coastal regions of Jamaica consist predominantly of raised reefs and terraces belonging to the Upper Coastal group. These exist as 4 m high cliffs and raised beaches of beach rock and limestone of the Falmouth, The Port Morant and the Hope Gate formations. These raised reefs consist of a diverse faunal assemblage similar to those on modern reefs. Coral biofacies observed in Pleistocene Port Morant Formation in coastal exposures at East Prospect, St. Thomas, Jamaica, show a well-defined paleogeographic distribution of biofacies which show striking similarities to the zonation and distribution described on modern reefs (Goreau, 1959; Geister, 1982 and 1988; Graus et al., 1984; Mallela et al., 2004; Wilson, 2005). Modern organisms have long been used to study the habitats of fossils and in a similar way modern habitats can and are used as analogues to ancient environments. In this particular study, the ancient reef was reconstructed using data collected on modern reefs by Graus et al. (1984) and Goreau (1959) in Discovery Bay, Jamaica and Geister (1982 & 1977) in Dominican Republic. Goreau’s (1959) model was used to identify the reef zones, Graus and McIntyre (1989) was used to determine if there were any variations in reef and back reef environment related to water depth and sediment fluxes and finally, Geister (1982) was used to classify reef which existed in the area. Studies done by Mitchell et al. (2000) dated a single coral in this area and determined the age to be Late Pleistocene (Sangamonian 132 ± 7Kyr).

Study Area
The study area is located in the Parish of St. Thomas Jamaica along the Prospect beach from Fisherman’s Bay to Battery Point (Fig. 1a & b).
Figure 1a. Map showing the location of the study area in Jamaica.

Figure 1b. Map showing the location of the areas studied and the various facies and biofacies.

Figure 2. Karstified limestone

Coral Biodiversity

*Diplora strigosa-Acropora palmata* Biofacies: corals were found in growth position in a 15 m wide exposure from the water’s edge to approximately 10 m and up to 15 m
inland. Individual colonies of both species ranged from about 0.5-1 m with extensive weathering and phytokarst development (Fig. 2). The coral assemblage observed in this zone in order of decreasing abundance were *D. strigosa* (Fig. 3a & b), *A. palmata* (Fig. 4), *P. furcata* (Fig. 9), *M. annularis* (Fig. 6), *A. cervicornis* (Fig. 10), *S. siderea*, *D. labirynthiformis*, *P. asteroides*, *M. cavernosa*, *I. rigida*, *D. stokesi*, *C. natans* (Fig. 5). The *A. palmata* colonies showed a dominant southwest alignment.
Figure 5. A. palmata

Figure 5. C. natans
Acropora cervicornis Biofacies: consists of abundant A. cervicornis together with bivalves and gastropods. The exposure is approximately 2-3 m high and extends for approximately 5-6 m. Other corals in this zone include A. palmata located at the base of the A. cervicornis stand and small thickets of P. furcata observed throughout the exposure (Fig. 10).
Mixed Coral Biofacies: consists predominantly of abundant *M. annularis* and *P. furcata* (Fig. 6). This area contained abundant fossil fragments of gastropods and bivalves in a dense coarse grained carbonate sand.

*Porites furcata* Biofacies: observed as small patches of up to 50 cm and was found closely associated with *A. cervicornis*. Abundant corals in this zone include *M. annularis*, *D. strigosa*; additional fossils species include bivalves, gastropods and echinoid spines.

Lagoon Facies: landward of the coral biofacies is a weathered limestone with coral fragments and sandstone pebbles (Fig. 7). A recent calcrite crust is present on the surface of the limestone. The facies consists of abundant rhizocretions (Fig. 8) and abundant fossil fragments as well as whole tests of the gastropod *Bulla* sp. *A. cervicornis*, *P. furcata* and *M. annularis* patch reefs scattered throughout the lagoon, patch reefs consist of abundant chonch shells.
Zonation
The coral zonation described by Goreau (1959) has striking similarities to the Pleistocene reef studied at East Prospect. Using the Goreau (1959) model the reef crest zone, back reef zone and the lagoon area were identified. The alignment of the *A. palmata* to the southwest indicates the possible wave direction during the Pleistocene. This direction compares well with the current wave regime along the southeastern coast of Jamaica. It is possible, however, that a large part of this zone as well as the reef front has been eroded away over time due to erosion caused by storm surges and unusually high energy waves in the breaker zone which occurs along this coastline. These processes are active on the modern reef and still continue to affect the lithified reef.

The mixed zone has been interpreted as the back reef zone (Fig. 11).

Figure 11. Cartoon of interpretation of coral zonation along Pleistocene reef, southeastern Jamaica.
The fossiliferous limestone with rhizocretions is indicative of the lagoon and nearshore zone. The rhizocretions are the result of roots of plants on the beach that became calcified (Fig. 11).

Using the Geister (1977) model the reef is classified as a strigosa-palmata reef as the *D. strigosa* and *A. palmata* were the dominant species at the breaker zone (Fig. 11). *A cervicornis* and *P. furcata* has been interpreted as patch reefs scattered throughout the lagoon and back reef areas as they are not continuous (Fig. 11).

Graus et al. (1984) indicated that patch reefs influence zonation when they become greater than 2 m high. This may have influenced the similar abundances and zonation of the *D. strigosa* and *A. palmata* reef crest. High bottom velocities influence mixed coral zones, however, these velocities may have been low enough to also influence sedimentation. This increase in sedimentation is indicated by the lateral extent of the lagoon as increases in sedimentation increases the lagoon area.

**Conclusion**

The succession at East Prospect shows a well-defined paleogeographic distribution of biofacies (Fig. 11). A belt of coral boundstone includes horizontally bedded limestone with coral assemblages characteristic of reef crest zone. Behind the zone are bioclastic carbonate fragments of coral suggestive of a patch reef and extensive rhizocretions. The rhizocretions indicate extensive trees growing on the beach as the lagoon behind the reef gets filled.

**References**


Glossary

Upper Coastal Group:

Facies: A body of rock with specified characteristics is a distinctive rock that forms under certain conditions of sedimentation, reflecting a particular process or environment of deposition. Facies based on fossil content are called **biofacies**.

Phytokarst: **Karst** terrain has distinctive characteristics of relief and drainage arising from the solution of soluble bedrock by natural waters.

Lithified: Lithification is the processes that converts “loose” sediment into “solid” sedimentary rock, e.g. sand to sandstone; beach sediment to beachrock

Rhizocretions: Calcified roots

Boundstone: carbonate rocks which are bound together in the original depositional environment by framework building organisms such as coral, encrusting organisms such as bryozoans or sediment trapping mechanisms such as those of the cyanobacteria. They can have complex structures which show cellular detail, or appear laminated.