Mesophotic Bioerosion: Variability in different deep reef habitats

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BACKGROUND

Providing crucial ecosystem services critical for sustained environmental health, the complex geomorphic structure of coral reefs is threatened by various anthropogenic stresses. Reef geomorphic complexity depends on the preservation of *in situ* coral framework and coral rubble accumulation. The ability to affectively manage reef systems, sustainably utilize their resources, and prevent continued habitat degradation rely on a fundamental understanding of all primary reef processes, including bioerosion. Bioerosion is a key process affecting reef development, accretion, and destruction. While many shallow-reef bioerosion studies have been conducted, with some showing variability in different environments,[1] there exists a gap in knowledge regarding the variability of this basic process in mesophotic coral ecosystems (MCEs). MCEs are low energy, low light deep-reef communities (30-150m) vital for many reasons such as serving as potential refugia for shallower reef species threatened by environmental degradation. The long-range goal of my research is to understand the significance of bioerosion in developing, shaping, and destroying MCE reefs, while contributing to their exploration.

OBJECTIVES & SPECIFIC AIM

- Determine macroboring variability in distinct MCE habitats and neighboring shallow reefs
- Calculate time-averaged % of coral rubble surface area bored and relative macroborer abundance

METHODS

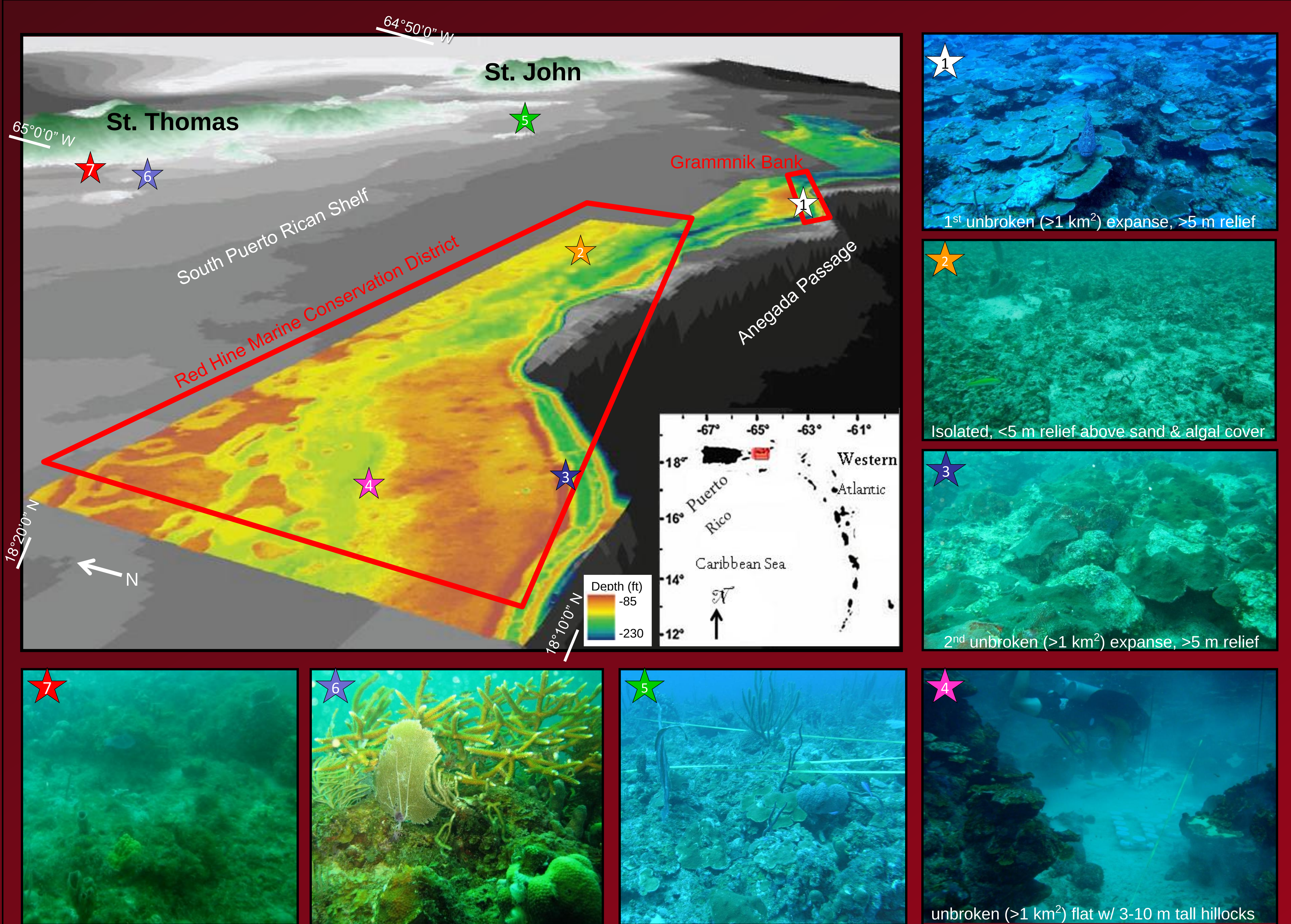

Figure 1: South Puerto Rican Shelf, U.S. Virgin Islands (NE 2x vertical exaggeration). A ban on benthic fishing and anchoring, and highly representative geomorphic deep-reef habitats[2], make the Hind Bank Marine Conservation District and Grammanik Bank ideal locations to study mesophotic bioerosion. Four distinct MCE habitats were surveyed: (1) primary high bank (127`); (2) deep patch reef (135`); (3) secondary high bank (111`); and (4) hillock basin (138`). Shallow sites were surveyed for comparison: (5) mid-shelf patch reef (65`); (6) shallow patch reef (30`); and (7) fringing/patch reef (30`). Map and descriptions modified from Smith et al. (2010)[2]; bathymetric high resolution side scan sonar imagery[3] and NOAA.

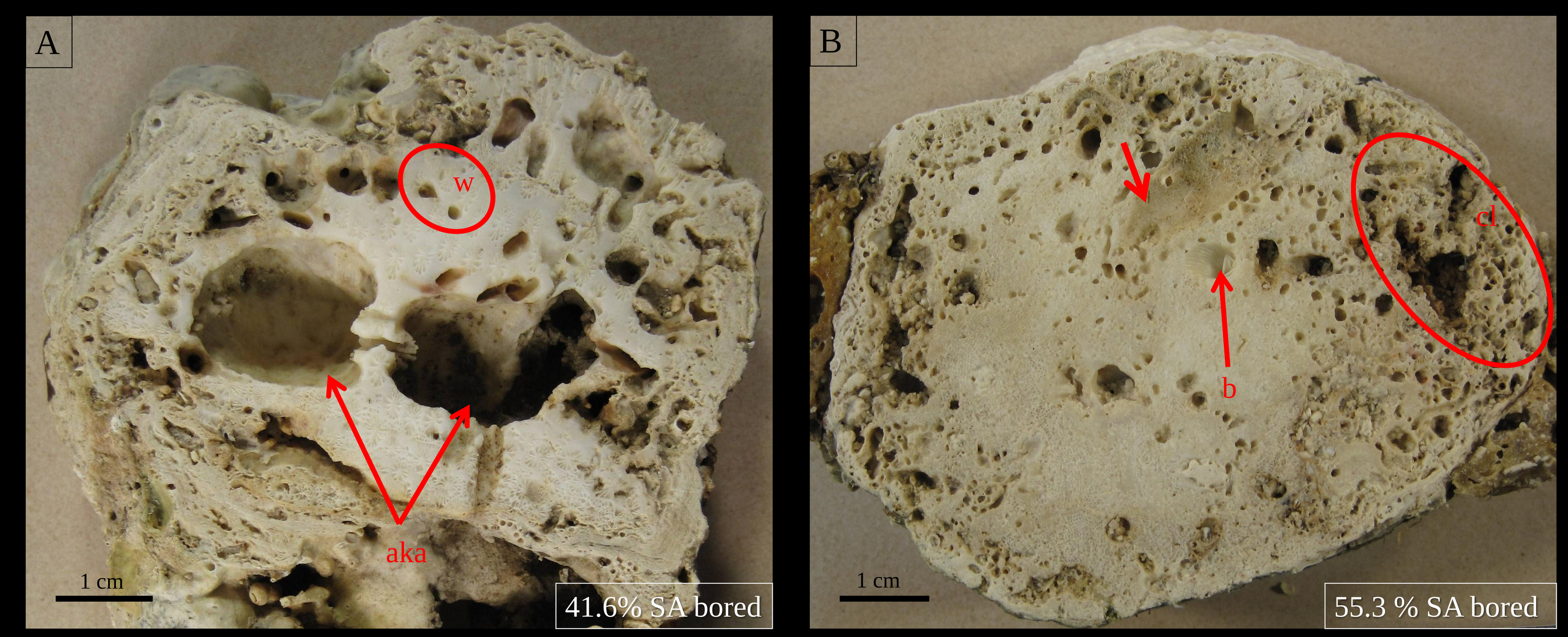

Figure 2: At each site, 4-9 coral rubble samples were collected randomly by tri-mix/nitrox diver pairs. Coral rubble, cut perpendicular to growth axis, was photographed for point-count analysis (> 200 points). (A) *Stephanocoenia intersepta* rubble from hillock basin bored in the center by polychaete and sipunculan worms (w), and the sponge species *Aka brevitubulatum.* (B) *Porites astreoides* rubble from the primary bank with extensive sponge borings characteristic of *Cliona* spp. (Cl), bivalve boring (*Lithophaga* spp.) top center, and a barnacle (b). SA = surface area.

RESULTS

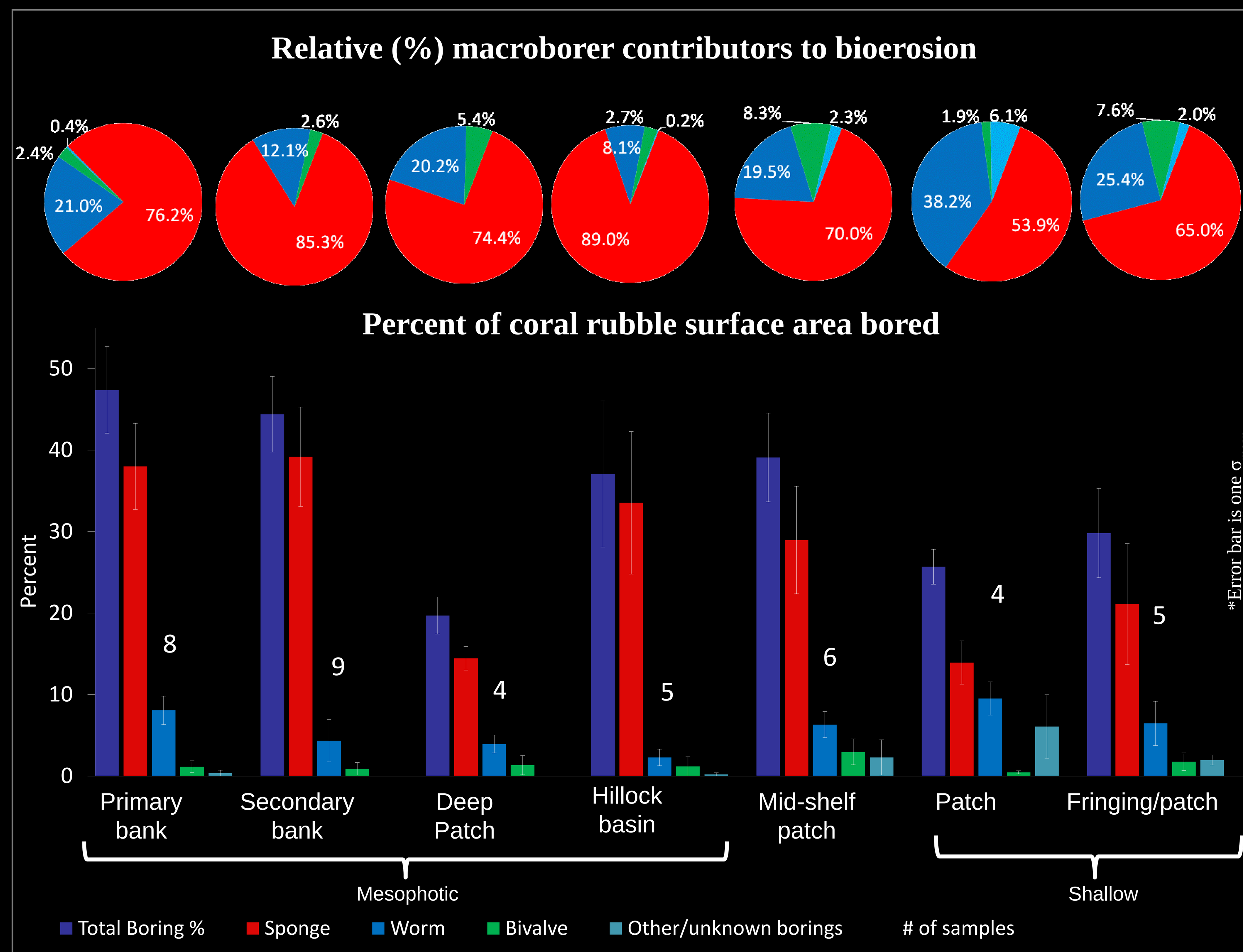

Figure 3: MCE reef rubble bored more but with less macroborer diversity than shallow reefs (except deep patch) following recorded trends.[1,4,5] One-way ANOVA test verifies significance between all sites ($F_{6,34}=2.99$, $P=0.02$). Sponges are the primary macroborers at all sites; their borings generally follow trend[4] of increasing relative abundance with depth. Kruskal-Wallis test indicates significant differences in total boring (P=0.05) and worm (P=.03) percent at mesophotic sites. Boring in banks is visibly greater than in other mesophotic habitats. The deep patch has a distinct, highly consistent boring pattern with lowest total percent bored and a high worm contribution.

Environmental/Ecological Trends[2]

Basins/neighboring patches		Banks
⬇	Coral Cover	⬆
⬇	Water velocity	⬆
⬆	Mean temperature	⬇
⬆	Chlorophyll concentration	⬇
⬆	Water density	⬇
⬆	Recent partial mortality	⬇

LONG-TERM RESEARCH

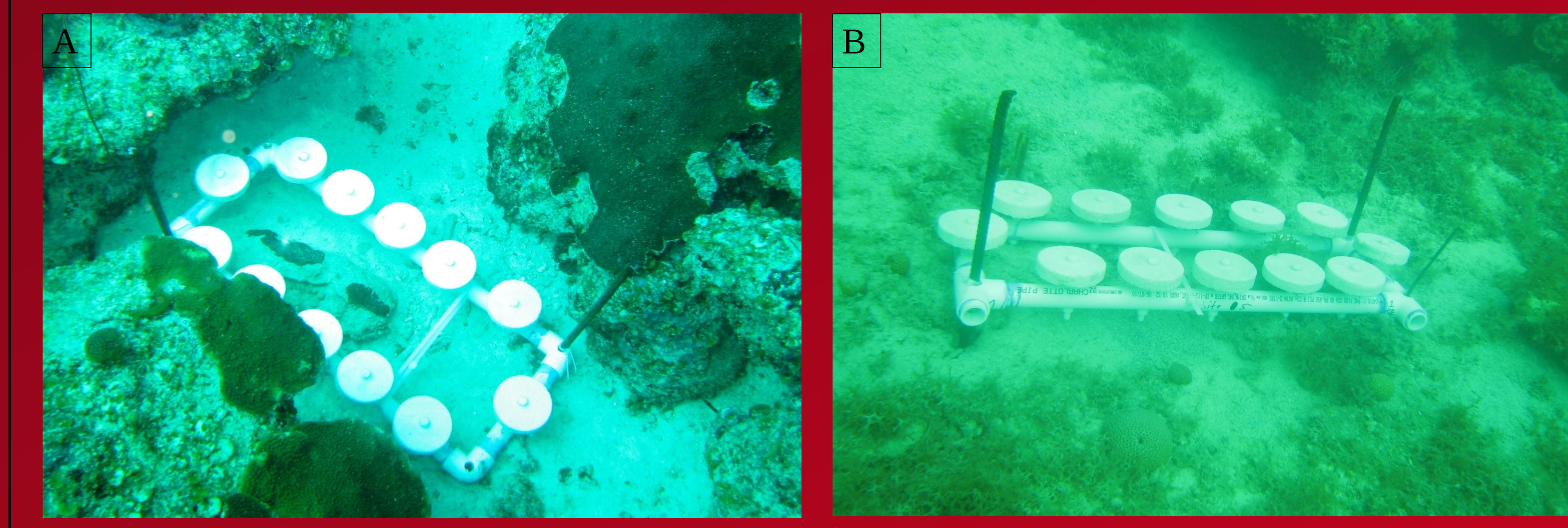

Figure 4: While coral rubble was collected, experimental coral substrate disks of pristine *Montastraea faveolata* mounted onto PVC quadrants were attached to the seafloor for an analogous study to determine bioerosion rate variability of grazers, macroborers, and microborers. Three disks from each quadrant will be collected once a year for three years. (A) College Shoal, a mesophotic (111') secondary high bank reef and (B) Blackpoint reef, a fringing patch reef at a depth of 30 feet.

CONCLUSIONS

- Mesophotic coral rubble from different habitats record significantly varying macroboring patterns
- Macroboring variability likely attributable to differences in environmental conditions,[6,7] as well as localized ecology (e.g., low bioerosion in deep patch possibly due to dominance of less dense corals[8] and/or high encrustation of protective crustose coralline algae[9])
- Bioerosion variability partially responsible for maintaining distinct mesophotic habitat geomorphology; possibly shaped original structure (seismic data could help answer this)
- Results useful for predicting ecological responses from changing environmental conditions and interpreting paleoenvironments of deep fossil reefs

ACKNOWLEDGEMENTS

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