

OBSERVATIONS ON THE OCTOCORAL FAUNA OF SOUTHEAST FLORIDA'S OUTER SLOPE AND FORE REEF ZONES

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ABSTRACT

Three present and two previous surveys of outer slope and fore reef (20-50 m) zones at various localities indicate a rather uniform assemblage of 44 octocoral species along approximately 360 km of the southeastern Florida coast.

INTRODUCTION

Several recent studies have included records of Caribbean octocorals to depths exceeding 20 m (Pérez, 1976; Antonius et al., 1978; Van den Hoek et al., 1978; Bunt et al., 1981; Burke, 1982; Muzik, 1982; Rutzler and Macintyre, 1982; and Goldberg, 1983), but only Kinzie (1973: Jamaica) and Goldberg (1973: Florida) presented extensive quantitative information. Goldberg (1973) surveyed coral-octocoral communities to 50 m off Palm Beach County. The few other Florida east coast *in situ* surveys which presented information on octocoral distribution and abundance beyond 20 m depth include an environmental assessment of beach renourishment projects off adjacent Broward (Courtenay et al., 1974) and Dade (Courtenay et al., 1975) counties, and resource inventories at Key Largo (Antonius, 1974) and Looe Key (Antonius et al., 1978). A later Key Largo Coral Reef National Marine Sanctuary Deep Water Resource Survey (KLNMS survey; NOAA, 1981) included a brief inventory of octocorals to 76 m depths. This report con-

solidates previous knowledge and presents new information on basic octocoral habitat, distribution, and abundance at southeast Florida's outer slope and fore reef.

MATERIALS AND METHODS

Brief SCUBA and submersible surveys were conducted at three southeast Florida localities. Breakers reef (Fig. 1A), 1 km east of the Breakers Hotel at Palm Beach, was surveyed in March 1976. An 80-min drift dive covered the 114 m wide reef area. Qualitative collections and clearance of 1 m² quadrats provided data from 20 and 24 m depths.

Three sites seaward of French, The Elbow, and Carysfort reefs (Fig. 1B) in 27-56 m depths were surveyed in June 1979 from the Johnson-Sea-Link (JSL) submersible as part of the KLNMS survey. Dive periods were 2 h 33 min from 33.5 to 38.1 m at French reef and 3 h 15 min from 38.1 to 56.4 m at The Elbow. A supplemental SCUBA dive was made to 27.4 m at Carysfort reef. The JSL's mechanical arm and lockout divers procured samples. The JSL camera/strobe and a diver-held NikonosTM camera provided *in situ* photographs. Miscellaneous octocorals collected by other investigators supplemented

material.

Geological studies (Shinn et al., 1981) at Looe Key National Marine Sanctuary (LKNMS; Fig. 1C) in September 1980 provided on-site support for three days' work to 32 m depths. Qualitative inventories, a quantitative (20 m) transect at 27 m depth, and supplemental collections at 18-25 m depths documented the octocoral fauna.

Observations were recorded on underwater ASCOTTM paper. Collected specimens (preserved in alcohol) provided confirmation of field identification and were deposited in the Florida Department of Natural Resources Invertebrate Reference Collection, Bureau of Marine Research, St. Petersburg, Florida. Classification follows Bayer's (1981) revision of the Octocorallia.

RESULTS

The Breakers reef was representative of the outermost of three coral-inhabited terraces offshore of Palm Beach County. From a crest at 14 m depth, finger-like mounds extended seaward from the main reef body; the slope gradually decreased and ended at a flat rubble/sand plain in about 25 m depth. Octocorals, the most conspicuous sessile macroinvertebrates, overshadowed encrusting or plate-like stony corals. Large flabellate *Iciligorgia schrammi* colonies were common. Eleven octocoral species were recorded at a 20 m site and forty-six colonies were collected within 1 m². *Plexaura flexuosa* was most abundant, but greatest biomass was contributed by *I. schrammi*. Six other species were added but only 15 colonies were cleared from a 1 m² sample at 24 m depth (Table 1).

Three sites off Key Largo basically represented deep slope and fore reef zones of bank barrier reefs of the Florida reef tract. Star corals (*Montastraea*), lettuce corals (*Agaricia*), clustered *Madracis*, and numerous sponges and octocorals colonized moderate relief mounds in 26-33 m depths at Carysfort. *Iciligorgia schrammi* and species of *Pseudopterogorgia* appeared most abundant and were among 13 octocoral species collected at 27.4 m (Table 1).

Discontinuous coral mounds on a flat rubble plain were observed at 33.5 m depth off French reef. Octocorals which appeared to be common between 33-35 m depths included *Iciligorgia schrammi*, species of *Pseudopterogorgia*, *Briareum asbestinum*, and *Plexaura flexuosa*. *Pseudopterogorgia*

bipinnata, *I. schrammi*, and four other species were collected at 35.4 m. Beyond 35 m depth, coral mounds were replaced by low outcrops inhabited by *Ellisella barbadensis*, *I. schrammi*, and species of *Eunicea*, *Muricea*, and *Pseudopterogorgia*. Flabellate *Swiftia exserta* and branched ellisellids (*Nicella schmitti* form) were the most conspicuous attached macrobenthic organisms between outcrops in 36-38 m (Table 1).

At about 38 m depth off The Elbow, rocky outcrops harbored *Iciligorgia schrammi*, slender euniceids, species of *Pseudopterogorgia*, and branched ellisellids. *Swiftia exserta* was abundant; *Iciligorgia schrammi*, *Eunicea pinta*, *Eunicea succinea*, *Pseudopterogorgia bipinnata* and *Ellisella elongata* also were collected, and *N. schmitti* was observed there. *Pseudopterogorgia bipinnata* and *E. elongata* were taken from rocky patches at 40.5 m depth. Below about 45 m depth, few low outcrops interrupted an otherwise algal-dominated community; only *S. exserta* was collected there (Table 1).

Nineteen species were collected or observed within the 27.4 - 56.4 m depths surveyed at Key Largo (Table 1). Six species were sampled only at 27.4 m and 13 species were found between 30 and 40 m. An unidentified *Eunicea* was collected by geologists at French reef in 76.2 m.

An intermediate reef area with low discontinuous outcrops represented a comparatively shallow subzone of the slope in about 15-20 m depths at Looe Key. Octocorals dominated the macrobenthic fauna. At 20 m depth, the slope abruptly dropped 10 m. Along the drop-off, two species of *Pseudopterogorgia* were most abundant; these species were accompanied by at least 14 other octocoral species collected at 25-27 m depths (Table 1). A few flagelliform *Ellisella barbadensis* occurred at the drop-off/sand flat margin; otherwise, only *I. schrammi*, *P. porosa*, and *M. laxa* were collected at about 30 m depth (Table 1).

DISCUSSION

Below the major slope break at depths of 12-20 m, a seaward discontinuous ridge occurs from Key West to Bal Harbor (north of Miami) and extends northward to at least West Palm Beach and probably beyond (Shinn et al., 1977). This ridge or "outer reef" is usually separated from the "named reefs" by a 500-1000 m wide sand-filled

trough in the Florida Keys. From north Miami to Palm Beach, this ridge is a relict shelf edge coral reef 10 m in relief and 15-30 m deep inhabited by a deeper reef fauna composed predominantly of octocorals, sponges and scattered coral heads (Lighty, 1977).

Goldberg (1973) surveyed three reef-like parallel ridges from Miami to Palm Beach. He designated the third ridge or terrace as the "outer reef" with a platform to about 20 m depth, reef slope to 30 m, and a fore reef flat rubble plain extending beyond 30 m. Gorgonian octocorals were the most conspicuous reef slope biota. Goldberg termed the outer reef slope the *Iciligorgia* zone because of the biomass and abundance of *I. schrammi*. Gorgonians also represented the most conspicuous invertebrates of the fore reef, although numbers of species were greatly reduced there.

Courtenay et al. (1974, 1975) made similar observations at the outer reef off adjacent Broward and Dade counties to the south. *Iciligorgia schrammi* was the most common of ten and six octocoral species reported from those two surveys, respectively. *Pterogorgia anceps*, the only species they listed that was not listed in Goldberg's (1973) or my Palm Beach County surveys, may have been confused by them with its congener, *P. guadalupensis*.

Thirty-nine species are now known to comprise the octocoral reef fauna in 20-50 m depths off Palm Beach County (Table 1). Combined records of the Goldberg (1973) and Breakers reef surveys list 29 species from the outer reef slope, 7 inhabiting both the slope and fore reef, and 3 species known only from the fore reef zone. Species reported only in the Palm Beach County surveys include *Diodogorgia nodulifera*, *Lophogorgia cardinalis*, *Muricea pendula*, *Pseudoplexaura crucis*, *Eunicea palmeri*, *Eunicea clavigera*, *Plexaurella pumila*, *Pseudopterogorgia rigida*, *Pseudopterogorgia navia* and three unidentified species belonging to the genera *Pseudoplexaura*, *Pseudopterogorgia* and *Ellisella* (Table 1). Of these 12 species, only *D. nodulifera*, *E. clavigera*, and an unidentified *Pseudoplexaura* were reported in both surveys. The other nine species were reported only by Goldberg (1973), and seven of these together represented only 1% of his sampled population; their absence in the Breakers survey is not surprising. Of the remaining two species, *Eunicea palmeri* comprised

5.6% and 20% of all octocorals in Goldberg's two reef slope subzones; my unidentified *Eunicea*, comprising about 13% of all octocorals in two quadrats at Breakers reef, was likely *E. palmeri*. An unidentified species of *Ellisella*, evidently not *E. barbadensis* which was reported from both surveys, comprised 0.4-0.7% of all octocorals at Goldberg's two reef slope subzones and 14% of all octocorals at the fore reef. *Diodogorgia nodulifera*, 5% of the fore reef fauna sampled by Goldberg, was common and accounted for about 10% of the Breakers fauna sampled.

Of the nine named species listed only in the Palm Beach County surveys, *M. pendula* is a temperate species and *D. nodulifera* and *L. cardinalis* are deep water species at the shallow limits of their ranges. The five species remaining include three Caribbean taxa (*Pseudoplexaura crucis*, *Plexaurella pumila*, *Pseudopterogorgia navia*) not otherwise reported from Florida and three (*Eunicea palmeri*, *Eunicea clavigera*, and *Pseudopterogorgia rigida*) usually found in depths shallower than 20 m in the Florida Keys.

The named outer reefs off Key Largo are basically bank barrier reefs, not continuous with or adjacent to land, and consist of a back reef, a platform with a reef flat and spur and groove formation, a reef slope, and a fore reef. Prominences 1-2 m high which form spurs generally less than 5 m wide, occur parallel to the platform margin between 20-35 m depths in KLNMS (Jaap, 1981; Jameson, 1981; Shinn, 1981; Wheaton, 1981). Spur relief decreases as depth increases, and spur distribution becomes increasingly sparse as the reef slope grades into the fore reef cobble zone.

Twenty octocoral species were recorded in depths greater than 20 m off Key Largo (Table 1): six species from the outer slope, seven species from both the slope and fore reef, and seven species only from the fore reef zone. Of these, only *Ellisella elongata* was not recorded from either Looe Key or Palm Beach County (provided Goldberg's unidentified ellisellid was not this species); *E. elongata* is basically a deep-water species at its shallow range limit.

Looe Key, in the lower Keys, exhibits the classic spur and groove formation of well-developed reefs of the Florida reef tract (NOAA, 1983). Antonius et al. (1978) distinguished five zones at Looe Key: patch reef, reef flat, fore reef with spur and groove

system, deep reef with a drop-off, and deep ridge. They divided the deep reef (slope) into a shallow plateau and steep slope with a drop-off; however, no distinction between subzones was made in their species tabulations. Existence of the deep ridge is unconfirmed in records of Antonius' submersible dives at Looe Key, which contain no reference to the ridge (John Reed, Harbor Branch Foundation, pers. comm.). The ridge was not found by seismic profiling (Lidz et al., 1985).

Records combined from Antonius et al. and my surveys listed 27 species from the Looe Key outer slope and 2 species distributed on both the slope and fore reef, for a total of 29 octocorals in depths beyond 20 m (Table 1). Neither survey sampled the fore reef zone deeper than about 35 m, and no species were recorded only in the fore reef zone. Species recorded only in the Looe Key outer reef surveys include *Erythropodium caribaeorum*, *Plexaura homomalla*, *Eunicea asperula*, *Pseudoplexaura wagneri*, and *P. flagellosa*. Antonius et al. reported the first four species and both surveys recorded *Pseudoplexaura flagellosa*. All five are typically wide ranging Caribbean reef species.

Together, the five surveys (Goldberg, 1973; Antonius et al., 1978; three present) indicate that 48 octocoral taxa, including 44 identified species, inhabit southeast Florida's outer slope and fore reef in depths between 20 and 50 m. Although derived from five surveys conducted by at least three investigators using different methodologies and degrees of effort, the combined records provide a broad information base of octocoral communities at these depths.

Totals of 39, 20, and 29 octocoral taxa were reported from Palm Beach, Key Largo, and Looe Key, respectively. Seventeen of 48 total taxa were recorded only at single localities. Among the remaining 31 taxa, Palm Beach and Key Largo had 17 in common, 21 were at both Palm Beach and Looe Key, and Key Largo and Looe Key shared 14. Eisemann (1981) reported KLNMS algal species composition and depth distribution to be strikingly similar to those surveyed by Eisemann (1978, 1979) in deep water off Palm Beach (33-42 m), where a relatively uniform benthic flora resembled that collected in the KLNMS *Lithothamnion* cobble zone.

Seven octocoral species (*Iciligorgia schrammi*, *Plexaura flexuosa*, *Pseudopterogorgia americana*, *Eunicea calyculata*, *Gor-*

gonia ventalina, *Muricea laxa* and *Eunicea pinta*) occurred between 20-30 m depths at all three localities (Table 1). The first three species were recorded during all five surveys; four surveys listed the next two species, and the last two species were documented in three surveys. *Iciligorgia schrammi* and *Ellisella barbadensis* were present in the greater than 30 m depth fore reef zone at all three localities; both species were reported in three of five surveys. When slope and fore reef records are combined, *Briareum asbestinum* and *Eunicea succinea* are added to make a total of eleven octocoral species whose distributions span the deeper reef zones at all three localities.

Differences in numbers of taxa shared among sites may be artifacts of sampling differences previously stated. Although a few taxa at Palm Beach show temperate affinities, the remaining taxa at all sites are representatives of the Caribbean fauna. This distribution agrees with Bayer's (1961) observation that "on the continental shore, the shallow water (to 46 m) West Indian gorgonian fauna stops roughly at Jupiter Inlet at the northern border of Palm Beach County." Some taxa here reported are deep-water species whose records between 20-50 m represent occurrences near the shallow limits of their ranges. The remainder are shallow-water species whose distributions extend into deeper reef zones. Together, these records indicate a relatively uniform assemblage of octocorals occupying deep reef areas over a distance of at least 360 km off the southeastern Florida coast.

Kinzie (1973) reported 42 octocoral taxa from 0 to 75 m depths off northern Jamaica; of these, 33 taxa (78%) occupy 20-50 m depths off southeastern Florida. Bathymetric ranges of 28 of these 33 taxa likewise extended into or through 20-50 m depths at Jamaica. Of the remaining five taxa, three (*Eunicea tourneforti*, *Muricea muricata*, and *Pterogorgia citrina*) occurred only at depths less than 20 m at Jamaica, and *Swiftia exserta* occurred only at depths greater than 50 m there. Together, these studies indicate that a relatively uniform octocoral assemblage occupies 20-50 m depths throughout the northern Caribbean region.

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TABLE 1.—Comparison of outer reef octocoral records from surveys at three southeast Florida localities.

Species	Palm Beach County			Key Largo			Looe Key		
	Goldberg 1973	Wheaton Breakers	French	Wheaton Elbow	Carysfort		* Antonius et al. 1978	Wheaton	
<i>Briareum asbestinum</i>	OS		FR				OS		
<i>Erythropodium caribaeorum</i>							OS		
<i>Diodogorgia nodulifera</i>		FR	OS						
<i>Iciligorgia schrammi</i>	OS	FR	OS	FR	FR	OS	OS	FR	OS
<i>Swiftia exserta</i>	OS	FR	OS	FR	FR				
<i>Plexaura flexuosa</i>	OS		OS	FR		OS	OS		OS
<i>Plexaura homomalla</i>							OS		
<i>Pseudoplexaura porosa</i>						OS	OS		OS
<i>Pseudoplexaura flagellosa</i>							OS		OS
<i>Pseudoplexaura wagnaari</i>							OS		
<i>Pseudoplexaura crucis</i>		FR							
<i>Pseudoplexaura</i> sp.	OS		OS						
<i>Eunicea asperula</i>							OS		
<i>Eunicea palmeri</i>	OS								
<i>Eunicea calyculata</i>	OS					OS	OS		OS
<i>Eunicea fusca</i>	OS		OS				OS		
<i>Eunicea laciniata</i>	OS						OS		
<i>Eunicea mammosa</i>			OS				OS		
<i>Eunicea succinea</i>			OS		FR		OS		
<i>Eunicea tourneforti</i>	OS						OS		
<i>Eunicea clavigera</i>	OS		OS						
<i>Eunicea pinta</i>	OS			FR	FR	OS			OS
<i>Eunicea</i> sp.			OS	FR**					
<i>Plexaurella dichotoma</i>	OS						OS		
<i>Plexaurella fusifera</i>	OS						OS		OS
<i>Plexaurella nutans</i>				FR		OS	OS		OS
<i>Plexaurella pumila</i>	OS								
<i>Muricea muricata</i>			OS				OS		
<i>Muricea elongata</i>			OS				OS		
<i>Muricea laxa</i>		FR	OS	FR		OS			OS
<i>Muricea pendula</i>		FR							
<i>Muriceopsis flavida</i>	OS						OS		OS
<i>Muriceopsis petila</i>	OS			FR					
<i>Gorgonia ventalina</i>	OS					OS	OS		OS
<i>Pseudopterogorgia bipinnata</i>				FR	FR	OS	OS		OS
<i>Pseudopterogorgia acerosa</i>			OS				OS		OS
<i>Pseudopterogorgia americana</i>	OS		OS			OS	OS		OS
<i>Pseudopterogorgia rigida</i>	OS								
<i>Pseudopterogorgia elisabethae</i>	OS								OS
<i>Pseudopterogorgia navia</i>	OS								
<i>Pseudopterogorgia</i> sp.	OS								
<i>Pterogorgia citrina</i>			OS			OS			
<i>Pterogorgia guadalupensis</i>	OS					OS			
<i>Lophogorgia cardinalis</i>		FR							
<i>Ellisella barbadensis</i>	OS	FR	OS	FR			OS	FR	OS
<i>Ellisella elongata</i>					FR				
<i>Ellisella</i> sp.	OS	FR							
<i>Nicella schmitti</i>	OS	FR		FR	FR	OS			

OS = outer reef slope (20-30 m depth)

FR = fore reef (30+ m depth). Not Antonius et al. fore reef (= reef platform spur and groove).

* Antonius et al. made no distinction between sub-zones of the deep reef in their quantitative species tabulation.

** Incidental collection by geologists.

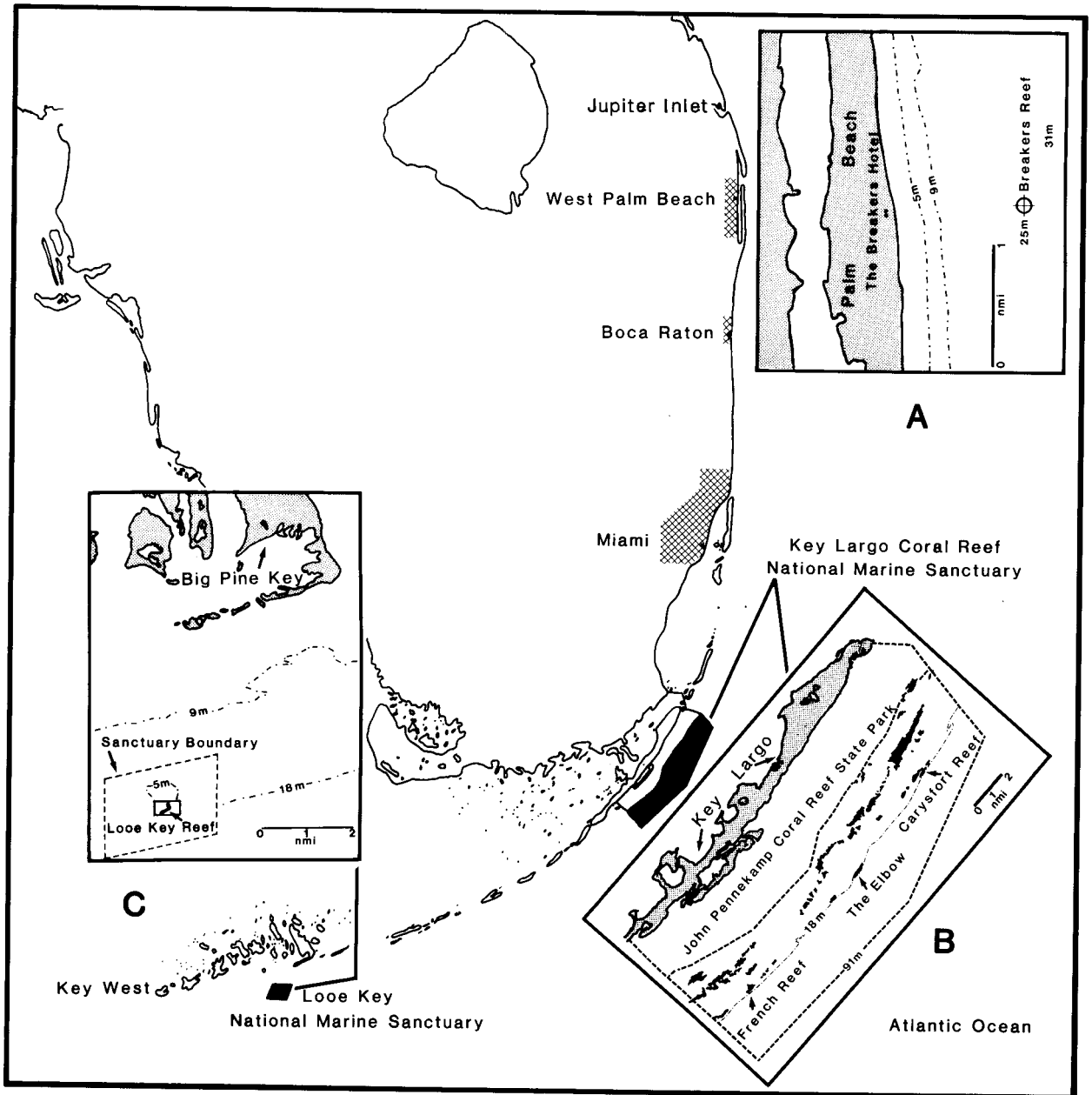


FIGURE 1. — Geographic localities of survey sites: A. Breakers reef, Palm Beach County; B. Key Largo reefs; C. Looe Key reef.