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Past Stony Coral Growth (Extension) Rates on Reefs of Broward County, Florida: Possible Relationships with Everglades Drainage

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Introduction

Scleractinian reef building corals can be long-lived (hundreds of years) and produce massive calcareous skeletons. These skeletons preserve a skeletal record of both time and growth. Alternating bands of high and low-density skeletal material are present and are visible through X-radiography, where each pair of bands represents approximately one year's annual extension of the coral. The presence of time-dependent banding within coral skeletons can provide a useful tool for reconstructing environmental variables that affect growth (and also the chemical composition) of coral skeleton. Skeletal growth includes: physical lengthening of the coral skeleton (extension), material distribution within the skeleton (density), and mass accretion of the skeleton over time (calcification), all of which may be quantified over time. The chemical characteristics of the coral skeleton coupled with the inherent chronological record of the growth bands also can provide environmental information. The carbon and oxygen stable isotopic composition of the skeleton is valuable for reconstruction of temperature, salinity, and light level characteristics. The chemical composition of the skeleton can mimic the chemical composition of the seawater in which the coral grew. The fluorescence characteristics of the skeleton can show the influence of terrestrial water input. Trace element composition of the skeleton can show water temperature (Sr/Ca), upwelling (Ba/Ca), radioactivity (e.g., U/Ca), and hydrocarbon pollution (e.g., V/Ca).

Reef corals growing on coral reefs of Southeast Florida (Broward County) are at the extreme northern end of their range, increasing their sensitivity to environmental limiting factors. Because Everglades restoration will significantly affect canal discharge and hence possible ocean salinity variations, one purpose of this investigation was to determine if salinity and canal discharge had impact on coral growth.

Methods

In this study we have analyzed the skeletal growth (annual skeletal extension) of over 154 corals collected from reefs of Broward County, Florida. Specimens consisting of two coral species (star corals (*Montastrea annularis* (*M.a.*) complex and brain corals *Diploria labyrinthiformis* (*D.l.*)) were collected at 4 sites at two depths (9m and 18m) along an approximately 30 mile north south latitudinal gradient. Once collected, coral skeletons were sectioned using a large diamond bit masonry saw into slabs approximately 0.5-cm thick. Slabs were oriented normal to growth band surfaces. Multiple slabs were cut from each coral for replication and comparison of banding patterns. Each slab was X-radiographed onto Kodak AA Industrex film to reveal density banding. X-ray negatives were printed into positives for the entire length of the coral growth record. Annual extension (from top of one high density –HD- band portion to the next lower HD top) for each band was measured by caliper along two separate transects, normal to growth band boundaries.

Normalized coral chronologies were constructed by dividing the mean of each growth measurement transect into each annual extension value. Each normalized or index transect was

then averaged into a whole index coral master chronology. Normalized annual linear skeletal extension rates of the corals were examined over 16 common years (1985-1970). Individual normalized coral chronologies were ensemble averaged into site, depth, and combined site depth master chronologies for each of the two species.

Individual site masters (by species and depth) were compared to environmental variables. Environmental data included water temperature and density (salinity) from Miami Beach, rainfall (Lower East Coast) as tabulated by SFWMD, and canal discharge (North New River canal USGS) data. Man-induced perturbations (i.e. beach renourishment projects) were also compared.

Results

Site averages of absolute coral growth indicated that southern 9m deep specimens (.49 cm/yr for *M.a.*, .51 cm/yr for *D.l.*) had higher rates of growth than northern counterparts .34 cm/yr for *M.a.*, .45 cm/yr for *D.l.* In the southern collection sites, 9 m deep growth of both species tended to be greater than 18m deep growth (.33 cm/yr *M.a.*, .42 cm/yr *D.l.*).

Correlation analysis indicated that the time pattern of coral extension was similar among sites, species, and depths. This was exemplified by the obvious agreement of site master chronologies. (Average master chronology correlation over the period 1985-1970 ranged from $r=.4-.8$, $n=45$) Comparisons of chronologies to recorded environmental variables (water temperature, salinity, and canal discharge) revealed a positive correlation of coral extension with density (salinity), and negative correlations with rain and discharge.

While a gradient of decreasing intensity of correlation away from canals was not well defined, for Rain: deep *M. annularis* and deep *D. labyrinthiformis* were more highly negatively correlated with rain than corresponding mid depth series. This may be a light effect associated with light limitation at depth in more rainy/cloudy years. For discharge: mid *M. annularis* and mid depth *D. labyrinthiformis* were more highly correlated negatively with discharge than corresponding deep series.

This study indicates that freshwater sources, including those emanating from the Everglades Drainage canals may adversely affect offshore coral growth. Further investigations are needed to gauge the extent of past effects and the predict future impacts related to Everglades restoration.

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