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Gulf of Mexico Science

Volume 23
Number 1 *Number 1*

Article 10

2005

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DOI: 10.18785/goms.2301.10
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Recommended Citation

Precht, W. F., M. L. Robbart, G. S. Boland and G. P. Schmahl. 2005. Establishment and Initial Analysis of Deep Reef Stations (32-40 M) at the East Flower Garden Bank. Gulf of Mexico Science 23 (1).
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Gulf of Mexico Science, 2005(1), pp. 124–127
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ESTABLISHMENT AND INITIAL ANALYSIS OF DEEP REEF STATIONS (32–40 M) AT THE EAST FLOWER GARDEN BANK.—Two distinct coral reef habitats have been delineated at the Flower Garden Banks (FGB) (Rezak et al., 1985). The shallowest areas of the banks (<36 m) comprise a coral assemblage dominated by *Montasraea-Diploria-Porites* with 19 common scleractinian coral species present (see Aronson et al., 2005). In deeper water, 36–48 m, the community is comprised primarily of a *Stephanocoenia-Millepora* assemblage and contains 13 coral species (Rezak et al., 1985). There are also monospecific fields of *Madracis mirabilis* that can be found overlapping both depth zones. Coral cover is high in both zones and is interrupted by areas of bare reef rock and patches of biogenic sand.

Since 1988, the Minerals Management Service (MMS) has been assessing coral cover, diversity, growth, and condition (bleaching, diseases, and mortality) within restricted areas and narrow depth ranges (17–25 m) at each of the FGB. It is tempting to extrapolate the long-term monitoring results of Gittings et al. (1992), Dokken et al. (2003), and Aronson et al. (this issue) and conclude on the basis of those surveys that the reef habitats contained within the entire coral cap (17- to 48-m depth range) are in excellent condition. Although these are important and valuable data, conclusions about reef condition in deeper habitats cannot be made. To increase the value and utility of these long-term monitoring data, there have been programmatic additions to increase the survey area into deeper reef habitats. Data obtained from these deeper habitats may also have important implications with regard to ongoing and expected global climate change with the future possibility of elevated water temperatures throughout the region.

To accomplish this objective, repetitive quadrat stations were installed at the East Flower Garden Bank (EFGB) in Apr. 2003 by teams of scientific divers from MMS and the Flower Garden Banks National Marine Sanctuary (FGBNMS). Using a pneumatic hand-held drill, holes were drilled into the reef framework and stainless steel posts were implanted to mark station locations. In all, eight stations were established at 31.7- to 39.9-m depth on the east-facing slope of the EFGB. These stations lie due east of the long-term coral reef monitoring site established by MMS at the EFGB in 1988 and 1989 (Gittings et al., 1992; see also Aronson et al., 2005). Because these repetitive stations are intended to follow the health of specific coral communities through time, their placement was observer-biased being intentionally placed in areas that had high coral cover, although the entire deep reef habitat on this flank of the EFGB appeared to have a generally very high coral cover.

Initial photographs of the deep reef stations were obtained in Aug. 2003. Photographs were taken from a height of 2.0 m above the reef surface using a Nikonos V camera equipped with Kodak Ektachrome 200 ASA, 36-exposure slide film and a 15-mm lens (distance = 2 m, *f*-stop = 5.6). An aluminum T-frame was constructed to keep the focal distance of the camera at exactly 2 m off the reef surface (Gittings et al., 1992). Two Nikonos SB-105 strobes were attached to each end of the T-frames and set on TTL and slave. Camera attitude was precisely determined using a high-quality underwater compass and bubble level attached to the metal T-frame. The images produced represented 8 m^2 of the substrate. Photographic slides were digitized and analyzed using the point-count method in Photoshop 7.0. A total of 250 random dots were placed on each photograph. By digitizing these photographs, we can superimpose future images for temporal comparisons. Using these methods it is possible to assess growth, loss of tissue, estimates of coral cover, species diversity and evenness, competition, incidents of bleaching and disease, and other metrics of reef health.

Diversity was calculated using the Shannon–Weiner diversity index and from it, species evenness was determined. The Shannon–Weiner diversity index (H') was calculated as:

$$H' = -\sum_{i=1}^{k} p_i \ln p_i$$

where k was the number of species present and p_i was the proportion (n_i/N) of the ith species. Evenness (J') was calculated as:

$$J' = \frac{H'}{H'_{\max}}$$

where $H'_{\max}$ was the maximum possible diversity ($H'_{\max} = \log k$).

Initial results.—These deep stations are dominated by massive and plating colonies of *Montastraea franksi* and *M. cavernosa.* Other corals identified include *M. faveolata, Diploria strigosa,*

TABLE 1. Species within deep repetitive quadrat stations (31–40 m). Values do not add up to 100 percent due to the coral category (unidentified species —1.97%), not included in the species list.

Species	Percent cover
Montastraea franksi	46.08
Montastraea cavernosa	19.61
Montastraea faveolata	10.34
Diploria strigosa	7.30
Mussa angulosa	3.65
Colpophyllia natans	3.49
Millepora alcicornis	2.58
Stephanocoenia intersepta	2.35
Montastraea spp. (combined)	1.82
Madracis mirabilis	0.38
Porites spp. (combined)	0.38

Mussa angulosa, Stephanocoenia intersepta, Madracis mirabilis, Millepora alcicornis, Porites spp., and *Colpophyllia natans* (Table 1). Average coral cover is 76.5% at these deep stations and is among the highest measured in the entire region. *Lobophora* spp. are the dominant macroalgae with an average cover of 6.7%, although crustose coralline algae are almost as abundant (5%). Bare space (11%) includes filamentous turf algae (<3 mm) and barren areas (Fig. 1). Coral diversity (*H'*) was lower at deep stations than at shallower sites attesting to a diminution of species with depth (Rezak et al., 1985), whereas evenness (*J'*) was the same, reinforcing visual impressions of the dominance of only a few species, namely *M. franski* and *M. cavernosa* (Table 2). Incidence of partial coral mortality due to bleaching, disease, and predation were also rare at these stations. These data are remarkably similar to results reported by Bright (1982) for benthic communities at 29-m depth at the EFGB. This 29-m site was established in 1977 by Texas A&M University and resurveyed in 1980 as part of a monitoring program for the U.S. Department of the Inte-

TABLE 2. Coral cover and SE, Shannon–Weiner diversity index (H') and evenness (J') index at deep repetitive quadrat stations in 2003. EFGB (2003) and WFGB (2003) are from Aronson et al., 2005.

Location	% cover	H'	J'
EFGB deep	76.5 ± 11.9	0.6	0.7
EFGB (2003)	53.2 ± 3.0	1.5	0.7
WFGB (2003)	57.1 ± 3.8	1.4	0.7

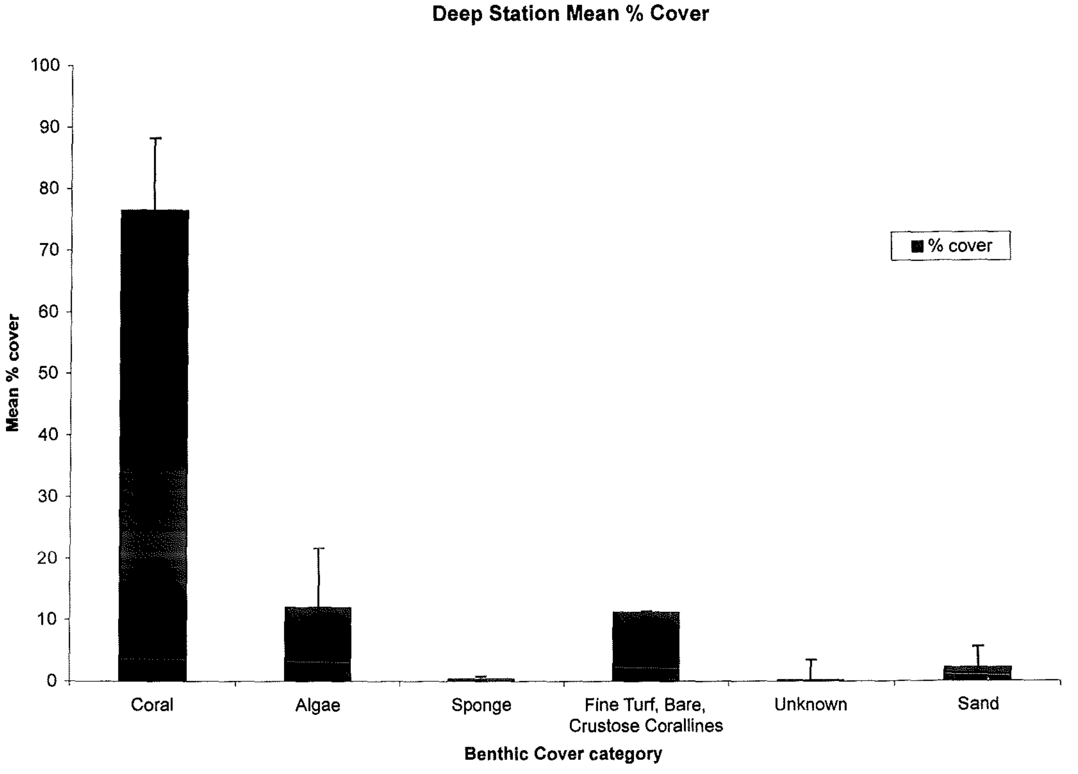

Fig. 1. Coral cover by category at the deep repetitive photo quadrats in 2003.

DOI: 10.18785/goms.2301.10

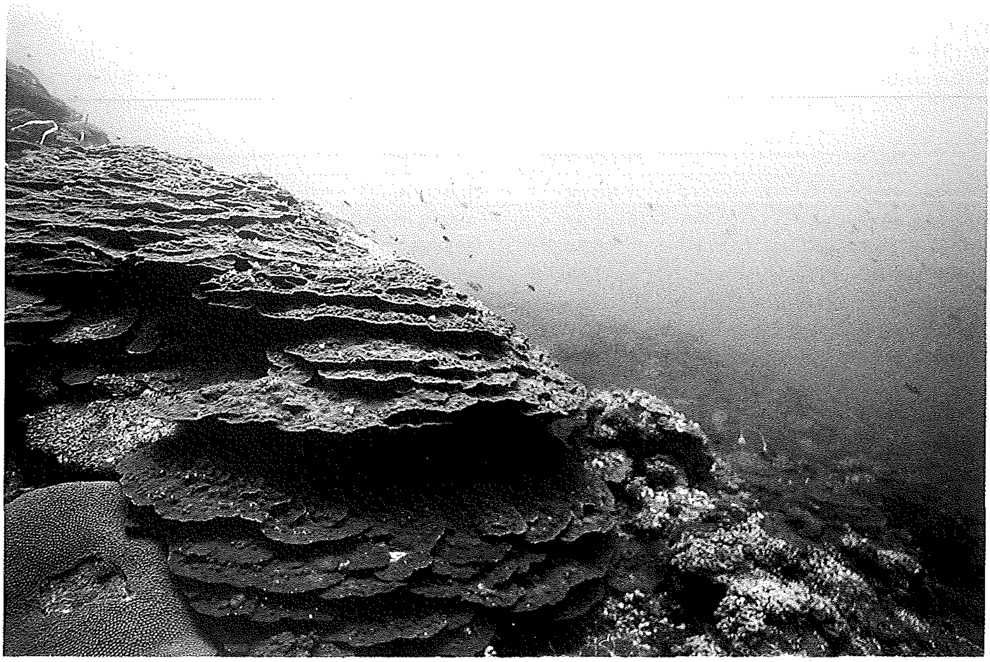

Fig. 2. Oblique angle photograph of the deeper reef community between 30 and 40 m on the EFGB in Apr. 2003. Dominant species are shingle-like growth forms of *Montastraea franksi*.

rior, Bureau of Land Management. It is located approximately 100 m due south of our present deep site (this report). Most notably total coral cover in 1980 was 73% at 29 m compared with 76% in 2003 (this study).

These deeper sites at the EFGB show high coral cover like their shallower counterparts (see Aronson et al., 2005; Table 2). The reef at these depths (31–40 m) exhibits morphological characteristics typical of deep reef habitats from throughout the region including plating morphologies (Fig. 2), with high surface area available for maximal absorption of photosynthetically active radiation. Additionally, species dominance changes with depth, with an increase in heterotrophic corals species, and a subsequent decrease in photoautotrophs (see Lesser et al., 2000).

Although plating and shingle-like forms of *Montastraea* spp. are the most common benthic constituents of this habitat (Fig. 2), this coral community is transitional between the shallow *Montastraea-Diploria-Porites* zone and the deeper *Stephanocoenia-Millepora* zone of Rezak et al. (1985). The high coral cover zone described in this article is dominated by *M. franksi* and *M. cavernosa*, whereas *Stephanocoenia intersepta* and *Millepora alcicornis* were small constituents (2.58% and 2.35%, respectively).

Most notably, the deeper reef community at the EFGB is devoid of large plating agariciids. For comparison, on the fore-reef slope at Discovery Bay, Jamaica, large foliose and plating forms of *M. franksi* and *Agaricia* spp. are the most abundant corals in this depth range, with *Agaricia* previously becoming more important with both increasing depth and slope angle (T. F. Goreau and N. I. Goreau, 1973; Liddell and Ohlhorst, 1987). Interestingly, many of these plating agariciids in Jamaica, especially *Agaricia lamarcki* suffered partial or complete mortality from coral bleaching events in the late 1980s and 1990s (Sebens, 1994; Precht, unpubl. data from 30 and 40 m at LTS Reef, Discovery Bay, Jamaica), whereas *M. franksi* routinely recovered from these episodes. Thus, one possible explanation for the exceptional condition of the deep reef community at the EFGB is the absence of these temperature-sensitive agariciids at this depth. Agariciids in general are known to be extremely sensitive to bleaching, and bleaching-related mortality appears to be high in these species (Sebens, 1994; Fitt and Warner, 1995; Aronson et al., 2002; Robbart et al., 2004).

As previously mentioned, the coral assemblage identified in this study is transitional between the shallower assemblage of *Montasraea-Diploria-Porites* (see Aronson et al., 2005) and the deeper water assemblage of *Stephanocoenia-*

Millepora (Rezak et al., 1985). The condition of the deep reef at the EFGB is currently exceptional and shows essentially no difference in species composition or total coral cover from early monitoring studies at similar depths at the EFGB. Therefore, understanding the role of deeper reef environments, their susceptibility or resistance to bleaching and related causes of mortality (or both), and the effects of being buffered from the impacts of fluctuating and increasing sea surface temperatures is of critical importance. To this end, continued long-term monitoring of these deeper stations will enhance our knowledge of community dynamics (and stability) at the EFGB in particular and provide insight with respect to the effects of depth on coral reef populations in general.

Acknowledgments.—Special thanks to the divers from MMS (David Ball and Les Dauterive) and NOAA (Sarah Bernhardt, Emma Hickerson, and Doug Weaver) for help with installation of the repetitive stations. Thanks to Rich Aronson, Susan Childs, Ken Deslarzes, Steve Gittings, Emma Hickerson, Steven Miller, and James Sinclair for helpful discussion and advice. Dave Roberts assisted with diving logistics. This study was funded by the Minerals Management Service, U.S. Department of the Interior, Washington, DC, under Contract Numbers 1435-01-02-CT-85088 and 1435-04-04-CT-33137. Funding was also provided by the Flower Garden Banks National Marine Sanctuary (FGBNMS). Field work was carried out under permits from FGBNMS.

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Gulf of Mexico Science, 2005(1), pp. 127–132
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OBSERVATIONS OF THE ANTIPATHARIAN "BLACK CORAL" *PLUMAPATHES PENNACEA* (PALLAS, 1766) (CNIDARIA: ANTHOZOA), NORTHWESTERN GULF OF MEXICO.—Antipatharians are found throughout the world's oceans but are most common in tropical deep-