1981 - 22

W. E. SWEET

DEPARTMENT OF OCEANOGRAPHY · 1949 · TEXAS A&M UNIVERSITY · 1949 ·

NORTHERN GULF OF MEXICO TOPOGRAPHIC FEATURES STUDY

FINAL REPORT

VOLUME FIVE

Submitted to the
U.S. Department of the Interior
Bureau of Land Management
Outer Continental Shelf Office
New Orleans, Louisiana

Contract No. AA551-CT8-35

Department of Oceanography
Texas A&M University
College Station, Texas

Technical Report No. 81-2-T

Research Conducted Through
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CONTRIBUTORS

PROGRAM MANAGER

Joseph U. LeBlanc

PROJECT CO-DIRECTORS

Richard Rezak
Geological Oceanography

Thomas J. Bright
Biological Oceanography

PRINCIPAL INVESTIGATORS

Thomas J. Bright
Larry J. Doyle
Stefan Gartner
Choo S. Giam
Thomas W.C. Hilde
Thomas S. Hopkins
Joseph U. LeBlanc
David W. McGrail
Patrick L. Parker
Bobby J. Presley
Richard Rezak
Richard S. Scalan
William W. Schroeder
John C. Steinmetz
J. Kenneth Winters

ASSOCIATES

Dan K. Adkison
William Bandy
Dan Boatwright
Greg Boland
Paul Boothe
Lynn M. Bryant
Cindy Buddenberg
Yu-Hsin Chen
Doug G. Clarke
Christopher Combs
Mike R. Dardeau
Elaine De Mann
George Dennis
Guy Denoux
John J. Dindo
Jan Donley
Sylvia Earle
Mary Feeley
Doug K. Gilbert
Fern Halper
Dale Harber
Jeff Hawkins
Sylvia Herrig
Allan F. Hooker
Doyle Horne
Y. Hrung
David Huff
John S. Jenkins
Ming-Jung Jiang
James Kendall
Cathy Knebel
Chao-Shing Lee
Arlette Levitan
Eric H. Livingston
Charles H. Lutz
Linda B. Lutz
Larry Martin
Greg Minnery
Grace Neff
Rose Norman
Judy Pate
Linda Pequegnat
Eric Powell
David Risch
Lauren Sahl
John S. Schofield
Jay A. Shapiro
George Sharman
Brenda Shaw
James Stasny
Robert J. Taylor
Joan M. Uebelacker
Susan Wagner
Steve Viada
Wei Wang
Waris Warsi

EDITOR

Rose Norman

VOLUME FIVE

CHAPTER XXII: FLORIDA MIDDLE GROUND

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CHAPTER XXI
FLORIDA MIDDLE GROUND

P.I.'s: T. Hopkins, W. Schroeder, T. Hilde, L. Doyle, J. Steinmetz

INTRODUCTION

T. Hopkins

PURPOSE AND SCOPE

This study was undertaken at the invitation of Texas A&M University for the University of Alabama and the University of South Florida to participate in a joint study of the Florida Middle Ground. The overall study objective was to characterize the topographic high known as the Florida Middle Ground (FMG) using submarine sampling, geophysical profiling, open circuit SCUBA, shipboard instrumentation, and *in situ* instruments for measuring currents, salinity, and temperature. The characterization was designed to establish ranges of spatial and temporal variation in the chemical, geological, and physical environment of the Florida Middle Ground, and should produce qualitative and quantitative management-oriented biological data describing the lesser known aspects of the fauna and flora of the central portion of the Florida Middle Ground. The characterization makes maximum possible use of, but does not seriously duplicate, data gathered under BLM contracts 08550-CT4-11, 08550-CT5-30, and AA550-CT7-34.

This chapter provides an integrated multidisciplinary overview of the Florida Middle Ground. The overview has been designed to integrate complete geophysical mapping with site specific submarine ground truthing, geological sampling, physical oceanographic *in situ* and time series recording, and biological and chemical sampling. The geophysical, physical, and geological data (Sections 1-3) are used to describe the setting for biological data (Section 4). The collection of biological data itself was designed around management concepts to address two diverse management objectives: 1) to determine whether the Florida Middle Ground (or portions thereof) should be designated as a "Habitat Area of Particular Concern," e.g., in need of protection; and 2) to devise specific monitoring approaches which are feasible and cost effective. Of parallel interest is the question of annual and seasonal variability in weather patterns and how these processes must dictate and sometimes moderate the decision-making process.

DESCRIPTION OF THE STUDY

The study area lies on the Outer Continental Shelf (OCS) of the eastern Gulf of Mexico about 150 km south of the north Florida coast and 160 km northwest of Tampa Bay (Austin, 1971). The mapping area lies in BLM lease blocks 249-254, 293-298, 337-342, 382-387, 426-431, 471-475, 515-519, and 559-562 on the Florida Middle Ground NOS NH 16-12 (OCS) chart. The reefal portion of the Florida Middle Ground has the distinction of being the northernmost living coral reef habitat in the Gulf of Mexico (Hopkins, 1974). It is located in an area bounded by 28° 10' N to 28°43' N and 084° 10' W to 084°25' W (see Figure XXI-1, pocket). The greatest reef development lies within this radius; the relief varies from 23 to 40+ m in depth. The overall complex trends north and south, and exhibits complex and rugged topography in sharp contrast to the relatively smooth bottom characterizing most of the west Florida OCS (Jordan, 1952; Back, 1972; and Grimm and Hopkins, 1977).

Seven cruises were undertaken during this characterization effort. Table XXI-1 summarizes efforts on these seven cruises.

TABLE XXI-1
SUMMARY OF CRUISE EFFORTS SUPPORTING THE 1978-1979 CHARACTERIZATION OF THE FLORIDA MIDDLE GROUND

DATES	CHIEF SCIENTIST	PLATFORM	EFFORT
30 Aug - 16 Sep 78	Hilde	R/V JOYRO	Mapping
28 Sep - 20 Oct 78	Hopkins	R/V BELLOWS	Multi-Disciplinary
4 Nov - 13 Nov 78	Hopkins	M/V RED SEAL	Submersible/ Geological Grabs
15 Jan - 4 Feb 79	Hopkins	R/V BELLOWS	Multi-Disciplinary
26 Mar - 30 Mar 79	Hopkins	R/V ROUNSEFELL	Multi-Disciplinary
19 Jun - 11 Jul 79	Hopkins	R/V BELLOWS	Multi-Disciplinary
15 Jan - 21 Jan 80	Lutz	R/V ROUNSEFELL	Instrument Recovery

OCEANOGRAPHIC SETTING

Physical

Since Fausak (1979, pp. 894-899) has provided a recent review of the physical oceanographic setting surrounding the Florida Middle Ground, the reader is referred to this source.

Geological

Doyle and Sparks (1979) recently summarized the sediment characteristics of the MAFLA OCS. The area under consideration is called the West Florida margin, formed since Jurassic time and characterized by 4,600 m of carbonates and evaporites. Jordan (1952) first recorded the existence of this topographic high, and Gould and Stewart (1955) confirmed Jordan's suggestion of reefal growth based on calcareous algae collections dredged from the area. Brooks (1962) visited the area with open-circuit SCUBA, providing the first detailed evidence that the Florida Middle Ground is a hermatypic community with similarities to the Florida Keys. Jordan (1952) has hypothesized that the reefal formation is indicative of a drowned river valley. Back (1972) presented an in-depth study of the bathymetry, sediment texture, and bottom currents in the area. Brooks (1973) has summarized the geological history of the eastern Gulf of Mexico.

Pyle et al. (1977) have reviewed the seismic data and described the morphology as "dominated by two parallel ridges which strike approximately north-south, and a 'plug-like' reef structure which separates the two ridges at their southern terminus." They found, and Hopkins (personal observation) concurs, that steepest slopes are developed adjacent to the flat central inter-reef plain, open to the north, and bounded by the east and west ridges and the plug to the south. Their conclusion is that the eastern ridge is developed along the strike of the seaward margin of a Tertiary limestone terrace which dips seaward under the western ridge, and that the western ridge developed on a southward prograding spur defined by the 36 m isobath. They also provide evidence for "Karren-like" karst development on the "southern extension" of the eastern ridge. This area is a lesser known portion of the reef and exhibits dissected pinnacle-like development with about 5 m of relief (35-40 m depth). The pinnacle-like character of the prominences of this "southern extension" are "probably the result of both Karstification during emergence and secondary growth after subsequent transgression" (Pyle et al., 1977).

In a personal communication to R. Back (Pyle et al., 1976), H.K. Brooks indicated that a radiometrically dated sample from a core taken on the east ridge showed a carbon-14 date of about 6,000 years B.P. and a net accumulation rate of about 0.3 m/1,000 years.

Back (1972) has reported strong currents on reef crests (about 100 cm/sec), and Hopkins' divers have encountered the same periodic phenomena over the years. It appears to correlate with tidal forces. Deep sand ripples in the coarse skeletal sands strike north and south and further suggest currents flowing east or west. In contrast, Jordan (1952) indicated that the "plug reef" development mentioned above may suggest southerly movement provided that it developed on a channel divide.

Chemical

Corcoran (1973) reports a paucity of nutrient data and absence of POC/DOC data in the eastern Gulf of Mexico. Corcoran (1973) and Fanning (1974) do not add any significant data to the available data base. Under BLM Contract #08550-CT4-11, Fanning (1974) reports summer benthic nutrient concentrations as follows:

NUTRIENTS		$\bar{X}$	n	Range
PO_4P	(μg-at/1)	0.10	6	0.00-0.19
NO_3N	(μg-at/1)	0.20	6	0.15-0.25
NO_2N	(μg-at/1)	0.02	6	0.01-0.04
SiO_2	(μg-at/1)	1.66	7	0.83-2.45

On the same contract, Knauer and Aller (1974) report DOC with a $\bar{X}$ of 1.53 milligrams carbon per litre of water (mg C/l)(R = 0.73-2.78) and POC with a $\bar{X}$ of 0.20 mg C/l (R = 0.14-0.29).

BLM Contract #08550-CT5-30 apparently did not support nutrient data collection; however, Table 128 of that final report reveals average POC/DOC values by depth zones and seasons. In reviewing the data, Jeffrey (1979) reports a range of 0.96 to 1.30 mg C/l for DOC and POC concentrations of 0.049 to 0.116 mg C/l for September/October 1975. No depths were given. In her own study, Jeffrey (1979) provides the following values for fall and winter on the Florida Middle Ground.

SEASON	$\bar{X}$	POC	$\bar{X}$	DOC
Fall	0.02	0.010-0.029	1.15	1.08-1.21
Winter	0.158	0.088-0.212	0.88	0.77-1.20

These data show that POC varies inversely with DOC by season. Jeffrey also noted that the largest variation in POC data over a five-day period occurred over the Florida Middle Ground and at Panama City, to the northwest.

Biological

Apparently, Gould and Stewart (1955) can be credited with the first biological investigations of the Florida Middle Ground. When Brooks (1962) visited the area with open-circuit SCUBA, he reported living alcyonarians, coralline algae, hermatypic corals, milleporines, and tropical fish similar to those he observed on deeper reefs of the Florida Keys. Back (1972), in the course of his geological observations on the Florida Middle Ground, was accompanied by Hopkins and others who made additional trips to the area in 1971 and 1972. Algal collections from these years' efforts led to reports on plankton by Cheney and Dyer (1974) and Austin and Jones (1974). Invertebrate and icthyological observations for this period were reported by Hopkins (1974), Smith and Ogren (1974), and Smith et al. (1975).

Under BLM Contract #08550-CT4-11, Hopkins (1974) conducted extensive diving and dredging in the geographic locale cited for the study area. This effort was followed by BLM Contract #08550-CT5-30, in which Hopkins described the Florida Middle Ground epifaunal community as the "North Middle Ground High Relief Epifaunal Assemblage," an assemblage having a distinct tropical fauna and flora. The major results of this effort have appeared in the literature (Grimm and Hopkins, 1977; Shaw and Hopkins, 1977; Hopkins et al., 1977a; Hopkins et al., 1977b; Vittor and Johnson, 1977, and Dardeau et al., 1980). Smith's research on the fishes of the Florida Middle Ground (1976) (not directly supported by BLM) is reported in a peer-reviewed article.

In addition to the macroepifauna and flora, it is important to consider other benthonic data from this area. Bock (1979) has summarized the information on foraminifera; Blake (1979) has described macroinfaunal molluscs; Heard (1979) has described macroinfaunal crustacea; Vittor (1979) has described macroinfaunal polychaetes, and Shipp and Bortone (1979) have described demersal fish from the area. All of these efforts, along with a reiteration by Dames and Moore (1979) that the Florida Middle Ground is a unique association, were supported by BLM Contract #AA550-CT7-34.

SECTION 1: MAPPING AND SUB-BOTTOM PROFILING

P.I.: T. Hilde
Associates: G. Sharman, W. Warsi, C. Lee, M. Feeley, M. Meyer

METHODS OF INVESTIGATION

General

The survey was conducted aboard the M/V JOYRO, a 25.9 m utility boat, owned by Oceanonics, Inc. and operated by Profiler, Inc. of Houston, Texas. A portable van on board the vessel housed all electronic equipment and recorders necessary for the operation except for the navigation equipment, which was operated in the wheelhouse.

Navigation

Navigation and positioning for both legs of the northern Florida Middle Ground survey were accomplished using the "JK" LORAC service chain. The LORAC receiving system was interfaced to a Decca Autocarta System consisting of a PDP 11/05 computer, TI 733ASR Data Terminal, Houston Instruments DP-3 Plotter, and a Decca Survey 10409 Left/Right Display. The navigation equipment was located in the wheelhouse to facilitate communications between the navigator and the helmsman. The Autocarta System assisted the helmsman by displaying distance off line and recording the positioning fixes and depths on magnetic tape cassettes for later processing.

LORAC calibration was performed at a known platform location near the survey area. Lanecount was tracked on an analog recorder, and a closed lanecount traverse was made to and from the survey area to further insure the correctness of the lanecount. Lanecount was also checked frequently at a buoy specially emplaced for that purpose. The anchor for this buoy, a 55 gal. cement-filled oil drum, also served as the benchmark for the survey areas; see Volume Two, Table VII-3. Shot points (navigation fixes) were taken and recorded at 152 m (500 ft) intervals. An automatic event marker was used to place shot points on all the survey records. Communication with the electronics van was by intercom, and equipment operators in the electronics van annotated the records with line and shot point numbers. The survey was plotted at a scale of 1:12000, and approximately 2214 km (1376 statute miles) of survey data were obtained during the Florida Middle Ground mapping cruise (see Table XXI-2).

Bathymetry

The echosounder used to obtain bathymetric data was a Raytheon DE 719B. The unit has a depth range of 132.9 m. The echosounder transducer was mounted on the port side of the vessel 6.1 m aft of the LORAC antenna, and at a depth of 3.3 m. A bar check to 16.4 m was made regularly. The stylus rotation was set to correspond to a seawater sound velocity of 1520 m per second, and the transducer draft on the recorder was set at 3.3 m. The recorder uses dry paper 20.3 cm wide.

The echosounder was coupled with an Interspace Technology Model 412 Autotrack (digitizer), and the output of the digitizer was interfaced

TABLE XXI-2
NORTHERN FLORIDA MIDDLE GROUND DATA ON DIRECTION AND DISTANCE OF SURVEY LINES AND BENCHMARK LOCATION

A. SURVEY LINES

	REGULAR SURVEY LINES		TIE LINES		SURVEY LINE DISTANCE	
LEGS	Direction	Spacing	Direction	Number	Statute Miles	Kilometres
Leg I	E-W	300 m	---	0	230	370
Leg II	E-W	300 m	N-S	8	1146	1844
TOTAL					1376	2214

B. BENCHMARK LOCATION

DEPTH (ft/m)	x/y	LAT./LONG	LORAN A	LORAC R/G
94 ft	249401	28°35'0.23"	3H0=2665	790.15
28.67 m	-10382354	84°20'23.85"	3H1=3820	865.35

(The 55 gal. cement-filled oil drum left on the Florida Middle Ground served as anchor for the navigation buoy during mapping cruise leg II.)

with the Autocarta Computer. This system failed to operate properly, and depths were later read from the analog records. Depth at each shot point was recorded in feet and later converted into metres by computer.

Side-Scan Sonar

Side-scan data were collected with a Klein Side-scan Sonar System, Model 400. This consisted of a Klein Model 421 Recorder and a Model 402 Towfish. The system operates at a frequency of 105 kHz $\pm$ 10%. The recorder was set at the 150 m range, giving a record of 50 lines/cm.

The side-scan sonar fish was towed behind the vessel from the center stern. To stream and recover the towed sonar fish, an electrically powered winch was mounted at the stern. The amount of cable payed out during a survey line varied with the depth to the bottom and the speed of the vessel. Survey line length was recorded in the operator's log.

Sub-Bottom Profiling

Two systems were used for sub-bottom profiling. These were 1) the ORE Model 310 Pipeline Transceiver, coupled with an EPC 4200 Recorder for high resolution sub-bottom profiling, and 2) an EG&G Model 231-232 Uniboom (boomer) operated at 500 joules, coupled with an EPC 4600 Recorder for somewhat deeper penetration. The ORE Model 310 operates at selectable frequencies of 3.5, 5, 14, and 200 kHz. It was operated at 3.5 kHz for the present survey. The ORE transducer fish was deployed from a davit on the starboard side of the vessel 7.62 m aft of the LORAC antenna at a depth of 12 m. The EG&G boomer sled was towed on the port side of the vessel 20 m aft of the LORAC antenna. The hydrophone streamer was deployed on the starboard side of the vessel, with the hydrophones 23 m aft of the LORAC antenna. The recorders were operated at a 1/4 second sweep rate.

RESULTS

Bathymetry

The Florida Middle Ground consists of a complex set of north-south trending ridges which rise 10-18 m above general surrounding shelf depths of 38-44 m (Figure XXI-1, pocket). Within the region surveyed, at least five separate ridges can be identified. Two of the ridges, composed of numerous segments with slightly varied trends, have a greater north-south continuation than the others; they are located between 84° 12'W and 84° 16'W, and between 84°20'W and 84°24.5'W. In the northern and central region of the survey area they are separated by a 5-9 km wide trough or channel at general shelf depths (38-40 m). In the southern third of the region, however, a third ridge complex occupies the position of this channel between the two longer north-south ridges, leaving greatly narrowed channels (2 km or less) separating the three ridge complexes. Two additional ridges, having less relief, exist along the western margin of the surveyed area. One of these extends south at depths of 35-38 m from the northwest corner of the survey area, and the other extends south along 84°24'W at depths of 36-40 m from the west side of the more prominent western ridge.

Minimum depths along the crests of the ridges vary between 32 and 25 m. Ridge crest depths are 25-27 m deep in the east central region, and there are also depths of less than 26 m along the northern part of the long western ridge. In the south central region, minimum depths on ridges and peaks range from 28-32 m. In general, peak and ridge crest depths become greater from the north and northeast (where they are about 26 m deep) to the south and southwest (where they are 32 m or deeper)(Figure XXI-1, pocket). Surrounding shelf depths also increase in a southwest direction from about 38 m on the northeast to greater than 44 m on the southwest. The shelf gradient east of the survey region is about .2 m/km, increasing on the west to about 1.1 m/km towards the continental slope. A few isolated peaks in the central survey area have minimum depths of 23 m (i.e. at 28°32.31'N, 84°17.72'W, and 28°32.28'N, 84°18.52'W).

Both the maximum relief of the ridges and peaks and the local relief on top of the ridges increase to the south. This increase is shown in the bathymetry (Figure XXI-1, pocket) and in the roughness map of the seafloor, constructed from the side-scan sonar records (Figure XXI-2, pocket). Local relief on top of the ridges increases from less than 1 m in the north to greater than 3 m in the south. Relief on top of the ridges consists primarily of steep isolated peaks and most likely represents recent, patchy reef growth. The density of distribution of these features and the amount of local relief both increase to the south, yet minimum water depths are deeper in the south.

Other features which contribute to the seafloor roughness include depressions, sand waves or ripples, and small relief topographic lineations which may be outcrops (Figure XXI-2, pocket). The depressions that show up in the side-scan sonar records are located in the channels, away from the ridges, and to some extent along the base of the ridges. They are probably related to subsurface topography or structure and to bottom current scour. The sandwaves are most abundant on the ridges and their flanks. The strike of the crests and troughs of the sandwaves is generally east-west, which suggests that dominant bottom current directions are north-south. The small linear features are also associated with the ridges and strike in various directions but are most often sub-parallel to the trend of the ridge on which they are found. These features have less than 1 m of relief and are probably outcrops of older structures (earlier reef growth) which form the foundation of the ridges.

Several important, intermediate-scale features of the bathymetry are not obvious in either the bathymetric chart (Figure XXI-1, pocket) or the seafloor roughness map (Figure XXI-2, pocket). These are 1) a general east-west asymmetry of the ridges, 2) the common occurrence of narrow depressions at the base of and paralleling the west side of the ridges, and 3) gentle swells in the seafloor, well away from the ridges. These features can best be seen in east-west profiles of the bathymetric data (Figure XXI-3). They are primarily related to erosional and depositional processes.

Nine east-west profiles of the bathymetry and subsurface structure, evenly distributed from north to south, were selected from the 128 east-west survey lines (see index of profiles, Figure XXI-3) to characterize the bathymetric features and subsurface structure (Figure XXI-4). Although some of the ridges have equally steep slopes on both east and west sides, most of the ridges are steep-sided on the west and have long gentle slopes on the east. This feature is shown clearly in the profiles of lines 33, 48, and 86 (Figure XXI-4). The depressions at the base of the western slopes of the ridges are shown particularly well on lines 86 and 104, but can be seen in all of the profiles (Figure XXI-4). These depressions are 300-500 m wide and 1-3 m deep. A much shallower depression can also be seen on the east side of the western ridge complex (lines 60 and 75). In this case the eastern side of the ridge has a steep upper slope, and it appears that the seafloor currents have acted, in this exceptional case, to reduce the size of the typical long gentle eastern slope that exists for most of the ridges.

The broad swells of the seafloor in the channels or troughs between the more widely separated ridges are barely noticeable on the much reduced profiles of Figure XXI-4, yet can be observed in profiles of lines 18, 48, and 75. These are areas of suspected greater deposition. They show more clearly in the examples of the Uniboom records, to be discussed later.

Between closely spaced ridges the trough depths are generally shallower by several metres than between widely separated ridges (Figure XXI-4, lines 48 and 104). Regardless of trough depth, they all have relatively smooth seafloor surfaces when compared to the tops of the ridges. This factor is taken as evidence for areas of sedimentation.

Although the ridge tops are irregular, with considerable local relief (in the range of 1-5 m), the profiles in Figure XXI-4 show that they are rather broad and either flat or dipping to the east in their overall dimensions. Based on the associated diving and sampling program carried out in conjunction with this study (see below, Section 3, p. 48) and previous studies, the high local relief can be interpreted to be active reef growth, while the broad nature of the ridge tops can be interpreted as an older, dead reef complex. The common general depth of the broad surfaces could indicate either former subaerial exposure and erosion, or the effects of storms and hurricanes on the reefs at or near their present water depths.

From the bathymetry alone, it would appear that the Florida Middle Ground ridges are reef structures with a patchy distribution of live reefs, and that the troughs and valleys between the ridges are being filled with carbonate sediment derived, in part, from the ridges. The sediment studies associated with this project indicate that in the limited area sampled the sediments are primarily corroded carbonate sands characterized by molluscan shell hash. The asymmetry of the ridges

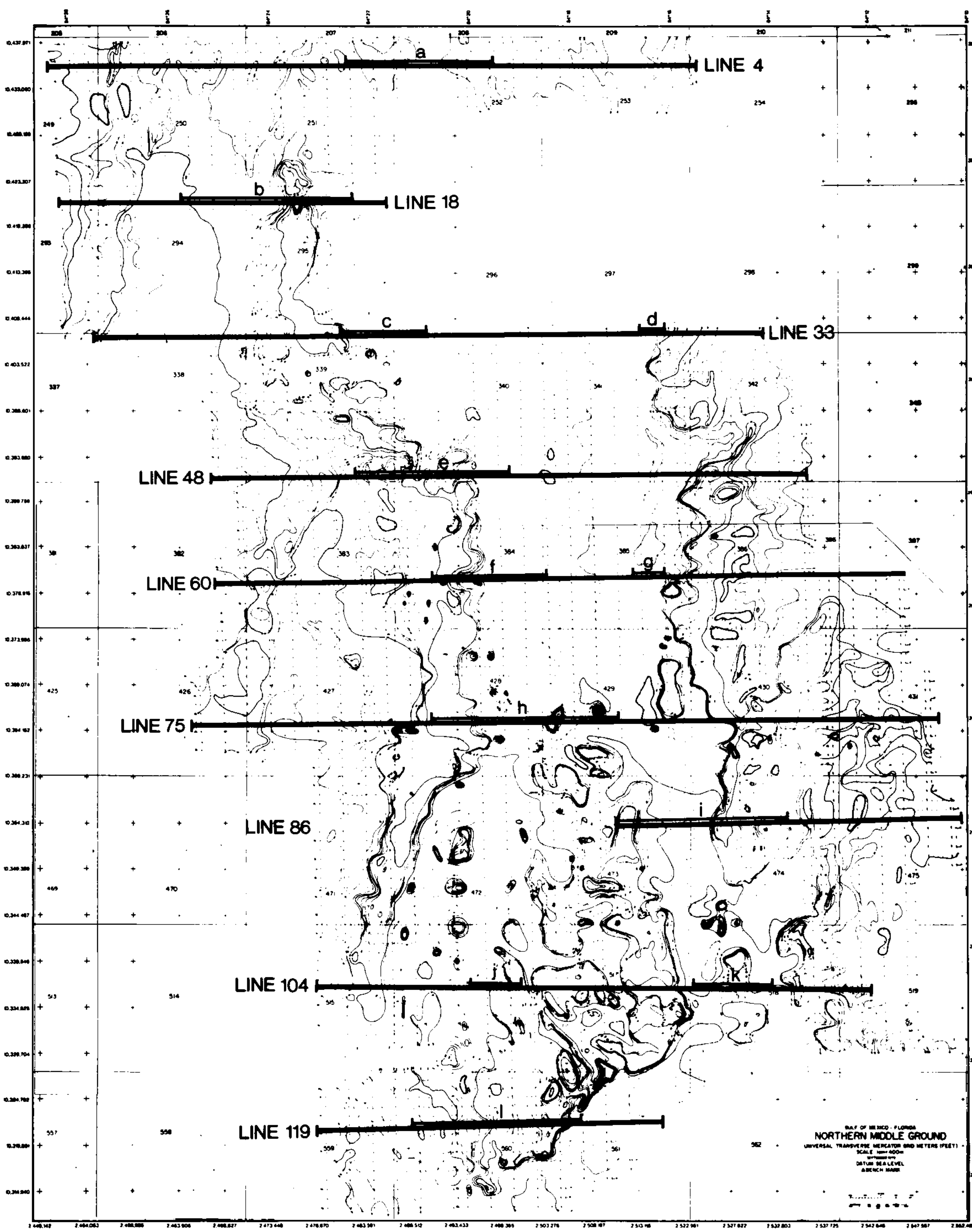

Figure XXI-3. Index of Uniboom seismic reflection profile line drawing and record section shown in Figures XXI-4 and 6 through 8, respectively. Letters over bars indicate respective record sections, Figures XXI-6 through 8.

suggests that the sediment is either being piled up against the eastern ridge slopes or that it is coming off the ridges, building talus slopes. The latter case could be accomplished by storm and hurricane action. Jordan (1973) has shown that the prevailing hurricane directions in this region, from 1941-1971, have been to the northeast. The previously described trend to greater local relief on top of the ridges which have deeper crests may indicate that present reef growth can be more successfully maintained in slightly greater water depths where effects of storms and hurricanes are less destructive. The scour at the base of the slopes on the west sides of the ridges is certainly related to accelerated bottom water movement, probably due to the restrictive effects of the ridge topography on prevailing currents.

Subsurface Structure

The shallow subsurface structure of the northern Florida Middle Ground has been determined from the Uniboom and 3.5 kHz seismic reflection profiles and is illustrated in Figures XXI-4 through 8. An index of the selected line drawing structural profiles and examples of Uniboom records (Figures XXI-4, 6, 7, 8) is shown in Figure XXI-3. Only Uniboom reflection records are shown because the 3.5 kHz data showed little or no additional internal structure. The uppermost sediments and structure of the ridges were transparent to the 3.5 kHz signal, suggesting homogeneous, non-stratified, Recent sediments, and a non-stratified internal structure to the ridges.

Four separate seismic stratigraphic sequences can be distinguished from the Uniboom seismic reflection data:

1. Uppermost Transparent Sequence - here the lower boundary is a strong, flat reflector that is observed throughout the region and whose upper surface is the seafloor between the ridges. Variations in thickness of this sequence are due to variations in depth of the seafloor; this sequence displays rare internal, generally conformable reflections.

2. Ridges - these are built upward from the same lower boundary of the sequence just described. Whereas the upper transparent layer displays rare weak internal reflectors, the ridges have no internal reflections and more strongly attenuate the seismic signal.

3. Middle Sequence - this sequence is also mostly transparent. It is bounded on the top by the above mentioned flat, ubiquitous reflector and on the bottom by a locally rough and irregular but regionally flat reflector. Rare internal reflectors of the middle sequence can be seen to onlap the lower boundary, and this sequence pinches out against the lower bounding sequence along a NNW-SSE line that extends through the entire survey area.

4. Lower Sequence - this sequence is immediately beneath the middle sequence in the western part of the survey area and directly overlain by the upper sequence in the eastern part of the survey area. This can be considered a seismic basement for the shallow penetration

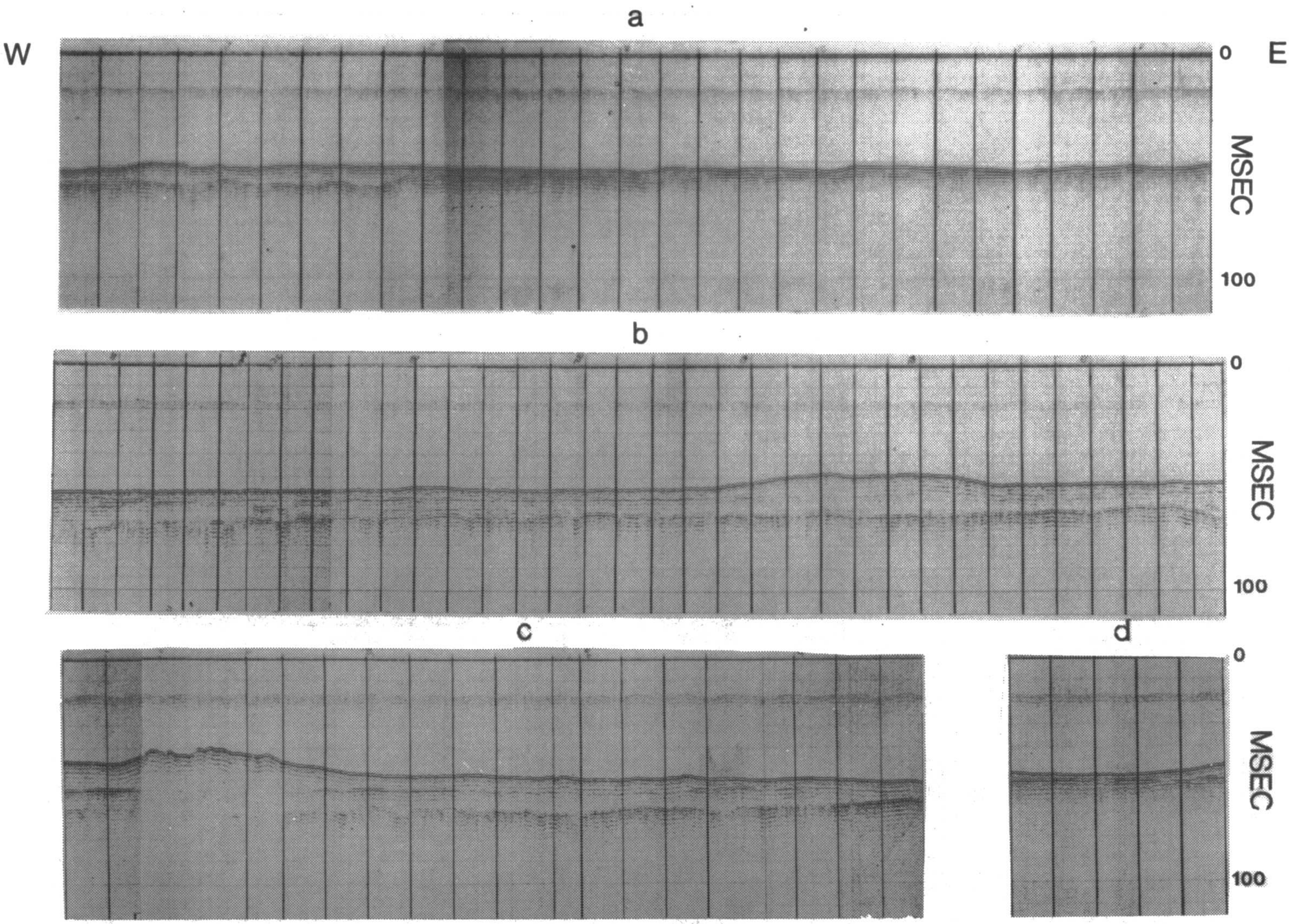

Figure XXI-6. Uniboom seismic reflection records for northern region E-W lines (see Figure XXI-3) for locations). Vertical scale is two-way travel time in milliseconds. Horizontal scale = 500 ft between shot points'(vertical lines on records).

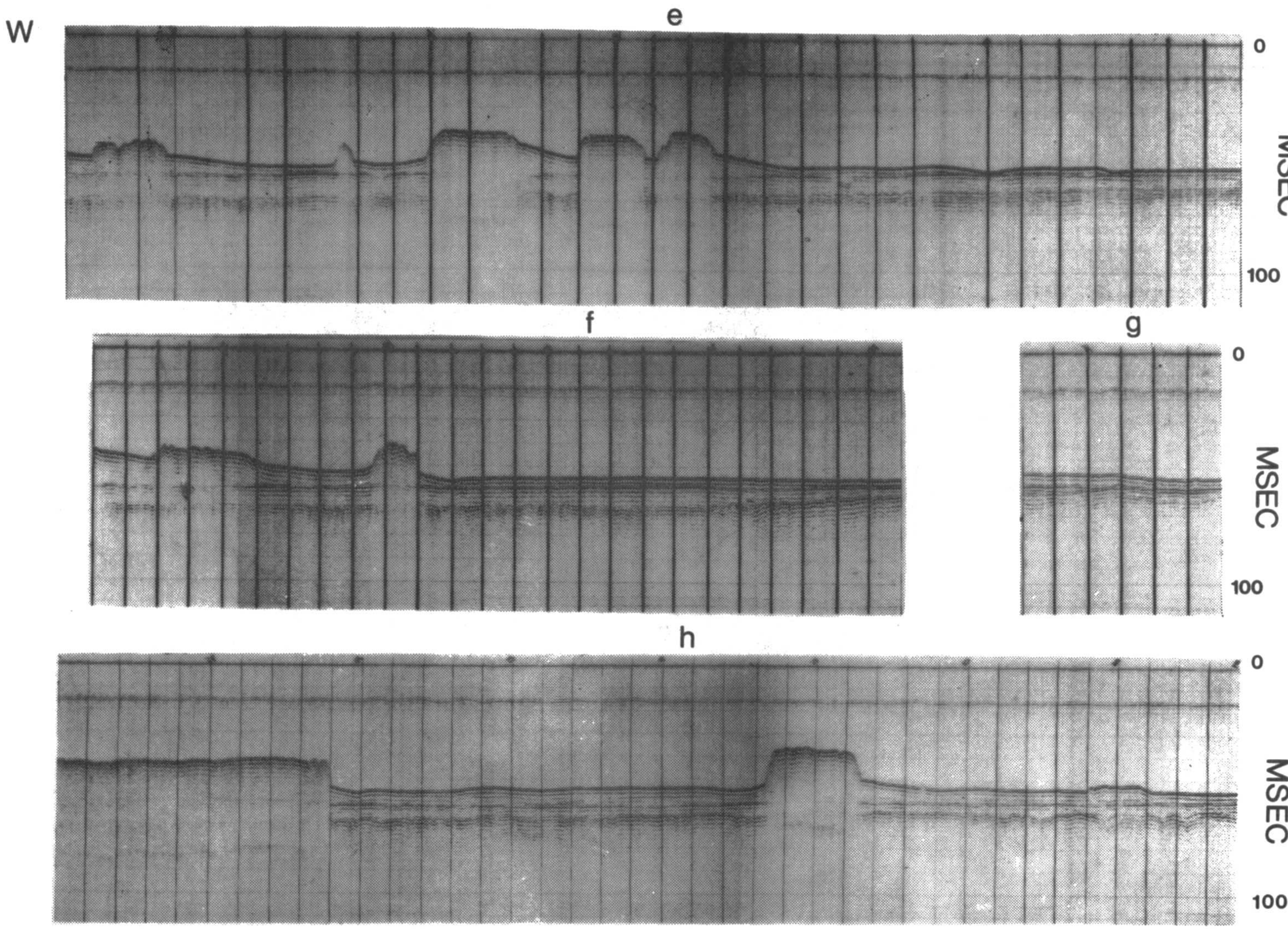

Figure XXI-7. Uniboom seismic reflection records for central region E-W lines (see Figure XXI-3 for locations). Vertical scale is two-way travel time in milliseconds. Horizontal scale = 500 ft between shot points (vertical lines on records).

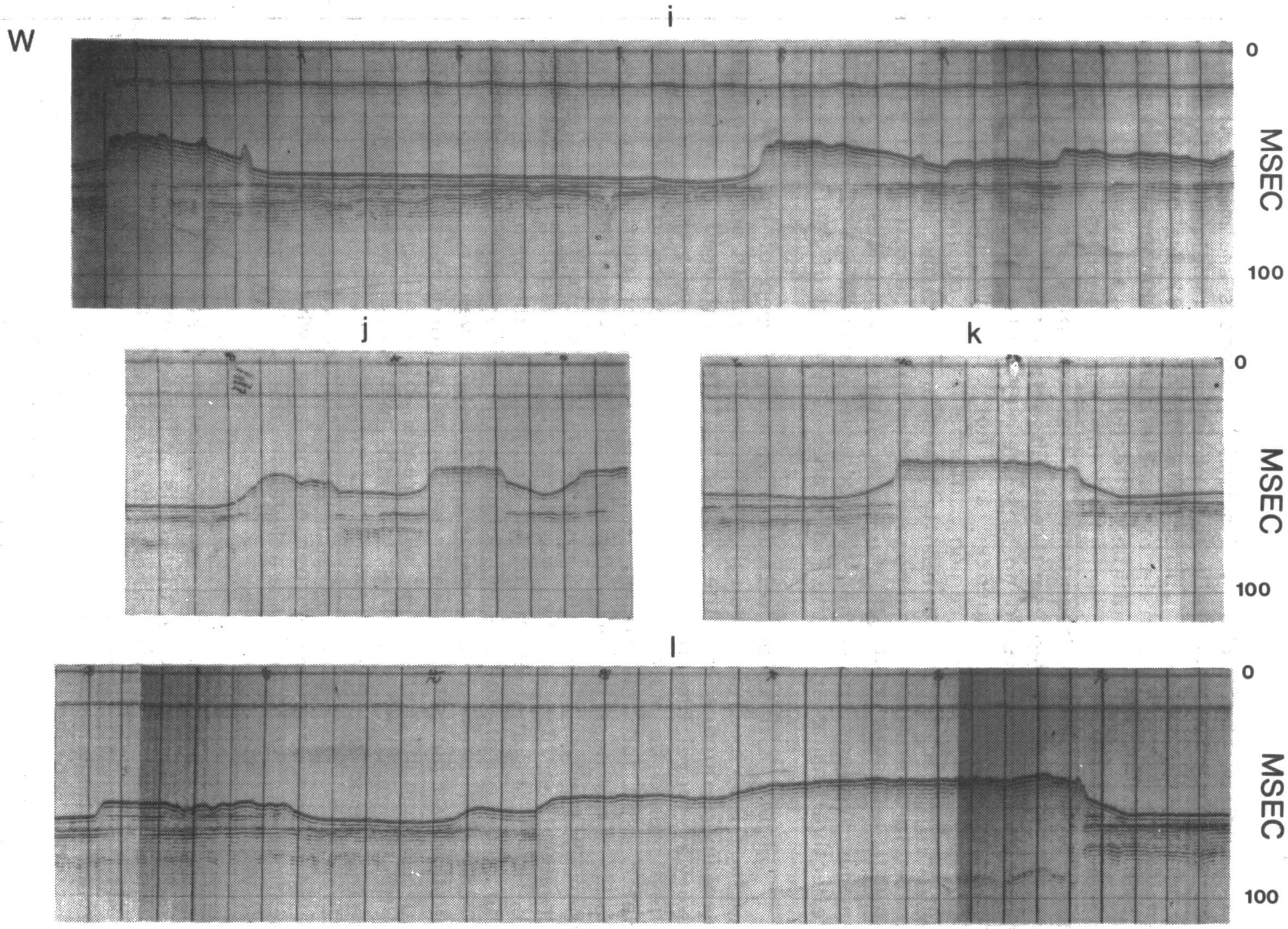

Figure XXI-8. Uniboom seismic reflection records for southern region E-W lines (see Figure XXI-3 for locations). Vertical scale is two-way travel time in milliseconds. Horizontal scale = 500 ft between shot points (vertical lines on records).

and shaded, respectively, and the pinchout of the middle sequence towards the east-northeast is along the line separating non-shaded and shaded areas (Figure XXI-5, pocket). This distribution can also be seen in the nine line drawings of the seismic reflection profiles (shown in Figure XXI-4) and in the samples of the reflection profiles (Figures XXI-6a, 6d, 7g, and 8i). In the far northeast corner of the region, both the middle and basement sequence of this surface are exposed on the seafloor (Figure XXI-5, pocket). This area is the diagonally lined area enclosed by the heavy, double dashed lines, where the uppermost sequence has either not been deposited or has been eroded away. Actually, the 3.5 kHz data show a patchy, very thin layer of Recent sediments covering this erosional surface in parts of this region. It is, however, so thin as to be negligible, and because it cannot be resolved in the Uniboom records, it was not mapped.

It is upon the mapped erosional surface that all of the features of the northern Florida Middle Ground have been constructed. Following the period of lower sea level and associated subaerial erosion that produced the gently southwest sloping surface and drainage pattern seen in Figure XXI-5 (pocket), a rise in sea level allowed reef growth to be initiated. This reef development and associated deposition in the areas between the reefs has continued to present time. This development could have occurred in as little as the last 10,000 years, when a brief, approximately 40 m low stand of sea level has been suggested (Curray 1960, 1965). Whatever the exact ages, these are certainly all Pleistocene events.

The lower reflector (surface of the basement sequence) also probably represents an erosional surface at an earlier time. The roughness and depressions in surface of the western part of the basement sequence, where it is overlain by the middle sequence, suggest Karst topography and therefore a more consolidated carbonate rock (Figures XXI-4, 6b and 6c, 7e, 7f, 7h, and 8). For Karst structure development, a relatively longer period of exposure would be likely. Where the above described later period of erosion cut down into the basement sequence (shaded area of Figure XXI-5, pocket), the Karst topography is missing and has apparently been eroded away (Figures XXI-6d, 7g, and 8i). Figure XXI-8i is a particularly clear example of the middle sequence pinchout and the smoother surface of the basement sequence.

The previously discussed upper sequence and surface features that reveal present and Recent depositional and erosional conditions are worth noting again briefly. Figures XXI-6 through 8 show that the asymmetric nature of the reefs is due to wedges of sediments banked up against the east sides of the reefs. These gentle eastern slopes are clearly underlain by sediments on top of the former erosional surface that can be seen to extend beneath both the slopes and the reefs (Figures XXI-7e and 7f, 8i and 8l). In several areas there is partial wipe out of the subsurface reflection beneath the reefs (Figure XXI-5, pocket), but this is not so extensive as to preclude the interpretation that these flattish surfaces exist throughout the region and extend beneath the reefs.

The channels on the western margins of the ridges can be seen clearly in Figures XXI-7h and 8j, 8k, and 8l. In areas such as in the center of profile "j" of Figure XXI-8, scour has been extensive enough to keep the seafloor almost barren of sediment down to the former erosional surface.

Areas of most active present reef growth are probably represented in the Uniboom profiles by the steep local peaks on top and often at the margins of the ridges (Figures XXI-7e, 7f, 7h, and 8i, 8k, 8l). In the records shown, the westernmost ridge shown in Figure XXI-8i is the best example of active present reef growth.

Hazards

No fault structures or indications of either gas seepage or gas within the shallow subsurface structure were observed. The only geological hazards in the region would be related to currents, prevailing storm and hurricane conditions, and the strength and stability of the seafloor sediments and reef structure. Except for bottom sediment transport, the seismic reflection data show no reason to suspect that the seafloor sediments and structures are unstable.

SECTION 2: PHYSICAL AND CHEMICAL OCEANOGRAPHY

P.I.'s: T. Hopkins, W. Schroeder

METHODS AND MATERIALS

General

During the period of October 1978 to December 1979, water column temperature, salinity (conductivity), dissolved oxygen, light penetration and nutrient data (DOC, POC, NO_3, NO_2, PO_4, SiO_4), as well as meteorological observations were collected at four stations. During the same period, in situ current, temperature, and salinity (refractive index) data were obtained at three stations. The sampling schedule and station locations are shown in Table XXI-3 and Figure XXI-9. The water column sampling schedule and the deployment sequence of the in situ instrumentation are presented in Tables XXI-4 and 5, respectively.

Meteorology

Meteorological observations were taken four times a day, while anchored on station, generally during the time periods 0600-0700 h, 1200-1300 h, 1800-1900 h, and 2200-2300 h, local time. Observations were made following the procedures set forth in U.S. Naval Oceanographic Office Publication No. 607 (Instruction Manual for Obtaining Oceanographic Data) and included wind speed and direction, sea state, air and sea surface temperatures, barometric pressure, sky condition, and present weather.

Water Column Hydrography

Vertical profiles of temperature, salinity (conductivity), and dissolved oxygen were made while anchored on station. A Water Quality Surveyor (WQS), manufactured by the Hydrolab Corp., was used throughout the entire study for measuring the hydrographic parameters. Performance specifications for this system are presented in Appendix E, Table XXI-1. The WQS system consists of an underwater unit (sonde) containing probes for measuring temperature, conductivity, dissolved oxygen, and depth. A multiple-conductor, water-blocked, urethane-jacketed bay type instrument cable connects the sonde to a deck read-out unit. The instrument was wet-bath calibrated at the Dauphin Island Sea Lab on a routine six-month cycle and internally calibrated before each profile. Data reduction and processing were carried out at the Dauphin Island Sea Lab.

Light Penetration

Measurements of in situ light levels were taken with a CM2™ submarine illuminance meter supplied by Texas A&M University. The instrument system consists of a submersible photocell, a deck readout unit with internal batteries, and a connecting cable. Readings were taken while anchored on station by lowering the photocell to preselected depths during the period plus or minus one hour of local

TABLE XXI-3
STATION INFORMATION

<u>Station 151</u>

Water Column and *in situ* Instrument Station
28°32.24' North Lat.
84°18.58' West Long.
Bottom Depth: 29 m
Instrument Depths: Current Meter[1]: 25-26 m
Refractometer/Thermograph[2]: 26 m

<u>Station 247</u>

Water Column and *in situ* Instrument Station
28°36.39' North Lat.
84°15.64' West Long.
Bottom Depth: 31 m
Instrument Depths: Current Meter[1]: 26-27 m and 9-10 m
Refractometer/Thermograph[2]: 27 m

<u>Station Sink Hole</u>

Instrument Station
28°34.12' North Lat.
84°15.83' West Long.
Bottom Depth: 34 m
Instrument Depth: Refractometer/Thermograph[2]: 32 m

<u>Station 481</u>

Water Column Station
28°31.13' North Lat.
84°19.05' West Long.

<u>Station 491</u>

Water Column Station
28°27.43' North Lat.
84°17.25' West Long.

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[1]The current meter was deployed on a free tether line that is attached to a taut-line buoy system. The near-surface current meter was installed only during the fourth deployment period (See Table XXI-5).

[2]The refractometer/thermograph mounting bracket is an integral part of the taut-line buoy system.

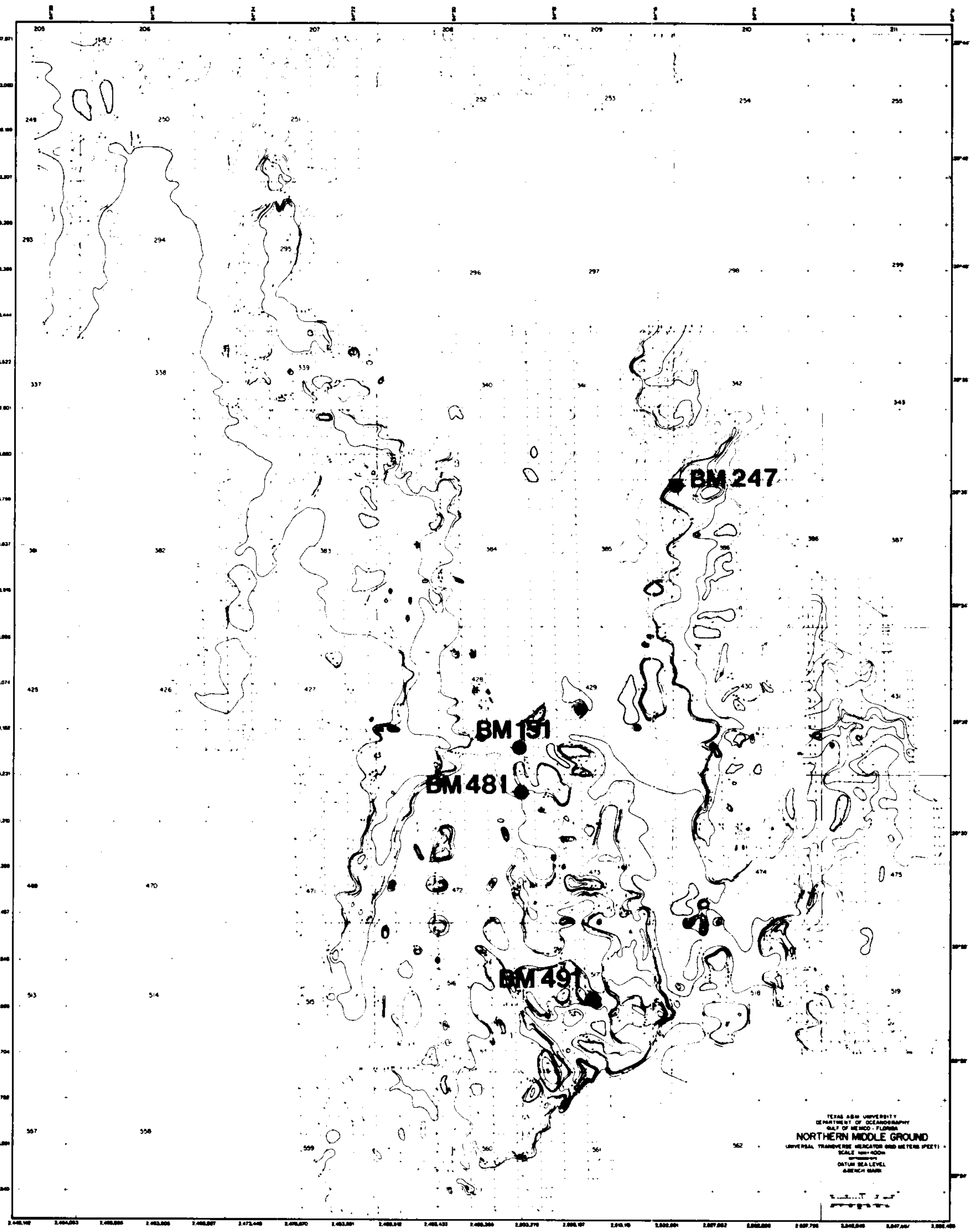


Figure XXI-9. Bathymetric chart of the Florida Middle Ground, supplied for this report by Texas A&M. Locations of the four benchmark stations and the transects which cross them are shown. The horizontal line shows the length of the transect and the vertical line the spread of the samples about the horizontal.

TABLE XXI-4
WATER COLUMN SAMPLING SCHEDULE

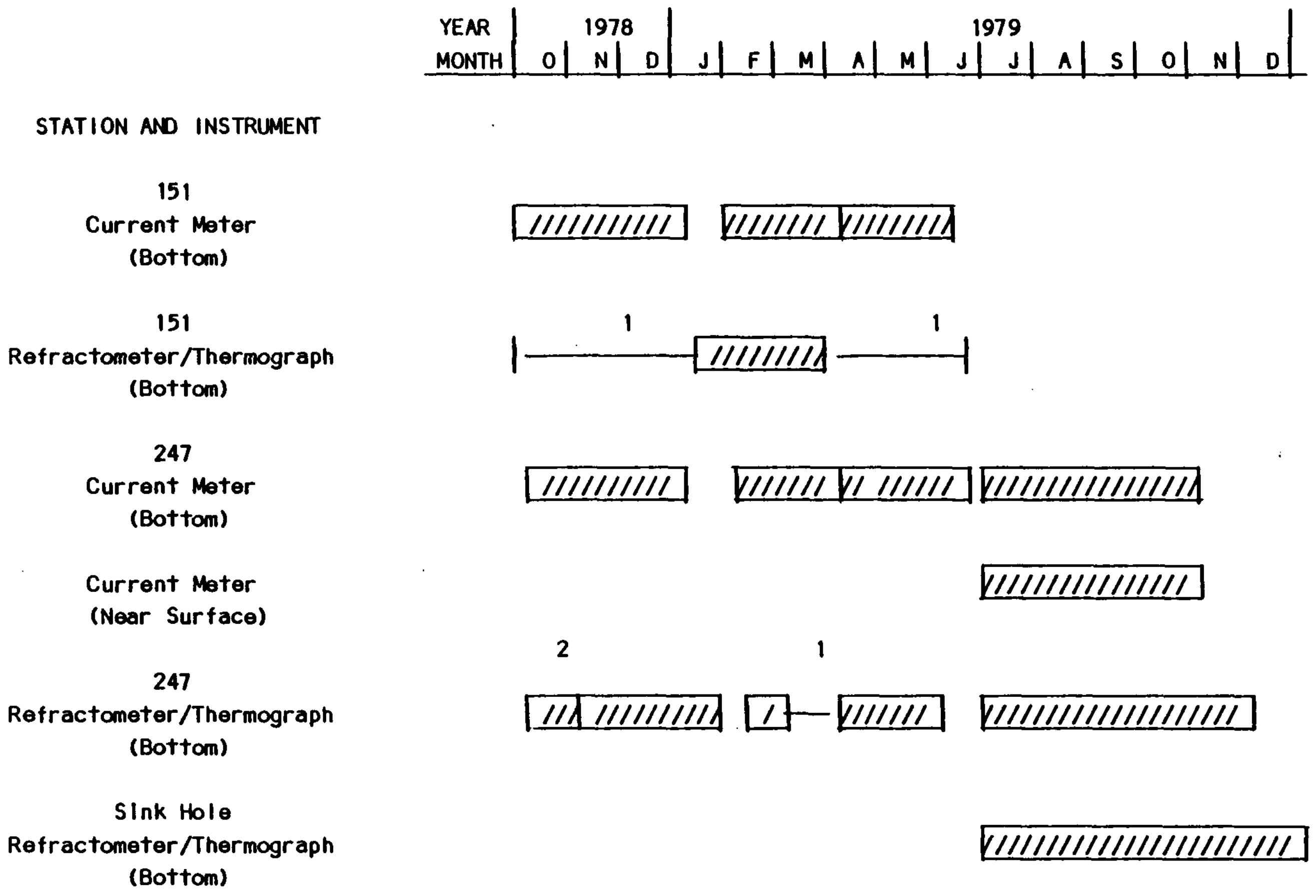
CRUISES		STATIONS 151	247	481	491
Dates:		1-5 Oct 78	11-14 Oct 78	6-8 Oct 78	14-18 Oct 78
FMG-01	A	8	6	6	8
	B	0	0	0	0
FMG-02	A	-	-	-	-
	B	-	-	-	-
Dates:		16-19 Jan 79	26&30 Jan 79		30-31 Jan 79
FMG-03	A	7	**	0	0
	B	3	**	0	0
Dates:		28-29 Mar 79	27-28 Mar 79		
FMG-04	A	**	**	0	0
	B	0	*	0	0
Dates:		25-30 Jun & 9-10 Jul 79	20-25 Jun 79	7-9 Jul 79	3-7 Jul 79
FMG-05	A	12	10	4	8
	B	7	5	**	4

A. Number of vertical profiles for temperature, salinity, and dissolved oxygen.
B. Number of vertical profiles for light penetration.

*Instrumentation not available.
**Data not scheduled to be collected.

TABLE XXI-5

DEPLOYMENT SEQUENCE OF THE *IN SITU* INSTRUMENTATION



[1]Instrument failure.
[2]Temperature data only.

apparent noon. Quality control procedures were limited to routine internal calibration. Data reduction and processing were carried out at the Dauphin Island Sea Lab.

In Situ Recording Instruments

Refractometer-Thermograph

Time series observations of salinity and temperature data were obtained using Environmental Devices Corporation (ENDECO) Type 101 recording refractometer-thermographs. Performance specifications are presented in Appendix E, Table XXI-2. The Type 101 unit incorporates a 16 mm camera and crystal timer for recording the data. The timer was set on a one hour cycle. It is a self contained unit using "D" cell batteries for power. The units were deployed on taut-line buoy systems.

Quality control consisted of: 1) an initial calibration by the manufacturer; and 2) data cross checks using the independently derived water column hydrographic data. Data reduction was carried out by ENDECO. Texas A&M provided additional data processing services during the analysis stage. Data analysis was carried out at the Dauphin Island Sea Lab.

Current Meter

Time series observations of water velocities were obtained using an ENDECO Type 105 recording current meter. Performance specifications are presented in Appendix E, Table XXI-2. The Type 105 current meter used the same film recording and power systems as the Type 101 unit. Deployment was by free tether line attached to a taut-line buoy system.

Quality control consisted of an initial manufacturer's calibration. Data reduction and processing was the same as for Type 101 data.

Dissolved Oxygen and Nutrients

Samples for dissolved oxygen were taken using a 30-litre Niskin bottle lowered to just below the surface, to one-half the depth of the photic zone, and to near-bottom. Nutrient samples were obtained by subsampling the dissolved oxygen samples. All samples were delivered to Texas A&M, where preparation and analysis were performed in the laboratory of Dr. James Brooks, using the procedures described below.

Sample Preparation

Dissolved Organic Carbon

Samples for organic carbon determinations were transferred from the Niskin sampler into duplicate glass-stoppered 1-litre reagent bottles. The bottles were stored in the dark until analysis. Aliquots of sample water were filtered through precombusted 25 mm Gelman Type A glass fiber filters. A vacuum of 330 mm Hg pressure was used in the filtration process to prevent rupturing of planktonic material. The filtrate was frozen for laboratory analysis.

Particulate Organic Carbon

Particulate organic carbon (POC) sampling procedures were similar to those for dissolved organic carbon. Two 1-litre or smaller aliquots of seawater were filtered within one hour of sample acquisition through precombusted glass fiber filters. One filter was placed in each of two ampoules and frozen for laboratory analysis. Each ampoule was labeled with a station designation and volume of water filtered. Filter blanks were also prepared to insure noncontamination.

Nitrate, Nitrite, Phosphate, and Silicate

Sampling involved placing unfiltered aliquots of seawater into 6-oz. Whirl-Pak plastic containers and freezing until analysis. Samples for dissolved SiO_2 were filtered through .00045 mm glass fiber filters.

Sample Analysis

Sample analysis procedures for the three types of analyses were as follows.

Dissolved Organic Carbon (DOC)

Ten millilitres of the filtrate were placed with 0.2 mg of oxidant ($K_2S_2O_8$) and 0.25 ml of 6% H_3PO_4 in each of three 10-ml glass precombusted ampoules. The ampoules were purged of inorganic carbon and sealed. The sealed ampoules were heated for 24 h at 100°C to convert the organic carbon to CO_2. The carbon dioxide content of each ampoule was determined on a Total Carbon System Analyzer (Oceanography International Corp.) by flushing the gaseous contents of the ampoule with nitrogen into the gas stream of a nondispersive infrared analyzer sensitized to CO_2. DOC concentrations were determined in triplicate and corrections made for reagent blanks. Concentrations are reported as milligrams carbon per litre of water (mgC/l). Accuracy and precision are generally better than a few percent.

Particulate Organic Carbon (POC)

Analytical procedures were similar to those for DOC, except that concentrations were corrected for filter blanks instead of reagent blanks. POC concentrations were determined in duplicate and reported as milligrams carbon per litre of water (mgC/l). Because of the greater variability in organic particulate samples from one replicate sample to the next, precision is generally $\pm$ 5%.

Nitrate, Nitrite, Phosphate, and Silicate

Some of the more biologically important forms of the micronutrient elements of nitrogen, phosphorus, and silicon were determined with a

Technicon Autoanalyzer II. The methods of Strickland and Parsons (1972) were used in these determinations, with specific procedures as given by Technicon Instruments Corporation of Tarrytown, NY, Industrial Methods No. 100-70W (NO_3 and NO_2), 161-71W/B (NO_2), 155-71W (PO_4), and 105-71W (SiO_2).

The analysis of nitrite and nitrate was done under acidic conditions, where the nitrite ion reacts with sulfanilamide to yield a diazo compound which couples with N-1-naphthylethylenediamine dihydrochloride to form a soluble dye which was measured colorimetrically. Nitrate was reduced to nitrite by a copper-cadmium reductor column and determined by difference (Kamphake et al., 1967; American Public Health Association, 1971; Armstrong et al., 1967).

Phosphate was determined by reaction with ammonium molybdate and potassium antimonyl tartrate in acidic medium to form an antimony-phosphomolybdate complex. This complex is reduced by ascorbic acid to an intensely blue colored complex which is proportional to the phosphorus concentration (Murphy and Riley, 1962).

For analysis of silicates, silicomolybdate was reduced to molybdenum blue by solution in ascorbic acid. Before the addition of ascorbic acid, oxalic acid was introduced to the sample stream to eliminate interference from phosphates (Brewer and Riley, 1966).

RESULTS AND DISCUSSION

Meteorology

Cruise FMG-01 (Fall 1978)

Light to moderate winds, calm to slight seas, and hot days/warm nights interrupted by early fall cold front passages with high winds and rough seas summarize the meteorological conditions during FMG-01. The winds were mostly from the north and east at 10 to 15 knots. During pre- and post- cold front passages, the winds were south and west at 20 to 35 knots and north and east at 20 to 35 knots, respectively. Rain and thunderstorms accompanied the cold fronts. Sky conditions were mostly partly cloudy to cloudy. Air temperatures ranged from 22 to 33°C and sea surface temperatures were 25 to 30°C. Squall lines associated with prefrontal activity produced at least one confirmed water spout.

Cruise FMG-03 (Winter 1979)

Moderate winds, slight to moderate seas, and warm days/cool nights interrupted by mid-winter cold front passages with high winds, rough seas and colder air temperatures describe the meteorological conditions during FMG-03. On three separate occasions during this cruise, intense cold front passages forced the R/V BELLOWS to abandon station and run for safe harbor. While on station, winds were mostly out of the east at 5 to 15 knots. Sky conditions were generally partly cloudy to cloudy. Air temperatures ranged from 12 to 23°C, and sea surface temperatures were 16.5 to 20°C.

Cruise FMG-04 (Early Spring 1979)

Light to moderate winds, calm to slight seas, and warm days/cool nights summarize the meteorological conditions during FMG-04. The winds were mostly from the northeast to the southeast at 5 to 15 knots. Sky conditions were generally clear with < 10% cloud cover. Air temperatures ranged from 13 to 22°C and sea surface temperatures were 16.5 to 18.5°C.

Cruise FMG-05 (Early Summer 1979)

Very light to light winds, calm to slight seas, and hot days/warm nights summarize the meteorological conditions during cruise FMG-05. Around 10% of the time, seas were glassy-calm and no wind occurred. There was no dominant prevailing wind direction, and wind speeds were generally 5 to 10 knots. Thunderstorms with moderate to moderately-heavy squalls (winds of 15-25 knots) occurred during one 48-hour period. Sky conditions were most often partly cloudy. Air temperatures ranged from 25 to 34.5°C, and sea surface temperatures were 26.5 to 29.5°C.

Water Column Hydrography

Cruise FMG-01 (Fall 1978)

The vertical profile of temperature, salinity, and dissolved oxygen presented in Figure XXI-10 is representative of the water column hydrography observed during cruise FMG-01. Temperatures were warmer on the surface (average = 27.1°C; range = 24.9 to 28.5°C) and colder on the bottom (average = 23.9°C; range = 22.0 to 26.0°C). Most of the water column (0 to approximately 21 m) was near isothermal. A thermocline was present from approximately 21 m to the bottom. Thermal gradients of up to 0.7°C/m were measured.

Surface salinities were slightly lower (average = 34.4 ppt; range = 33.9 to 35.0 ppt) than bottom salinities (average = 35.5 ppt; range = 35.0 to 36.2 ppt). All profiles were observed to have stable salinity structures. Dissolved oxygen values above approximately 21 m ranged between 5.2 to 6.6 ppm, or 80 to 103% saturation. Dissolved oxygen values below approximately 21 m ranged between 1.9 to 5.9 ppm or 26 to 84% saturation.

Cruise FMG-03 (Winter 1979)

The vertical profile of temperature, salinity, and dissolved oxygen presented in Figure XXI-11 is representative of the water column hydrography observed during cruise FMG-03. Surface to bottom temperatures were isothermal and ranged between 17.0 to 20.0°C. Salinities were nearly always isohaline, ranging between 34.8 to 35.5 ppt. Dissolved oxygen values ranged from 6.4 to 7.3 ppm, or 85 to 95%

saturation. The dissolved oxygen values were either slightly lower on the bottom (< 0.5 ppm) or uniform with depth.

Cruise FMG-04 (Early Spring 1979)

The vertical profile of temperature, salinity, and dissolved oxygen presented in Figure XXI-12 is representative of the water column hydrography observed during Cruise FMG-04. Temperatures were slightly warmer on the surface (average = 17.7°C; range = 17.2 to 18.2°C) than on the bottom (average = 17.2°C; range = 17.1 to 17.4°C). The salinity structure was either isohaline or surface waters were slightly lower (0.1 to 0.5 ppt). Salinity values ranged between 34.6 to 36.2 ppt. Dissolved oxygen concentrations ranged between 6.2 to 6.8 ppm, or 79 to 87% saturation. No obvious vertical structure prevailed.

Cruise FMG-05 (Early Summer 1979)

The vertical profile of temperature, salinity, and dissolved oxygen presented in Figure XXI-13 is representative of the water hydrography observed during Cruise FMG-05. Temperatures were warmer on the surface (average = 27.9°C; range = 26.2 to 29.2°C) and colder on the bottom (average = 25.4°C; range = 24.5 to 26.0°C). The water column thermal structure generally consisted of two or three temperature steps or thermoclines with gradients of 0.2 to 0.4°C/m.

The salinity structure was essentially isohaline with values ranging between 34.6 to 35.8 ppt. Dissolved oxygen concentrations were either slightly higher on the surface (5.7 to 7.2 ppm, or 83 to 109% saturation) than on the bottom (5.2 to 6.6 ppm, or 79 to 100% saturation), or nearly uniform with depth.

Light Penetration

Cruise FMG-03 (Winter 1979)

Vertical profiles of relative illuminance versus depth are presented in Figure XXI-14. Profiles 151-1 and 151-2 (from station 151) were made early in the cruise, while the other three profiles were made late in the cruise after the passage of two cold fronts over the area. The 151 profiles show that the 50% light level was between 5 and 7 m, the 20% light level was around 15 m, and the 10% light level was at depths of 20-25 m. The three profiles made after the cold front passages show that the 50% light level was in the upper 3 m of the water column, the 20% light level was around 4 to 5 m, and that at a depth < 20 m, light levels were < 5%.

Cruise FMG-05 (Early Summer 1979)

Vertical profiles of relative illuminance versus depth are presented in Figure XXI-15. Except for the three profiles to the far right on Figure XXI-15, the data show that the 50% light level generally occurred at depths of 20-25 m and that the lowest light levels at 25 m were > 30%. The three profiles to the right show a greater degree of attendance but even so have minimum light levels

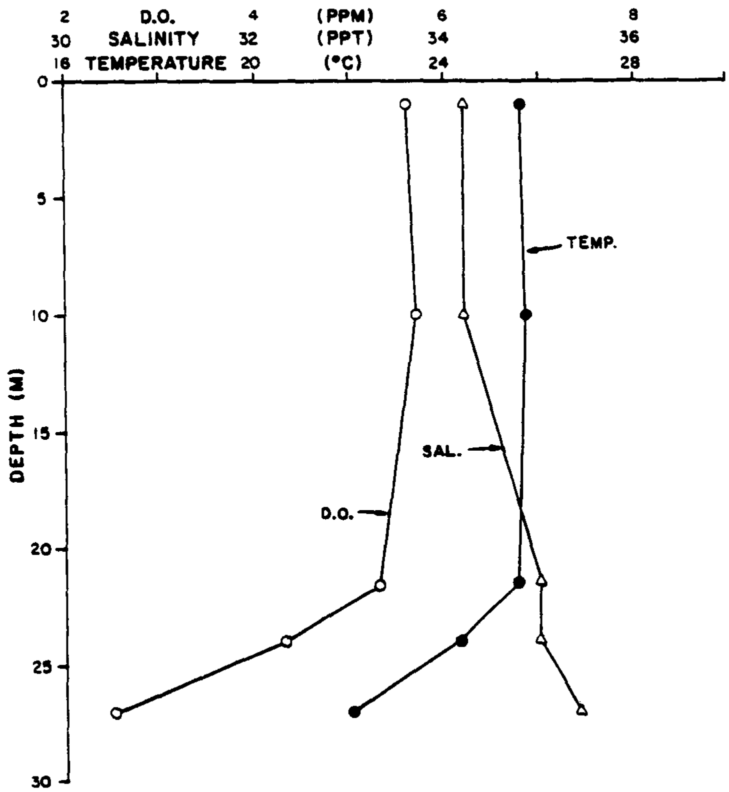


Figure XXI-10. Vertical profiles of temperature, salinity, and dissolved oxygen. Cruise FMG-01, station 491.

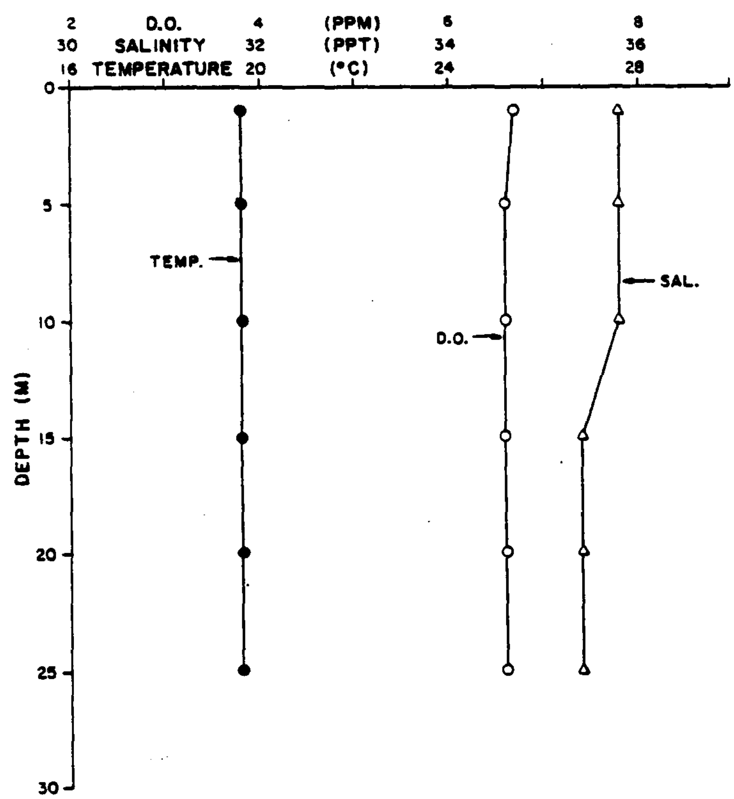


Figure XXI-11. Vertical profiles of temperature, salinity, and dissolved oxygen. Cruise FMG-03, station 151.

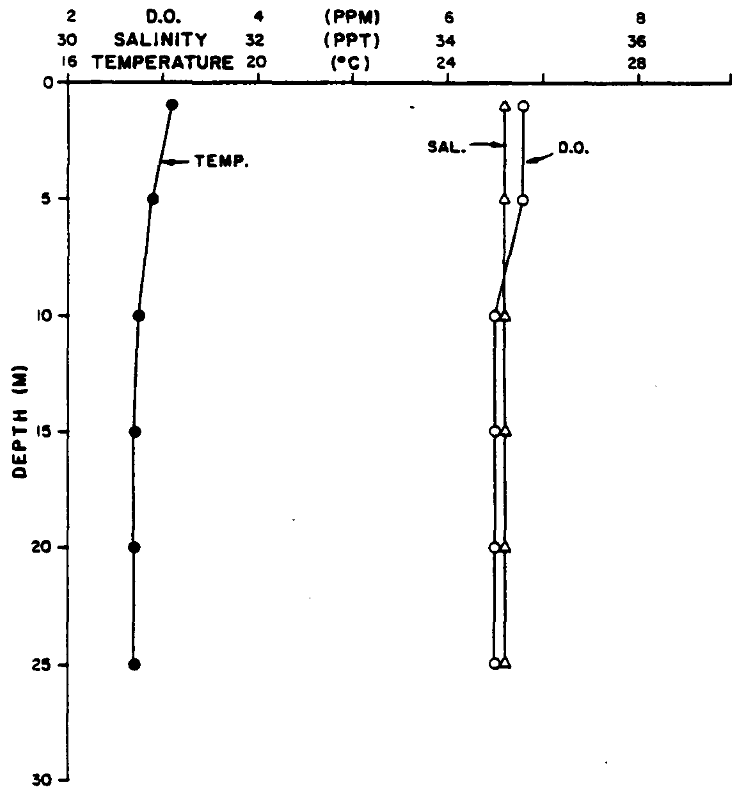


Figure XXI-12. Vertical profiles of temperature, salinity, and dissolved oxygen. Cruise FMG-04, station 151.

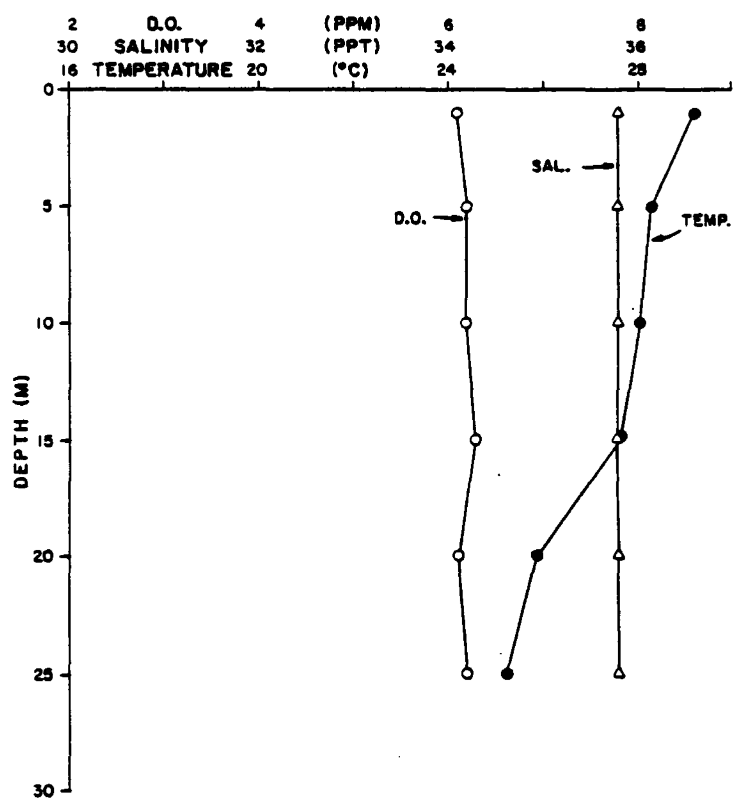


Figure XXI-13. Vertical profiles of temperature, salinity, and dissolved oxygen. Cruise FMG-05, station 481.

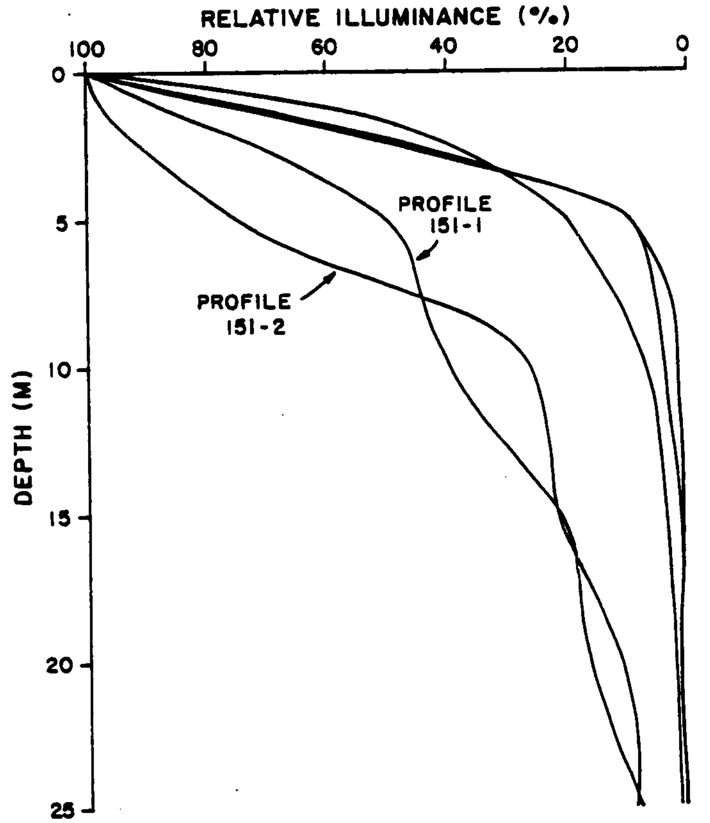


Figure XXI-14. Light penetration profiles. Cruise FMG-03 (winter 1979).

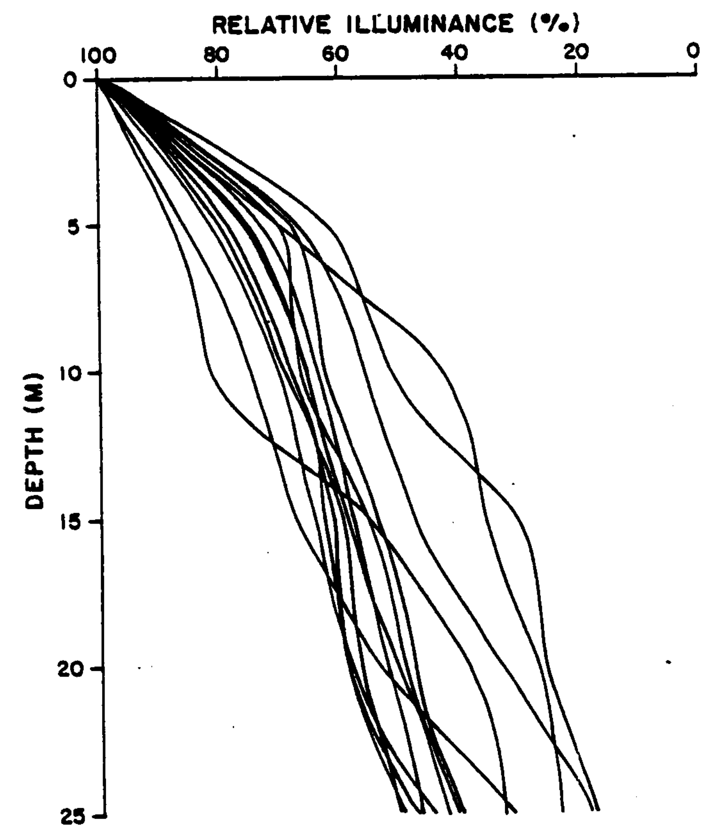


Figure XXI-15. Light penetration profiles. Cruise FMG-05 (early summer 1979).

around 20% at 25 m. No obvious meteorological or hydrographic events were associated with these three profiles.

In Situ Recording Instruments

Salinity (Refractive Index)

Periodic interference by the bristles of the lens cleaning brush with the path of light between the outside light source and lens of the refractometer caused a random set of artificially low salinity values to be generated. This situation renders the salinity time series data set only partially usable. The general salinity trend and a range of salinity values can be discerned from the salinity data set. When cross checked against the water column salinity data, good agreement is found.

From October through December, 1978, average salinity values of 34 to 35 ppt were measured, with extreme observations ranging at ± 1.0 to 2.0 ppt, about the average. Over the period January to June, 1979, average salinity values increased to 35-36 ppt with an outside range of ± 0.5 to 1.5 ppt, about the average. Then from July to mid September, 1979, the average salinity decreased to 34-35 ppt and dropped to 33-34 ppt during late September to mid November, 1979. From late November until mid December, 1979, salinities increased slightly to 34-35 ppt. The outside range of values from July through December, 1979, was generally ± 1.0 to 1.5 ppt, about the average.

These salinity values all fall well within the ranges reported in previous studies. Rinkel (1975) reports near-bottom salinity values for the West Florida continental shelf in the vicinity of the Florida Middle Ground across a range of 33.0 to 36.4 ppt. Fausak (1979) presents anchor station time series data at the Florida Middle Ground with near-bottom salinities ranging from 34.0 to 36.0 ppt. Both of these reports illustrate salinity structures that vary between isohaline to highly stratified haloclines.

Temperature

The individual deployment periods of the ENDECO 101 units at stations 151, 247, and Sink Hole cover a total time span of approximately 14.5 months (Table XXI-5, above). In order to construct the most complete thermal record possible from these three stations, selected portions of the various records are combined to form one single data set. This single record provides continuous temporal coverage from mid October, 1978, to mid December, 1979, except for two weeks in June, 1979.

The daily 24-hour observations from the combined data set have been grouped into Julian weeks and summarized by calculating Julian week averages and the averages of the daily maximum and daily minimum values over each Julian week, and identifying the absolute maximum and absolute minimum value during each Julian week. These data are presented in Figure XXI-12 (above).

For the purpose of this report the winter and summer seasons have been defined as the 13 coldest and 13 hottest weeks of a year, respectively. The spring and fall seasons are defined as the transitional periods which may or may not have 13 weeks each (e.g., a spring could have 14 weeks and a fall 12 weeks).

Following this scheme, the winter season occurred during Julian weeks 4 to 16, 1979 (Figure XXI-16) or from late January through most of April. The average winter temperature was 17.3°C and the absolute range was 15.2 to 19.9°C. The lowest temperatures were measured during Julian week 9 (late February to early March). The summer season occurred during Julian weeks 30 to 42, 1979 (Figure XXI-12, above) or from late July through most of October 1979. The average summer temperature was 27.6°C and the absolute range was 24.6°C to 29.4°C. The highest temperatures were measured during Julian week 39 (late September to early October 1979).

The spring season occurred over the 13-week period of Julian weeks 17 to 29, 1979 (Figure XXI-12, above) or late April through most of July. No data were available for Julian weeks 23 and 24 because of instrument servicing. The average spring temperature was 23.3°C and the absolute range was 17.8 to 26.9°C. Over the full 13 weeks, the average rate of temperature increase was approximately 0.4°C per Julian week.

There were two fall seasons over the period of instrument deployment: 1) a complete 13-week fall 1978-1979 (Julian week 43, 1978, to Julian week 3, 1979) from late October through most of January; and 2) a partial 8-week fall 1979-1980 (Julian weeks 43 to 50, 1979) from late October through mid December. The average temperature during the 1978-1979 fall was 22.3°C, with an absolute range of 17.9 to 24.5°C. The average temperature for the 8 weeks of the fall of 1979-80 was 23.8°C, with an absolute range of 21.2 to 26.5°C.

The differences between the absolute maximum and absolute minimum values during the fall, winter, and spring seasons were generally 0.75 to 2.0°C. This would indicate that during these periods the lower portion of the water column was nearly isothermal and that there were no intrusions into the study area of waters with strikingly different thermal properties. The vertical profiles of temperature presented in Figures XXI-11 and 12 support this isothermal structure position.

On the other hand, the difference between the absolute maximum and absolute minimum values during the summer were as great as 2.0 to 5.0°C. This would suggest that a thermocline structure existed in the lower portion of the water column at or near the measurement point of the recording refractometer/thermograph. Since these temperature differences generally prevailed throughout the summer season, it is unlikely that these differences resulted from intrusions of waters with different thermal properties. The vertical profiles of temperature presented in Figures XXI-10 and 13 (above) confirm the existence of thermocline structures in the lower portions of the water column.

The thermal structure observed over this 14-month period agrees very well with the specific temperature values reported by Rinkel (1975) and Fausak (1979) and the montly mean temperatures presented in Robinson (1973).

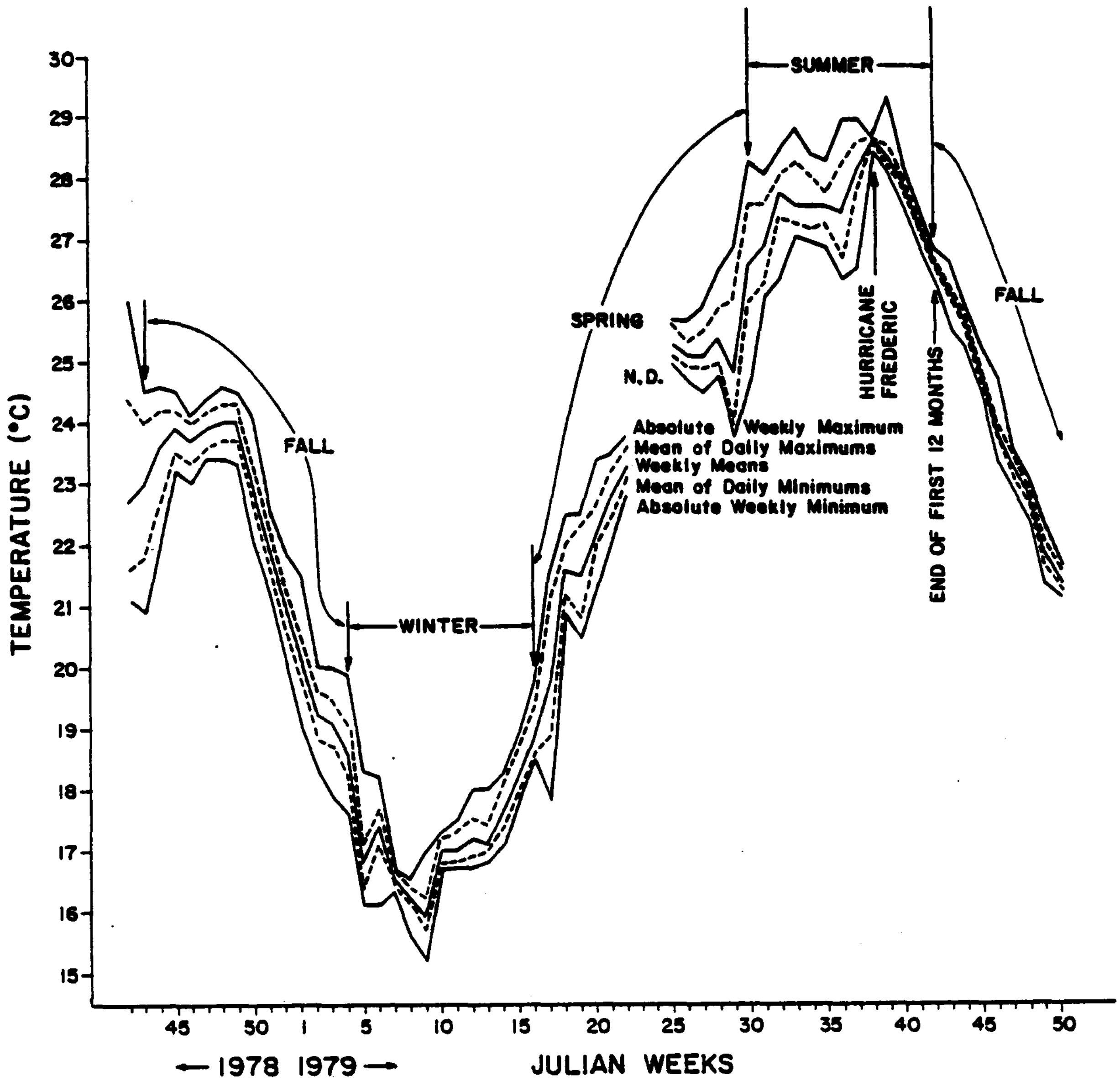


Figure XXI-16. Near-bottom thermal structure.

Currents

Near-bottom current data were collected at stations 151 and 247 from early October, 1978, to mid June, 1979 (Figure XXI-9 and Tables XXI-3 and 5, above). From mid June to early November, 1979, station 151 was abandoned and near-bottom and near-surface measurements were made at station 247 only (Tables XXI-3 and 5).

Cross correlation computations between the data sets collected at Stations 151 and 247 show that generally a high degree of correlation (> 0.75 coherency squared) existed between the two stations and a very high degree of correlation (> 0.95 coherency squared) occurred around the periods of 24 and 120 to 130 hours. Power spectra records for all of the individual data sets indicate that most of the energy occurs at periods of 12.3 to 12.6 hours and 23.8 to 26.9 hours (Figure XXI-17). The 12.3 to 12.6 hour period is the semidaily tide (approx. 12.4 hours), while the 23.8 to 26.9 hour period is a combination of the daily tide (approx. 24.8 hours) and inertial motions (approx. 25.2 hours). Rotary spectral analysis of the data shows that the majority of the energy at the daily tide-inertial periods (approx. 24 to 25.5 hours) is clockwise in its rotation (Figure XXI-18). Therefore the energy present was principally inertial because inertial motion has a clockwise rotation and daily tides have an anti-clockwise rotation.

Some of the individual power spectra records had secondary peaks in the 72 to 144 hour periods (3 to 6 days). These 3- to 6-day events are thought to be a result of atmospheric forcing. The highest energy levels at the 3- to 6-day periods occurred during the months of January through March 1979. This is consistent with the fact that the frequency of cold front passages over the study area is greatest during these months. Figure XXI-19 presents a 14-day period at station 151, from mid-January to 1 February 1979. The 3- and 4-day periods illustrated coincide perfectly with the passage of cold fronts. Figure XXI-20 is a similar plot presenting similar data before, during, and after Hurricane "Frederic."

Mean flow calculations show that the currents at the two sites are highly variable with very low mean velocities (Table XXI-6). The greatest individual velocities measured during non-storm events generally ranged between 20 and 40 cm/sec. The near-surface meter at Station 247 recorded the highest velocity measured during the entire deployment sequence: approximately 87 cm/sec during Hurricane "Frederic" (September 12, 1979). The maximum near-bottom velocity was approximately 61 cm/sec^2, recorded at station 247 during Tropical Storm "Claudette" (July 22, 1979).

Information dealing with fluctuating portions of time series current records can be obtained by solving for the eigenvalue of the variance tensor and determining the orientation of the principal axis. Texas A&M performed these calculations on all eight Florida Middle Ground data sets. The results are presented in Table XXI-7 and Figures XXI-21 and 22. The variance at both stations 151 and 247 is maximized along an east (90°) to west (270°) axis (Table XXI-7). This

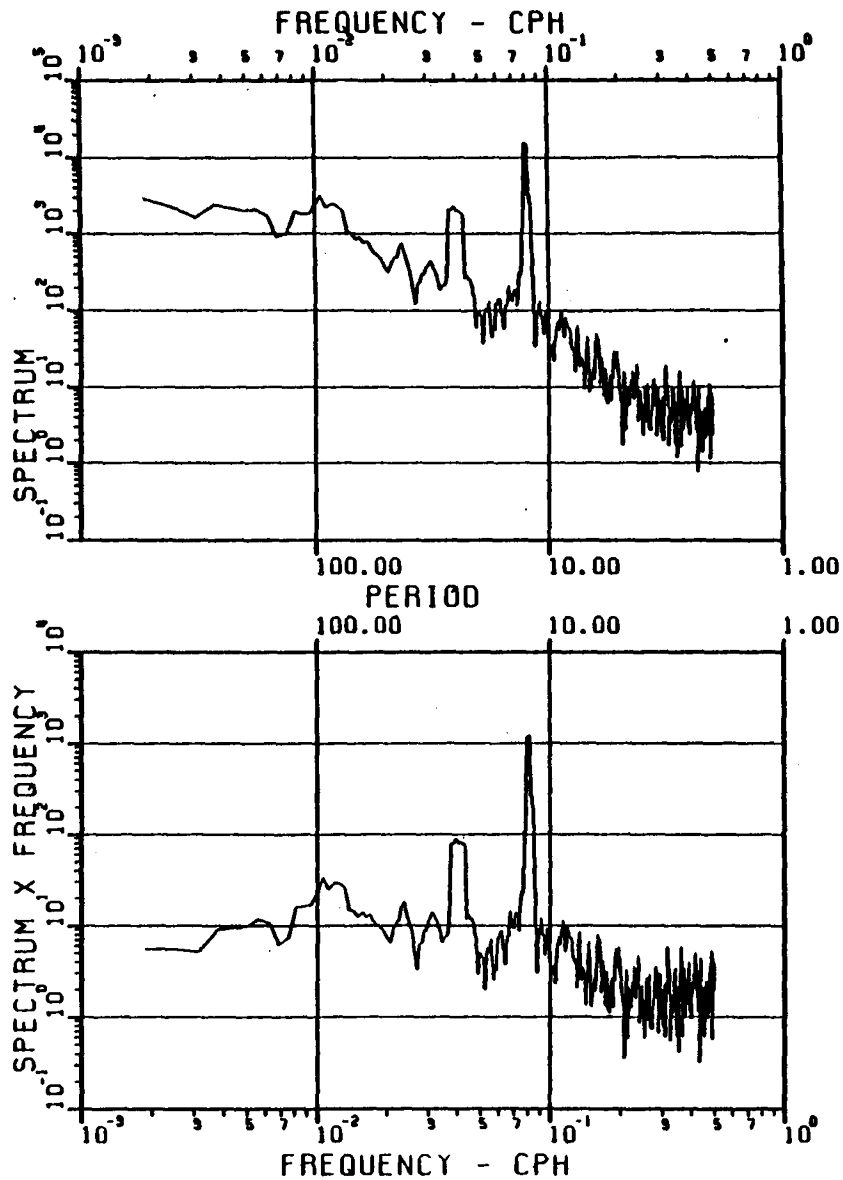


Figure XXI-17. Raw power spectrum of the east-west components from the second deployment at station 151.

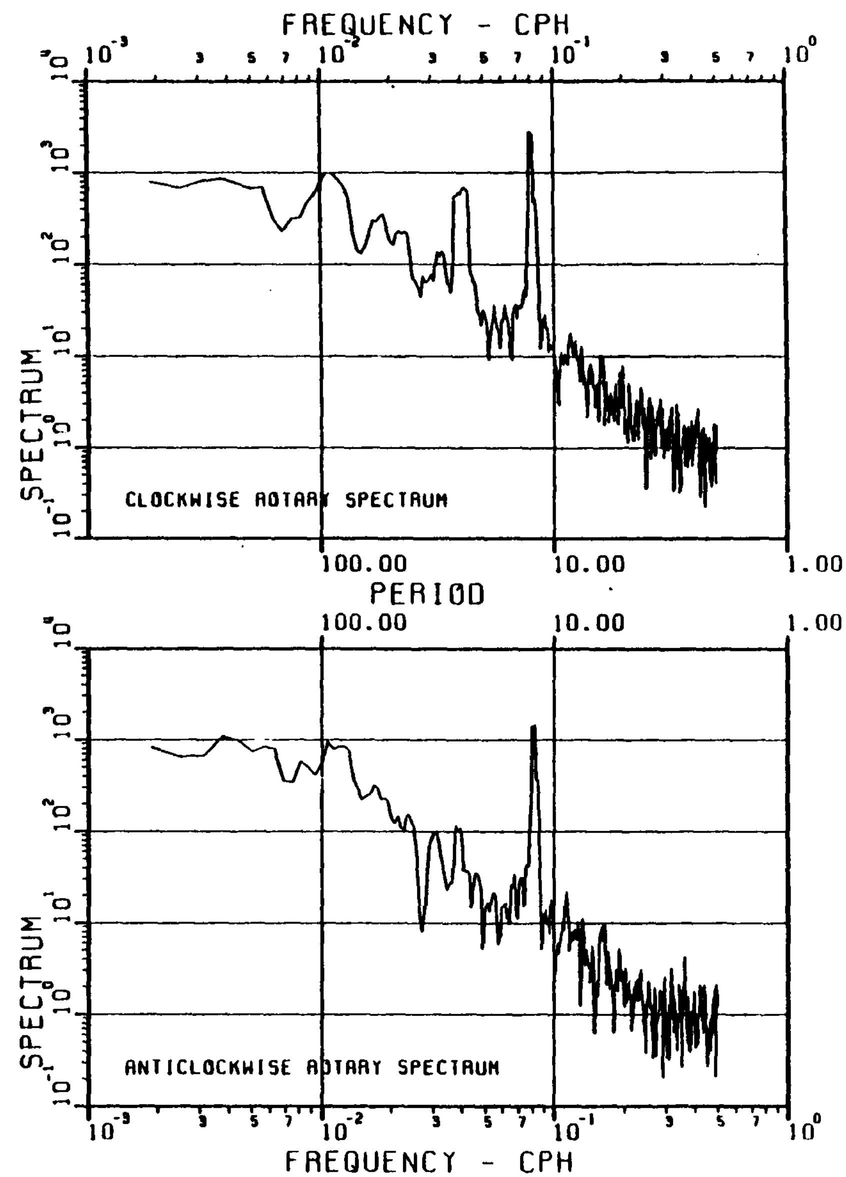


Figure XXI-18. Rotary spectrum of the second deployment at station 151.

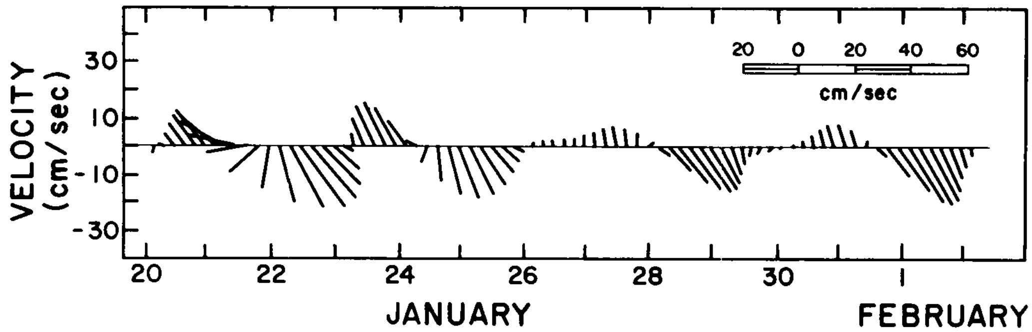


Figure XXI-19. Time series plot of low-pass filtered record from the second deployment at station 151.

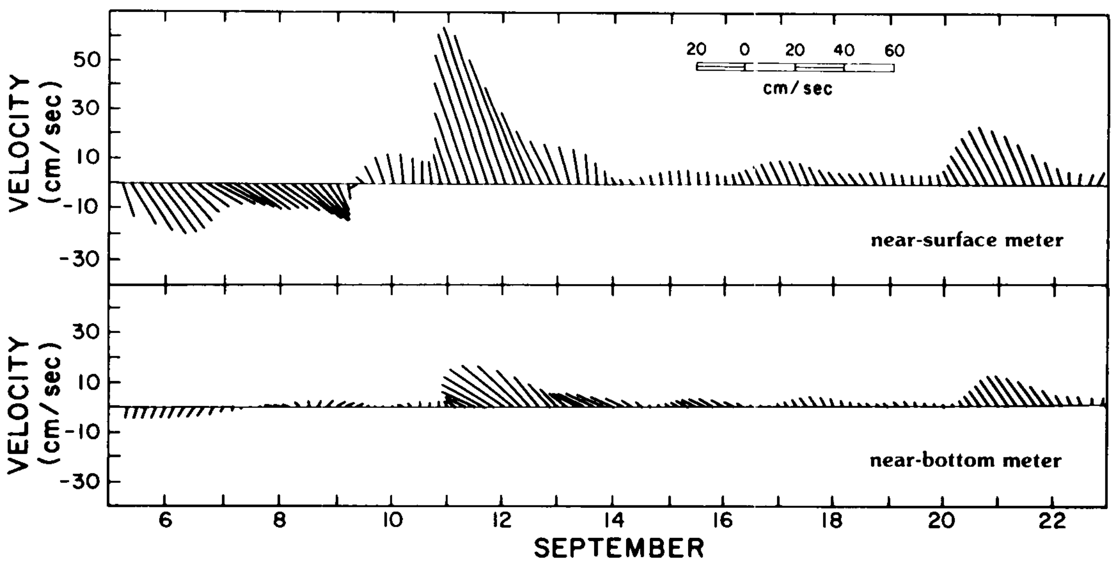


Figure XXI-20. Time series plots of low-pass filtered records of pre-, during, and post-Hurricane "Frederic" (Station 247).

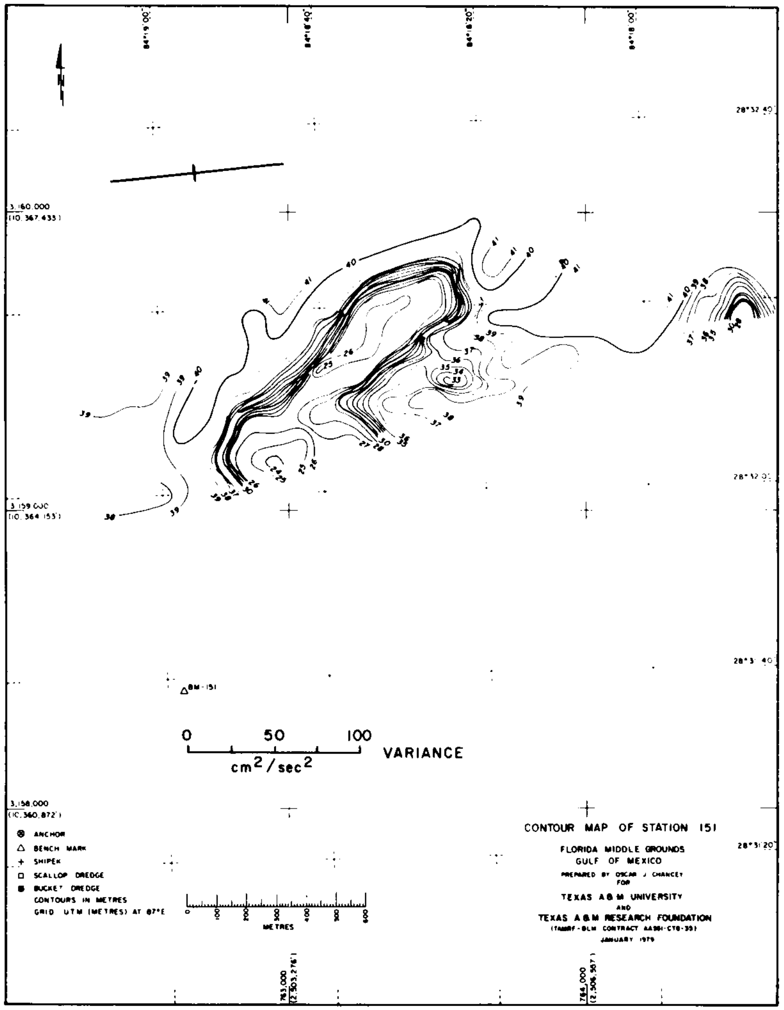


Figure XXI-21. The principal axis of variance during the third deployment at station 151.

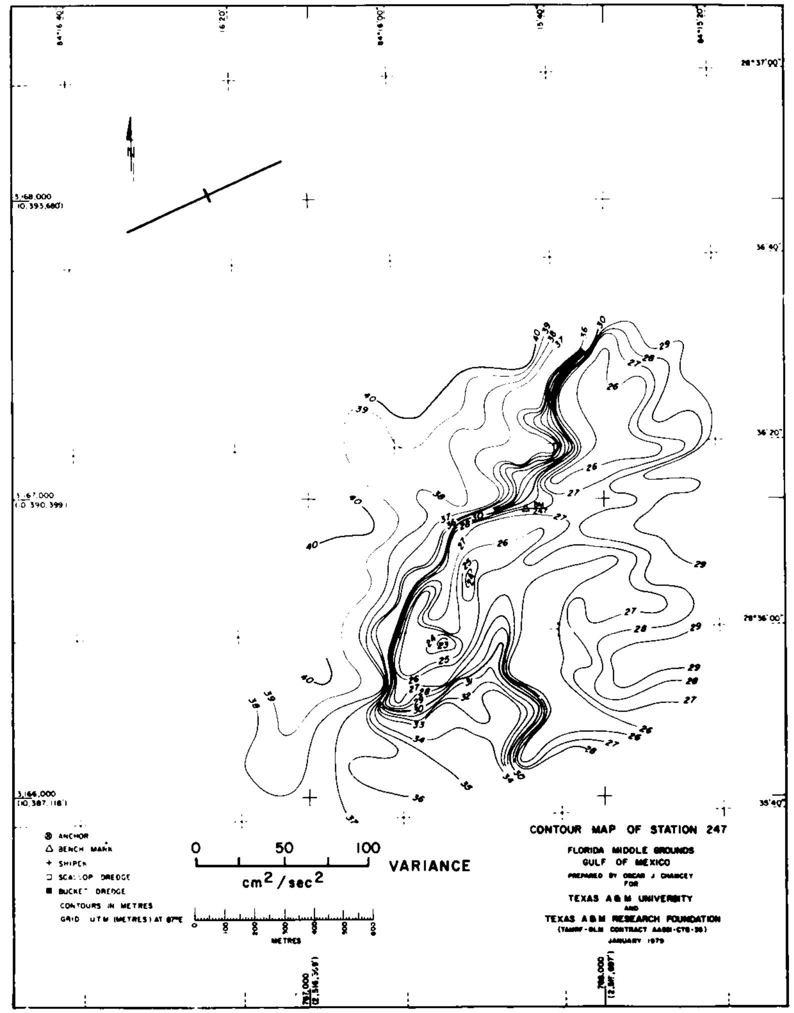


Figure XXI-22. The principal axis of variance during the third deployment at station 247.

TABLE XXI-6
MEAN VELOCITY CALCULATIONS FOR STATIONS 151 and 247

Station 151

October 5 to December 31, 1978 (Near-Bottom) NNW @ 0.9 cm sec^{-1}.

January 18 to March 29, 1979 (Near-Bottom) SSE @ 2.0 cm sec^{-1}.

March 29 to June 20, 1979 (Near-Bottom) N @ 0.9 cm sec^{-1}.

Station 247

October 13, 1978 to January 2, 1979 (Near-Bottom) WNW @ 1.5 cm sec^{-1}.

January 30 to March 28, 1979 (Near-Bottom) SE @ 0.9 cm sec^{-1}.

March 28 to June 15, 1979 (Near-Bottom) WSW @ 1.6 cm sec^{-1}.

June 22 to November 26, 1979 (Near-Surface) W @ 0.7 cm sec^{-1}.

June 22 to November 3, 1979 (Near-Bottom) NW @ 1.6 cm sec^{-1}.

TABLE XXI-7
ORIENTATION OF THE PRINCIPAL AXES OF VARIANCE AND THE PERCENT OF VARIANCE ALONG THESE AXES FOR STATIONS 151 AND 247

STATION 151	PRINCIPAL AXIS (°Mag)	% OF VARIANCE IN THE RECORD ALONG THE PRINCIPAL AXIS
October 5 to December 31, 1978 (Near-Bottom)	71-251 (ENE-WSW)	82
January 18 to March 29, 1979 (Near-Bottom)	108-288 (ESE-WNW)	83
March 29 to June 20, 1979 (Near-Bottom)	96-276 (E-W)	91
STATION 247		
October 13, 1978 to January 2, 1979 (Near-Bottom)	75-255 (ENE-WSW)	88
January 30 to March 28, 1979 (Near-Bottom)	84-264 (E-W)	89
March 28 to June 15, 1979 (Near-Bottom)	64-244 (ENE-WSW)	93
June 22 to November 26, 1979 (Near-Surface)	93-273 (E-W)	75
June 22 to November 3, 1979 (Near-Bottom)	78-258 (E-W)	92

orientation of the principal axis is generally parallel to the isobaths of the adjacent coral reef complexes at both stations (Figures XXI-21 and 22). The percentages of the variance in each near-bottom record along the principal axis range between 82 and 93%. This indicates a high degree of polarization of the flows. When compared to the general shelf circulation information presented in the final report of BLM Contract #08550-CT4-16 (July 15, 1975), no significant differences are found between the currents of the Florida Middle Ground and the currents of the West Florida Continental Shelf in the vicinity of 26°N latitude.

Hurricanes and Tropical Storms

Three hurricanes and one tropical storm impacted the study area during the 1979 hurricane season. A summary of the current meter data collected at the time of each of these events is presented in Table XXI-8. In early July Hurricane "Bob" moved from the southwestern Gulf of Mexico on a north-northeast heading and made landfall near Grand Isle, LA. Maximum near-surface currents were 32-36 cm/sec to the east, and near-bottom currents were 38-48 cm/sec to the west. Later in July, tropical storm "Claudette" moved from the south central Gulf of Mexico on a northwest heading and made landfall southwest of Galveston, TX. Maximum near-surface currents were 35-42 cm/sec to the north-northwest, and near-bottom currents were 49-61 cm/sec to the west-northwest. During early September, Hurricane "David" moved out of the Caribbean and up the Atlantic coast of Florida. The maximum currents were 47-57 cm/sec to the east near the surface, and 20-25 cm/sec in both an easterly and westerly direction near the bottom.

In mid-September Hurricane "Frederic" came out of the Caribbean, crossed over Cuba into the southeastern Gulf of Mexico, and moved on a north-northwest heading making landfall at the Alabama-Mississippi state line. The eye of the storm came within 225-250 km of the Florida Middle Ground, while the eastern edge of the storm passed over the study area. At 26°N latitude, 86°W longitude (or approx. 330 km south-southwest of the Florida Middle Ground), "Frederic" passed over NOAA Bouy EB-42003. Winds of 120 kph from the northeast and 113 kph from the south were recorded during the early morning hours of September 12, 1979. Wave heights reached 21 m. The highest measured winds of "Frederic" were 233 kph, recorded on the Alabama coast.

The impact of "Frederic" on the study site is illustrated in Figures XXI-20 and 23. The near-surface and near-bottom low-pass filtered current vectors associated with the pre-, during, and post-hurricane periods are presented in Figure XXI-20. Maximum unfiltered pre-storm (September 6-9) currents were southerly to easterly at 30 to 40 cm/sec near the surface, and variable 20 to 30 cm/sec near the bottom. The filtered vectors in Figure XXI-20 show the non-tidal flow of the pre-storm period to be generally southeast at 15 to 25 cm/sec. During the storm (September 12), maximum unfiltered velocities reached 87 cm/sec in a north-northwest direction near the surface and 35 cm/sec in a northwest direction near the bottom. The maximum non-tidal flow during the storm was 68 cm/sec for near-surface currents, and 26 cm/sec for near-bottom currents (Figure XXI-20). Unfiltered post-storm

TABLE XXI-8
SUMMARY OF UNFILTERED MAXIMUM CURRENT OBSERVATIONS COLLECTED
DURING HURRICANES AND TROPICAL STORMS (1979 HURRICANE SEASON)

HURRICANES	NEAR SURFACE		NEAR BOTTOM	
	cm sec^{-1}	°Mag	cm sec^{-1}	°Mag
Hurricane "Bob"				
July 9	34	95	27	240
July 10	32	58	48	248
July 11	36	67	38	267
Tropical Storm "Claudette"				
July 22	42	342	61	282
July 23	35	348	49	305
July 24	24	53	43	283
Hurricane "David"				
September 2	24	59	25	274
September 3	47	177	20	72
September 4	57	173	21	68
Hurricane "Frederic"				
September 11	71	339	33	288
September 12	87	340	35	315
September 13	44	338	20	300

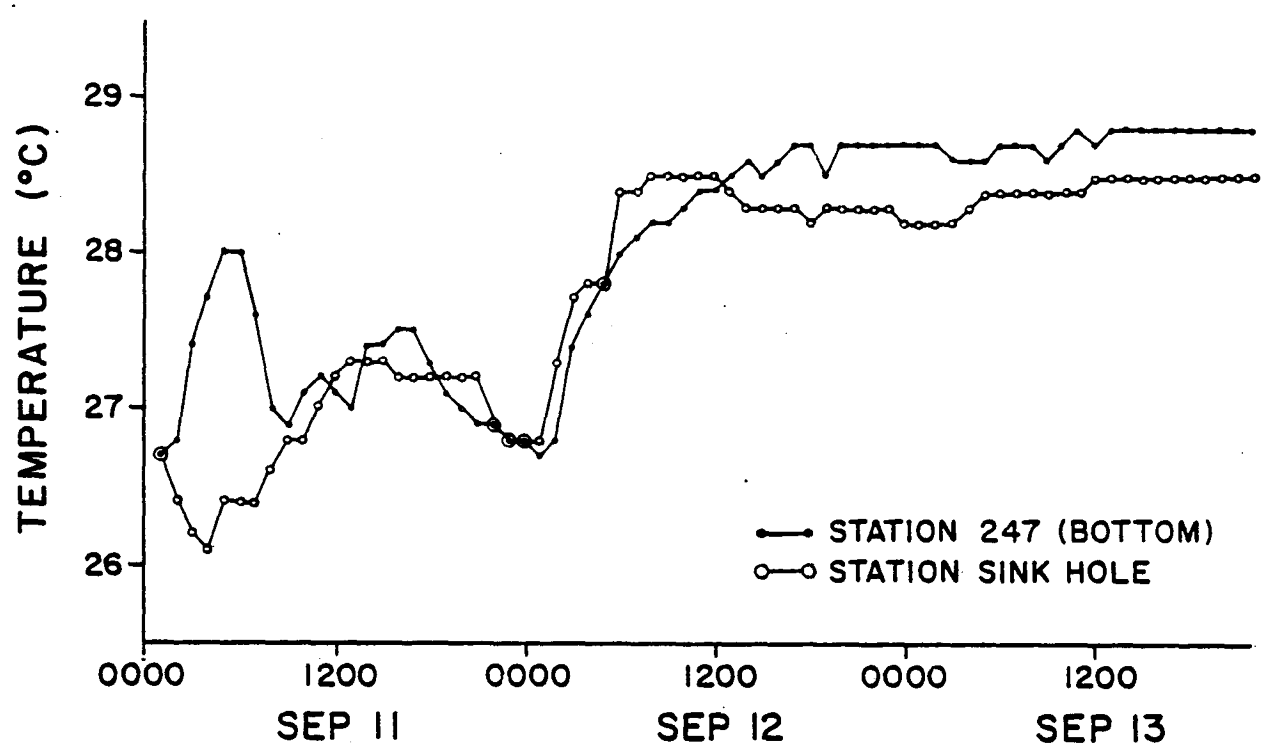


Figure XXI-23. Thermal structure of the near-bottom waters during the passage of Hurricane "Frederic" at Stations 247 and Sink Hole.

(September 13-22) currents were generally northerly, < 50 cm/sec both near the surface and near the bottom. The post-storm non-tidal currents were north to northwest, < 30 cm/sec both near the surface and near the bottom.

The thermal structure of the near-bottom waters in the study area during the passage of "Frederic" is depicted in Figure XXI-23 (above). Hourly temperature measurements from stations 247 and Sink Hole are illustrated for September 11-13. Pre-storm (September 11) data indicate that a thermocline existed near the same depth as the ENDECO 101 sensors because of the wide range of temperature values (> 1.0°C) over periods of < 6 hours. As the storm passed to the west (September 12), the temperatures increased to approximately 28.5°C, suggesting a rapid mixing of the water column by the high seas accompanying the storm. Post-storm (September 12-13) temperatures remained uniform with time, indicating a complete breakdown of the thermocline. The water column did not develop another thermocline in 1979, as evidenced by the late September and October thermal structure depicted in Figure XXI-16 (above, p. 36).

Nutrients

Seasonal combined, station combined, and individual comparison of Stations 151 and 247 data are displayed in Tables XXI-9 through 11.

With respect to seasonal combined data, two-way ANOVA indicates highly significant differences between seasons (df = 2; $p = < 0.01$) for POC, DOC, NO_3, NO_2, and SiO_2; and there is a significant difference in PO_4 between seasons (df = 2; $p = < 0.05$). The two-way ANOVA also indicate highly significant station differences for POC, DOC, and SiO_2 (df = 4; $p = < 0.01$). Table XXI-11 compares the combined seasonal data for stations 151 and 247, for example, and the differences are exemplified. No consistent pattern is evident.

With the exception of silicate, all of the nutrient data values are considerably higher than previously reported means and ranges. We were aware of this possibility after the fall sampling and instituted cross-checks and extra samples. We have no reason, at this time, to challenge the data, and we conclude that the Florida Middle Ground is a sizeable nutrient source which generally peaks during the fall months.

TABLE XXI-9
SEASONAL COMPARISON OF COMBINED STATION NUTRIENT DATA
OVER THE FLORIDA MIDDLE GROUND IN 1978-1979

VARIABLE	UNITS	OBS.(N)	MEAN	RANGE
		FALL		
POC	µg C/L	28	73.5	49.0-125.0
DOC	mg C/L	27	2.50	1.3-5.4
NO_3-N	µg-at/L	28	0.91	0.22-2.23
NO_2-N	µg-at/L	28	0.40	0.15-0.67
PO_4-P	µg-at/L	28	0.42	0.17-0.86
SIO_2-SI	µg-at/L	28	3.66	1.20-7.83
		WINTER		
POC	µg C/L	30	59.4	30.0-81.0
DOC	mg C/L	9	3.06	1.6-4.2
NO_3-N	µg-at/L	11	0.45	0.19-1.88
NO_2-N	µg-at/L	11	0.23	0.17-0.48
PO_4-P	µg-at/L	11	0.35	0.88-0.77
SIO_2-SI	µg-at/L	11	1.66	0.90-2.20
		EARLY SUMMER		
POC	µg C/L	106	51.75	27.0-76.0
DOC	mg C/L	76	2.09	0.80-5.20
NO_3-N	µg-at/L	39	0.36	0.29-0.47
NO_2-N	µg-at/L	39	0.21	0.17-0.23
PO_4-P	µg-at/L	39	0.35	0.21-0.42
SIO_2-SI	µg-at/L	39	1.31	0.90-1.90

TABLE XXI-10
STATION COMPARISON OF COMBINED SEASONAL NUTRIENT DATA OVER
THE FLORIDA MIDDLE GROUND IN 1978-1979

VARIABLE	UNITS	OBS.(N)	MEAN	RANGE
		STATION 151		
POC	μg C/L	55	52.65	27.0-89.0
DOC	mg C/L	39	2.52	1.0-5.0
NO_3-N	μg-at/L	27	0.50	0.19-1.88
NO_2-N	μg-at/L	27	0.27	0.17-0.48
PO_4-P	μg-at/L	27	0.38	0.18-0.86
SiO_2-Si	μg-at/L	27	1.70	0.90-3.80
		STATION 247		
POC	μg C/L	56	55.84	39.0-77.0
DOC	mg C/L	31	2.63	1.10-5.20
NO_3-N	μg at/L	21	0.50	0.28-1.23
NO_2-N	μg at/L	21	0.26	0.17-0.52
PO_4-P	μg at/L	21	0.33	0.17-0.43
SiO_2-Si	μg at/L	21	2.29	1.10-5.17
		STATION 481		
POC	μg C/L	17	64.95	45.0-118.0
DOC	mg C/L	10	2.20	0.90-5.40
NO_3-N	μg at/L	14	0.66	0.29-1.40
NO_2-N	μg at/L	14	0.35	0.21-0.67
PO_4-P	μg at/L	14	0.38	0.21-0.57
SiO_2-Si	μg at/L	14	2.75	1.10-5.00
		STATION 491		
POC	μg C/L	32	62.12	45.0-125.0
DOC	mg C/L	24	1.46	0.80-3.00
NO_3-N	μg at/L	18	0.74	0.29-2.23
NO_2-N	μg at/L	18	0.30	0.15-0.67
PO_4-P	μg at/L	18	0.40	0.23-0.67
SiO_2-Si	μg at/L	18	2.63	0.90-7.83

TABLE XXI-11
COMPARISON OF STATIONS 151 and 247 MEAN NUTRIENT DATA BY SEASON

VARIABLE	N	STATION 151	N	STATION 247
		FALL		
POC	8	72.3	6	57.5
DOC	7	3.40	6	1.57
NO_3-N	8	0.68	6	0.90
NO_2-N	8	0.39	6	0.41
PO_4-P	8	0.43	6	0.33
SiO_2-Si	8	2.58	6	4.28
		WINTER		
POC	18	54.1	12	67.4
DOC	8	3.10	1	2.70
NO_3-N	7	0.52	2	0.28
NO_2-N	7	0.23	2	0.18
PO_4-P	7	0.41	2	0.22
SiO_2-Si	7	1.51	2	2.05
		EARLY SUMMER		
POC	29	46.4	38	51.9
DOC	24	2.06	24	2.90
NO_3-N	12	0.37	13	0.35
NO_2-N	12	0.21	13	0.20
PO_4-P	12	0.32	13	0.35
SiO_2-Si	12	1.22	13	1.41

SECTION 3: GEOLOGY AND SEDIMENTOLOGY

P.I.'s: L. Doyle, J. Steinmetz
Associates: G. Brooks, D. Parker

METHODS AND MATERIALS

Surface sediment samples were taken at four stations on the Florida Middle Ground during each of four cruises between October 1978 and July 1979. Station locations were selected by the biological research group. Station locations and the sediment sampling transects associated with them are shown in Figure XXI-9 (above, p. 23). The samples were collected by diver, Shipek grab sampler, and bucket dredge. During the January 1979 cruise, Shipek and dredge samples were taken along transects across each of the four stations. Figures XXI-24 through 27 are Map-O-Graph enlargements of known sample locations within the transects. Unfortunately, the sample locations for the November 1978 and January 1979 transects across station number 247 are not available because the navigator failed to record the data. A total of 178 samples were collected and analyzed for grain size, calcium carbonate content, and total organic carbon, using techniques described in Dames and Moore (1979). Clay mineralogy was determined for ten samples using the X-ray diffraction techniques described in Dames and Moore (1979).

Carbonate constituent analysis was performed by the point whole grain count method (Carver, 1971), which obviates any bias that may occur due to size differences. At least 100 particles were identified from each sample, giving a 95% chance of finding any constituent making up 3% of the total sediment (Dennison and Hay, 1967). With the exception of the transect samples, several replicates were taken from each station. Stations, sampling periods, and number of samples collected are shown in Table XXI-12. Textural and carbonate content data from 28 samples taken previously throughout the Florida Middle Ground and described in Birdsall (1978; see Table XXI-13) are incorporated in the interpretation of results.

RESULTS

Results of analyses for grain size, calcium carbonate content, total organic content, and carbonate constituents are shown in Appendix E, Tables XXI-3 through 5, and are summarized in Table XXI-14 and Figures XXI-28 through 32. Three of the benchmark stations are located on bathymetric highs. Station 481 is located on the flank of a ridge. Mean grain size at the four stations varies from 0.41 mm (1.37 Ø) to 1.88 mm (-0.99 Ø). Standard deviation varies from 0.86 Ø to 0.15 Ø, which corresponds with moderate to very well sorted sediment, according to the classification of Folk (1965).

Perusal of the mean grain size at each of the stations shows that size increased from October/November 1978 through January 1979 through June 1979 (Figures XXI-28 through 31). A Student T-test run on these data showed increases to be significant at the 95% level. Table XXI-15 also shows that at the 95% confidence level sediment populations from the four stations tested with the Student T-test were significantly different from each other over most of the sampling periods.

Grain size of the transects taken across the stations, shown in Figure XXI-32, shows a weak relationship with depth. Stations in the swales at over 35 m depth between the ridges tend to be finer than those on the ridge tops. There is a corresponding weak relationship of higher calcium carbonate values (which range from 75% to over 99%) with the coarser grain sizes on the ridge tops, and a weak inverse relationship of total organic carbon content (which ranges from 0.12% to 0.27%) with grain size (Figures XXI-33 and 34).

Figures XXI-28 through 31 show the mean percentage of values of all replicates of carbonate constituent analysis for each of the four stations for each major sampling. The grains are generally corroded and not fresh. Corrosion is reflected in the high percentages of grains so worn that they are unidentifiable. Unidentifiable grains (listed in the "other" category along with minor or trace amounts or echinoid, coelenterate, ostracod, planktonic foraminifera, algal remains, and non-skeletal particles) are often the most prominent constituents in the samples, and if not first in number are always second. Of the identifiable grains, molluscan fragments are most important, distinctly followed by barnacles, bryozoans, annelids, and benthic foraminifera. Constituent analyses of the samples from the transects across the stations are generally similar to those for the stations themselves. No constituent trends between the ridges and the valleys are readily apparent, with the possible exception of a slight increase in benthic foraminifera in the low areas.

The clay size fraction of the Florida Middle Ground sediment was usually less than 5%. All but a few percent of the clay size fraction were $CaCO_3$. The only clay mineral detectable in the insoluble residue was hydrobiotite (biotite-vermiculite).

DISCUSSION

The sampling scheme was of such limited scope that a complete characterization of the Florida Middle Ground sediments is not feasible. The primary function of the sediment program has been to provide a sedimentary framework for the biology of the four benchmark stations. The problem of the limited nature of the study was compounded by the navigator's failure to properly record locations for samples taken on transects across station 247 on the November 1978 and January 1979 cruises. Despite these limitations, several interesting points about the Florida Middle Ground are suggested by the data.

First, the grain size distribution is patchy and has a detectable seasonal variation. Similar trends have been noted by Doyle and Sparks (in press) for the West Florida Shelf as a whole. Although patchiness of sediment texture is not surprising given the rugged character of the Florida Middle Ground bottom, the seasonal trend is surprising. Of special interest is the progression to coarser grain size with each successive sampling. This trend may be the result of deposition following the relaxation of the Eastern Gulf after the late summer and fall hurricane season, during which the outer shelf bottom was stirred up. Additionally, successive winnowing of the higher prominences in the Florida Middle Ground by tidal currents and the Loop Current during the succeeding winter and spring may have contributed. Sediments on the higher areas represented by the four stations are moderately to very well sorted, suggesting that they are being actively winnowed, while samples from the low areas are poorly sorted, suggesting that they are at most partially protected from winnowing. Winnowing in the adjacent lows, then, is less of a factor, although erosion is not necessarily entirely absent, since most of this sediment is still sand size and has an increased amount of insoluble residue. If considerable carbonate detritus were being deposited in the valleys, the insoluble residue should be masked and be lower. Higher insoluble residues in the valleys suggest that clastic carbonate deposition and production are limited.

Carbonate constituents are most interesting and diagnostic. Their corroded condition, and the fact that of those particles which are recognizable, mollusc and barnacle fragments predominate, reveal a much closer affinity to parts of the adjacent open shelf than to a typical coral reef environment. Table XXI-16 shows some sediment types from Caribbean coral reefs after Milliman (1974) and, for comparison, sediment composition from the Florida Middle Ground. The differences are obvious and significant. Although parts of the reef may appear to be flourishing, it is not producing enough carbonate particles to mask the relict shelf constituents.

Two end members come to mind by way of explanation of the sediment differences. First, the Florida Middle Ground may not be flourishing. Indeed it may be barely hanging on through recruitment via the Loop Current. On the other hand, storms (especially hurricanes) may transport significant amounts of sand size sediments across the Eastern Gulf shelf (Doyle and Sparks, in press; Doyle, Neurauter, and Pyle, 1980), enough to mask _in situ_ production. Evidence for the latter is present in the bedforms discussed by Doyle, Neurauter, and Pyle (1980) and in the variation through time shown in the texture of open shelf stations (Doyle and Sparks, in press) and on the Florida Middle Ground itself. Evidence for the former is present in the television surveys of the area, which show that most of the growth of reefal organisms is upward. There is little lateral growth, indicating a bioherm which is under considerable stress and not one that is flourishing. The answer may be at a point somewhere between both end members in the continuum.

TABLE XXI-12
STATIONS (FIRST THREE NUMERALS OF WHOLE #), SAMPLING PERIODS, AND NUMBER OF REPLICATES

Station	Number of Samples Collected			Transects	
	10/78	11/78	01/79	11/78	01/79
151	20	20	10	10	-
247	10	10	10	15*	10*
481	10	—	10	8	-
491	10	—	10	15	-

*Coordinates of sampling sites not provided

TABLE XXI-13
TWENTY-EIGHT SAMPLES TAKEN FROM FLORIDA MIDDLE GROUND, DESCRIBED IN BIRDSALL (1978), AND THEIR PERTINENT GRAIN SIZE AND PERCENTAGE $CaCO_3$

Station No.	Station Locations		Water Depth (m)	% Silt	Grain Size			% Calcium Carbonate
	Latitude	Longitude			Mean φ	Mean mm	σ (φ)	
1	28°27'N	84°20'W	38	5	0.378	0.811	1.260	97.83
2	28°30'N	84°20'W	41	22	3.063	0.086	1.203	85.79
3	28°33'N	84°20'W	39	21	3.107	0.118	1.115	71.85
4	28°35'N	84°19'W	37	20	3.177	0.114	1.161	71.61
5	28°37'N	84°20'W	37	9	0.485	0.758	1.689	91.65
6	28°40'N	84°19'W	37	11	2.808	0.149	1.170	44.87
7	28°41'N	84°19'W	37	4	1.007	0.498	1.372	79.12
8	28°43'N	84°20'W	37	5	0.956	0.522	1.416	78.89
9	28°45'N	84°20'W	35	2	0.475	0.763	1.034	78.89
10	28°47'N	84°20'W	34	12	3.015	0.124	0.948	44.23
11	28°51'N	84°20'W	34	12	2.988	0.127	0.977	45.38
12	28°51'N	84°23'W	32	4	2.927	0.134	0.613	18.17
13	28°50'N	84°25'W	35	1	0.694	0.653	1.153	82.94
14	28°49'N	84°26'W	43	6	3.000	0.125	0.712	26.01
15	28°46'N	84°25'W	40	14	1.952	0.262	1.737	79.39
16	28°44'N	84°25'W	41	10	2.615	0.173	1.191	59.30
17	28°42'N	84°26'W	42	29	3.439	0.098	1.126	77.30
18	28°38'N	84°26'W	41	5	0.707	0.647	1.522	92.79
19	28°37'N	84°26'W	43	15	2.820	0.148	1.296	70.16
20	28°34'N	84°25'W	46	9	1.358	0.411	1.317	89.16
21	28°31'N	84°25'W	41	2	0.824	0.588	0.975	92.61
22	28°30'N	84°30'W	50	4	0.181	0.909	1.242	90.89
23	28°30'N	84°27'W	48	5	1.259	0.435	1.200	69.82
24	28°30'N	84°25'W	50	13	2.035	0.246	1.293	76.94
25	28°27'N	84°25'W	50	5	2.174	0.228	1.084	72.04
26	28°25'N	84°25'W	55	13	2.827	0.147	1.124	79.63
27	28°23'N	84°25'W	56	11	2.870	0.141	1.082	69.17
28	28°20'N	84°25'W	59	15	2.921	0.135	1.149	83.04

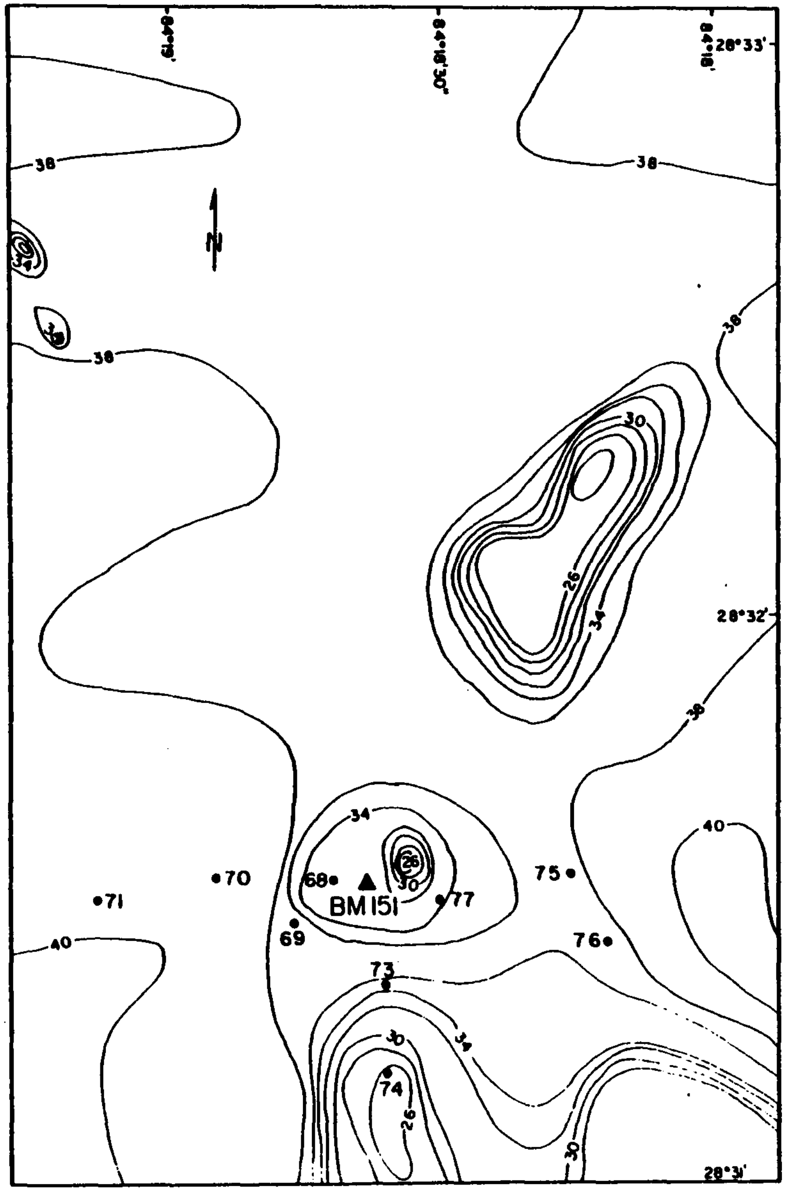


Figure XXI-24. Bathymetric map of station 151, showing transect sampling sites.

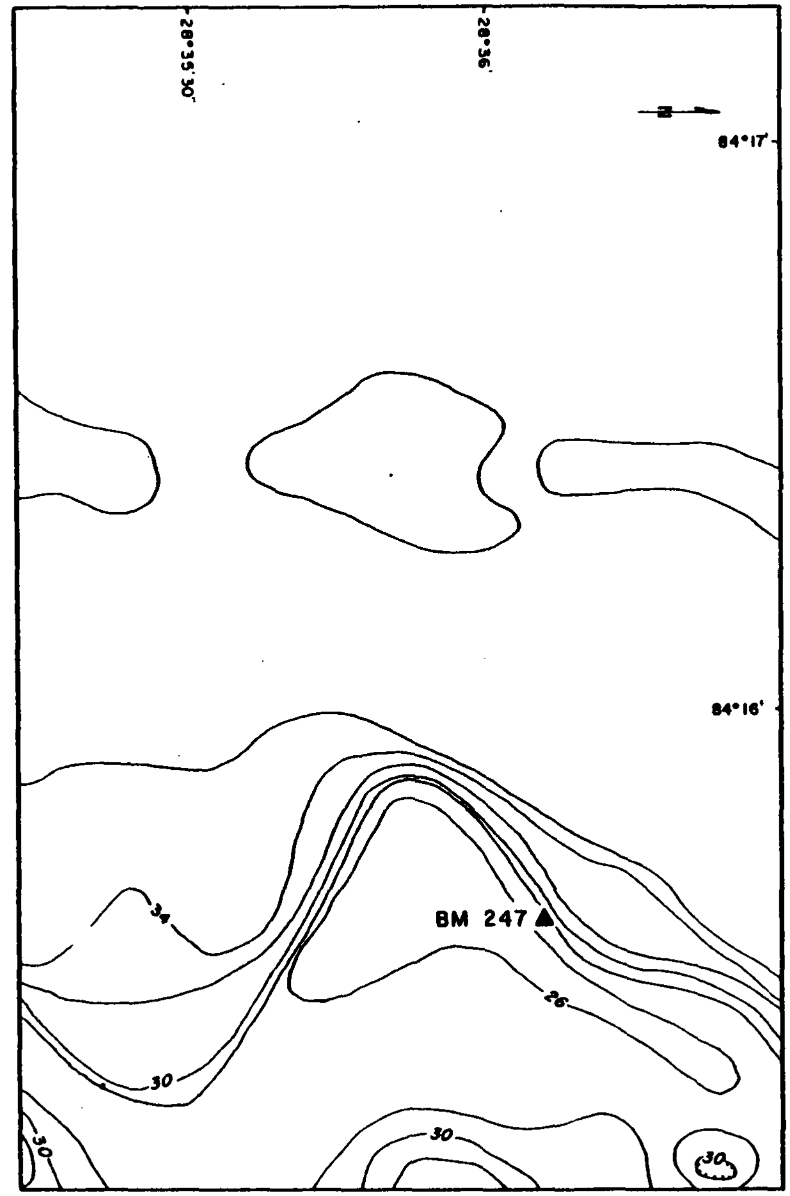


Figure XXI-25. Bathymetric map of station 247; transect sampling sites unavailable.

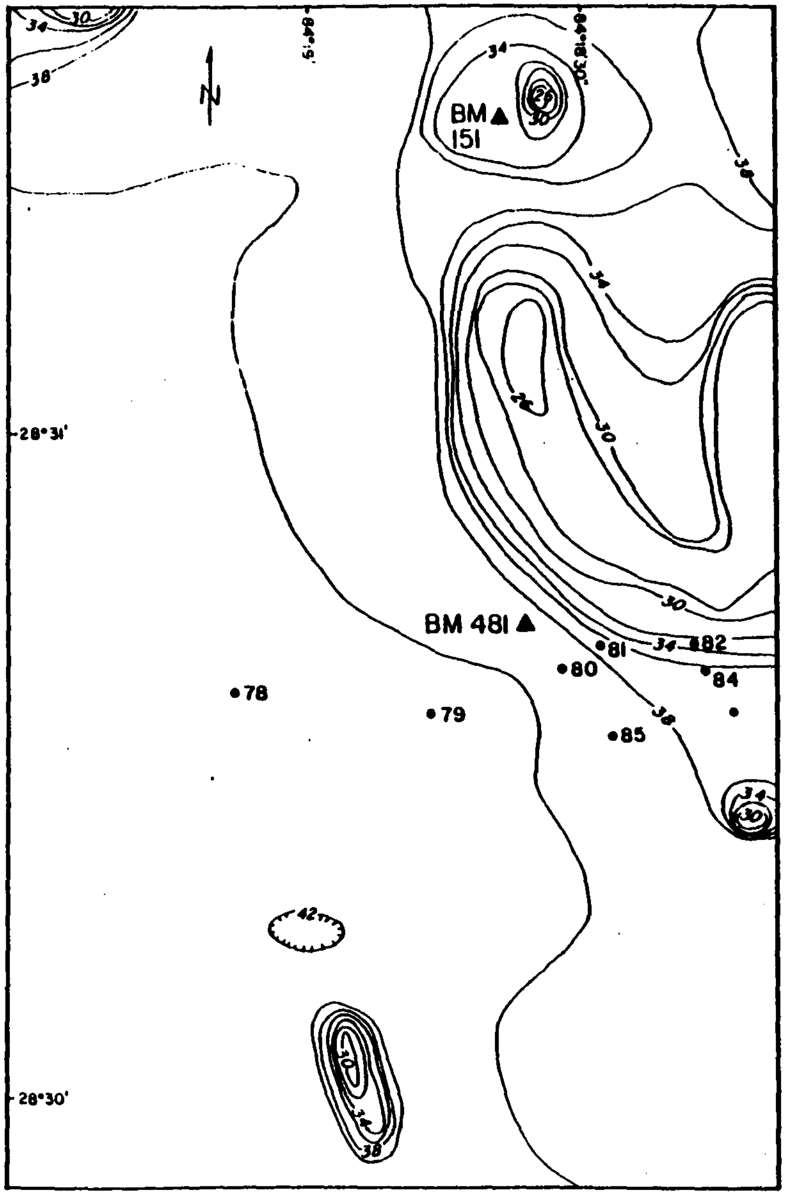


Figure XXI-26. Bathymetric map of station 481, showing transect sampling sites.

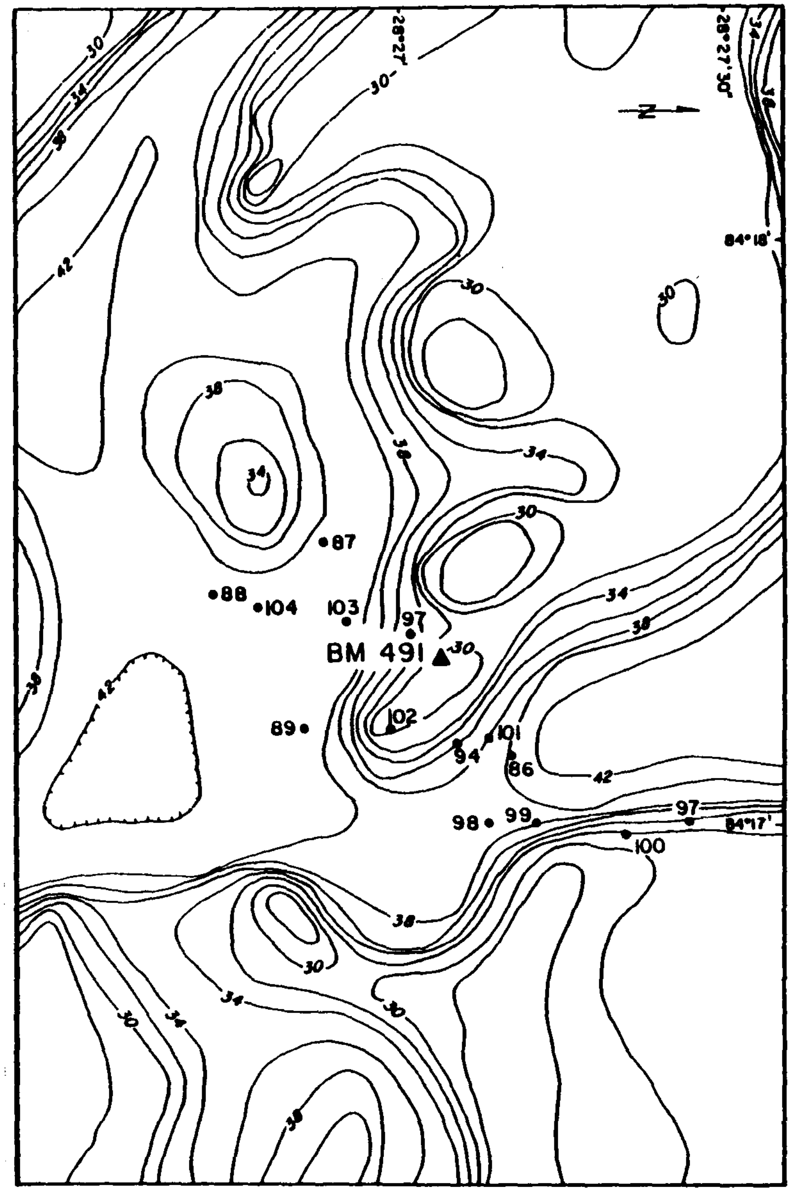


Figure XXI-27. Bathymetric map of station 491, showing transect sampling sites.

TABLE XXI-14
SEDIMENT CHARACTERISTICS SUMMARY
Transects (11/78)

Sample No.	Depth (m)	Grain Size $\bar{X}$ ϕ	Grain Size $\bar{X}$ mm	Grain Size σ ϕ	$\%CO_3$	%TOC	Sediment Consituents (relative %) Moll	Barn	Benthic Foram	Annelid	Bryozoa	Other*
Sample 247 (no sample coordinates)												
247210181105-1	36.0	2.69	0.16	1.09	92.34	0.241	14.67	0.00	8.67	0.67	1.67	74.32
247210181105-2	37.5	2.65	0.17	1.04	93.67	0.208	46.40	3.00	8.60	2.20	2.80	37.00
247210181105-3	39.0	0.27	0.87	0.91	98.77	0.144	39.40	7.00	6.60	3.00	1.80	42.20
247210181105-4	37.5	0.20	0.90	1.39	98.79	0.202	38.20	8.40	4.40	3.60	3.00	42.40
247210181105-6	27.4											
247210181105-7	28.3	0.93	0.54	1.08	98.85	0.168	35.80	6.40	3.40	4.60	4.00	45.80
247210181105-8	30.0											
247210181105-9	30.0	-1.16	2.32	1.46	99.35	0.128	37.60	5.00	4.80	4.00	1.00	47.60
247210181105-10	31.0	-0.30	1.30	1.06	99.99	0.173	31.40	5.80	3.20	4.20	8.00	47.40
247180181105-1	39.8	0.11	0.95	1.21	98.32	0.128	31.80	8.00	3.80	2.00	1.00	53.40
247180181105-2	35.6	-0.68	1.68	2.16	98.74	3.143	37.40	7.80	1.80	3.60	4.00	45.40
247180181105-3	27.4	0.09	0.96	1.06	99.28	0.126	37.60	3.60	3.40	2.80	2.00	50.60
247180181105-4	28.8											
247180181105-5	30.0	-0.11	1.11	1.37	98.75	0.139	34.20	7.00	4.20	4.00	1.60	49.00
247180181105-6	31.0	-0.31	1.31	1.33	98.83	0.150	43.60	5.40	3.60	3.00	3.00	41.40
151210181107-1	32.0	-0.36	1.36	1.75	99.01	0.151	14.67	7.67	5.00	5.00	7.00	60.67
151210181107-2	34.1	-0.09	1.09	1.36	99.23	0.136	32.25	1.63	5.92	6.12	3.06	51.02
151210181107-3	38.1	3.04	0.12	1.38	93.82	0.330	33.80	3.60	15.40	4.60	4.80	37.80
151210181107-4	36.6	2.42	0.20	0.90	78.15	0.135	34.84	0.91	10.40	1.13	2.04	50.68
151180181107-1		2.29	0.21	1.36	75.01	0.161	34.60	1.40	11.80	2.00	2.20	48.00
151210181108-1	34.7	0.40	0.80	1.19	99.09	0.111	35.60	4.00	5.00	3.20	2.00	50.50
151210181108-2	25.6											
151210181108-3	36.6	1.08	0.48	1.75	96.75	0.152	36.40	5.00	6.60	2.60	4.20	45.20
151210181108-4	36.6											
151210181108-5	36.6	0.15	0.93	1.17	99.28	0.378	39.28	1.80	6.41	2.61	1.01	48.94
481210181108-1	37.5	2.63	0.17	1.07	85.47	0.105	14.33	0.33	12.00	4.00	2.00	67.34
481210181108-2	37.5	2.68	0.17	1.09	90.65	0.218	34.65	0.00	5.95	0.00	0.00	59.40
481210181108-3	37.5	-0.23	1.23	1.20	86.06	0.137	34.00	13.00	0.00	1.00	4.00	48.00
481210181108-4	35.6	-0.37	1.37	1.43	94.46	0.132	41.00	6.00	5.00	6.00	4.00	38.00
481210181108-5	33.8	-0.87	1.87	1.65	95.77	0.163	43.00	2.00	8.00	7.00	6.00	34.00
481210181108-6	34.3	-0.81	1.81	1.06	98.06	0.146	39.00	8.00	6.00	1.00	2.00	44.00
481210181108-7	33.8	-0.57	1.57	1.63	98.25	0.099	30.00	6.00	7.00	7.00	6.00	44.00
481210181108-8	35.6	0.39	0.81	1.41	98.83	0.126	38.80	6.00	6.00	1.80	2.80	44.60
491210181109-1	40.2	-0.43	1.43	1.59	83.07	0.176	14.00	4.67	4.33	6.67	7.33	63.00
491210181109-2	36.6	0.02	0.99	1.23	91.45	0.164	36.00	5.00	5.00	6.00	2.00	46.00
491210181109-3	26.5	-0.30	1.30	1.12	92.46	0.145	48.00	2.00	7.00	2.00	4.00	37.00
491210181109-4	40.2	0.10	0.95	1.23	91.53	0.153	36.40	0.80	5.60	1.80	1.80	53.60
491210181109-5	41.1	0.37	0.82	1.21	90.40	0.163	34.00	0.80	5.40	2.60	1.40	55.80
491210181109-6												
491210181109-7	36.6											
491210181111-1	32.9	-0.16	1.16	1.28	92.34	0.115	45.00	5.00	2.00	6.00	1.00	41.00
491210181111-2	43.9	2.22	0.22	2.08	86.68	0.487	33.00	0.00	8.00	0.00	0.00	59.00
491210181111-3	43.9	0.39	0.81	1.40	96.55	0.209	38.00	6.00	6.00	3.00	1.00	46.00
491210181111-4	30.2	-0.64	1.64	1.27	96.63	0.138	49.21	4.21	3.68	2.89	2.37	37.64
491210181111-5	43.9	-0.18	1.18	0.85	97.74	0.162	28.00	6.00	6.00	8.00	5.00	47.00
491210181111-6	28.3	0.53	0.74	1.36	92.24	0.406	31.00	3.00	2.00	5.00	5.00	54.00
491210181111-7	41.1	-0.61	1.61	1.65	87.45	0.266	37.00	1.00	9.00	6.00	5.00	42.00
491210181111-8	43.5	0.15	0.93	1.50	90.84	0.381	29.80	2.40	6.40	4.00	1.60	55.80

*Echinoids, coelenterates, ostracods, algae (Halimeda and Goniolithon), planktonic foraminifera, unidentified particles, non-skeletal particles, etc.

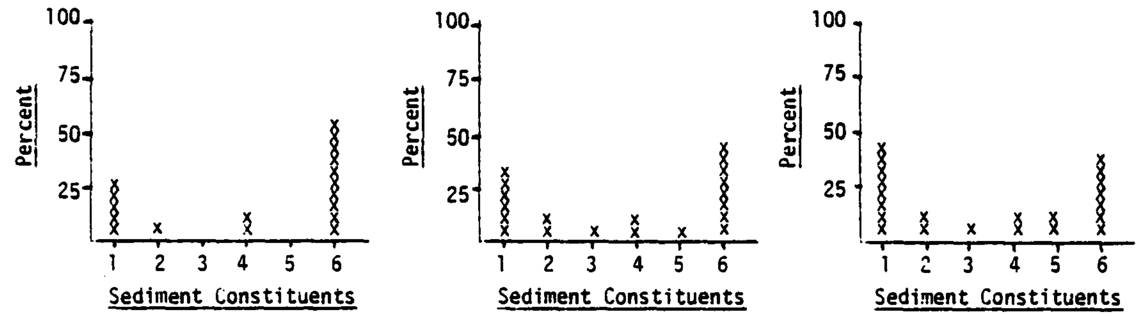
TABLE XXI-15
GRAIN SIZE T-TEST
(95% Confidence Interval)

SAME POPULATIONS			
Station	Date	Station	Date
151	01/79	151	06/79
247	01/79	247	06/79
247	10/78	481	10/78
247	06/79	481	06/79
247	06/79	491	06/79
481	06/79	491	06/79

DIFFERENT POPULATIONS			
Station	Date	Station	Date
151	10/78	151	06/79
151	10/78	151	01/79
247	10/78	247	06/79
247	10/78	247	01/79
481	10/78	481	06/79
491	10/78	491	06/79
151	10/78	247	10/78
151	01/79	247	01/79
151	06/79	247	06/79
151	06/79	481	06/79
151	10/78	481	10/78
151	10/78	491	10/78
151	06/79	491	06/79
247	10/78	491	10/78
481	10/78	491	10/78

Station 151

10/78	01/79	06/79
Grain Size mean = 0.27ϕ (0.87 mm) st. dev. = 0.86ϕ	Grain Size mean = -0.62ϕ (1.62 mm) st. dev. = 0.45ϕ	Grain Size mean = -0.99ϕ (1.99 mm) st. dev. = 0.56ϕ
Percent Carbonate mean: 98.15 st. dev. = 0.70	Percent Carbonate mean = 91.25 st. dev. = 3.70	Percent Carbonate mean = 94.06 st. dev. = 3.41
TOC (%) mean = 0.19 st. dev. = 0.08	TOC (%) mean = 0.27 st. dev. = 0.11	TOC (%) mean = 0.12 st. dev. = 0.01

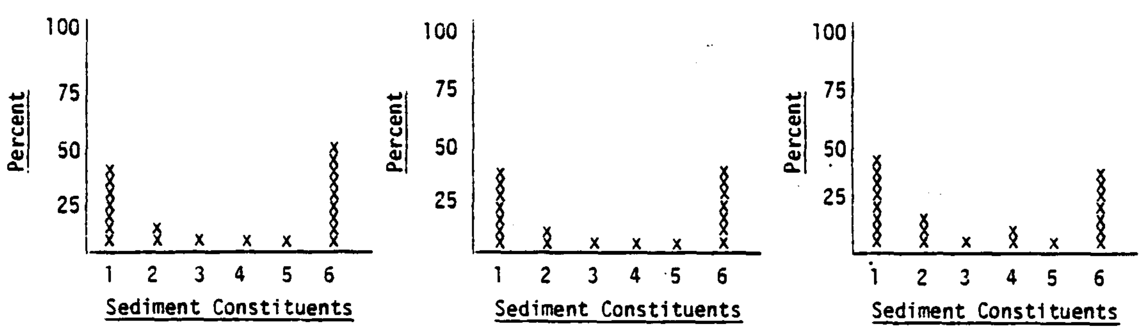


1 = mollusc, 2 = barnacle, 3 = benthic foraminifera, 4 = annelid, 5 = bryozoa, 6 = other

Figure XXI-28. Summary of textural and compositional characteristics of station 151.

Station 247

10/78	01/79	06/79
Grain Size mean = 1.21ϕ (0.45 mm) st. dev. = 0.23ϕ	Grain Size mean = -0.62ϕ (1.62 mm) st. dev. = 0.45ϕ	Grain Size mean = -0.99ϕ (1.99 mm) st. dev. = 0.56ϕ
Percent Carbonate mean = 98.69 st. dev. = 0.11	Percent Carbonate mean = 91.25 st. dev. = 3.70	Percent Carbonate mean = 95.34 st. dev. = 2.90
TOC (%) mean = 0.19 st. dev. = 0.11	TOC (%) mean = 0.27 st. dev. = 0.11	TOC (%) mean = 0.13 st. dev. = 0.01



1 = mollusc, 2 = barnacle, 3 = benthic foraminifera, 4 = annelid, 5 = bryozoa, 6 = other

Figure XXI-29. Summary of textural and compositional characteristics of station 247.

Station 481

10/78

Grain Size
mean = 1.37ϕ (0.41 mm)
st. dev. = 0.66ϕ

Percent Carbonate
mean = 98.69
st. dev. = 0.34

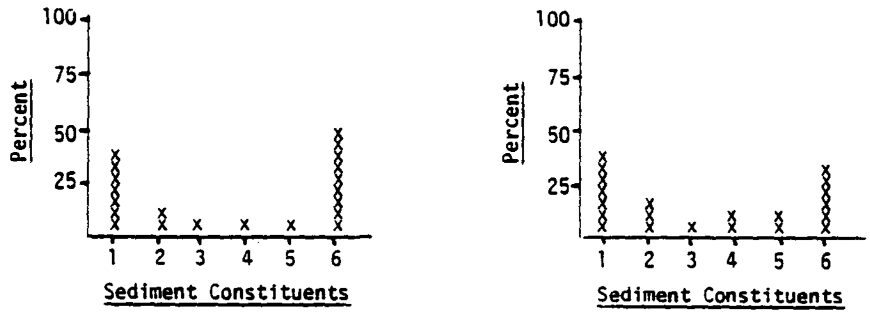
TOC (%)
mean = 0.19
st. dev. = 0.08

06/79

Grain Size
mean = 0.32ϕ (0.84 mm)
st. dev. = 0.28ϕ

Percent Carbonate
mean = 93.04
st. dev. = 4.59

TOC (%)
mean = 0.13
st. dev. = 0.01



1 = mollusc, 2 = barnacle, 3 = benthic foraminifera, 4 = annelid, 5 = bryozoa, 6 = other

Figure XXI-30. Summary of textural and compositional characteristics of station 481.

Station 491

10/78

Grain Size
mean = 0.89ϕ (0.55 mm)
st. dev. = 0.15ϕ

Percent Carbonate
mean = 98.75
st. dev. = 0.46

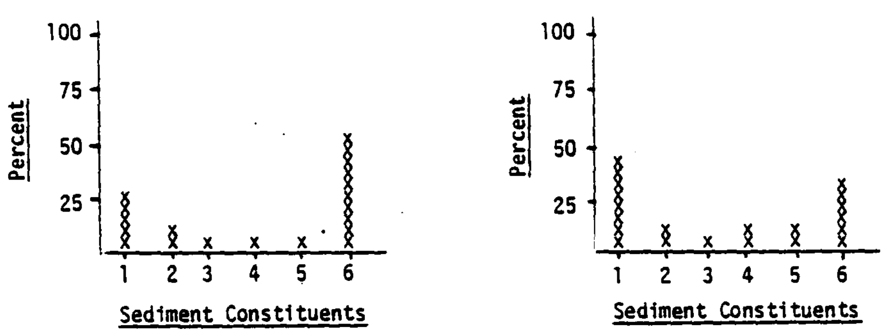
TOC (%)
mean = 0.22
st. dev. = 0.09

06/79

Grain Size
mean = 0.13ϕ (0.94 mm)
st. dev. = 0.34ϕ

Percent Carbonate
mean = 96.24
st. dev. = 2.05

TOC (%)
mean = 0.14
st. dev. = 0.01



1 = mollusc, 2 = barnacle, 3 = benthic foraminifera, 4 = annelid, 5 = bryozoa, 6 = other

Figure XXI-31. Summary of textural and compositional characteristics of station 491.

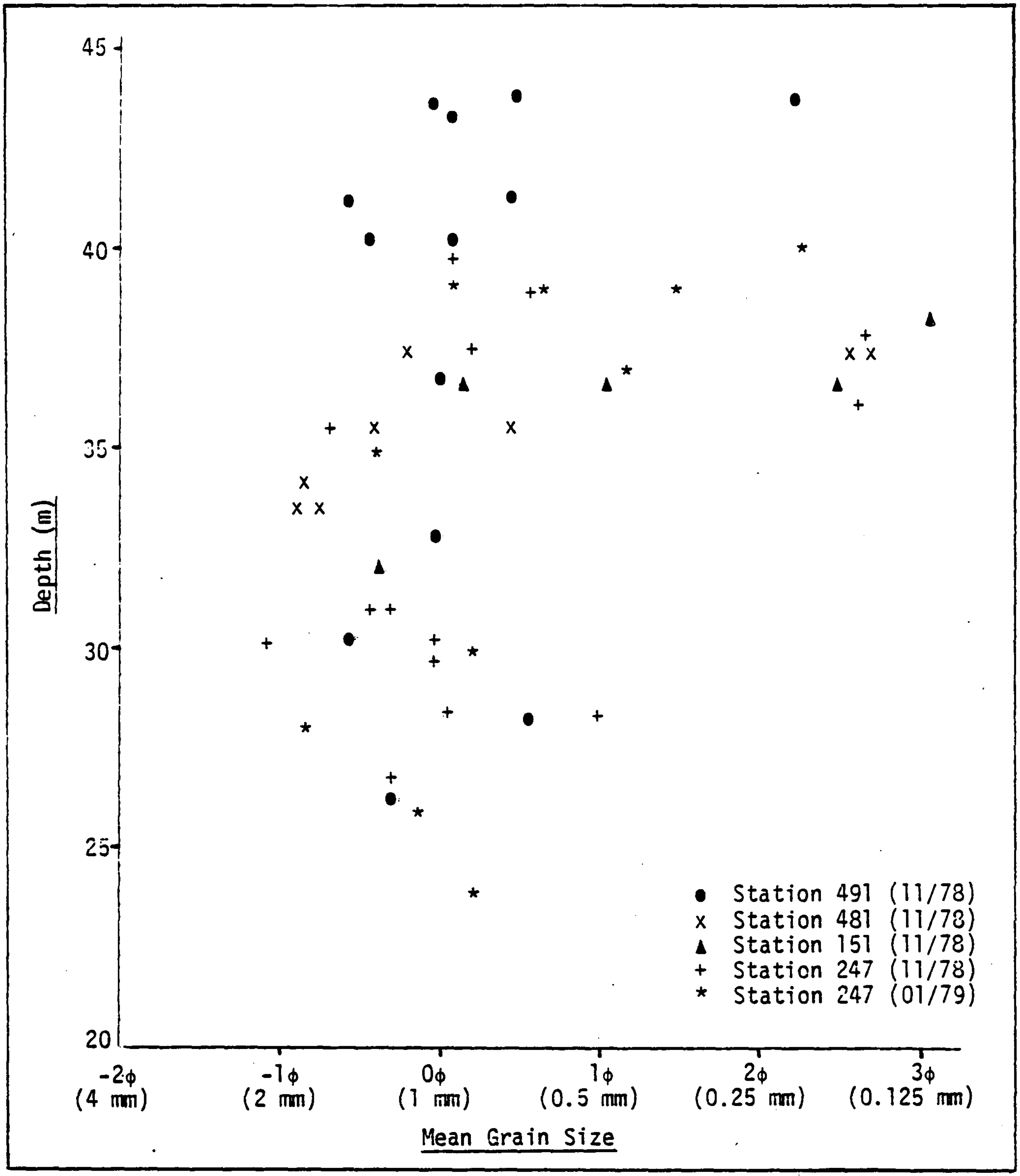


Figure XXI-32. Mean grain size plotted vs. depth.

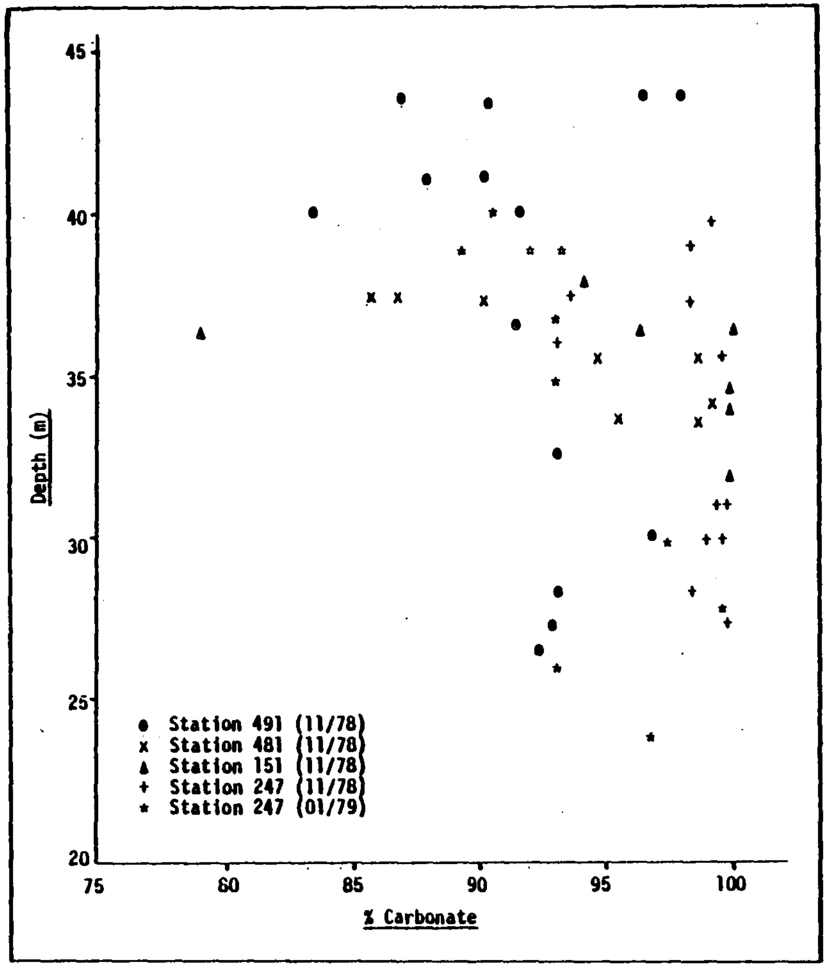


Figure XXI-33. Percent calcium carbonate plotted vs. depth.

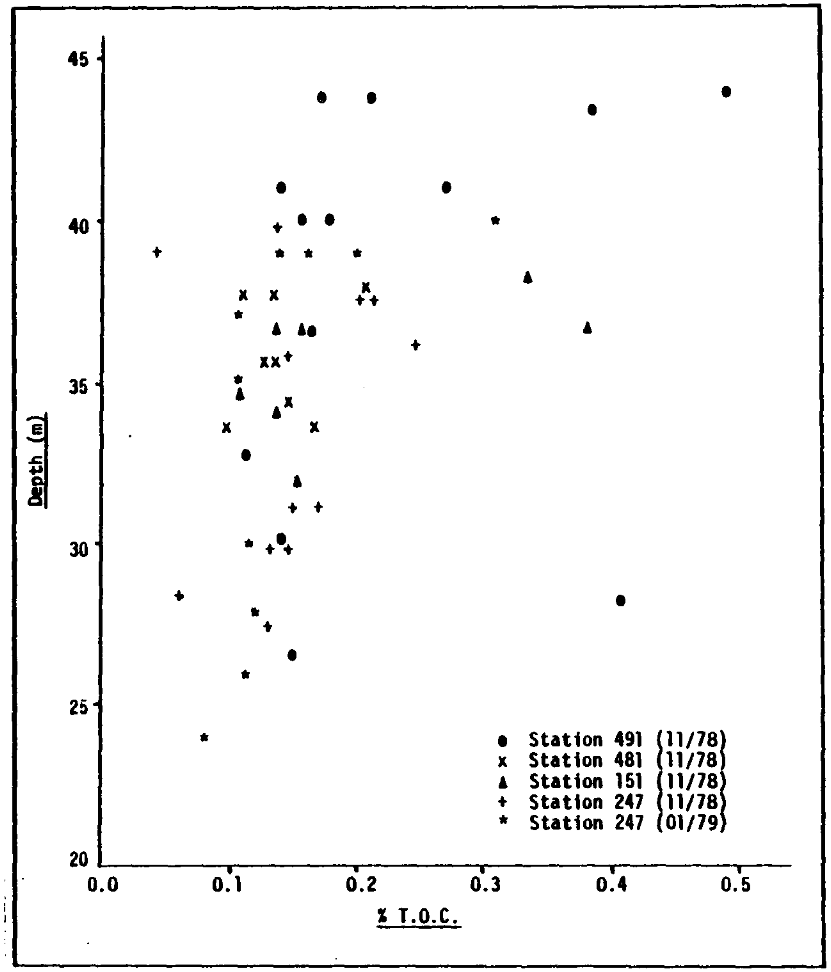


Figure XXI-34. Percent total organic carbon plotted vs. depth.

TABLE XXI-16
AVERAGE COMPOSITION OF PERIPHERAL REEF SEDIMENTS FROM
VARIOUS CARIBBEAN REEFS AND ATOLLS
(After Milliman, 1974)

<table>
<tr><th>Skeletal Fragments</th><th>Florida</th><th>Alacran Reef</th><th>Andros, Bahamas</th><th>Abaco, Bahamas</th><th>Ragged Islands, Bahamas</th><th>Hogsty Reef</th><th>Courtown Cays</th><th>Albuquerque Cays</th><th>Roncador Bank</th><th>Serrana Bank</th></tr>
<tr><td>Coral</td><td>20</td><td>26</td><td>24</td><td>27</td><td>12</td><td>27</td><td>35</td><td>30</td><td>25</td><td>33</td></tr>
<tr><td>Mollusks</td><td>12</td><td>7</td><td>6</td><td>11</td><td>18</td><td>22</td><td>10</td><td>9</td><td>15</td><td>5</td></tr>
<tr><td>Foraminifera</td><td>6</td><td>8</td><td>12</td><td>11</td><td>13</td><td>5</td><td>3</td><td>2</td><td>3</td><td>3</td></tr>
<tr><td>Coralline Algae</td><td>10</td><td>11</td><td>33</td><td>10</td><td rowspan="2">39</td><td>19</td><td>21</td><td>21</td><td>24</td><td>24</td></tr>
<tr><td><u>Halimeda</u></td><td>30</td><td>40</td><td>17</td><td>16</td><td>2</td><td>28</td><td>32</td><td>17</td><td>17</td></tr>
<tr><td>Misc. Skeletons</td><td>7</td><td>1</td><td>6</td><td>5</td><td>4</td><td>1</td><td>—</td><td>1</td><td>1</td><td>1</td></tr>
</table>

SECTION 4: BIOLOGY
PI: T. Hopkins

METHODS AND MATERIALS

Algae

Algae were collected by divers in a random and 1/4 m^2 mode and placed in cloth bags under water. On deck, bags were picked clean, and each sample was given a unique descriptor label. Algae were preserved in opaque black bags in buffered formalin and stored until laboratory analysis. Algal biomass was determined on a pan balance with $\pm$ 0.2 g accuracy. All algal identifications were carried out in the laboratory of Dr. Sylvia Earle, California Academy of Sciences.

Foraminifera

Each of the sediment samples brought aboard ship was immediately subsampled for micropaleontological analysis. Approximately 100 cc of sediment were preserved in 900 cc of 40% formaldehyde and seawater. Preserved samples were transported to the laboratory and split using a Motoda sample splitting box (Motoda, 1959). Approximately 25 cc were retained for analysis; the remainder was archived in 40% formaldehyde and seawater.

To determine living specimens, samples were stained following the method of Walker et al. (1974), immersion in heated saturated Sudan Black B in 70% ethanol. The samples were suspended in the solution and maintained at 40°C for 30 min. They were then washed in 70% ethanol and allowed to dry.

Under the dissecting microscope, the benthic foraminifera were picked from the sediment, sorted, identified, and counted. Live (stained) and dead (unstained) foraminifera were picked until a total of 150-300 individuals were obtained from each sample.

Percentages were calculated for both the total (dead + live) and for live species present in each sample. Diversity and evenness values were then calculated for each sample and each station.

Sponges

Selected target sponge species were taken by divers and carefully placed in individual cloth bags. These collections were used for cryptofaunal analysis. No attempt was made to develop a complete sponge species list because neither time nor state of the art in sponge systematics warrants such an effort.

Sponge cryptofaunal procedures (Agelas dispar) were as described below.

1. Remove sponge from bag; rinse bag over screen (0.5 mm); save alcohol.

2. Decant contents of vials and jars over screen.

3. Rinse sponge thoroughly over screen.

4. Tear sponge into small pieces, opening all channels.

5. Rinse each sponge piece over screen; set pieces aside in tray.

6. Wash contents of screen into white enamel tray; sort animals into labeled vials.

7. Examine each sponge piece and remove animals.

8. Set finished sponge pieces with labels in tray on kitchen shelves to dry.

9. Dry thoroughly at 50°C in drying oven; weigh; save labels.

Corals

Live-dead ratios of *in situ* corals were determined by divers using a plotless line transect method, based on 5 m x 5 m quadrats. Because of a need to prioritize our time, we did not try to do extensive diversity counts of hard or soft corals. These data are now established (Grimm and Hopkins 1977; Grimm, 1978). Selected hard and soft corals were taken where apparently rare, unknown, or unrecognized species were encountered.

More specifically, discrete "heads" of *Madracis decactis*, about 10 cm x 10 cm in size, were taken for cryptofaunal studies. Each sample was carefully collected underwater in a cloth bag. On deck, each sample was placed in a pan and assigned a unique sample descriptor. Details on sample processing are as follows.

1. Remove coral from bag; rinse bag over screen; save alcohol.

2. Make notes on coral cover.

3. Immediately remove visible animals from coral and save in vial.

4. Use pick to break coral into clumps that will fit coral crusher.

5. Remove additional animals.

6. Break clumps in coral crusher to approx. 2 cm size or small fingers.

7. Place coral chips in gallon jar with sugar solution (1 lb./quart).

8. Stir coral chips briefly until animals float; pour sugar solution through screen into tray.

9. Repeat sugar wash twice.

10. Rinse coral chips with fresh water; pour through screen; repeat.

11. Rinse coral chips into sorting tray; rinse contents of screen into a second enamel tray.

12. Sort animals into labeled vials; examine coral chips, also, and remove animals.

13. Set finished coral chips with label in tray on kitchen shelves to dry.

14. Dry thoroughly at 50°C in drying oven; weigh; save labels.

Three *M. decactis* samples from each station were digested in a solution of 4% nitric acid - 5% formalin in water to remove the $CaCO_3$. Undigested remains were washed and sorted as above.

Ichthyofauna

A modified version of the point-diversity method used by Slobodkin and Fishelson (1974) was employed in studies of ichthyofauna. An increased number of replicate counts was used to compensate for reduced count durations.

In brief, the counting procedures were as follows:

1. At each station, a reconnaissance dive was made to acquaint the observers with the topographic layout of the reef structures. Demarcations between shallow reef flat, ridge, reef slope, and deep sand flat biotopes were noted.

2. On succeeding dives, count sites were selected at random within the biotope boundaries. Effort was made to avoid prejudicial choice of count sites due to the presence of prominent coral structures or particular fish species.

3. At the actual count site, the diver/observer settled on the bottom about 2.5 m from the center of the count area. Over a five-minute period, records were made of the number of all species of fish within a 2 x 2 x 2 m cube of water over the substrate. Effort was made to avoid counting the same fish twice. This became difficult at sites where purple reeffish, *Chromis scotti*, were particularly abundant, or when schools of greater amberjack, *Seriola dumerili*, passed through the count site. Species such as *Balistes capriscus*, *Calamus nodosus*, *Mycteroperca phenax*, and *M. microlepis* also tended to return to the site several times within a single counting period.

4. At the end of each count, a series of 35 or 50 mm photographs was taken of the site area. To use available bottom time efficiently, data for each count were recorded on slates with inscribed species lists. Depth, date, time, and biotope were recorded. All data were transcribed to field notes immediately following the dive.

Nine counts were taken at station 151 in November 1978 on a single dive of the research submersible DRV DIAPHUS. Videotape recordings were obtained for each count site. There appeared to be no significant attraction to or avoidance of the submersible during the counting procedures. Small groups of the neon goby, Gobiosoma oceanops, did congregate on the submersible's forward skids while the DRV DIAPHUS rested on the bottom.

To evaluate the adequacy of count sample sizes for each biotope (with the exception of patch reef for which only six counts were obtained), cumulative species curves were plotted (Figure XXI-35). To avoid artifactual depression of the curves due to a seasonal effect by winter samples, the order of counts was randomized prior to inclusion in the curve calculations. Although sample size differed substantially among biotopes (shallow reef flat, 36 counts; ridge, 23 counts; reef slope, 42 counts; deep sand flat, 18 counts), cumulative species curves for each follow essentially identical patterns. Although 52 species were observed during the counting efforts, the cumulative species curves begin to level out at 30 to 35 species, which corresponds with 15 to 20 counts. The relatively high number of "rare" species has the effect of extending the approach of the curves toward an asymptote. If sufficient additional counts were made, rare species would be encountered in each biotope until the curves approached the 50 species level. Sampling effort, however, is judged adequate to account for all dominant and the majority of rare species in the studied biotopes.

A total of 125 five-minute counts were completed during the course of the study. These were distributed among stations, seasons, and biotopes, as follows:

Station	Count
151	53
247	38
481	6
491	13
Other	15

Season	Count
Oct-Nov 78	36
Jan-Mar 79	23
Jun-Jul 79	66

Biotope	Count
shallow reef flat	36
ridge	23
slope	42
deep sand flat	18
patch reef	6

Artificial Habitats

In an attempt to 1) study cryptofaunal colonization and 2) develop a management tool, an artificial habitat program was employed. The artificial habitat is shown in Figure XXI-36. A total of 80 habitats were deployed; however, neither time nor money was available for complete analysis.

Habitats were anchored in "chains" of tens on station 151. The habitat deployment schedule is shown in Figure XXI-36. Habitats were recovered with contents intact by cloth bagging them *in situ*, sealing

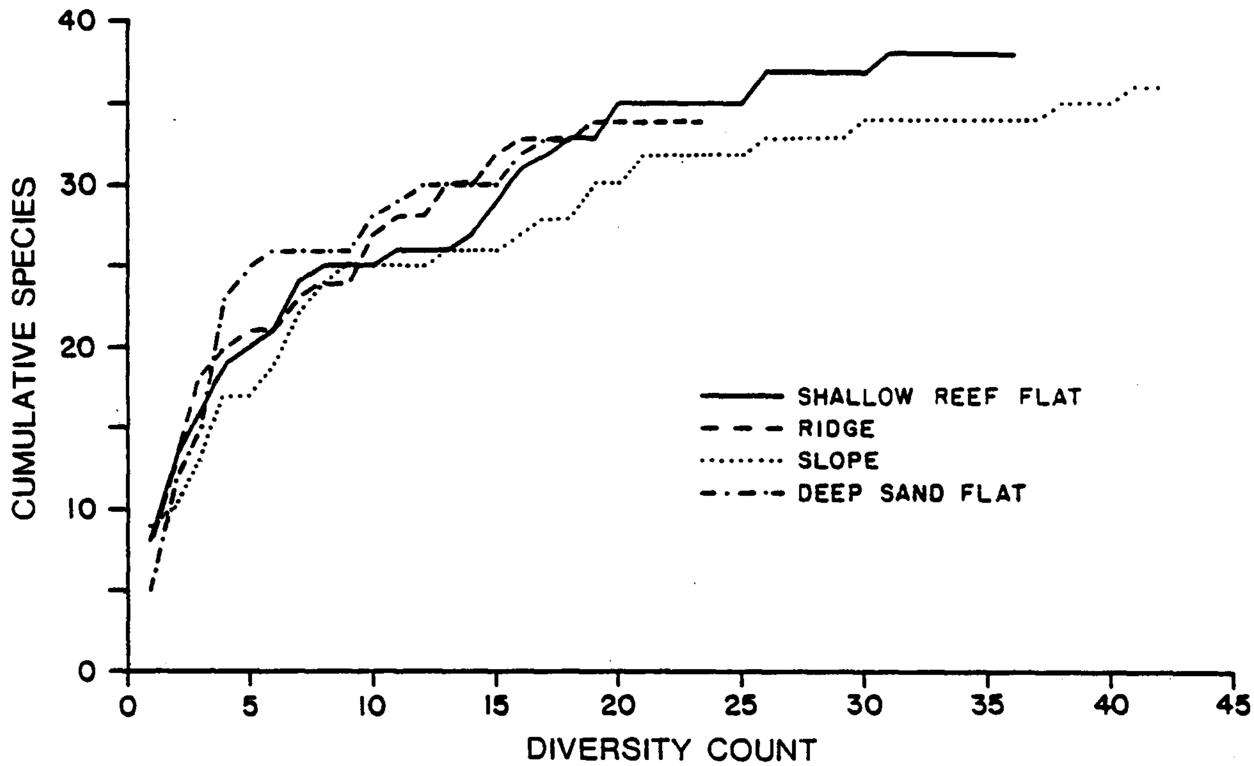


Figure XXI-35. Cumulative species chart for FMG fishes.

		CRUISE PICK-UP				
		OCTOBER	JANUARY	MARCH	JUNE	TOTAL
CRUISE SET:	OCTOBER	10 (16)	10 (103)	-	10 (263)	30
	JANUARY		10 (16)	10 (69)	10 (158)	30
	MARCH				10 (88)	10
	JUNE				10 (16)	10
	TOTAL					80

Numbers in parentheses indicate exposure time in days.

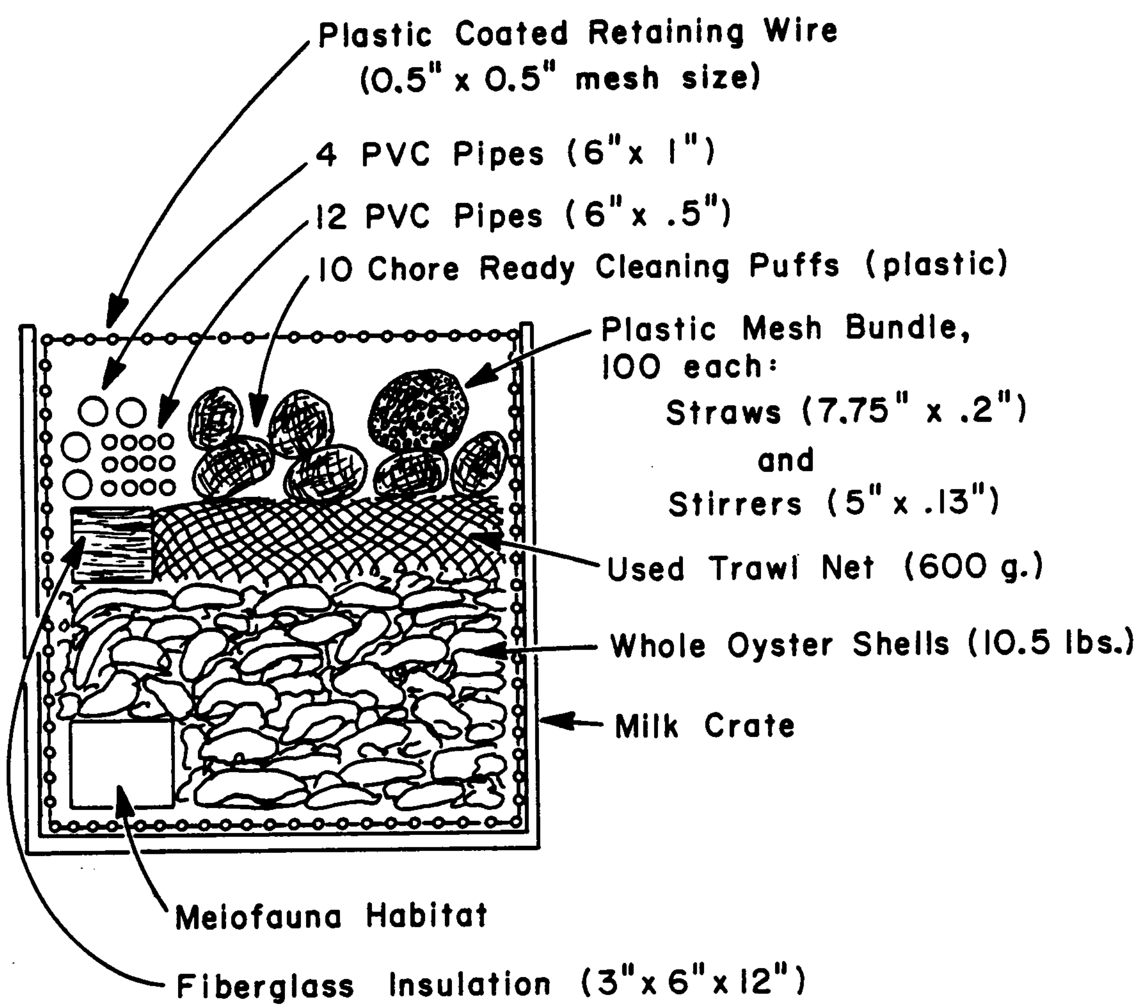


Figure XXI-36. The artificial habitat and deployment schedule.

them, and floating them to the surface. Once on board, the habitats were placed in individual pans, opened, and gross sorted. At this point, unique descriptors were assigned and the contents preserved. Upon return to the laboratory, the habitat contents were rough sorted and archived for further analysis.

Station Mapping

Two discrete station mapping efforts were made. During FMG-02, a series of transects was run using LORAC navigation and the ship's fathometer. Data were plotted on a LORAC grid and then replotted and contoured at Texas A&M.

The second effort involved in situ mapping of 5 x 5 m quadrats using methods described in Grimm (1978) and resulting in displays seen in Hopkins et al. (1977a).

Data Management and Analysis

Procedures for data management and analysis were reported in Chapter X of the third quarterly report (August 1979). Reproductions of these are included as Appendix F.

RESULTS AND DISCUSSION

Algae
S. Earle, T. Hopkins

During the fall and winter cruises, algae collections were less than successful due to time limitations imposed by weather. During the early summer cruise of 1979, an algal specialist was aboard. This enabled us to obtain a representative collection of species and quantitative samples of algal biomass.

Appendix E, Table XXI-6, shows algal species collected at comparative stations during 1979. It also compares this collection to the species list developed for the same time period in 1976. In June-July 1976, we encountered 74 species (45 Rhodophyta; 17 Chlorophyta; 12 Phaeophyta) compared to 79 species in 1979 (42 Rhodophyta; 23 Chlorophyta; 14 Phaeophyta). At first glance, this would appear to be remarkable consistency. However, a careful examination of the species composition between the two years' collections and species composition at each major station (151 vs 247) is rather noteworthy. For example, a Bray-Curtis Similarity Index (Bray and Curtis, 1957) shows only 36.6% similarity between the species lists of 1976 and of 1979.

Further examination (Appendix E, Table XXI-7), clearly shows rather dramatic shifts in similarities between years and stations. For example, comparing stations 151 and 247, to each other and to themselves in 1976 vs 1979, shows an across-the-scale similarity of very nearly 50% (49.5 and 50.0%, respectively). Examination of station 151 vs 247 in 1979 shows a similarity of 75.7%, as opposed to 58.8% in 1976.

Granted that similarity indices are not absolute, the data above clearly show that rather dramatic changes in the algal community have occurred since 1976.

Algal biomass data are displayed in Appendix E, Table XXI-8. The most significant feature of these data is the high values consistently encountered at station 247. A careful review of the station 247 species composition indicates that the major contributors to biomass (10 g or more) are not consistent from replicate to replicate. This fact lends credence to the high diversity/high biomass seen at this station. That is, high biomass is not a function of a single dominant species at this station. Although absolute values are not available, these data point to the same conclusion reached in 1975-76. Station 247 is a uniquely algal rich station, but we do not really know why.

Foraminifera

J. Steinmetz

Back (1972) identified 38 species of benthonic foraminifera associated with fine sediment (2.22 to 3.07 Ø) and 11 species with coarse sediment (-1.47 to 0.83 Ø). He noted a lack of small foraminiferal species and a corresponding lower diversity in coarse sediments, which he suggested may be a result of mechanical sorting by bottom currents of all but the largest foraminifera.

During this study, 89 species of benthonic foraminifera representing 49 genera, were identified at the Florida Middle Ground. Only 34 of these species, representing 20 genera, were observed to be live (by staining) when collected. The remaining 55 were only observed as dead (unstained) specimens. The complete species list, denoting those live and dead, is found in Appendix E, Table XXI-9.

Dominant Species (Foraminifera)

Dominant species, those comprising greater than 5% of the population, were tabulated for each station and each of the sampling cruises (Table XXI-17). Thirty species, representing 33% of all species identified, were dominant at at least one station during at least one sampling cruise. Four species (Amphistegina gibbosa, Planobulina exorna, Quinqueloculina lamarckiana, and Textularia agglutines) were always dominant at each station (100%) during each of four sampling cruises. Five additional species (Hoeglundina elegans, Peneroplis carinatus, Quinqueloculina bosciana, Rosalina sp., and Textularia conica) were dominant at almost all (78% to 93%) of the stations during all of the cruises. The remainder of the species were dominant only occasionally. Amphistegina gibbosa is the predominant foraminifera in all samples, averaging 37.5% of each assemblage. No trends are apparent relating dominance to the collecting season (Figure XXI-37). The relation between the number of dominant species in an assemblage and the collecting season for each station is listed in Table XXI-18 and is shown graphically in Figure XXI-37. The average number of dominant species at all four stations ranged between 13.0 and 13.7 for the sampling period. Station 491 contained the highest average number of dominant species for the sampling period (13.7). The average number of dominant species for each of the four sampling cruises ranged from 12.0 to 16.0. The highest average number of dominant species was recovered in January 1979 (16.0; based on two stations).

Live Species (Foraminifera)

Live (stained) specimens were collected in 85 (47%) of the 180 samples. The largest number of live species was 12. These were collected at station 151 by divers in October 1978. The largest percentage of living individuals was 14.5%; these were collected at station 481 by Shipek grab in November 1978.

The number of live species, total live count, and live percentage of total specimens are listed for each sample in Appendix E, Table XXI-10. The average percent live specimens/sample was calculated for each station, season, and method. Results are listed in Appendix E, Tables XXI-11 and 12, and shown graphically in Figure XXI-38. Station 151 contained the largest average percentage of living specimens/sample (3.9), samples collected in November 1978 contained the largest average percentage of living specimens/sample (4.3), and samples collected by Shipek grab contained the largest average percentage of living specimens/sample (4.9).

Diversity and Evenness (Foraminifera)

Appendix E, Table XXI-13, lists the number of samples, average number of species/sample, diversity, and evenness for each station, season, and method of collection on the Florida Middle Ground. These data were regrouped, summed, and averaged for each station and season (see Figure XXI-39 and Appendix E, Table XXI-14). No trends are apparent in the relation between number of species/sample and sample season. Diversity and evenness increase regularly from November 1978 to June 1979.

These data were also regrouped, summed, and averaged for each station, season, and method of collection. The results are listed in Appendix E, Table XXI-15, and shown graphically in Figures XXI-40 and 41. The number of species/sample diversity, and evenness for stations 247, 481, and 491 tend to be similar; however, they are noticeably less for station 151.

Hard and Soft Corals

C. Lutz

The study of hard and soft coral distribution under this contract was meant to be more qualitative than quantitative; however, quadrats were used for mapping, and a plotless line transect was used for general reconnaissance work.

TABLE XXI-17
DOMINANT FORAMINIFERAL SPECIES

Sampling Cruises
a = 10/78
b = 11/78
c = 01/79
d = 06/79

SPECIES	STATIONS			
	151	247	481	491
Amphistegina gibbosa	abcd	abcd	ab d	ab d
Archaias angulatus				a
Archaias compressus	b	b	b	
Articulina sp.			d	b
Asterigerina carinata	ab	a cd	ab	
Bigenerina irregularis				b
Cancris oblonga	b			
Cibicides rugosa	a		a d	a d
Cibicides sp.		bc	b	
Cribroelphidium poeyanum	a	bc		
Elphidium discoidale	c	c		d
Hoeglundina elegans	abcd	abcd	a d	ab d
Miliolinella circularis	c	bcd	b d	ab d
Miliolinella subrotunda		c		
Neoconorbina terquemi	a cd	cd		d
Peneroplis carinatus	abc	abcd	ab d	ab d
Peneroplis proteus		b	a	
Planorbulina exorna	abcd	abcd	ab d	ab d
Quinqueloculina auberiana	a d	a	ab d	
Quinqueloculina bicosta			b	
Quinqueloculina bosciana	abcd	bcd	ab d	ab d
Quinqueloculina lamarckiana	abcd	abcd	ab d	ab d
Reussella atlantica	c	bc	d	d
Rosalina sp.	abcd	bcd	d	ab d
Siphonina pulchra	c	d		
Spirillina vivipara	c			b
Textularia agglutinens	abcd	abcd	ab d	ab d
Textularia conica	abcd	abc	ab d	ab d
Virgulina sp.	b	d		ab
Weisnerella auriculata	d			

TABLE XXI-18
RELATION BETWEEN SPECIES DOMINANCE AND COLLECTING SEASON
FOR EACH STATION

STATION	SEASON				AVERAGE
	10/78	11/78	01/79	07/79	
151	14	13	15	11	13.3
247	9	15	17	13	13.5
481	12	13	*	14	13.0
491	13	14	*	14	13.7
Average	12.0	13.8	16.0	13.0	

*No sample taken

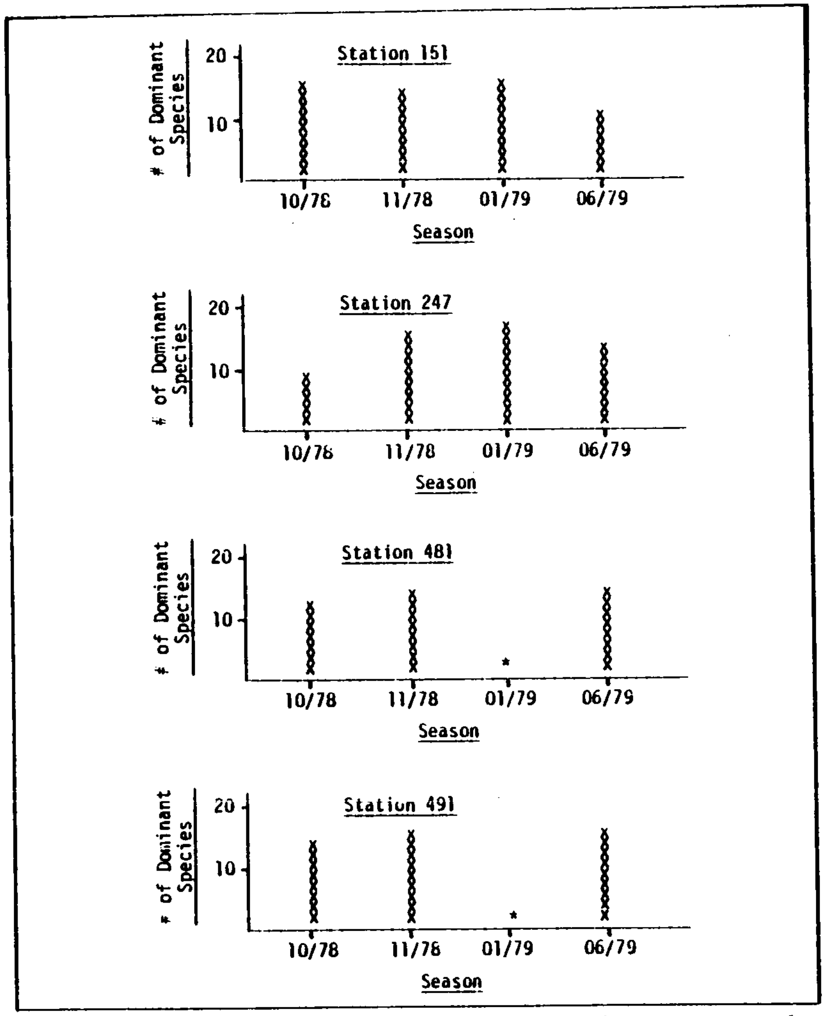


Figure XXI-37. **Relation between species dominance and collecting season for each season. * = no sample taken.**

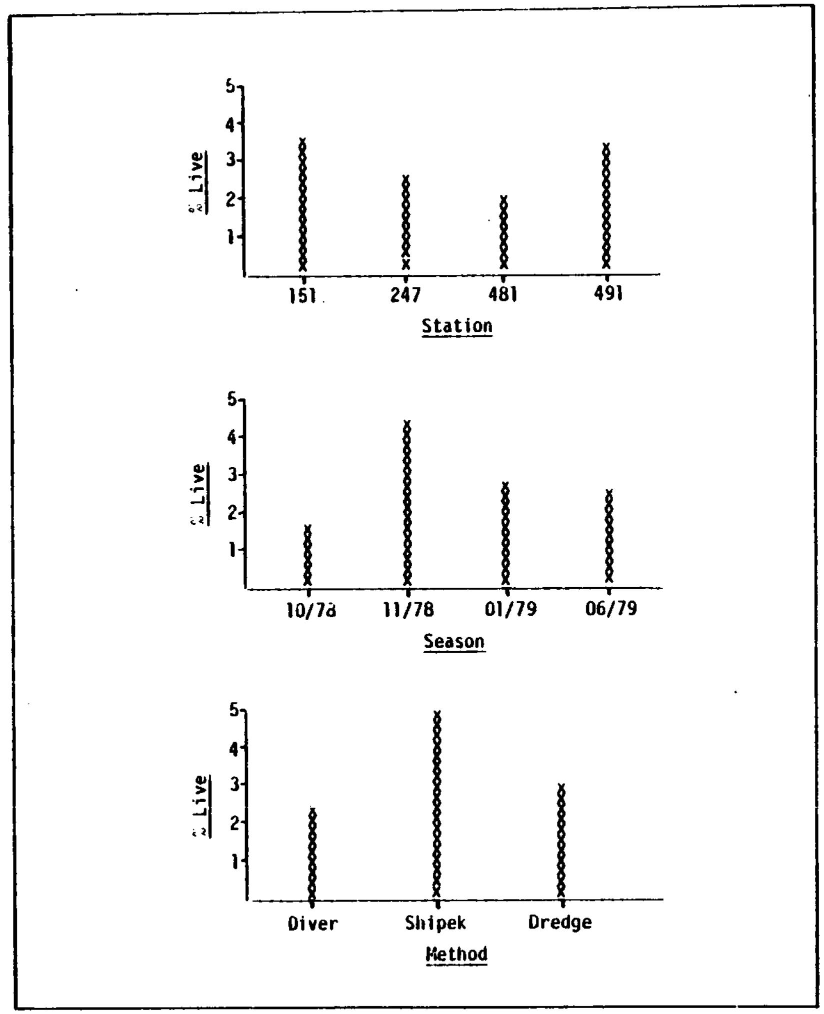


Figure XXI-38. **Average percent live specimens/sample of foraminifera for each station, season, and method on the Florida Middle Ground.**

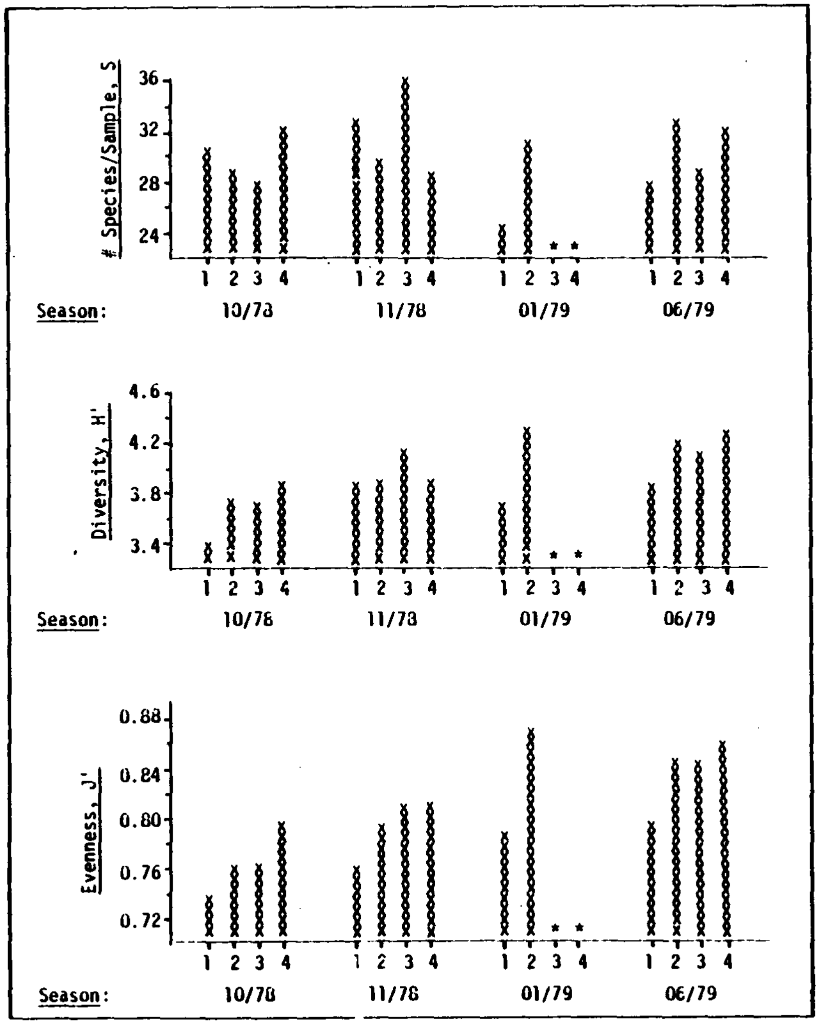


Figure XXI-39. Average number of species/sample (S), diversity (H′), and evenness (J′) grouped by station for each sampling season. 1 = 151, 2 = 247, 3 = 481, 4 = 491; * = no sample taken.

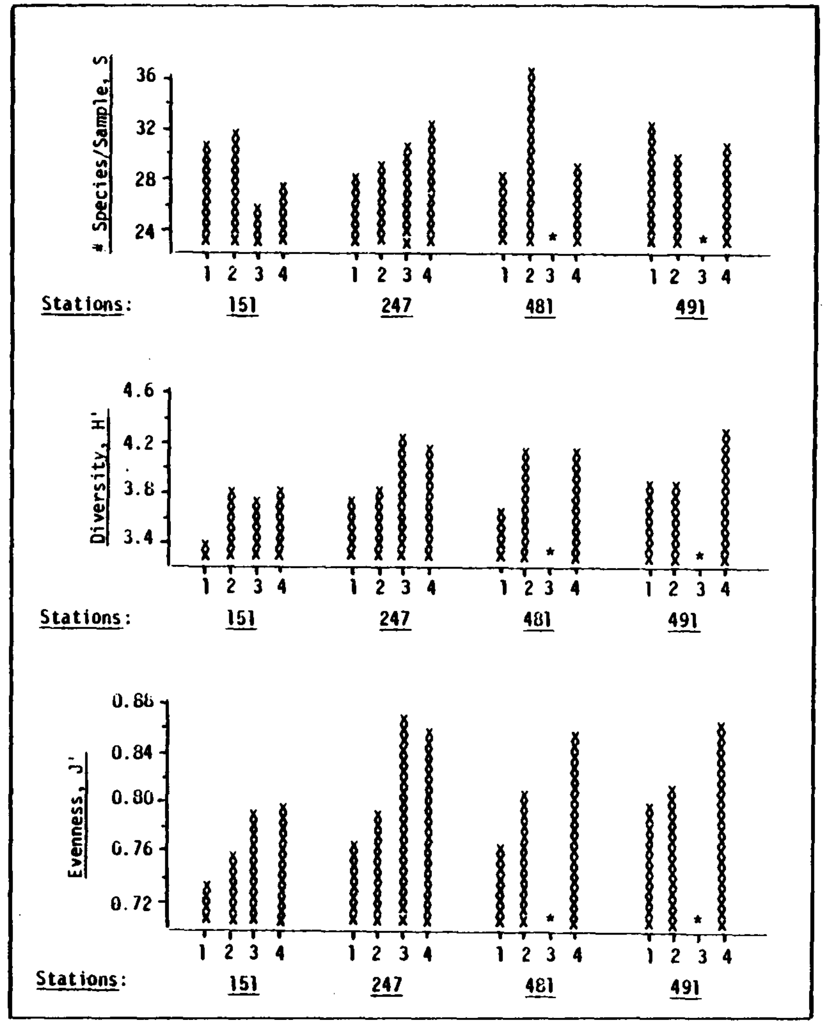


Figure XXI-40. Average number of species/sample (S), diversity (H′), and evenness (J′) of foraminifera grouped by station, season, and method of collection. 1 = 10/78, 2 = 11/78 3 = 01/79, 4 = 06/79; * = no sample taken.

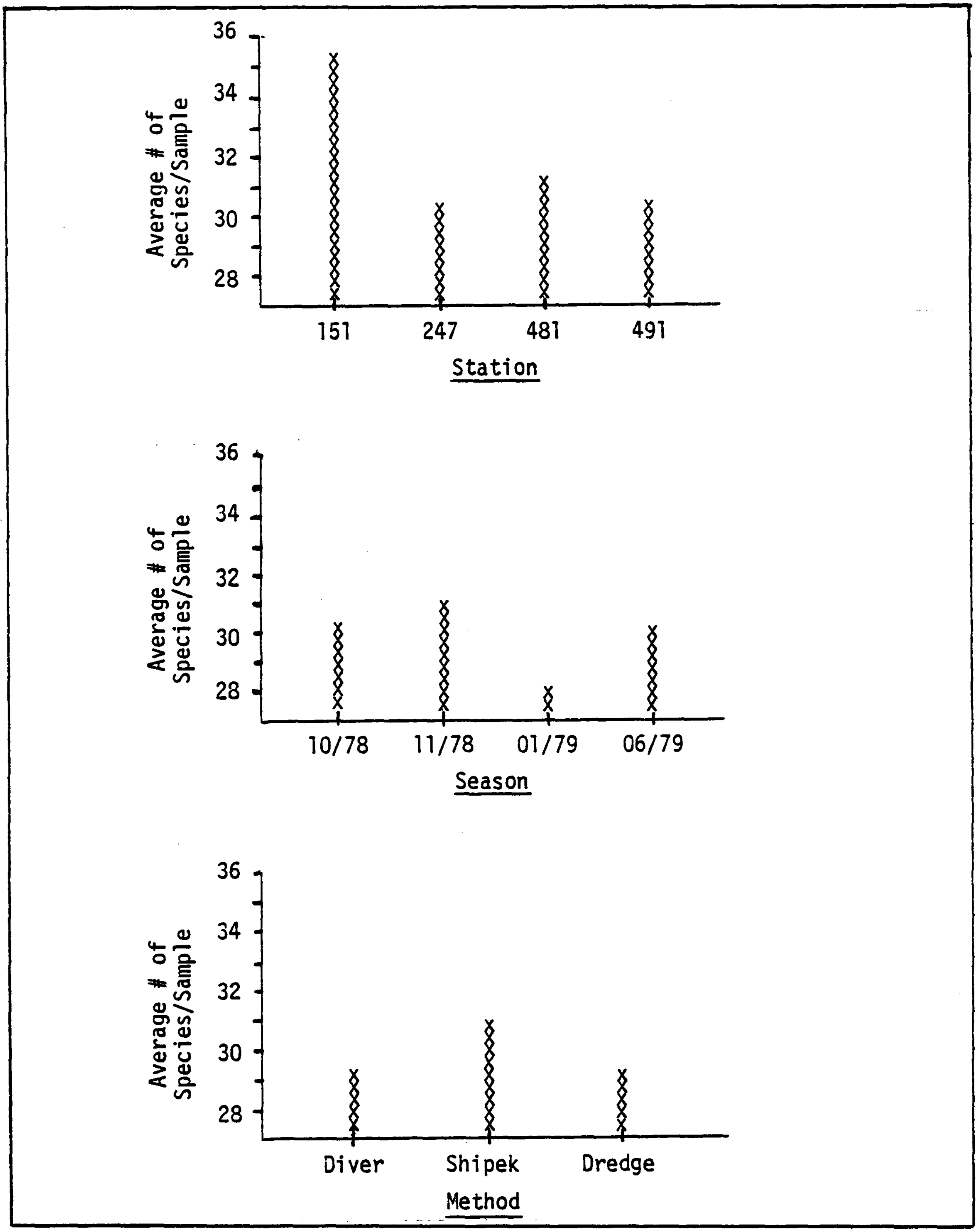


Figure XXI-41. Average number of species/sample, grouped by station, season, and method of collection.

Judged from the standpoint of a trained underwater observer with over twenty years of underwater experience, the Florida Middle Ground that we saw in 1978-1979 was not the lush deep water reef that we saw in the summer of 1976. Color slides and photographs will clearly substantiate the depauperated and emaciated condition of hard corals, milleporines, and soft corals. Although live/dead counts were made, they are generally inconclusive because in many cases involving smaller forms (Agaricia, Manicina, Meandrina and Scolymia) their numbers are so reduced that they are nearly absent. Not uncommonly, we encountered emaciated soft corals and dead Dichocoenia, Millepora, Oculina, and Porites. These conditions were particularly marked in the station Sink Hole and at station 151. Agaricia was noticeably absent, as witnessed by our inability to collect a single sample of Agaricia big enough to house the endemic corallicolous crab, Pseudocryptochirus hypostegus (Shaw and Hopkins, 1977).

Consequently, we conclude that some major perturbation has occurred at the Florida Middle Ground between July 1976 and September 1978, as evidenced by severely damaged and dead hard and soft corals.

Major support for this conclusion comes from Bullock and Smith, (1979), who report that reef biotas in 12-37 m deep water were adversely affected by the exceptionally cold winters of 1977 and 1978. We can postulate that a combination of storm surge and cold water (12-13°C) could have been responsible for the fauna encountered in 1978. A two-level effect would result in any combination of the following: 1) partial burial of low sedentary species of coral, e.g., Scolymia, Manicina, and Meandrina; 2) uprooting and breakage of delicate species, e.g., Agaricia and Millepora, along with many gorgonians; 3) xoozanthelle expulsion (all hermatypes); and 4) tissue necrotis (all hermatypes).

Polychaeta
J. Uebelacker

General Collections and Observations (Syllids)

The annelid class Polychaeta is one of the most important members of the coral reef infaunal biota in terms of abundance, diversity, and reef destruction. The family Syllidae has no involvement in reef destruction but is the predominant polychaete inhabitant of the greatest number of reef habitats, particularly living hosts. On the Florida Middle Ground, both abundance and diversity of syllids well exceed even that of the numerous tube-building sabellids and serpulids on hard substrates such as corals, and in sponges often exceed that of all other polychaete families combined. For this reason, and because of the overwhelming numbers of polychaetes obtained from collected samples, identification of polychaetes to species was restricted to the syllids.

Numbers of samples of the various host categories in which syllids were found are listed in Table XXI-19. These figures represent more than half of all Agelas and Madracis collected, roughly 10% of the

TABLE XXI-19
NUMBERS OF SAMPLES (MAJOR HOST CATEGORIES) IN WHICH
SYLLIDS WERE IDENTIFIED

HOST CATEGORY	FALL	WINTER	SUMMER	TOTAL
Agelas dispar	42	11	20	73
Other Sponges	18	11	24	53
Madracis decactis	29	10	20	59
Other Corals	4	5	12	21
Other Fauna/Algae	6	2	28	36
Artificial Habitats	10	1		11
Non-Living Substrates	42	10	23	75
TOTAL	151	50	127	328

other sponges and artificial habitats, and 100% of the remaining host categories.

A list of all habitats and host species collected, with the number of samples analyzed for syllids, appears in Appendix E, Table XXI-16.

Overall Trends (Syllids)

A total of 60 species in all four subfamilies of syllids has been identified from the Florida Middle Ground collections. A list of these species, arranged by relative overall occurrence, and showing relative abundance in each of the seven major habitat categories, is presented in Table XXI-20. Most of the ten species designated as abundant can also be considered fairly ubiquitous in occurrence within the 57 habitat type/host species sampled. Table XXI-21 illustrates the number and percentage of habitat/hosts in which each of these ubiquitous species occurred. Haplosyllis complex includes the three species designated as H. spongicola morphs A, B, and C, and constitutes the most widely occurring "species." H. spongicola, true to its name, is a notorious sponge-dweller, but also occupies numerous other reef habitats, and its widespread distribution in Florida Middle Ground collections is not surprising. All of the species listed in Table XXI-21 show a greater affinity for living hosts than for non-living substrates.

Habitats (Syllids)

Of the 57 habitat type/host species sampled and analyzed for syllids, the six containing the highest number of syllid species are listed in Table XXI-22. Of the total of 60 syllid species identified from the Florida Middle Ground, Madracis and Agelas harbor 84% and 62%, respectively. Other coral and sponge species also contained a high diversity of syllids, but the availability of Madracis and Agelas in terms of abundance and widespread occurrence at the Florida Middle Ground rendered them ideal species to collect intensively for cryptofaunal analysis. However, it should be kept in mind that results presented here, comparing Agelas and Madracis with other habitats or hosts, probably contain some bias owing to the disproportionately large collections of Agelas and Madracis compared to other habitat types. Although cumulative species curves were not calculated for habitat types, these would be effective in demonstrating whether such bias exists. Problems of bias can be alleviated by lumping the other habitats/hosts into the five major host categories listed in Table XXI-19, i.e., Agelas dispar, other sponges, Madracis decactis, other fauna/algae, and non-living substrates.

Sponges

Sponges in general, and Agelas dispar in particular, were popular, though not primary, habitats for most syllid species encountered in Florida Middle Ground collections. From Table XXI-21, the species group for which Agelas is the primary host (based on frequency of occurrence) includes only Branchiosyllis oculata and the uncommonly occurring Exogone sp. B.

TABLE XXI-20
OCCURRENCE OF SYLLID SPECIES BY HOST TYPE

Notes on Host Types:
Other Sponges includes ~31 spp. of sponges.
Other Corals includes hard corals, soft corals, and Millepora.
Other Faunas includes bryozoans, mollusks, echinoderms, anemones, tunicates, and hydroids.
Habitats includes 10 20-day and 1 3-month habitats.
Non-Living Substrates includes instruments and other human artifacts, rock, rubble, sediment, miscellaneous, dip net, dredge, shipek and sub arm/vac.

+ Present (< 15 of samples)
++ Common (15-50% of samples)
+++ Frequent (> 5% of samples)
P Primary host for given species.

RELATIVE OVERALL OCCURRENCE	SUBFAMILY	SPECIES	HOST TYPE: Agelas Dispar	Other Sponges	Madracis Decactis	Other Corals	Other Fauna	Artificial Habitats	Non-living Substrates
Abundant	Eusyllinae	Eusyllis cf. longicirrata	++	++	++	++	++	+++ P	+
Abundant	Syllinae	Branchiosyllis oculata	+++ P	++	++	++	+	++	+
Abundant	Syllinae	Haplosyllis spongicola (Morph B)	++	+++	+++ P	++	+++	++	++
Abundant	Syllinae	Syllis gracilis	++	+	+++ P	++	++	+++	+
Abundant	Syllinae	Trypanosyllis cf. gemmipara	++	++	+++ P	++	++		+
Abundant	Syllinae	Typosyllis cf. aciculata	+++	++	+++ P	++	++	+++	+
Abundant	Syllinae	Typosyllis armillaris	+++	++	+++ P	++	++	++	+
Abundant	Syllinae	Typosyllis corallicoides	++	+	+++ P	++	++	++	+
Abundant	Syllinae	Typosyllis lutea	+++	++	+++ P	++	++	++	++
Abundant	Syllinae	Typosyllis cf. variegata	+++	++	+++ P	++	++	++	+
Common	Autolytinae	Autolytus dentalius	++	+	++ P	+	+	+	+
Common	Autolytinae	Proceraea sp. A	+	+	++ P	++	+		+
Common	Exogoninae	Brania clavata	++	+	++		+	+++ P	+
Common	Exogoninae	Sphaerosyllis piriferopsis	+		++			++ P	++
Common	Eusyllinae	Eurysyllis tuberculata	+		++ P	+	+		
Common	Eusyllinae	Odontosyllis sp. B	++	+	++ P	++	++	++	+
Common	Eusyllinae	Opisthodonta sp. A	++	+	+++ P	++	+	++	+
Common	Eusyllinae	Pionosyllis weismanni	+	+	+++ P	+		+	+
Common	Eusyllinae	Pionosyllis sp. B	+	+	+++	+	+	+++ P	++
Common	Syllinae	Ehlersia cf. cornuta	+	+	+++ P	+			++
Common	Syllinae	Haplosyllis spongicola (Morph A)	++	+	+++ P	+	+	+	+
Common	Syllinae	Haplosyllis spongicola (Morph C)	+	++	++	++	+	++ P	+
Common	Syllinae	Trypanosyllis coeliaca	+	+	+++ P	+	+	++	+
Common	Syllinae	Typosyllis cf. lutea	+	+	+++ P	+			+
Common	Syllinae	Typosyllis cf. regulata	+	+	+++ P	+			++
Common	Syllinae	Sexual stolons	++	+	++	+	+	++	+
Uncommon	Autolytinae	Autolytus n. prolifer	+	+	++ P	+	+	+	+
Uncommon	Autocytinae	Autolytus sp. B	+	+	+ P		+		
Uncommon	Autolytinae	Sexual stolons	+		+	+	+	+	+ P

TABLE XXI-20 (Continued)

RELATIVE OVERALL OCCURRENCE	SUBFAMILY	SPECIES	HOST TYPE						
			Agelas Dispar	Other Sponges	Madracis Decactis	Other Corals	Other Fauna	Artificial Habitats	Non-living Substrates
Uncommon	Exogoninae	Exogone dispar	+	+	+	+	+	++ P	+
Uncommon	Exogoninae	Exogone lourei	+	+	++			++ P	+
Uncommon	Exogoninae	Exogone sp. B	+ P	+	+				+
Uncommon	Eusyllinae	Pionosyllis n. longocirrata		+	+ P	+		+	+
Uncommon	Eusyllinae	Pionosyllis weisnanni var.		+	++ P				
Uncommon	Eusyllinae	Plakosyllis sp. A						++ P	+
Uncommon	Eusyllinae	Sexual stolons			+ P	+			
Uncommon	Syllinae	Branchiosyllis cf. exilis	+	+	++ P	+	+		+
Uncommon	Syllinae	Opisthosyllis sp. B	+	+	++ P	+	+	++	+
Uncommon	Syllinae	Trypanosyllis coeliaca	+	+	++ P	+	+		
Uncommon	Syllinae	Typosyllis sp. A			+	+	+	++ P	++
Rare	Autolytinae	Autolytus sp. A			+				
Rare	Autolytinae	Autolytus sp. C		+				+	+
Rare	Exogoninae	Brania clavata W.			+ P				+
Rare	Exogoninae	Brania n. limbata							+
Rare	Exogoninae	Exogone cf. heteroseta			+				
Rare	Exogoninae	Exogone cf. molesta			+				
Rare	Exogoninae	Exogone sp. C	+		+ P				
Rare	Exogoninae	Sphaerosyllis erinaceus			+			++ P	+
Rare	Eusyllinae	Amblyosyllis sp. A			+	+	+	+	+
Rare	Eusyllinae	Dioplosyllis octodentata							+
Rare	Eusyllinae	Odontosyllis fulgurans	+		+ P				+
Rare	Eusyllinae	Odontosyllis sp. A	+		+				
Rare	Eusyllinae	Opisthodonta cf. pterochaeta							+
Rare	Eusyllinae	Paraplonosyllis longicirrata						+	+ P
Rare	Eusyllinae	Pionosyllis sp. C							+
Rare	Eusyllinae	Syllides sp. A	+		+ P				+
Rare	Syllinae	Ehlersia ferrugina							+
Rare	Syllinae	Syllis spongiphila			+				
Rare	Syllinae	Trypanosyllis cf. prampramensis		+	+ P		+		
Rare	Syllinae	Trypanosyllis sp. A			+				
Rare	Syllinae	Typosyllis hyalina		+	+ P	+			+
Rare	Syllinae	Typosyllis hyalina	+	+	+			+	+
Rare	Syllinae	Typosyllis lutea				+			+ P

< 20 Abundant
10-20 Common
3-10 Uncommon
< 3 Rare

TABLE XXI-21
OCCURRENCE OF THE MOST UBIQUITOUS SYLLID SPECIES IN THE HABITATS/HOSTS SAMPLED

SYLLID SPECIES	NUMBER OF HABITATS/HOSTS SAMPLED	PERCENT OF TOTAL HABITATS/HOSTS SAMPLED
Haplosyllis complex	46	81
Typosyllis aciculata	36	63
Typosyllis armillaris	36	63
Typosyllis variegata	32	56
Typosyllis lutea	31	54
Branchiosyllis oculata	28	49
Trypanosyllis cf. gemmipara	27	47

TABLE XXI-22
NUMBER OF SYLLID SPECIES FOUND IN THE SIX HABITATS HAVING THE HIGHEST NUMBER OF SYLLID SPECIES

HABITATS	TOTAL	FALL	WINTER	SUMMER	151	247	481	491
Madracis	51	49	27	45	44	38	46	38
Agelas	38	36	21	24	32	29	26	24
Artificial Habitats	31	25	20		31			
Shipek	31	31			15		20	23
Dredge	28	28				21	7	8
Millepora	28	19	4	24	19	4		24

TABLE XXI-23
STATION OCCURRENCE OF MOST UBIQUITOUS SYLLID SPECIES IN PERCENTAGE OF TOTAL HABITATS SAMPLED

SPECIES	STATION PERCENT			
	151	247	481	491
Haplosyllis complex	78	74	87	71
Typosyllis cf. aciculata	70	59	53	39
Typosyllis armillaris	65	62	53	36
Typosyllis cf. variegata	70	44	60	25
Typosyllis lutea	65	50	53	32
Branchiosyllis oculata	43	44	40	18
Trypanosyllis cf. gemmipara	56	41	27	29

Corals

Madracis decactis dwarfs the influence of all other corals in terms of syllid species frequency of occurrence (Table XXI-21). The species group for which Madracis is the primary host includes the following:

Haplosyllis spongicola
Syllis gracilis
Trypanosyllis cf. gemmipara
Typosyllis cf. aciculata
Typosyllis armillaris
Typosyllis corallicoides ?
Typosyllis lutea
Typosyllis cf. variegata
Autolytus dentalius
Proceraea sp. A
Eurysyllis tuberculata
Odontosyllis sp. B
Opisthodonta sp. A
Pionosyllis weismanni
Ehlersia cf. cornuta
Haplosyllis spongicola (Morph A)
Trypanosyllis coeliaca
Typosyllis cf. lutea
Typosyllis cf. regulata
Autolytus n. prolifer
Autolytus sp. B
Pionosyllis m. longocirrata
Pionosyllis weismanni var.
Eusyllinae sexual stolons
Branchiosyllis cf. exilis
Opisthosyllis sp. B
Trypanosyllis coeliaca ?
Brania clavata W.
Exogone sp. C.
Odontosyllis fulgurans
Syllides sp. A
Trypanosyllis cf. prampramensis
Typosyllis hyalina

Artificial Habitats (Syllids)

Although only 11 of the approximately 100 artificial habitats were analyzed for syllids, some trends are evident. After less than 20 days, the habitats had already accumulated fairly diverse syllid assemblages, including 51% of the total syllid species. These assemblages were dominated by small forms, particularly members of the subfamily Exogoninae (adults). The sediment-dwelling exogonins (as well as most of the other species listed below in the artificial habitat species-group) hypothetically entered the habitats from the calcareous sands upon which they rested and occupied pockets of sediment and detritus that had become trapped within the complex structure of the habitats. The artificial habitat species-group is constituted by the following species (from Table XXI-21):

?Eusyllis cf. longicirrata
Brania clavata
Sphaerosyllis piriferopsis
Pionosyllis sp. B
Haplosyllis spongicola (Morph C)
Exogone dispar
Exogone lourei
Plakosyllis sp. A
Typosyllis sp. A
Sphaerosyllis erinaceus

Other Habitats (Syllids)

Miscellaneous faunal and algal collections, and various non-living substrates harbored numerous syllid species, though generally not in any great abundance. Shipek grabs and dredge samples contained, respectively, 51% and 46% of the total syllid species. The non-living substrates tended to attract the same species as the artificial habitats and proved to be the primary habitat for Parapionosyllis longicirrata and Typosyllis ?lutea. The sexual stolons of the subfamily Autolytinae occurred primarily in surface dip-net samples taken at night.

No clear-cut commensal relationships were evident between the syllids and any of their hosts.

Stations (Syllids)

Table XXI-22 presents a breakdown, by station, of the number of syllid species occurring in the six habitats having the highest overall number of syllid species. Very little difference is apparent between stations. The occurrence of the most ubiquitous syllid species in the percentage of total habitats sampled is listed in Table XXI-23. Some minor differences are indicated here. At station 151, Typosyllis cf. variegata has a rather high frequency of occurrence compared to the other stations. Station 481 has a relatively low frequency of occurrence for Trypanosyllis cf. gemmipara. Station 491 exhibits abnormally low frequencies of occurrence for all species except the Haplosyllis complex.

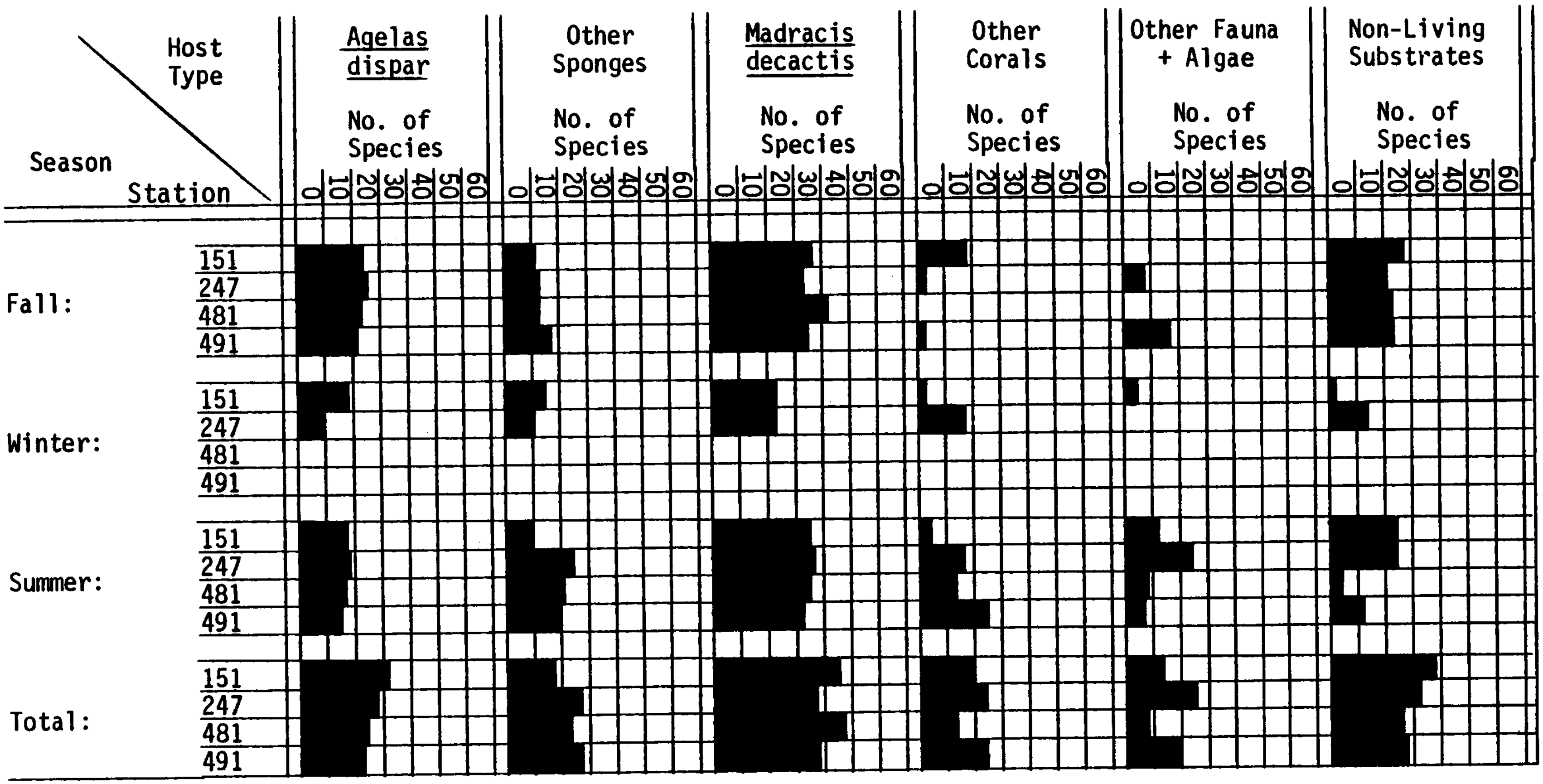
Table XXI-24 is a station and seasonal breakdown of number of syllid species found in each of the six major host categories (artificial habitats were excluded from this and subsequent figures since they were analyzed for only one station and primarily one season). No trends are evident. To test the assumption that no differences exist between stations with respect to number of syllid species per host category, a 2-factor analysis of variance was conducted using the total (non-seasonal) numbers from Table XXI-24. The ANOVA indicated significant differences in numbers of species between host types ($F = 12.282$; $df = 5, 15$; level of significance = 0.00007), but not between stations ($F = 1.312$; $df = 3, 15$; level of significance = 0.30714).

Seasons (Syllids)

Major sampling efforts were conducted during the fall of 1978 (FMG-01 & -02) and during the winter (FMG-03) and summer (FMG-05) of 1979. Seasonal numbers of syllid species in the six habitats having the highest overall number of syllid species are listed in Table XXI-22. Species numbers are generally depressed in these habitats in the winter samples. A somewhat different weak trend is illustrated in Table XXI-25. For the ubiquitous syllid species, the lowest occurrence in percentage of total habitat types sampled is generally during the fall, with the highest occurrences mainly in the summer. However, nowhere is the seasonal spread of percentage points very great.

The seasonal frequency of occurrence of the ten most abundant syllid species (from Table XXI-21) is shown in Table XXI-26. Overall seasonal trends are not particularly evident, although a decrease in percent occurrence during the winter might be suspected. To test for seasonal differences, a 3-factor analysis of variance between host type and season, using the ten syllid species as replication, was conducted with the data in Table XXI-26. Differences in frequencies of

TABLE XXI-24
NUMBER OF SYLLID SPECIES FOUND IN EACH HOST TYPE,
SEPARATED BY STATION AND BY SEASON



Note: Station 247 includes Station 047
Station 481 includes Station 482
Station 491 includes Station 492 and 493

TABLE 25
SEASONAL OCCURRENCE OF MOST UBIQUITOUS SYLLID SPECIES IN PERCENTAGE OF TOTAL HABITATS SAMPLED

SYLLID SPECIES	FALL	WINTER	SUMMER
Haplosyllis complex	73	65	81
Typosyllis cf. aciculata	48	50	57
Typosyllis armillaris	45	50	55
Typosyllis cf. variegata	42	45	50
Typosyllis lutea	27	40	55
Branchiosyllis oculata	30	30	50
Trypanosyllis cf. gemmipara	39	50	40

TABLE XXI-26

SEASONAL FREQUENCY OF OCCURRENCE (OF TOTAL SAMPLES, PERCENT IN WHICH SPECIES OCCURS) OF THE TEN MOST ABUNDANT SYLLID SPECIES, BY HOST TYPE.

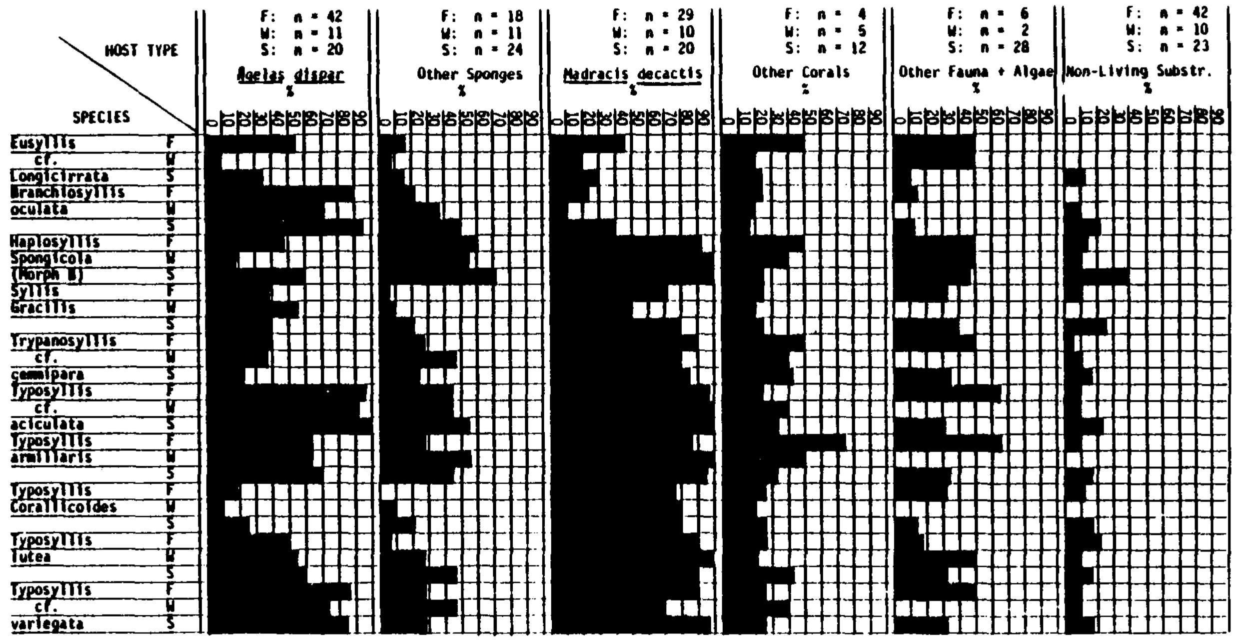
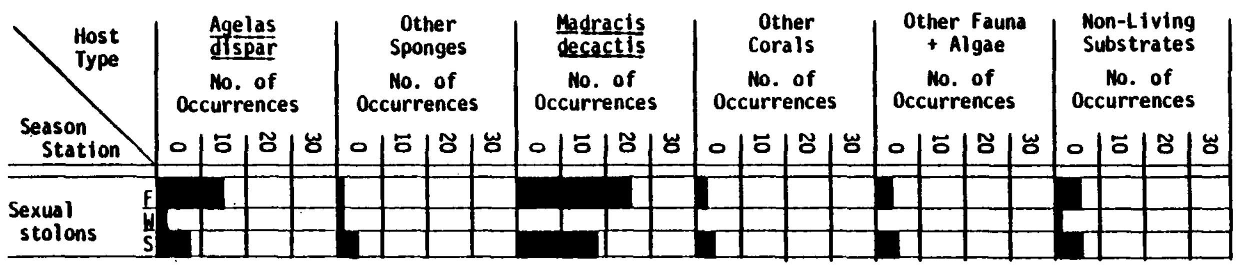


TABLE XXI-27

NUMBER OF SAMPLE OCCURRENCES OF SEXUAL STOLONS BY SEASON IN EACH HOST TYPE.



occurrence were highly significant for host type, as expected, ($F = 36.819$; df = 5, 172; level of significance 0.01), but much less significant for season ($F = 3.163$; df = 2, 172; level of significance = 0.05). The ten syllid species were used as replication in the analysis rather than as a distinct third factor to avoid problems that arise in interpretation of the ANOVA results due to suspected interactions among host type, season, and species.

Table XXI-27 illustrates the seasonal number of sample occurrences of syllid sexual stolons. Epitokes occurred predominantly during the fall and summer, and were virtually absent in winter.

Mollusca
D. Gilbert

General Collections and Observations (Mollusca)

The molluscan collection described here was collected from stations 151, 247, 481, and 491 during fall 1978, winter 1979, and summer 1979. A total of 591 samples was collected during the three seasons, comprising: 1) Madracis and other hard substrates, 2) Agelas and other sponge substrates, and 3) a variety of miscellaneous substrates. From these samples, 16,877 individuals representing 265 taxa were extracted. From these taxa, 222 species were identified: 156 Gastropoda, 1 Cephalopoda, 10 Polyplacophora, and 55 Bivalvia. The nitric acid procedure for corals destroyed the shells of 43 taxa, preventing species identification. As a result of this decalcification process, many molluscs were rendered unidentifiable below the class or ordinal level. For the purposes of computations herein, each taxa has been treated as a discrete and equal unit.

The ten dominant taxa from each station are arranged phylogenetically in Table XXI-28. Taking the ten dominant taxa from each of four stations showed a total of 28 dominant taxa among the four stations. These 28 taxa represent 11% of the 265 taxa identified, yet they make up 80% of the total individuals (13,502). The most abundant taxa, Hiatella arctica (6,826 individuals), makes up 41% of the total individuals and 50% of the individuals in Table XXI-28.

Stations (Mollusca)

Station 151 was sampled 137 times, resulting in the collection of 4,346 individuals from 133 taxa, yielding an average of 32 individuals per sample and 33 individuals per taxa. The ten dominant taxa from hard substrates represent 10% of the taxa present, 84% of the individuals, and 42% of the total individuals. From soft substrates, the ten dominant taxa represent 18% of the taxa, 89% of the individuals, and 38% of the total individuals. Hiatella arctica makes up 25% of the individuals from hard substrates, 56% of the individuals from soft substrates, or 45% of the total individuals.

Station 247 was sampled 217 times, resulting in the collection of 5,417 individuals from 161 taxa, yielding an average of 25 individuals per sample and 34 individuals per taxa. The ten dominant taxa from hard substrates represent 8% of the taxa present, 79% of the

TABLE XXI-28
TEN DOMINANT TAXA FROM FOUR STATIONS, ARRANGED PHYLOGENETICALLY AND SHOWING ZOOGEOGRAPHIC AFFINITY

SPECIES	STATION 151		STATION 247		STATION 481		STATION 491		ZOO-GEOG. CAT.	% OF TOTAL
	SUBSTRATE Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft		
Calliostoma jujubinum						3			Cbe	0.02
Rissoina fischer						4			Cbr	0.03
Turritella exoleata								1	Cbe	0.03
Cerithium litteratum	35	15		11		13		28	Cbr	0.76
Cerithiopsis sp. D						5		9	Cbr	0.10
Triphora nigrocincta						3			Cbe	0.02
Triphora turristhomae		8			24	3	60	10	Cbe	0.78
Crepidula acuelata						4			Cbe	0.03
Anachis layfresnay						4			Coe	0.03
Engina turbinella						5		4	Cbr	0.07
Pisania tineta		13	44	23					Cbe	0.59
Turbonilla protracta					8				Cbe	0.06
Arca imbricata				11			16		Cbe	0.20
Barbatia domingensis	202	21	457	21	129	106	686	12	Cbe	12.1
Arcopsis adamsi							24		Cbe	0.18
Gregariella coralliophaga		8		11	9			12	Cbe	0.29
Musculus lateralis	79	11	198	59	93	18	82	25	Cbe	4.2
Lithophaga bisulcata	61		150		15				Cbe	1.7
Lithophaga aristata	90		135		29		70		Cbe	2.4
Malleous candeanus	60	8	89	60	11	192	16		Cbr	3.2
Chlamys benedicti							33		Cbr	0.24
Diplodonta sp. A				8	18				-	0.2
Diplodonta punctata								4	-	0.03
Chama macesophylla							14		Cbe	0.10
Chione grus	303	137	179	143	55	131	34	43	Cbe	7.6
Gastrochaena hians	373	11	445	11	344	4	514	4	Cbe	12.7
Splengeria rostrata	13		123		46		102		Cbr	2.6
Hiatella arctica	533	1423	978	1142	380	799	648	809	Coe	49.8

Coe = Carolinian Eurythermic
Cbe = Caribbean Eurythermic
Cbr = Caribbean Restricted

individuals, and 52% of the total individuals. From soft substrates, the ten dominant taxa represent 13% of the taxa, 92% of the individuals from soft substrates, and 27% of the total individuals. Hiatella arctica makes up 28% of the individuals from hard substrates, 73% of the individuals from soft substrates, or 40% of the total individuals.

Station 481 was sampled 70 times, resulting in the collection of 2,743 individuals from 127 taxa, yielding an average of 39 individuals per sample and 22 individuals per taxa. The ten dominant taxa from hard substrates represent 8% of the total taxa, 42% of the total individuals, and 77% of the individuals from hard substrates. From soft substrates, the ten dominant taxa represent 8% of the taxa, 92% of the individuals from soft substrates, and 45% of the total individuals. Hiatella arctica makes up 25% of the individuals from hard substrates, 67% of the individuals from soft substrates, or 43% of the total individuals.

Station 491 was sampled 167 times, resulting in 4,371 individuals from 140 taxa, yielding an average of 26 individuals per sample and 31 individuals per taxa. The ten dominant taxa from hard substrates represent 7% of the total taxa, 77% of the individuals from hard substrate, and 55% of the total individuals. From soft substrates, the ten dominant taxa represent 7% of the total taxa, 89% of the individuals from soft substrates, and 22% of the total individuals. Hiatella arctica makes up 27% of the individuals from hard substrates, 74% of those from soft substrates, and 33% of the total individuals.

Seasons (Mollusca)

Since station 247 had the largest number of samples, taxa, and individuals, it was selected for seasonal analysis of the molluscan fauna. The hard coral Madracis had the largest mollusc population of all the other substrates examined. For this reason, 36 Madracis samples, representing three seasons in 1978-1979, are analyzed in Table XXI-29.

Because both volume and weight are measurements of the amount of substrate occupied, their average values ($\overline{X}_v$) and ($\overline{X}_w$), are listed for each season, along with comparative percentages. As can be seen from Table XXI-29, fall samples have almost two times the volume and ten times the weight of those taken during winter or summer. This extra substrate could be more than sufficient to account for the fall having the highest percent of individuals and taxa. From Table XXI-29 we can also see that samples from winter and summer 1979 have approximately equal weights and volumes. The remaining data suggest that: 1) in winter the number of taxa is reduced and the number of individuals is greater than during the summer; 2) in summer the number of taxa is greater and the number of individuals is fewer.

A Bray-Curtis examination of the species collected during the summer and winter demonstrates a 56% similarity. Distributional data are available for only 32 of the 39 species not collected during both summer or winter. Of these 32 species, 50% are Caribbean Restricted, 44% are Caribbean Eurythermic, and 6% are Carolinian Eurythermic (94%

TABLE XXI-29
SEASONAL RELATIONS OF SAMPLING THE MOLLUSCAN FAUNA
AT STATION 247

SEASON	NUMBER OF SAMPLES	$^{*}\bar{X}_w$ (grams)	$^{**}\bar{X}_v$ (ml)	PER-CENT $\bar{X}_w$	PER-CENT $\bar{X}_v$	PER-CENT IND.	PER-CENT TAXA
Fall	12	4139	1138	46.9	83.5	58	40
Winter	11	358	668	27.5	5.2	24	26
Summer	13	462	621	25.6	9.3	18	34

$^{*}\bar{X}_w$ = average weight
$^{**}\bar{X}_v$ = average volume

Caribbean affinity). Of these 32 species, 72% were found during the summer only; this fauna had 91% Caribbean affinity. The 28% which were collected during the winter had 89% Caribbean affinity.

The data available on seasonality suggest three conclusions: 1) the greatest change is during the summer, 2) the additional taxa are of a more Caribbean nature during summer than winter, and 3) the increase in number is accounted for by gastropod taxa and individuals. During the winter, the basic composition of the fauna remains the same, with the increase in the numbers of individuals per taxa being almost entirely a result of an increase in the number of individuals of those taxa which are found there throughout the year, mainly bivalves of a Caribbean Eurythermic nature.

Zoogeographic Considerations (Mollusca)

The 28 taxa in Table XXI-28 (above) represent 11% of the taxa collected and 80% of the total number of molluscs collected. Of these values, gastropods are 43% of the taxa and 2.5% of the individuals, and bivalves are 57% of the taxa and 97.3% of the individuals. (*Hiatella arctica*, a bivalve, makes up 49.8% of the individuals.) Distributional data are available for only 27 of the 28 dominant taxa. Of the 27 dominant taxa, 93% are Caribbean fauna (26% Caribbean Restricted + 67% Caribbean Eurythermic), and the Carolinian Eurythermic taxa are only 7% of the dominant taxa. With respect to percent of individuals, 7% are Caribbean Restricted, 43% are Caribbean Eurythermic, and 50% are Carolinian Eurythermic (*Hiatella arctica* = 49.8%).

When we remove the cosmopolitan species *Hiatella arctica*, which heavily influences the population data, the molluscan fauna becomes 27% Caribbean Restricted and 69% Caribbean Eurythermic, for a total of 96% of the fauna having Caribbean affinity and only 4% Carolinian Eurythermic.

Crustacea

Isopoda
(A. Hooker)

General Collections and Observations (Isopoda)

At least 21 species of isopods were collected from naturally occurring deep-reef habitats in the Florida Middle Ground. All six marine suborders (Gnathioidea, Authuroidea, Flabellifera, Valvifera, Aselloidea, and Bopyroidea) are represented, with a total of 12 families present. It is not surprising to find such a large number of isopods in a region characterized by corals and sponges, but very little work has been presented to date on the isopodan fauna from deep-reef habitats in the Gulf of Mexico. Other Western Atlantic studies revealed 30 species in the continental shelf region of Georgia and 47 species in the waters surrounding Puerto Rico.

The species collected from the Florida Middle Ground further support the mounting evidence that this region is influenced by both tropical waters from the Caribbean-derived Loop Current and more temperate waters, particularly in the winter months. Several tropical species were previously reported from Puerto Rico, and several temperate species are known to occur in waters off the Georgia coast. Along with these previously described species from two apparently distinct zoogeographic regions, there are at least seven new species, two new genera, and possibly a new family, all of which may be endemic only to the Florida Shelf. More time is needed to properly classify these species, and additional sampling is suggested to ascertain their distributional range. The fact that 33% of the species collected are not yet described further demonstrates the need for greater efforts in collecting and classifying isopods as well as other microcrustaceans.

Hosts and Associates (Isopoda)

Appendix E Tables XXI-17 through 30 present a breakdown of the total number of each species collected from their hosts, tabulated by station and cruise. For example, Appendix E Table XXI-21 is station 15 1's isopodan fauna for the first cruise (summer 78). The bar graphs in Figures XXI-42 and 43 depict the percent composition by various species in the two target cryptofauna hosts, *Agelas dispar* and *Madracis decatis*, for each cruise and station.

The sponge *Agelas* hosts fewer species than the coral *Madracis* (see Appendix E, Tables XXI-17 through 30). *Agelas* hosts at maximum seven species, but usually only five species were found, whereas *Madracis* was found to "support" as many as twelve species, with an average of eight species. Besides hosting fewer species, *Agelas* nearly always had the same numerically dominant species: *Carpias bermudensis* (see Figure XXI-42). It was not uncommon to find two-thirds of the total individuals present to be *C. bermudensis*. *Alcirona krebsii* and *Jaeropsis* sp. A were the major subordinates in *Agelas*. *Madracis*, on the other hand, seems to have no single, clear-cut dominant species. *Stenetrium occidentale* was often the most abundant, but *A. krebsii* and *C. bermudensis* were also dominant at particular stations and sampling periods (see Figure XXI-43).

Besides the aforementioned species, several other isopods were collected from the Florida Middle Ground. *Cirolana mayana* and a large number of *Eurydice littoralis* were collected in nocturnal dip-net efforts at station 15 1 and were also evident at the other stations. Shipek and submersible-obtained samples from the second cruise (fall 78) contained at least four species of Anthuroids, one Valviferan, and one Microcerberid not found in the other samples. All six of these species are probably new to science. From a sample of artificial habitats which were picked, Isopods* were represented by several species which are new to science. In order to fully evaluate the composition of the habitats, however, more time is required to determine the

*Not presented on species-host tables.

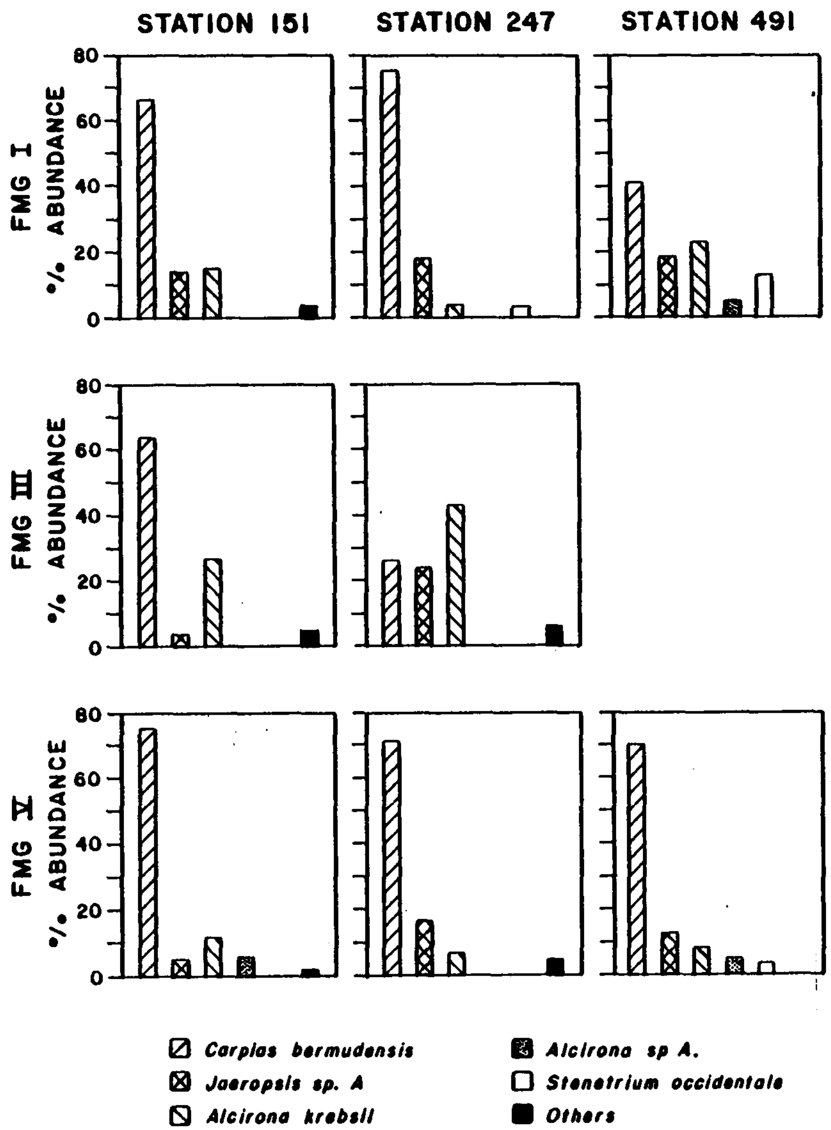


Figure XXI-42. Seasonal distribution of isopods using *Agelas* as host.

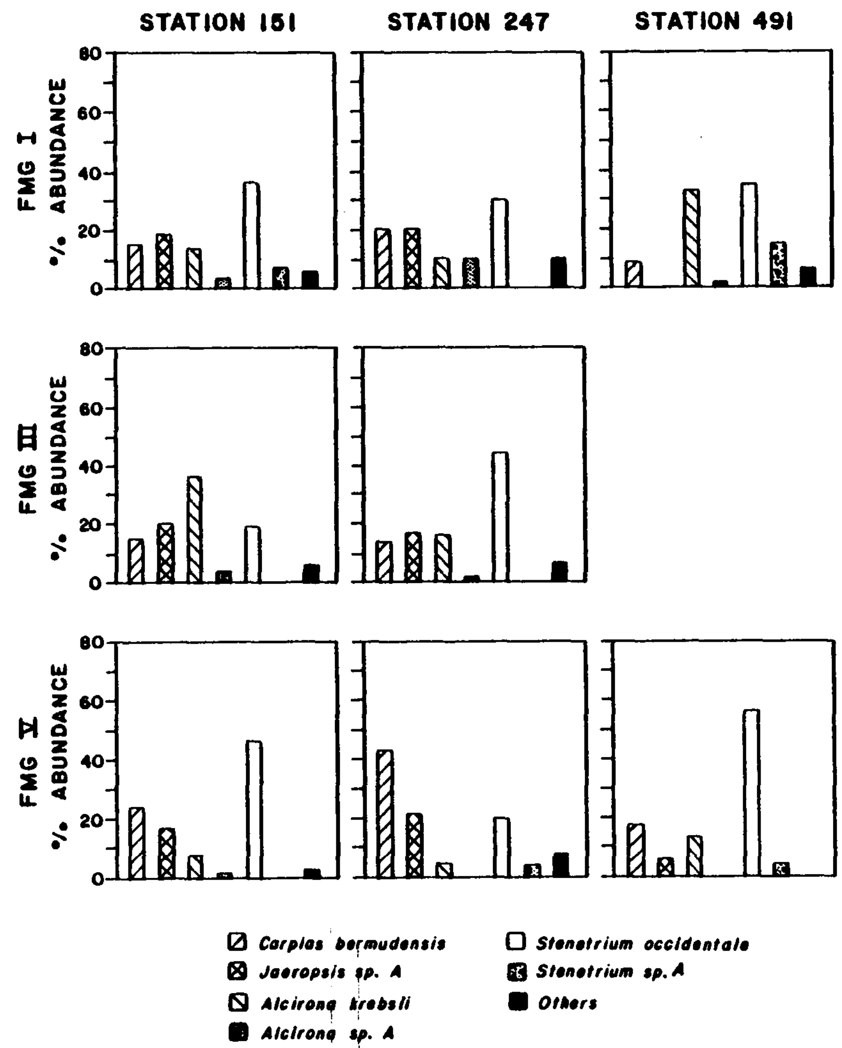


Figure XXI-43. Seasonal distribution of isopods using *Madracis* as host.

contents of all the habitats rather than a few. As for seasonal differences, conclusive statements are difficult. Appendix E Tables XXI-31, 32, and 33 represent the sum total of Agelas and Madracis isopods at all the stations for three cruises (FMG-01, -03, and -05, respectively). Figure XXI-44 shows percentages of the various species within Agelas and Madracis over time. Other than supporting previously mentioned hypotheses and statements, little concrete information can be drawn from any seasonal discrepancies, and any attempt to do so would be conjectural.

It would also be conjectural to draw much concrete information for any gross station differences. Appendix E Tables XXI-34, 35, and 36 summarize the total number of each species of isopod collected throughout the entire course of sampling from Agelas and Madracis at stations 151, 247 and 491, respectively. The bar graphs in Figure XXI-45 represent the present species composition at each station for the entire year's sampling of Agelas and Madracis. There are some differences between the stations. For example, C. bermudensis is relatively low at station 491, while S. occidentale is relatively abundant when compared to stations 151 and 247. However, any statements would be tenuous until an in-depth computer-assisted analysis can be performed.

As exemplified by our different sampling methods, three distinct spatial habitats were encountered in the Florida Middle Ground.

1. Planktonic samples were low in overall diversity but often high in concentrations, as many as 748 E. Littoralis and 28 C. mayana in a single dipnet sweep.

2. Rubble samples collected during FMG-02 contained mainly Anthuroids although several other species were present (see Appendix E, Tables XXI-26 through 28).

3. We observed a unique (although diverse) species assemblage linked to the corals and sponges of the reef, generally dominated by four species but containing several rarer species.

Amphipoda
(D. Adkison)

General Collections and Observations (Amphipoda)

Six specimens of Ingalfiellida were collected on cruise FMG-02. No specimens were taken on other cruises. The Ingalfiellida are infaunal amphipods and would not normally be collected by diving methodology. (FMG-02 employed a bucket dredge and a Shipek grab.)

The family Hyperiidae contains planktonic amphipods or species that are commensal with planktonic organisms. Most hyperiiod specimens were collected by night light. A few specimens were collected in the sponge and coral samples; they are considered as "contaminants," herein, and as such are not used in calculations.

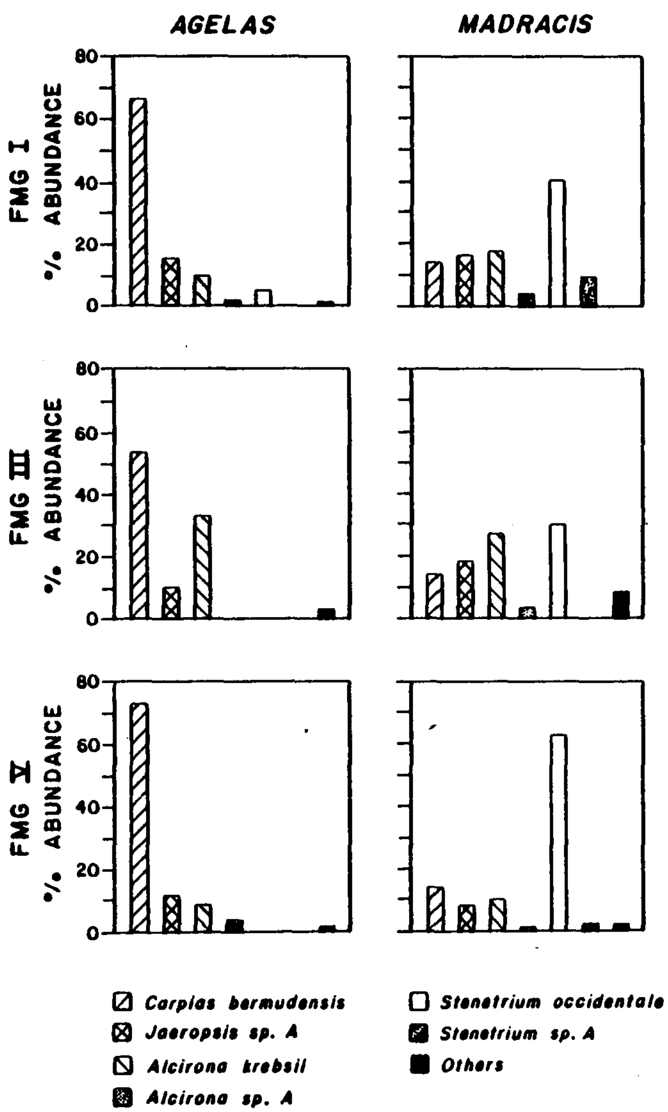


Figure XXI-44. Seasonal comparison of isopods from *Agelas* and *Madracis*.

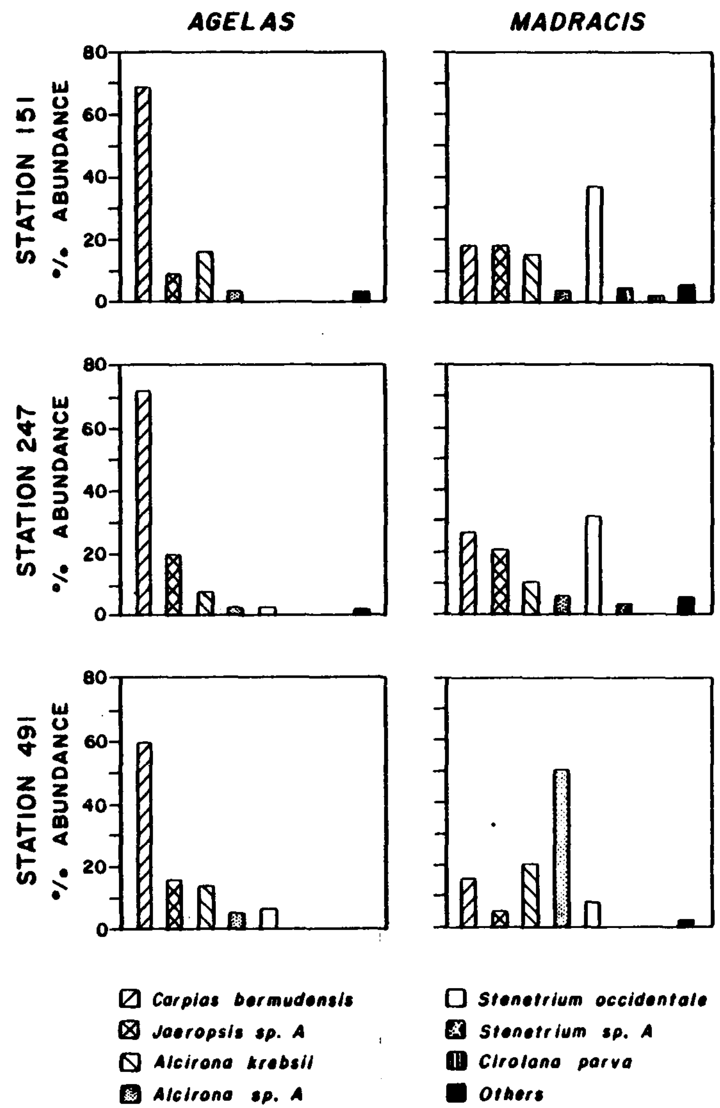


Figure XXI-45. Station comparison of isopods from *Agelas* and *Madracis*.

Because the Gammaridea make up the bulk of the taxa, the individuals collected are considered below under the various host types.

Hosts and Associates (Amphipoda)

Five categories of amphipodan hosts were recognized during this study: Madracis, Agelas, other sponges, Spondylus, and man-made objects.

Madracis. Appendix E Tables XXI-37 through 40 and Figures XXI-46-47, 49-50, and 52-54 deal with miscellaneous crustaceans which used Madracis as host. No station or seasonal differences are discernible from the data. The variation within samples with respect to presence and absence of a taxon and the number of individuals collected obscure any trends that may be present.

Examination of the data (Appendix E, Tables XXI-37 through 40) shows that the number of genera present varied from 15 to 23. Except for one extremely large Madracis sample (volume = 27,214 ml), the maximum number of genera in any one samples was 14. The three most common genera in both occurrence and number of individuals are Leucothoe (an ubiquitous commensal), Lijeborgia (commensal), and Elasmopus (cryptofaunal). The genus Lembos and the two tanaid families are the next three most common groups. After these taxa, the other genera occurred in less than half of the samples and generally were not collected in all seasons at all the stations.

Agelas. Appendix E Tables XXI-41 through 44, and Figures XXI-48 and 50 display host relationships of the sponge Agelas. In examining these data, a weak case for commensal-to-volume ratio can be made. The ratio is lowest in the fall and shows a slight increase from winter through summer. The commensal genera used were Colomastix, Leucothoe, and Leucothoides. Leucothoe is the most common animal, followed by Lijeborgia and Elasmopus. Diversity is lower on the Agelas sample than in Madracis, with only 9 and 15 genera, respectively, collected at a station per cruise. The per sample number of genera present ranged between 1 and 10. The apparent reduction in diversity is most likely due to the monotypic nature of the Agelas samples.

Other Sponges. Other sponge samples were dominated by the commensal Leucothoe and Colomastix. The ratio of individuals/volume was not computed.

Spondylus. An insufficient number of consistently "fouled" Spondylus was collected. The commensal/cryptofaunal community associated with Spondylus seems to vary with the major "fouling" component. The three most common components are: 1) algae, 2) an encrusting red sponge (?Microciona), and 3) Bryzoans/Hydroids.

Man-Made Objects. Erichthonius was the dominant organism on man-made objects (particularly on objects not resting on the bottom; e.g., the instrument array). The tubes of Erichthonius often formed a nearly complete mat on the instruments. In subsequent laboratory

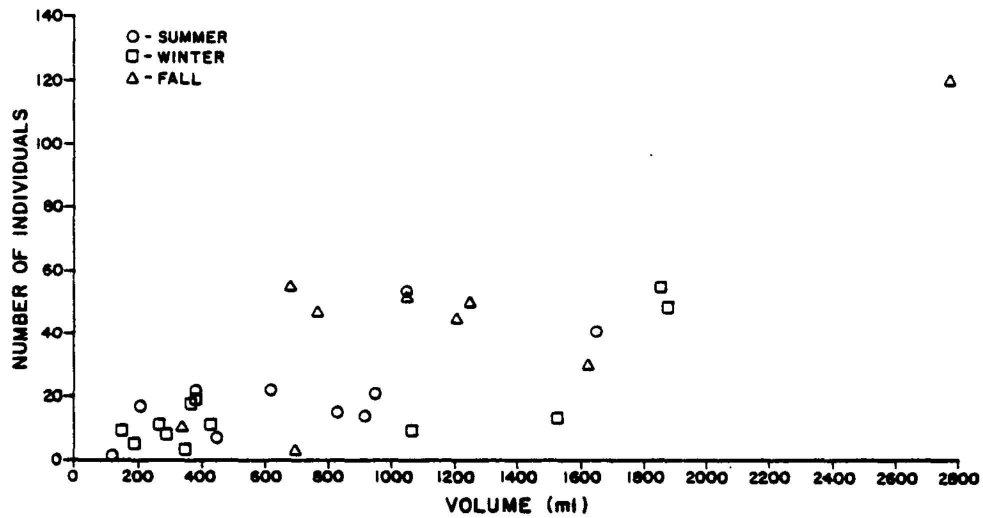


Figure XXI-46. Seasonal plot of number of individuals of miscellaneous Crustacea vs. volume of *Madracis* at station 151.

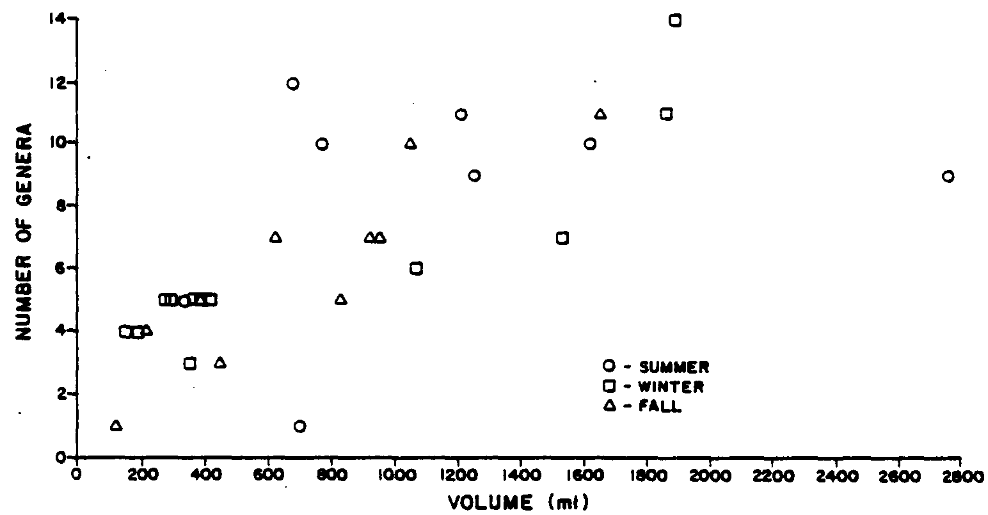


Figure XXI-47. Cumulative station/ season plot of number of genera of miscellaneous Crustacea vs. volume of *Madracis* at station 151.

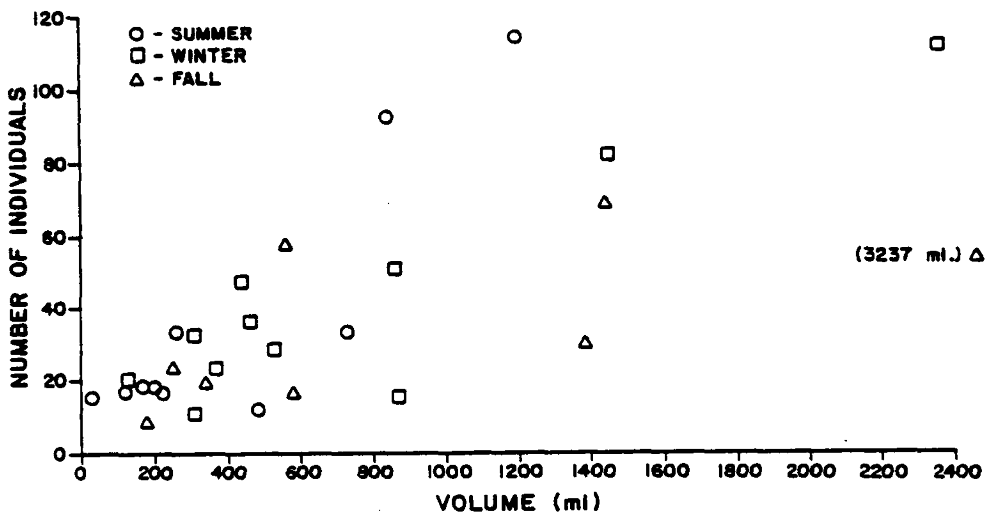


Figure XXI-48. Seasonal plot of number of individuals of miscellaneous Crustacea vs. volume of *Agelas* at station 151.

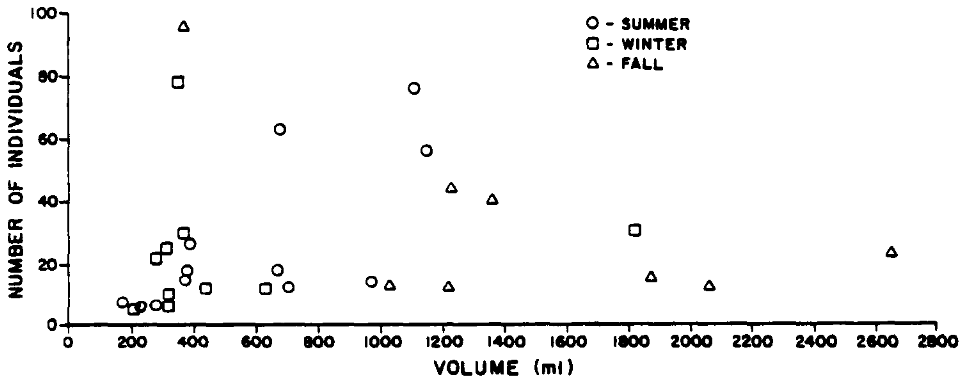


Figure XXI-49. Seasonal plot of number of individuals of miscellaneous Crustacea vs. volume of *Madracis* at station 247.

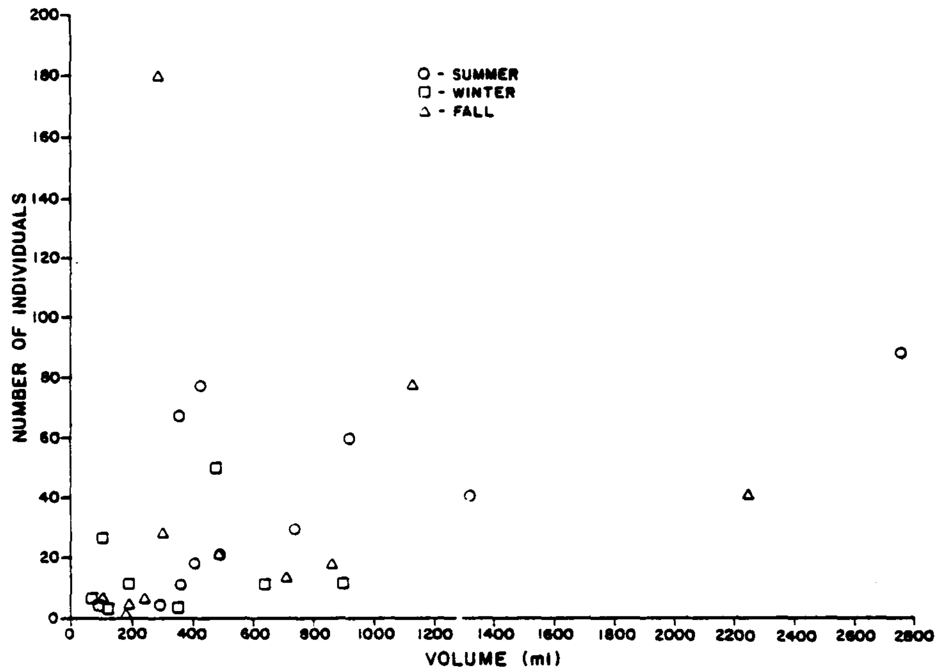


Figure XXI-50. Seasonal plot of number of individuals of miscellaneous Crustacea vs. volume of *Agelas* at station 247.

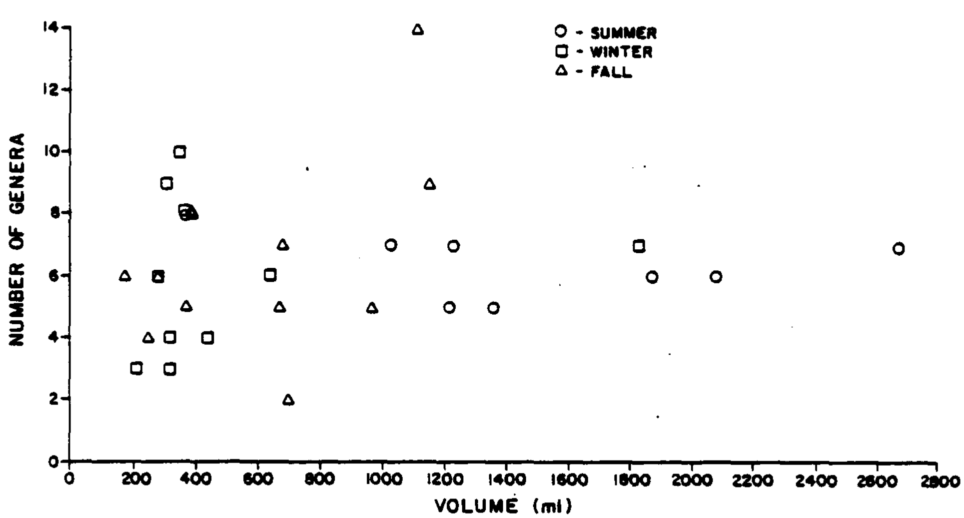


Figure XXI-51. Cumulative station/season plot of number of genera of miscellaneous Crustacea vs. volume of *Madracis* at station 247.

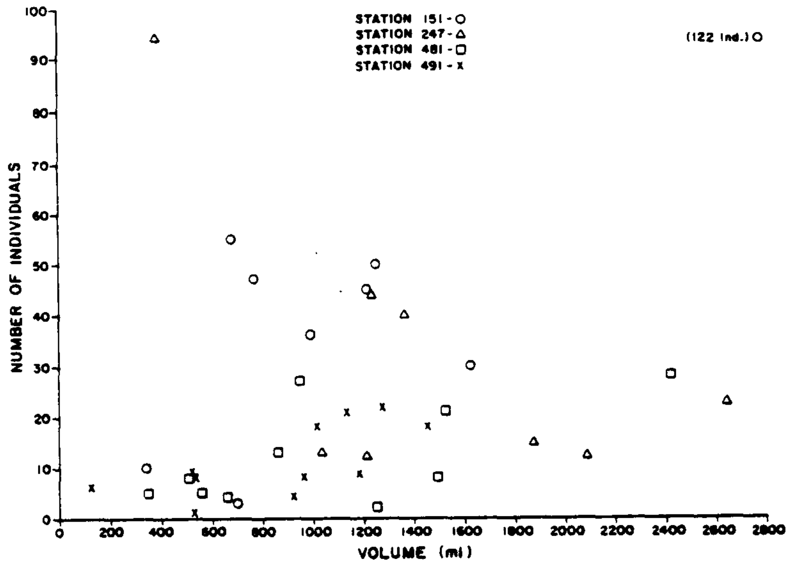


Figure XXI-52. Station plot of number of individuals of miscellaneous Crustacea vs. volume of *Madracis* from FMG-01.

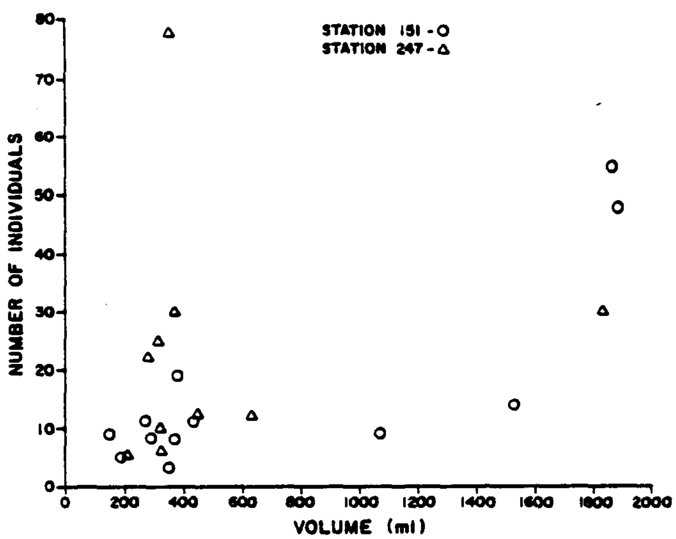


Figure XXI-53. Station plot of number of individuals of miscellaneous Crustacea vs. volume of *Madracis* from FMG-03.

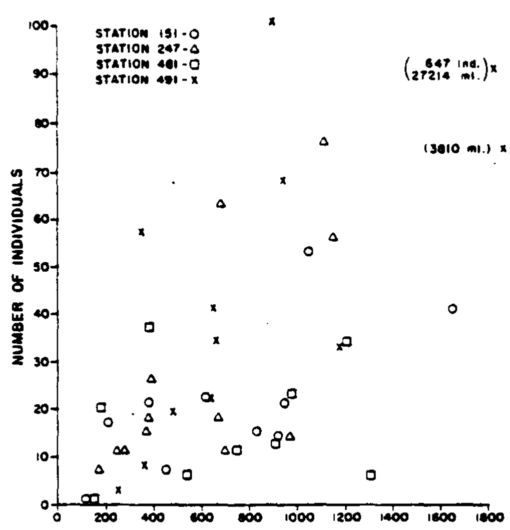


Figure XXI-54. Station plot of number of individuals of miscellaneous Crustacea vs. volume of *Madracis* from FMG-05.

observations, galatheid crabs (Galathea rostrata) were seen to prey heavily on Erichthonius, rapidly eliminating them from the aquaria. Xanthid crabs and shrimps rarely preyed on the amphipods. From this slim sense of circumstances, we believe that the dense mats of Erichthonius develop in the absence of predators. As the "fouling community" develops, hiding places for predators increase. Consequently, Erichthonius will then be reduced in numbers, and be found only rarely.

Caridea
(M. Dardeau)

General Collections and Observations (Caridea)

An astonishing diversity of caridean shrimps inhabit the deep-reef ecosystem of the Florida Middle Ground. Observations of the tropical nature of the fauna were first presented by Hopkins et al. (1977a), who reported no less than eight species for the first time from the northern Gulf of Mexico. Two additional species were recorded from the Florida Middle Ground by Dardeau et al. (1980) as both bathymetric and northern range extensions. The following observations confirm the previous suggestions of an unrecognized tropical shrimp fauna in suitable habitats in the deeper water (> 100 ft) of the continental shelf off Florida.

Fifty-two species of carideans, including representatives of seven families, have been identified (Appendix E, Table XXI-45). Seven additional species (Leptochela carinata, Gnathophyllum modestum, Periclimenaeus ascidiarum, P. wilsoni, Alpheus armatus, Trachycaris restrictus and Processa bermudensis) taken during prior studies (Dardeau et al., 1980; Hopkins et al., 1977a; author's collections) bring the number of carideans known from the Florida Middle Ground to 59 species representing eight families. By way of comparison, the largest number of carideans known from a single locality in the Western Atlantic was previously 48 species, from Antigua Island (Chace, 1972). Investigation of the West Flower Garden Bank, a similar deep-reef environment in the western Gulf, revealed only 27 species of carideans (Pequegnat and Ray, 1974). The transitional nature of the fauna is partially responsible for the unusually high number of species taken from the Florida Middle Ground; faunas from at least two zoogeographic provinces are present. Two physical phenomena contribute to the proliferation of tropical species in this temperate region. The primary reason is the tropical origin of the current system. The maximum northward intrusion of the Loop Current into the northeastern Gulf is during the spring and summer (Maul, 1974; Williams et al., 1977) and coincides with peak reproductive activity in caridean shrimps. A second reason is that the short period of low water temperatures and the much longer period of high temperatures, a circumstance augmented by the depth of the reef biotope, encourages the survival of tropical recruits and the establishment of breeding populations where a suitable habitat exists. Other species probably occur seasonally and depend on additional recruitment each spring.

The multitude of species taken in the course of this study results principally, however, from the exhaustive examination of a large number of distinct microhabitats. Many carideans are highly specific, obligate commensals, and most others are restricted to a relatively narrow range of physical and biological parameters. A total of 46 identified habitats were examined for the seasonal occurrence of caridean shrimps (Appendix E, Table XXI-45). Most of the habitats are biological components of the reef community, such as sponges, hard corals, and soft corals. Specific associates of each are discussed below.

Hosts and Associates (Caridea)

Four categories of caridean hosts and associates have been identified: sponges, hard corals, artificial habitats, and other habitats.

Sponges. Appendix E Tables XXI-46 through 49 summarize the numerical abundance of the caridean associates of 18 sponges. The total of 25 caridean species collected from sponge hosts can be divided into three groups based on their host specificity. Group I consists of casual, even accidental, associates such as *Leptochela papulata*, *Periclimenaeus schmitti*, *Periclimenes americanus*, *Alpheopsis labis* and *Alpheus floridanus*. These species are free-living but prefer a cryptic environment and are only incidentally associated with sponges. Their association is usually limited to the outer surface of the sponge, and they probably only enter the sponge temporarily, if at all. Most occur only in limited numbers and do not usually interact with the intra-sponge community.

The remaining two groups are, to differing degrees, more dependent on the sponge host. Since so little is known of the life histories and trophic relationships of these species, the extent of the dependence can only be inferred from the community structure in the sponges examined and by the degree to which a shrimp is associated with a single host.

Group II contains facultative commensals which frequently occur within sponges but are not limited to them. These species, mostly members of the genus *Synalpheus*, can form complex communities of as many as six species. Although they occur in other habitats, they are consistently present in fixed ratios in their host sponges (i.e. *Synalpheus pandionis*, *S. bousfieldi*, *S. brooksi*, *S. townsendi* and *Thor manningi* in *Agelas dispar*; *Periclimenes iridescens* in *Callyspongia fallax* and *Ircinia fasciculata*; and *Synalpheus brooksi*, *S. longicarpus* and *S. pectiniger* in *Spheciospongia vespara*; see Table XXI-30 and Appendix E, Table 49.

Group III species are obligate commensals of a single sponge host or of a few closely related species. They meet the exacting criteria proposed by Garth (1975) for a clear-cut organism-host relationship and are highly specialized for a commensal existence. In these species, 1) association with the living host is constant, 2) free-living individuals do not normally occur, and 3) all stages of postlarval life, including adult breeding individuals, are present in the host. At least six of the species associated with the Florida Middle Ground sponges (Periclimenaeus bredini, P. caraibicus, P. perlatus, Typton prionuris, Synalpheus agelas, and S. hemphilli) conform to these criteria.

Only by examining a large series of host sponges can the above groups be distinguished. All three groups can be clearly seen in Agelas dispar (Table XXI-30). This sponge hosts a characteristic community whose more subtle aspects are only evident because of the large number of samples examined. The occurrence and abundance of key species are indicative not only of the identity of the host but also of its size.

Hard Corals. Of the five species of hard corals collected (Appendix E, Table XXI-50), only colonies of Madracis decactis were taken in significant quantities. Consequently, the following discussion is restricted entirely to associates of that species.

The caridean associates of Madracis decactis cannot be categorized as easily as those of the sponges. None of the 18 species found with M. decactis are restricted entirely to that species. Although caridean symbionts of anthozoan coelenterates are known from the Indo-Pacific, none have been reported from the Western Atlantic, with the possible exceptions of Rhynochocinetes rigens and Gnathophyllum circellum, two species not collected on the Florida Middle Ground. Most of the associates of M. decactis are free-living and are known from a wide spectrum of habitats. For example, each of the species reported from the other four hard corals also occurs on Madracis. The species associated with M. decactis, like Group I sponge associates, prefer a cryptic environment and are doubtless attracted to the sediment-filled, compact growth form and the readily available trophic resources in the form of epifauna. Despite the absence of exclusive associates, however, M. decactis can be characterized by several indicator species. Synalpheus pandionis, S. scaphoceris, S. townsendi, Thor manningi, and Alpheopsis labis were present in at least 20% of the samples examined. The latter three species were present in at least 50% of the samples. As in Agelas dispar, the species present tended to form a stable community with species present in fixed proportions.

Artificial Habitats. Caridean shrimps from the artificial habitats have not been identified. Perusal during the sorting procedure revealed a diverse fauna which differs qualitatively from that of the natural reef. In other words, the artificial habitats sample species that are difficult or impossible to sample otherwise. Further study would probably reveal a diverse system in which seasonal recruitment ultimately determines community structure.

Other Habitats. The soft corals were a fourth element of the reef biotope harboring commensal shrimps. Occurrences of Neopotonides beaufortensis and Hippolyte nicholsoni on Muricea spp. and Eunicea calyculata are summarized in Table XXI-30. The two shrimp were also present on Lophogorgia cardinalis, Pseudopterogorgia acerosa, and Pseudoplexurella wagenaari. Tozeuma serratum and N. beaufortensis were

TABLE XXI-30

OCCURRENCE OF CARIDEAN SHRIMPS IN TEN (10) SELECTED HOSTS

(Presence Expressed as Percentage)

Caridean Shrimps	Madracis decactis				Agelas dispar				Callyspongia vaginalis				Callyspongia fallax				Verongia fistularis			
	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T
Anchistioides antiquensis														33	76	52				
Neopontonides beaufortensis							3	1												
Periclimenaeus bredini			2	1																
Periclimenaeus caraibicus											40	20			18	11				
Periclimenaeus chacei	5		7	5																
Periclimenaeus maxilluliidens	7		2	4			5	2			20	10			6	4				
Periclimenaeus perlatus											20	20					25		11	16
Periclimenes americanus	2	21	16	12											6	6			5	3
Periclimenes iridescens	2	8	11	7	2	33	3	2			60	60		33	47	33	6		32	18
Periclimenes perryae																			11	5
Typton gnathophylloides		4		1																
Typton prionuris		4		1									43	33	12	22				
Alpheopsis labis	71	50	68	65			10	4												
Alpheus floridanus	10		2	5	2			1												
Automate evermanni	2			1																
Synalpheus agelas					83	86	98	89												
Synalpheus bousfieldi	12				17	10	20	17												
Synalpheus brooksi					17	14	13	15												
Synalpheus goodei	7		2	5			3	1												
Synalpheus hemphilli											60	60								
Synalpheus herricki	2	4	2	3	12		3	6												
Synalpheus longicarpus					5			2												
Synalpheus minus																				
Synalpheus pandionis	21		27	19	39	48	40	39												
Synalpheus scaphoceris	26	29	23	25											6	4				
Synalpheus townsendi	79	88	82	82	93	90	85	89			50	50	29	67	82	67	6		26	16
Hippolytid Genus 'A'					2															
Hippolyte nicholsoni																				
Hippolyte zostericola															6	4			5	3
Thor manningi	52	54	50	52	7	19	15	13			20	20	14		24	19			5	3
Disclas serratirostris															6	4				

TABLE XXI-30 (Continued)

Caridean Shrimps	Ircinia fasciculata				Pseudoceratina crassa				Eunicea calyculata				Muricea elongata				Muricea laxa			
	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T
Anchistioides antiquensis																				
Neopontonides beaufortensis									17		27	21	17		27	30	50			8
Periclimenaeus bredini	50	100	100	80																
Periclimenaeus caraibicus																				
Periclimenaeus chacei																				
Periclimenaeus maxillulidens																				
Periclimenaeus perlatus																				
Periclimenes americanus															7	5				
Periclimenes iridescens	17		20	20					33			21	33	100	27	30	25	25		23
Periclimenes perryae																				
Typton gnathophylloides																				
Typton prionuris																				
Alpheopsis labis																				
Alpheus floridanus																				
Automate evermanni																				
Synalpheus agelas																				
Synalpheus bousfieldi																				
Synalpheus brooksi																				
Synalpheus goodei																				
Synalpheus hemphilli																				
Synalpheus herricki																				
Synalpheus longicarpus																				
Synalpheus minus					17			11												
Synalpheus pandionis																				
Synalpheus scaphoceris																				
Synalpheus townsendi	33	33	33	33	35		33	33												
Hippolytid Genus 'A'																				
Hippolyte nicholsoni									84		27	42	50	100	7	30	100	67	25	46
Hippolyte zoestericola																				
Thor manningi					33			22												
Discias serratirostris																				

taken from a specimen of *Ellisella elongata*. Small populations of *N. beaufortensis* and *H. nicholsoni* were consistently present on nearly all soft coral species collected (10-30% occurrence), and in many cases populations of the two species coexisted.

The community associated with the mollusc, *Spondylus americanus*, also deserves mention. On its upper valve this bivalve supports a dense fouling community of algae, hydroids, and other epifauna which, in turn, may sustain several caridean species. Species taken from this fouling mat include, *Periclimenes americanus*, *Alpheopsis labis*, *Alpheus normanni*, *Synalpheus pandionis* and *S. townsendi*. Additionally, *Pontonia margarita*, an obligate commensal of molluscs previously known from *Aequipecten*, *Pteria*, and *Pinctada* (Chace, 1972), was taken from within the mantle cavity of *Spondylus*.

With the exception of *Periclimenes perryae*, an obligate commensal of *Astrophyton muricatum*, the Florida Middle Ground is conspicuously devoid of echinoderm commensals. Repeated examination of *Diadema antillarum* failed to produce specimens of *Tulearocaris neglecta*, a species known both from the Caribbean and the western Gulf (Chace, 1972; Pequegnat and Ray, 1974). Similarly, investigation of *Lytechinus variegatus* did not produce any specimens of *Gnathophyllum americanum* or *Gnathophylloides mineri*. Considering the abundance of other commensal species, the paucity of echinoderm associates seems significant but is, at this time, inexplicable.

In light of the above discussion of commensal associations, it is apparent that qualitative differences in species composition between stations would depend to a large degree on the availability of host species at each station. Appendix E, Table XXI-51, summarizes the numerical abundance of caridean shrimps at each station. Any gross difference in species abundances between stations can readily be attributed to collecting effort.

Two Caridean Host Species

Sampling effort for two host species, *Madracis decactis* and *Agelas dispar*, was standardized to allow detailed examination of the between-

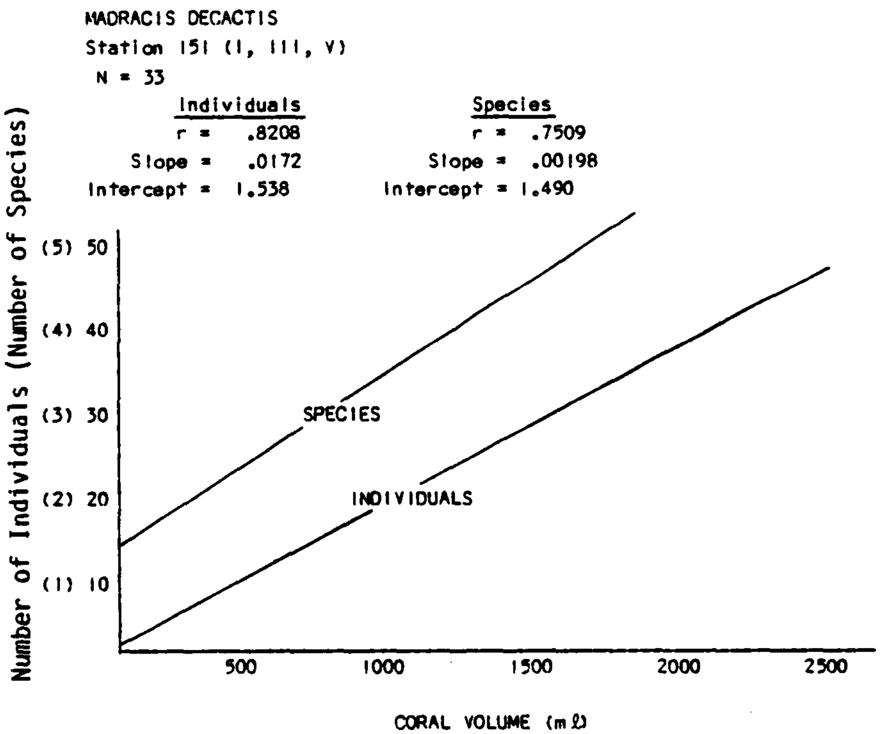


Figure XXI-55. Plot of total number of individuals and total number of species against coral volume for all seasons at station 151.

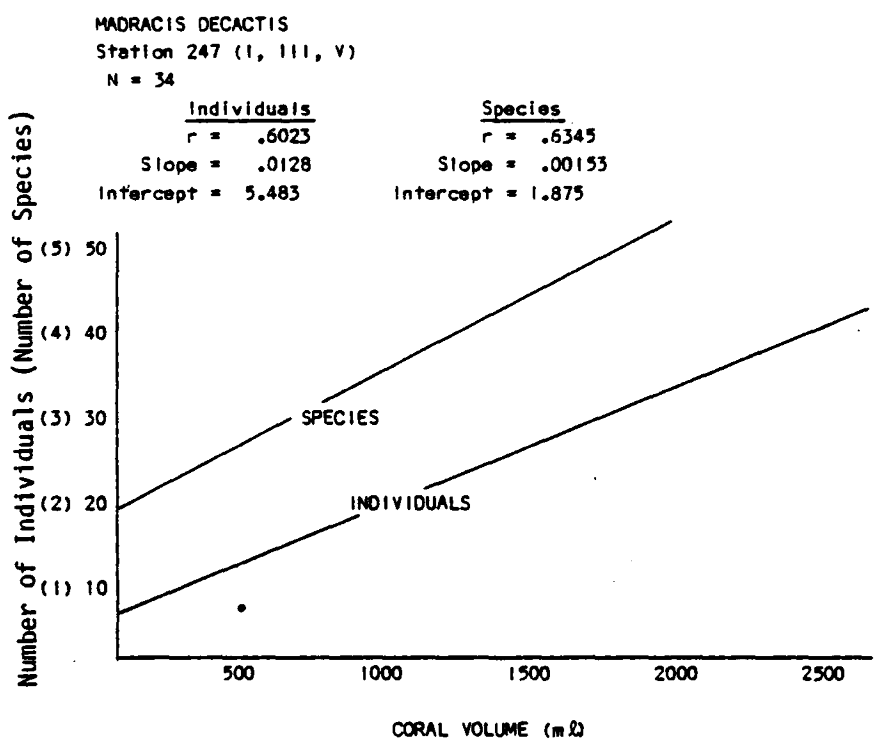


Figure XXI-56. Plot of total number of individuals and total number of species against coral volume for all seasons at station 247.

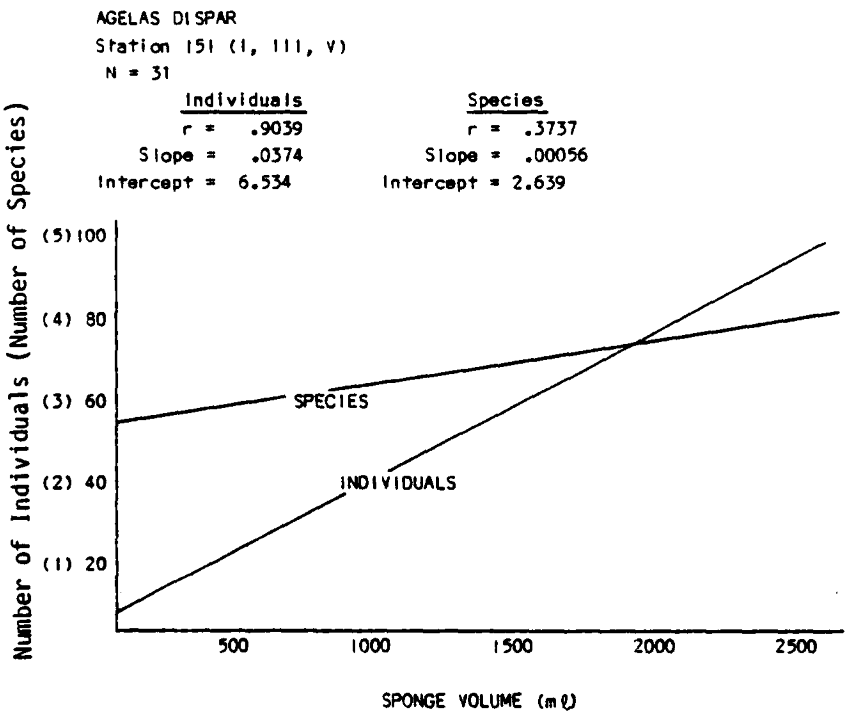


Figure XXI-57. Plot of total number of individuals and total number of species against sponge volume for all seasons at station 151.

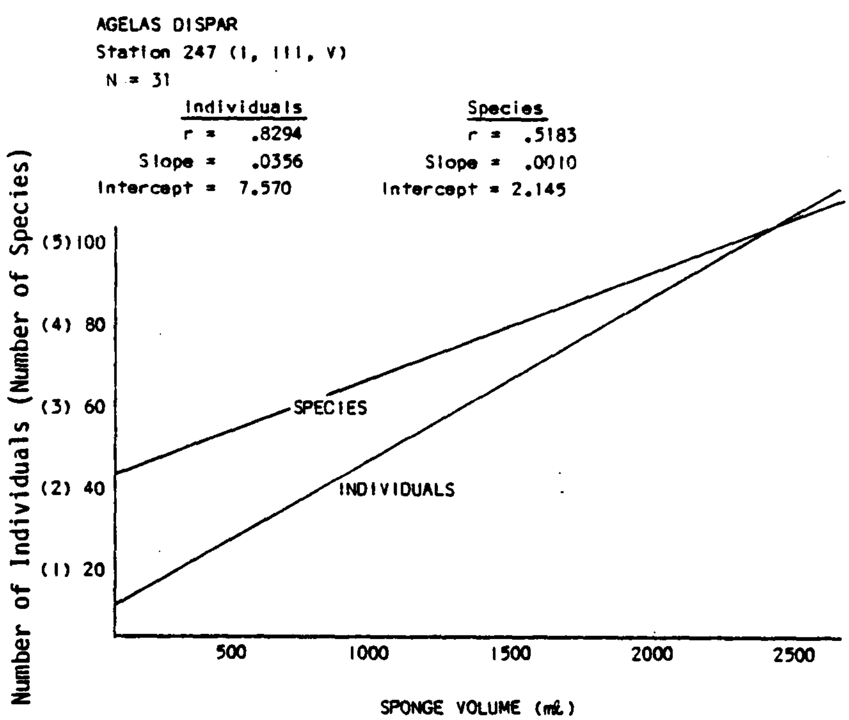


Figure XXI-58. Plot of total number of individuals and total number of species against sponge volume for all seasons at station 247.

A number of corals in the 600-1000 ml size range had very few S. townsendi. Since this apparently empty niche has not been filled by any other caridean species (athough it is quite possible that they have been filled by members of another taxon), the overall correlation of total number of individuals with coral size is poor. In addition, except for in the very small (< 500 m) sponges at Station 247, there are both more species and more individuals in a sponge of a given size from station 151.

The situation in Agelas dispar is somewhat more complex. Two species, Synalpheus agelas and S. townsendi, dominate the species composition of the host. At station 151, each species contributes equally to the slope, but at station 247 abundance of S. townsendi far exceeds that of S. agelas. This dominance is most evident in the larger sponges. As in Madracis decactis, more individuals inhabit a sponge of a given size at station 151 than at 247.

The number of species present in Agelas is generally higher than in Madracis, although it does not correlate as well with host size. As in Madracis, at least in sponges of up to 1500 ml, more species are likely to be present in a sponge of a given size at station 151 than at 247. At station 151, however, there is a strong tendency for the number of species to fall off in the larger sponges, resulting in a low slope and a poor correlation. Although sponges in the 200-600 ml size range at station 247 still tend to harbor one and even two species more than the larger sponges, the tendency is not as pronounced. The presence of individuals of these additional species is partially responsible for the good correlation between total numbers of individuals and sponge size at both stations, despite fluctuations in the abundance of the dominant species.

Seasonal abundance of caridean shrimps is summarized in Appendix E, Table XXI-52. Although much of the seasonal variation can be attributed to a biased collecting effort, some populations do show a real decline during winter and a subsequent increase in the spring. Predictably, this cyclic variation in abundance is particularly noticeable among the less abundant commensal species with tropical affinities like Periclimenaeus spp., Periclimenes iridescens, Synalpheus bousfieldi, S. pandionis, and Hippolyte nicholsoni. Anchistioides antiguensis was taken only in winter and summer samples, despite repeated collections of its host sponge, Callyspongia fallax, during the fall. Anchistioides sp. is known to be free-living in other localities and may take refuge in sponges in response to a seasonally abundant predator.

Seasonal variation in the communities associated with Madracis decactis and Agelas dispar is somewhat ambiguous (Figures XXI-59 through 70). At station 151, caridean populations in the fall and winter samples of M. decactis are quite similar (Figures XXI-59 and 60). Both abundance of Synalpheus townsendi and the total number of individuals of all species correlate well with the size of the coral heads. In the summer, however, coral size has very little effect on the size of the commensal populations (Figure XXI-61). In fact, the population of the dominant species, S. townsendi, actually tends to

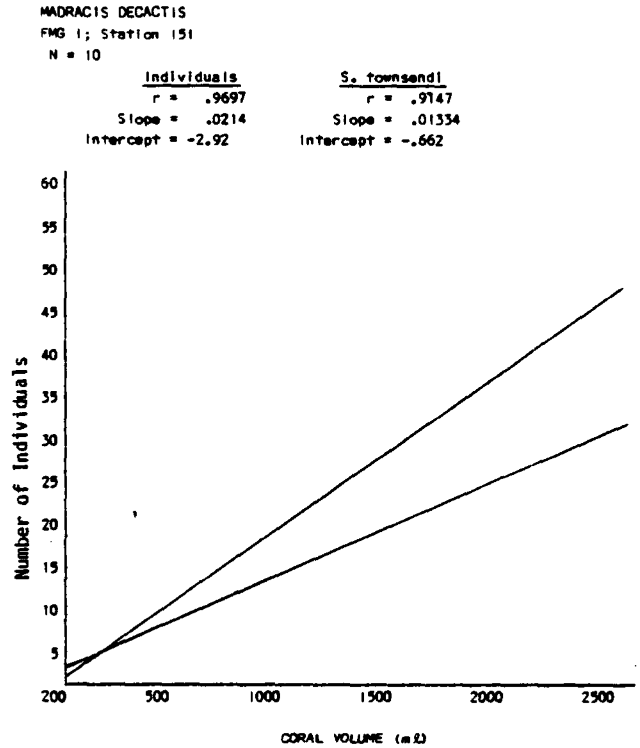


Figure XXI-59. **Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the fall sampling period at station 151.**

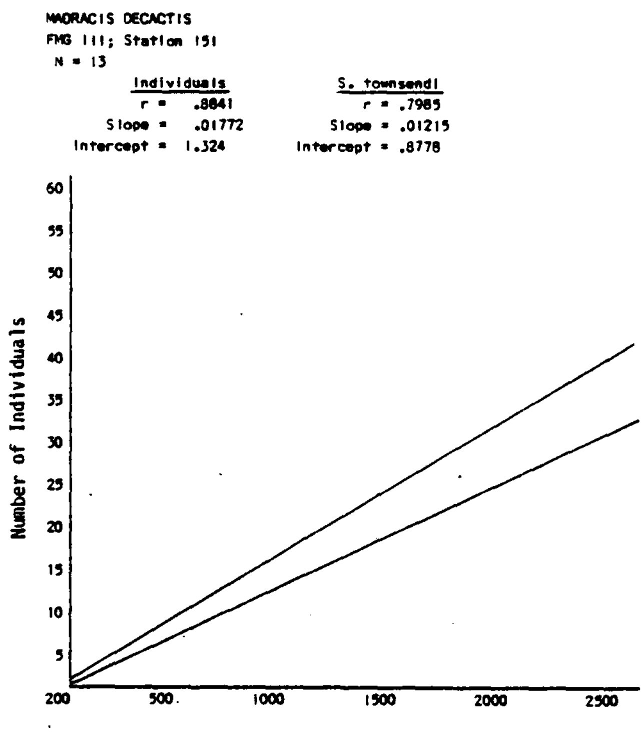


Figure XXI-60. **Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the winter sampling period at station 151.**

MADRACIS DECACTIS
FMG V; Station 151
N = 9

Individuals	S. townsendi
r = .0658	r = -.2350
Slope = .00106	Slope = -.00339
Intercept = 12.53	Intercept = 9.134

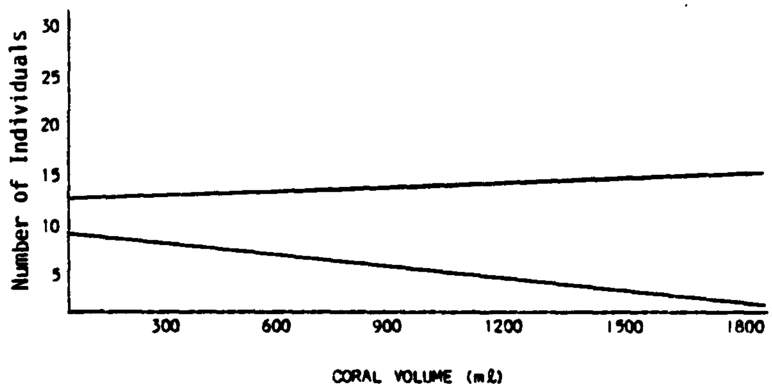


Figure XXI-61. Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the summer sampling period at station 151.

MADRACIS DECACTIS
FMG I; Station 247
N = 11

Individuals	S. townsendi
r = .3895	r = .4006
Slope = .0068	Slope = .0047
Y Intercept = 15.48	Y Intercept = 11.11

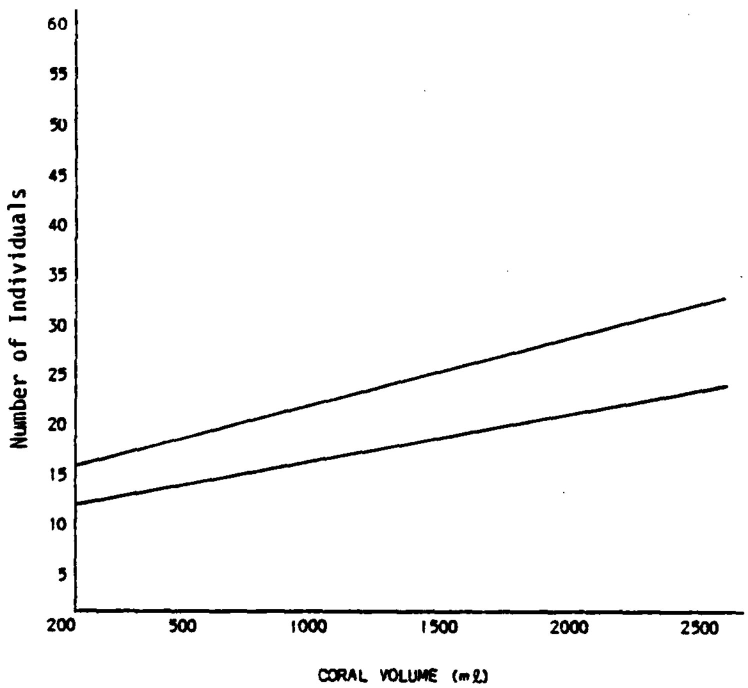


Figure XXI-62. Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the fall sampling period at station 247.

MADRACIS DECACTIS
FMG III; Station 247
N = 11

Individuals		S. townsendi	
r =	.7756	r =	.6604
Slope =	.0175	Slope =	.0126
Intercept =	3.29	Intercept =	1.936

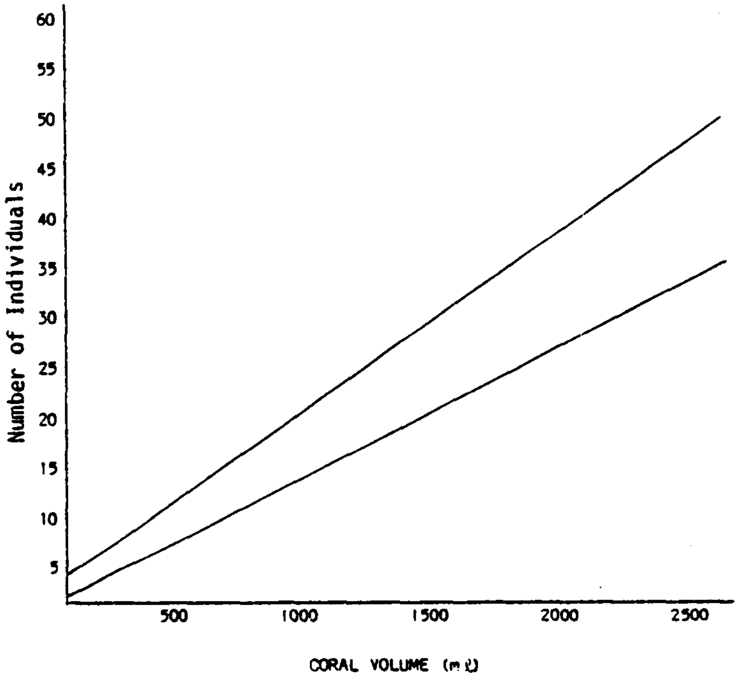


Figure XXI-63. Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the winter sampling period at station 247.

MADRACIS DECACTIS
FMG V; Station 247
N = 10

Individuals		S. townsendi	
r =	.1688	r =	.05128
Slope =	.00377	Slope =	.00083
Intercept =	7.358	Intercept =	5.509

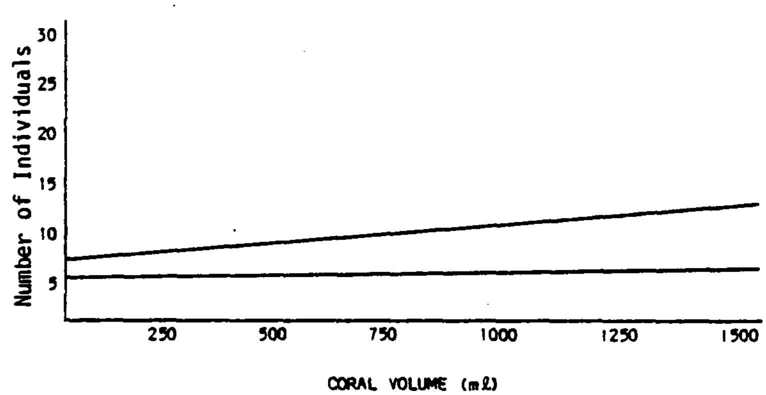


Figure XXI-64. Plot of total number of individuals (a) of all species, and (b) of *Synalpheus townsendi*, against coral volume during the summer sampling period at station 247.

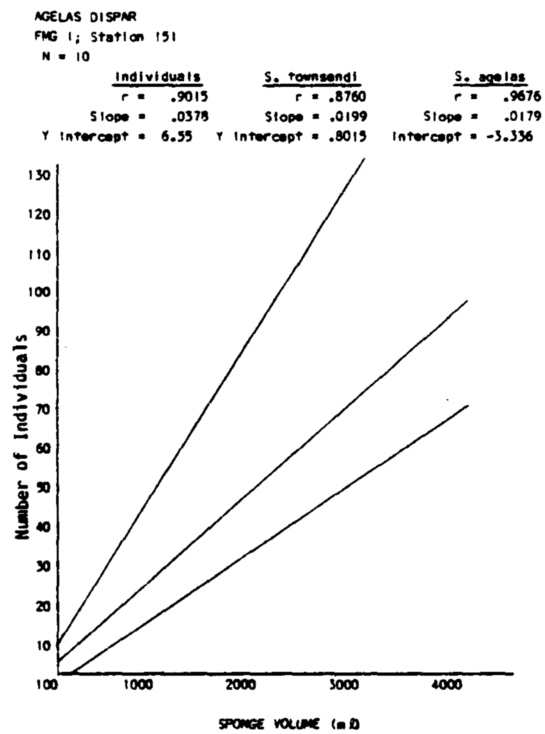


Figure XXI-65. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the fall sampling period at station 151.

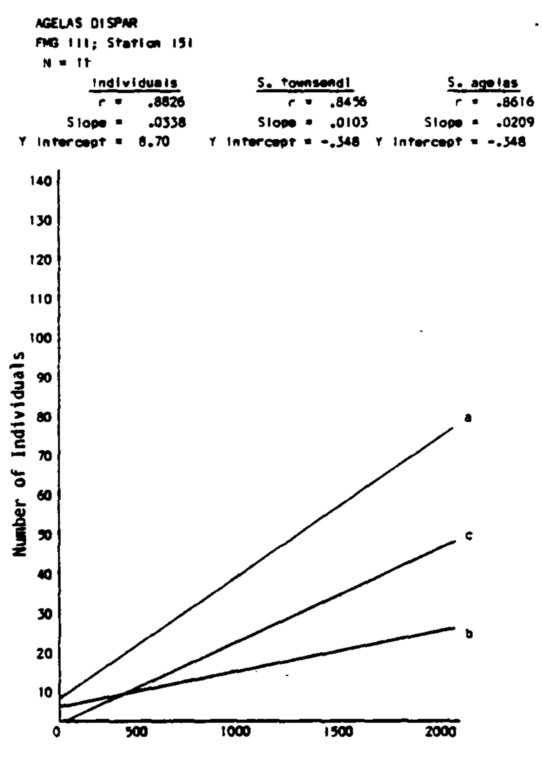


Figure XXI-66. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the winter sampling period at station 151.

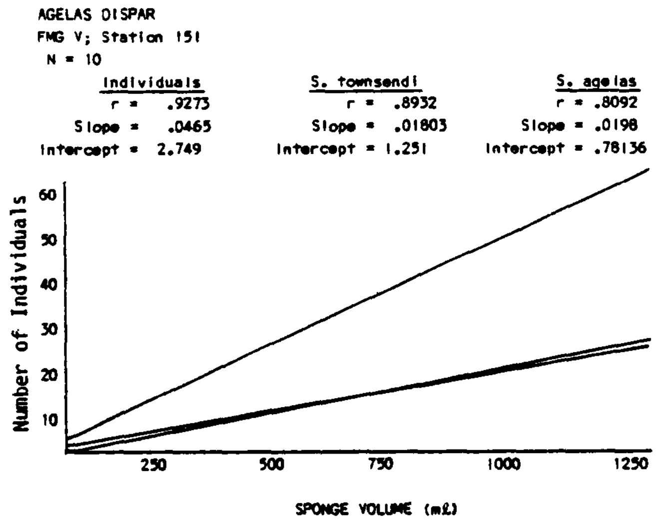


Figure XXI-67. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the summer sampling period at station 151.

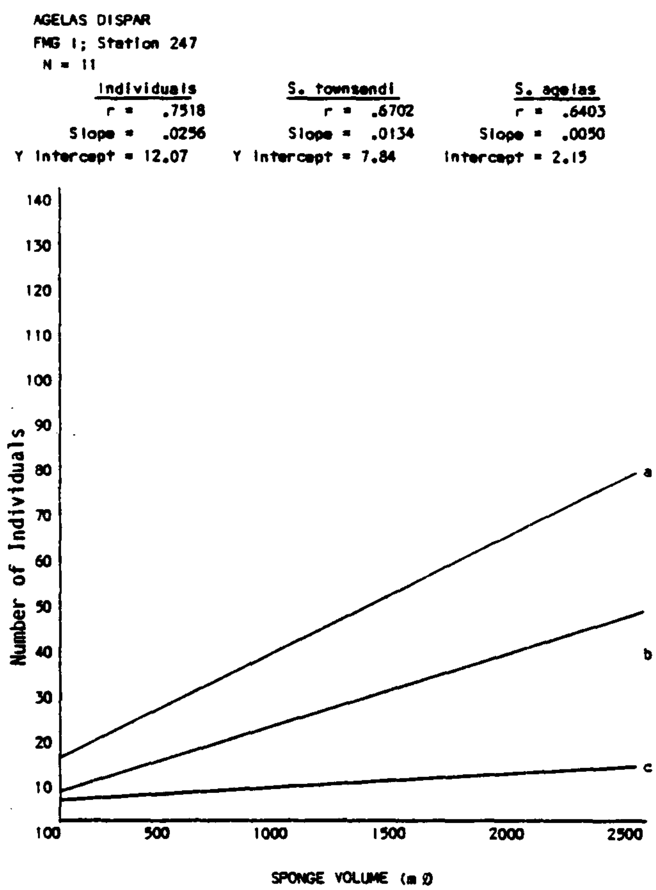


Figure XXI-68. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the fall sampling period at station 247.

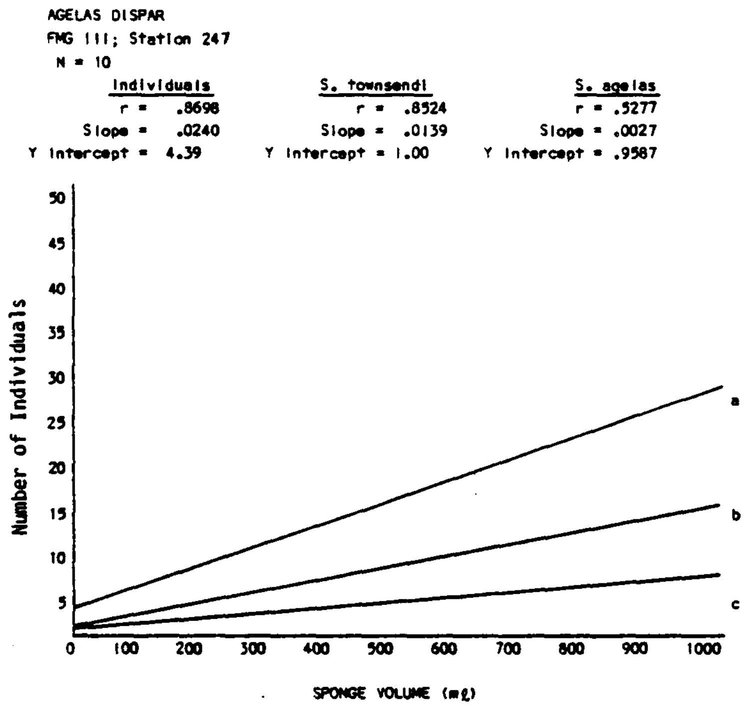


Figure XXI-69. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the winter sampling period at station 247.

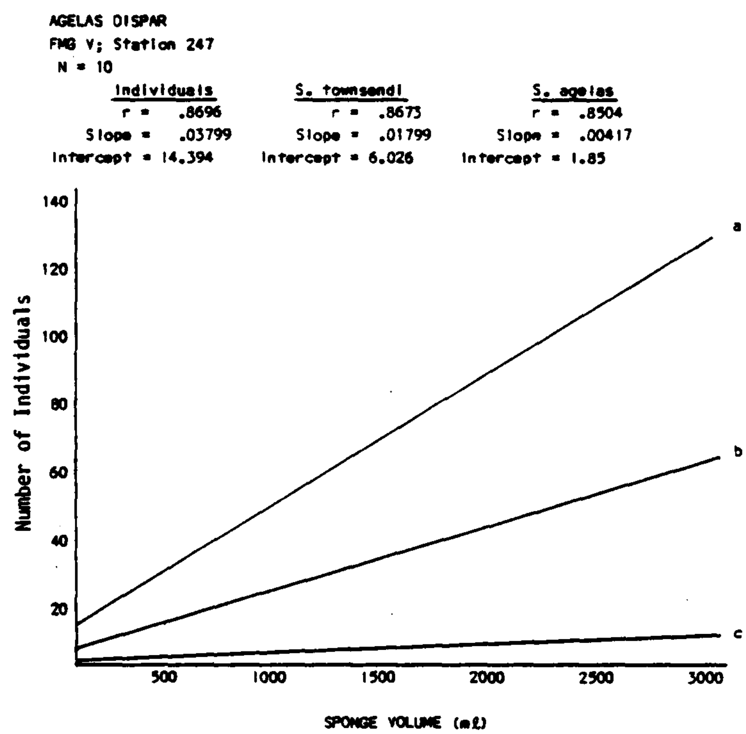


Figure XXI-70. Plot of total number of individuals (a) of all species, (b) of *Synalpheus townsendi*, and (c) of *S. agelas* against sponge volume during the summer sampling period at station 247.

TABLE XXI-31
NEW RECORDS OF CARIDEAN SHRIMPS FROM THE FLORIDA MIDDLE GROUND AND THE NORTHERNMOST PREVIOUS RECORD

SPECIES	NORTHERNMOST PREVIOUS RECORDS
Disclas serratirostris	Bermuda and central eastern Florida
Periclimenaeus bredini	Yucatan and the West Flower Garden
Periclimenaeus caraibicus	Yucatan, Leeward Is., Windward Is.
Periclimenaeus perlatus	Panama and the Dry Tortugas
Typton gnathophylloides	Dry Tortugas
Typton prionurus	Dry Tortugas
Typton vulcanus	Columbia and the Dry Tortugas
Alpheopsis trigonus	Yucatan, Barbados, and Bermuda
Synalpheus hemphilli	Bermuda, east Florida, and Dry Tortugas
Synalpheus scaphoceris	Dry Tortugas and West Flower Garden
Hippolyte nicholsoni	Leeward Islands and Windward Islands

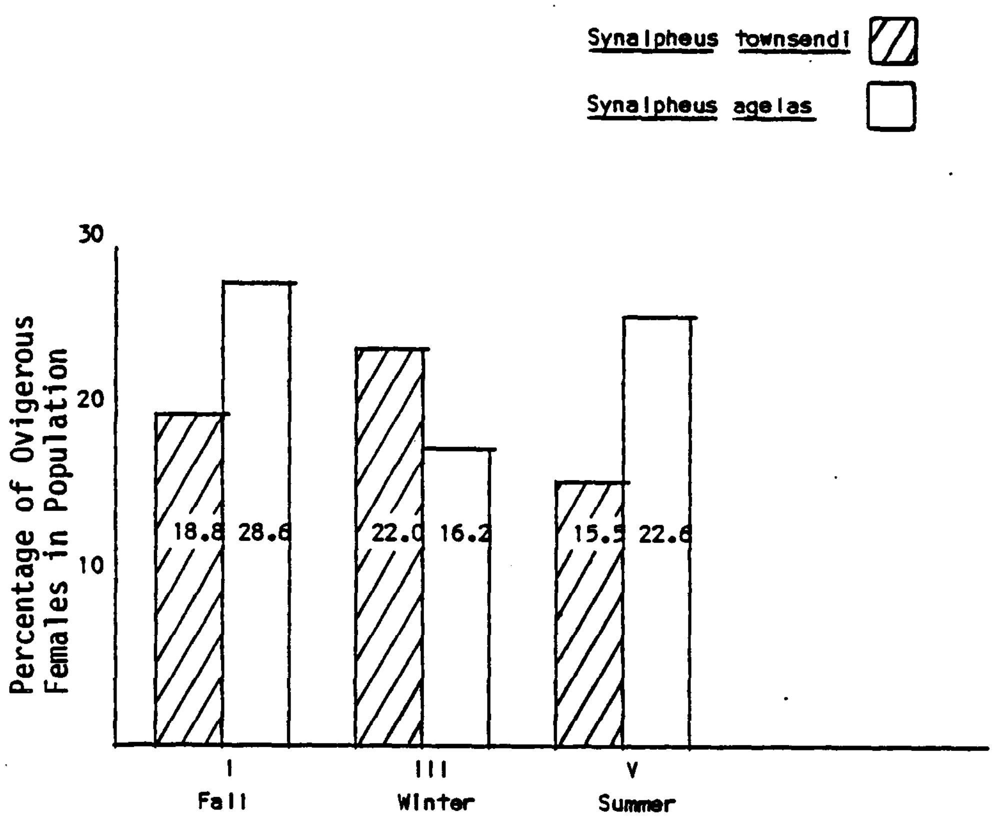


Figure XXI-71. Comparison of seasonal breeding activity of two associates of Agelas dispar; Synalpheus townsendi, an ubiquitous, temperate species, and S. agelas, a subtropical obligate commensal.

decrease in the larger corals. Summer populations of Madracis associates at station 247, including numbers of individuals for the other seasons, do not correlate well with coral size at this station, primarily because of the fluctuations in abundance of S. townsendi (Figure XXI-64).

Seasonal variation in the cryptofaunal community of Agelas dispar is a little clearer. At both stations 151 and 247 numbers of individuals per unit volume are lower during the winter months, as indicated by the slightly lower slopes (Figures XXI-65 through 70). Correlation coefficients are uniformly high for all seasons at both stations, indicating that population density is proportional to the volume (available habitat) of the sponge and that climatic conditions seem to play only a minor role in population regulation.

In some species, reproductive activity may be attenuated, or eliminated entirely, during the winter months. The breeding activity of the two principal species associated with Agelas dispar is compared in Figure XXI-71. Reproduction, measured by the percentage of ovigerous females in the population, is continuous throughout the year and peaks during the winter in Synalpheus townsendi, a temperate species which ranges as far north as North Carolina. In S. agelas, a species restricted to more subtropical regions, reproductive activity is highest in the fall, declines in the winter, and then recovers during the summer months. Apparently, accommodation to local conditions by S. agelas results in a seasonal adjustment of breeding activity.

Many valuable systematic observations were made in the course of the ecological studies. Two new species, distinct at the generic level, have been discovered. Descriptions of the color pattern of live material were prepared for 26 species of shrimp, many for the first time. The known range of 11 species can now be extended into the northern Gulf of Mexico (Table XXI-31). As a result of the examination of material from the Florida Middle Ground, the questionable taxonomic status of two species of Synalpheus has been resolved. The material and data collected throughout the study have advanced the understanding of caridean systematics and ecology, not only for the deep-reef biotope of the Florida Middle Ground, but for the entire Western Atlantic.

Anomura/Brachyura
(C. Lutz)

General Collections and Observations (Anomura/Brachyura)

Ten species of crabs account for 85% of the Anomura/Brachyura taxa. Of the ten, two species are either unrecognizable or new to science. Dominant species are:

Pagurus brevidactylus	Pachycheles ackleianus
Pagurus carolinensis	Pachycheles rugimanus
Pagurus sp.	Galathea rostrata
Nematopaguroides n. sp.	Pseudomedeaus agassizzi
Paguristes tortugae	Pilumnus dasypodus

Stations (Anomura/Brachyura)

There were no significant station differences between stations 247, 481, and 491. Station 151, however, yielded information which showed not only differences between the Madracis and Agelas in terms of numbers of individuals, but also differences in terms of species abundance. Table XXI-32 compares the rank order of species abundance in Madracis vs. Agelas.

Seasons (Anomura/Brachyura)

No consistent pattern of seasonality was exibited by these taxa. Overall it appears that the fall showed more Madracis individuals per unit of habitat at stations 151 and 247, but this trend was reversed at stations 481 and 491. For Agelas, fall samples yielded consistently higher numbers than winter or early summer. As for number of species per host between seasons, there seems to be no seasonal difference ($\bar{X}$ = 3.3 species/sample).

Other Crustaceans
(D. Adkison)

Other crustaceans collected included Tanaidacea, Leptostraca, and Stomatopoda. Two Tanaidacea families were recorded, but we have been unable to work beyond this point. They were generally more prevalent than Madracis samples. Two genera of leptostracans were encountered, Nebalia and Paranebalia. Both were seldom found; Paranebalia was the more prevalent of the two. Paranebalia is reported to live in crevices in coral and is not generally found burrowing through sediment as the other nebalids do. Our collections tend to support this observation. Nebalia may also spend time as a cryptofaunal form. The few specimens of Nebalia we collected might have been in the small scattered sediment pockets in the Madracis and sponges, and not in the crevices of the host per se. Gonodactylus bredini and Meiosquilla sp. were the only stomatopods recorded. The one damaged specimen of Meiosquilla was collected by bucket dredge on Cruise FMG-02. The few G. bredini collected were found in the Madracis samples. Our collecting efforts may not adequately have sampled this larger motile form.

Echinoderms
(T. Hopkins)

The echinoderm fauna at the monitoring stations yielded several surprises, the foremost of which is the almost total decline in the Diadema antillarum population and its replacement by the more temperate water species, Arbacia punctulata, at a ratio of 56:1 at stations 151 and 247. A second, less quantitative, but equally dramatic observation was the sharp decrease in the number of basket-stars, Astrophyton muricatum, which were formerly abundant along the Millepora ridges. As noted above (p. 103), even when Diadema or Astrophyton were found, their commensal shrimp were not.

There seems to be no change in the Ophiothrix angulata population. This ubiquitous temperate species appears to have maintained its past

TABLE XXI-32
RANK OVER ABUNDANCE OF ANOMURA/BRACHYURA IN MADRACIS
VS. AGELAS AT STATION 151

MADRACIS		AGELAS	
1.	Psuedomedeaus agassizzi	1.	Pachycheles ackleianus
2.	Pagurus sp.	2.	Pachycheles rugimanus
3.	Pargurístes tortugae	3.	Pseudomedeaus agassizzi
4.	Galathea rostrata	4.	Pilumnus dasypodus
	Pagurus brevidactylus		Pagurus sp.
	Pachycheles rugimanus	6.	Pagurus brevidactylus
7.	Pachycheles ackleianus	7.	Nematopaguroides n. sp.
8.	Pilumnus dasypodus		Pagarus carolinensis
9.	Nematopaguroides n. sp.	8.	Paguristes tortugae (Rare)
10.	Pagurus carolinensis	10.	Galathea rostrata (Not Found)

levels. A second species, Ophiothrix suensoni, whose occurrence is closely tied to the sponge Callyspongia vaginalis, was totally unaccounted for, away from its host habitat. On the other hand, the sponge Ageles dispar appeared to have its normal complement of Ophiactis cf. quadrispina, which occurs in it almost exclusively. Amongst coral rubble and under rocks, we encountered several members of the Amphiuridae and Ophiodermatidae previously collected (Ophiostigma isacanthum and Ophioderma appressum).

The asteroid fauna was represented by Coscinasterias tenuispina during all seasons and by Echinaster sp. during the late fall. The occurrence of Echinaster on the reef was of scientific interest in that a) it had not normally been encountered on the reef and, more significantly, b) it appeared to be distributed in piles which we assume to be breeding aggregations. The biology of Echinaster is almost totally unknown, and its systematic organization in the Gulf and Caribbean is thoroughly confused.

The ubiquitous sea cucumber, Isostichopus badinotus, was not notably evident; however, it was not an abundant reefal occupant in past years.

Ichthyofauna
(D. Clarke)

General Collections and Observations (Ichthyofauna)

During the course of the investigation, 127 species (representing 49 families) were collected and/or observed. Of these, 20 species are new records for the Florida Middle Ground. A comparative species list is given in Appendix E, Table XXI-53, for this and previous investigations. The total number of species recorded at the Florida Middle Ground is thus raised to 197, with 64 families being represented. Most speciose families include the serranidae (14 species this study, 21 total), gobiidae (11 species this study, 11 total), Carangidae (5 species this study, 10 total), labridae (8 species this study, 9 total), ophichthidae (7 species this study, 8 total), and pomacentridae (4 species this study, 7 total).

Although four previous studies have dealt with the Florida Middle Ground ichthyofauna (Austin, 1971; Smith et al., 1975; Smith, 1976; Hopkins et al., 1977a), only that of Hopkins et al. (1976) involved an extensive sampling and observational effort. For comparative purposes, the results of Hopkins et al. (1977a) are of particular interest because of the re-use of several of their sampling stations in this study. As indicated in Appendix E, Table XXI-53, 91 species are listed by both studies: 40 species were observed by Hopkins et al. (1977a), but not in the present study; and 36 species were seen in the present but not the previous study. The high degree of dissimilarity in species lists may be attributable to a very high incidence of "rare" species, or to large fluctuations in species occurrence at the Florida Middle Ground from year to year. When all previous studies are included in the comparison, only 23 species are recorded in common, and only 58 of 197 species are recorded by four of the five investigations.

Further evidence of variability in species occurrences is revealed by comparison of relative abundance estimates given by this and previous studies, which cumulatively represent observations taken over an eight year span. Both Smith et al. (1975) and Hopkins et al. (1977a) reported the bicolor damselfish, Eupomacentrus partitus, as "frequent." In the present study, however, this species was seen very rarely. Likewise, the painted wrasse, Halichoeres caudalis, was listed as "common," and the bluehead wrasse, Thalassoma bifasciatum, was listed as "occasional" by the previous two studies, but both were rare in the present study. Interestingly, Hopkins et al. (1977a) reported T. bifasciatum to be "common at all stations," yet no adults and only extremely rare juveniles were sighted during the present investigation.

Of 20 new Florida Middle Ground records generated by this study, 5 are pelagic species (Strongylura marina, Syngnathus springeri, Elagatis bipinnulata, Kyphosus sectatrix, and Scomber japonicus) for which known distributions include the eastern Gulf of Mexico. Dasyatis americana, Callechelys perryae, and Ophichthus ocellatus are bottom dwellers which associate fortuitously with reef habitats. The remaining records are of true reeffishes. Two specimens of the green moray, Gymnothorax funebris, were collected at the Florida Middle Ground. Only one additional record for this species has been reported in the eastern Gulf of Mexico (Hastings, 1972). Also in the reeffish category are Halichoeres pictus, Bodianus pulchellus, and Liopropoma eukrines. The rainbow wrasse, H. pictus, was seen very rarely, whereas the spotfin hogfish, B. pulchellus, and wrasse bass, L. eukrines, were observed on a number of occasions during the fall 1978 and summer 1979 cruises. The latter two species occurred exclusively along the deeper portions of the reef slope, which perhaps accounts for their absence in records of previous studies. Powell et al. (1972) list the only other record for L. eukrines in the eastern Gulf, whereas B. pulchellus, according to Smith (1976), has not been recorded from this area.

The fringed filefish, Monacanthus ciliatus, was taken in surface dip nets with floating Sargassum. The remaining seven new Florida Middle Ground species recorded (Ogilbia sp., Emblemaria atlantica, Coryphopterus punctipectophorus, Gobulus myersi, Lythrypnus elasson, Psilotris celsus, and Gobiesox strumosus) consist of small, cryptic fishes. Of these, all have been reported from adjacent waters of the Gulf of Mexico, with the exception of L. elasson and P. celsus. The identifications of these two species are currently being verified.

With the exceptions of the rainbow runner, E. bipinnulata, southern stingray, D. americana, and rainbow wrasse, H. pictus (included herein as visual records), specimens and/or in situ photographs of the remaining new records were obtained. The ophichthids C. perryae and O. ocellatus, the belonid S. marina, the scombrid S. japonicus, and the syngnathid S. springeri were taken in surface dip nets at night. Bermuda chub, K. sectatrix, were sighted and photographed on several occasions. In the initial January sighting, four adults were seen swimming in a mixed school with greater amberjack, Seriola dumerili, of equal body size. In June several smaller chubs were repeatedly seen near the surface under the hull of the anchored R/V BELLOWS. Although not collected, both B. pulchellus and L. eukrines were photographed. The distinctive color patterns displayed by these species aid in confirmation of their identifications. Specimens of all remaining new records were obtained with sponge, coral, or artificial habitat samples.

Habitats (Ichthyofauna)

Sponges

Eleven fish species were collected in association with various sponges (see Appendix E, Table XXI-54). Gobiids accounted for 6 of 11 species. The yellowprow goby, Gobiosoma xanthiprora, and island goby, Lythrypnus nesiotes, were the most ubiquitous species, occurring with 10 and 7 different sponge species, respectively. According to the classification of Tyler and Boehlke (1972), G. xanthiprora is an obligate, morphologically unspecialized inquiline. At the Florida Middle Ground, the preferred host of G. xanthiprora is the tubular sponge Verongia fistularis. A large majority of occurrences of yellowprow gobies with sponges other than V. fistularis were by juvenile fishes. Livingston (1979) gives a detailed description of the life history of G. xanthiprora at the Florida Middle Ground.

It is a matter of conjecture as to whether or not the association of the island goby, L. nesiotes, represents true inquilinism. To date, the diminutive size of gobies of this genus has prevented in situ observations of its behavior. Quite possibly this species is actually associated with the sediments surrounding the bases of sponges or sediments trapped within sponge cavities.

Two obligative, morphologically specialized inquiline gobies, the tusked goby, Risor ruber, and sponge goby, Evermannichthys spongicola, were collected during the study. Risor ruber has previously been documented from sponges of the genus Ircinia (Tyler and Boehlke, 1972), while Pearse (1932, 1950) has reported occurrence of E. spongicola with Speciospongia vespera. The bronze cardinalfish, Astrapogon alutus, is a facultative sponge-dweller, as is the seaweed blenny, Blennius marmoreus. The remaining species (Lythrypnus elasson, Emblemaria atlantica, Starksia ocellata, Coryphopterus glaucofraenum, and Halichoeres bivittatus) are fortuitous sponge-dwellers.

The Scleractinian Coral Madracis decactis

Of 122 samples of Madracis decactis collected, 53 contained fishes (9 species, representing 6 families). Results are given in Appendix E, Table XXI-55. Two species, the island goby, Lythrypnus nesiotes, and checkered blenny, Starksia ocellata, accounted for 87% of the fishes collected and were most consistent in occurrence across seasons. Sample sizes were too small and unevenly distributed, however, to reveal distinct patterns in seasonal occurrence. January samples of

Madracis did have a much lower occupancy rate (24%) than samples collected in October or June (48 and 57%, respectively). Clear patterns of occupancy rates between stations were also not discernible. Excluding January samples, observed occupancy rates were 54% at station 151, 41% at station 247, 45% at station 481/482, and 65% at station 491. A single Madracis sample from station 491 accounted for 31 of 116 fishes collected. The volume of this sample was over seven times that of any other single coral specimen taken. Three fish species, Blennius marmoreus, Apogon pseudomaculatus, and Gymnothorax funebris, occurred only with the largest Madracis sample.

Luckhurst and Luckhurst (1976) reported on the fishes associated with 15 clumps of Madracis mirabilis taken from a shallow (10 m) fringing reef at Curacao. Of 15 samples, 11 were occupied (6 species, 19 individuals). Three species, Lythrypnus mowbrayi, Starksia atlantica, and Pseudogramma bermudensis, were numerically dominant. It is interesting to note the generic level comparison to be made from the association of L. nesiotes and S. ocellata with Madracis decactis at the Florida Middle Ground. These may represent examples of ecological equivalents among similar microhabitat types.

Artificial Habitats. Results for the artificial habitat portion of the study are as yet incomplete. Although rough sorting of fishes for all artificial habitats has been completed, fine sorting will undoubtedly recover additional specimens, especially of small juveniles. Appendix E, Table XXI-56, summarizes the occurrences of fish species in habitats with respect to station, duration of exposure, and date of recovery. After rough sorting, 78 of 92 artificial habitats were found to contain fishes. A total of 23 species, representing 11 families, were collected. Gobiids were the dominant taxa (5 species, 124 individuals), followed by clinids (4 species, 51 individuals), and apogonids (4 species, 46 individuals). Seaweed blennies, Blennius marmoreus, and leopard toadfish, Opsanus pardus, were also numerous.

Several trends in species recruitment and seasonality are apparent. Habitats exposed for short durations in January 1979 were much less successful in attracting fishes than were habitats set for equal durations in October 1978 or July 1979. Only four of ten January short duration habitats were occupied, whereas nine of ten were occupied for each of the comparable October and July groups. The July short-duration habitats were occupied by as many species as, and a greater number of individuals than, any other habitat group. Many of the fishes collected with the habitats recovered in June and July were juveniles, including all specimens of the slippery dick, Halichoeres bivittatus, and barred hamlet, Hypoplectrus puella. A substantial increase was noted in the number of species and individuals of the Jan-Jun and Mar-Jun exposed habitats in comparison with the Jan-Mar habitat group. This increase indicates that overall recruitment peaks within the mid-spring to early summer period. The Oct-Jan exposed habitat group showed reduced occupancies from that of the groups recovered in June and July, but this reduction may reflect seasonal emigrations in addition to abated recruitment.

There is some evidence of a station effect in species and individuals recruitment. A comparison of habitats exposed from October 1978 through July 1979 indicates higher success in terms of species recruitment at stations 151 and 491 than at stations 247 and 481. Interpretation of the results is somewhat hindered by the larger sample size (10 habitats) at station 151. Also, the actual sites at which habitat groups were set may have affected recruitment rates. Habitats at station 151 were placed in a small sand patch on the shallow reef flat, whereas habitats at 247 and 481 were set within large crevices below the ridge crest, and the 491 group was situated adjacent to several large formations on the reef slope.

Artificial habitats were effective fish attractants, especially with respect to juveniles, at the Florida Middle Ground. A greater variety of species occurred with this habitat than with any of the sponge or coral samples. The gobiids Gobulus myersi and Psilotris celsus, and the brotulid Ogilbia sp. were collected only in association with artificial habitats. Their natural habitats remain unknown. Artificial habitats provided suitable shelter sites for both diurnal (e.g. gobiids, clinids) and nocturnal (e.g. apogonids, grammistids) species. Many of the fishes associated with artificial habitats were opportunistic in their choice of shelter sites. Species having more pronounced habitat specificities, such as Gobiosoma xanthiprora, were not present in appreciable numbers. The numerical dominance of the ubiquitous Lythrypnus nesiotes may be attributable to the accumulation of sediments within the artificial habitat structures, although a straightforward relationship is not apparent. Other species, such as Opsanus pardus and Urophycis floridanus, were able to establish long-term residences within the habitats, as several fish attained sizes much larger than would have allowed them to exit and reenter through the outer habitat meshwork.

Species Diversity and Population Density Estimates (Ichthyofauna)

A major objective of the ichthyofaunal studies was the determination of the Florida Middle Ground ichthyofaunal community structure with particular reference to ecological diversity and population density. Previous investigations yielded extensive faunal inventories, but only listed cursory and qualitative estimates of species abundances. A more quantitative approach was followed in the present study. Although a number of studies of coral reeffish communities have reported diversity estimates (Risk, 1972; Alevizon and Brooks, 1975; Jones and Thompson, 1978), all were accomplished entirely or predominantly on shallow reef structures, generally at depths less than 15 to 20 m. Reef structures at the Florida Middle Ground lie between the 24 and 37 m depth contours. Due to logistical constraints imposed by time restrictions in working at these depths, none of the existing methodologies for estimating ichthyofaunal diversity (e.g., transect counts, species-time-area techniques) were suitable for application at the Florida Middle Ground.

A total of 125 five-minute counts were completed during the course of the study. These were distributed among stations, seasons, and biotopes, as follows:

(1) Stations:	151 = 53 counts		(2) Seasons:	Oct-Nov 78	= 36 counts
	247 = 38 counts			Jan-Mar 79	= 23 counts
	481 = 6 counts			Jun-Jul 79	= 66 counts
	491 = 13 counts				
Other locations	= 15 counts				

(3) Biotopes:	shallow reef flat sites	= 36 counts
	ridge sites	= 23 counts
	slope sites	= 42 counts
	deep sand flat sites	= 18 counts
	patch reef sites	= 6 counts

Analysis of the obtained data is summarized in Appendix E, Table XXI-57.

Highest diversity (H') was measured for the deep sand flat biotope, lowest for the ridge biotope. It should be pointed out that the deep sand flat as treated herein is actually a transition zone between the reef slope and deeper exclusively sand areas. Count sites in the deep sand flat were characterized by scattered small formations rising above the sand bottom. To further clarify the factors contributing to the calculated diversity values, species evenness components were derived (Pielou's E and Fager's NM_s). According to Pielou's (1975) measure, highest evenness occurred in the deep sand flat biotope, lowest in the ridge biotope, a trend which matches that of the diversity measure values. In contrast highest evenness as measured by Fager's (1972) method was found in the shallow reef flat (followed closely by the deep sand flat), whereas lowest evenness occurred in the ridge biotope. The distribution of a single species, *Chromis scotti*, appears to be a major factor in determination of diversity and evenness values. Purple reeffish are by far the most abundant fish at the Florida Middle Ground. Dense, loosely formed schools of this planktivorous damselfish hover within several metres of the substrate during the day. Their schools are concentrated above areas of prominent relief and, in particular, align along the ridge crest. Abundance of *C. scotti* decreases sharply away from the ridge crest and is lowest in the deep sand flat area.

In terms of actual numbers of species observed per count, the ridge biotope exhibited the highest mean. Lowest mean number of species per count occurred in the shallow reef flat. The ridge biotope also had the highest mean number of individuals per count, whereas the deep sand flat had the lowest, again reflecting the distribution of *C. scotti*.

Within biotopes, count data for each species were converted to number of individuals per 100 square metres to arrive at comparable estimates of population densities. Results are presented in Appendix E, Table XXI-58. *Chromis scotti* was the most abundant species in all biotopes, with peak population density in the ridge biotope. The slippery dick, *Halichoeres bivittatus*, was second most abundant in both the shallow reef flat and deep sand flat biotopes, and third most abundant in the ridge and slope biotopes. Although showing peak abundance in the shallow reef flat, slippery dicks were fairly evenly distributed in all studied biotopes. The position of the greater amberjack, Seriola dumerili, as second most abundant in the ridge biotope is somewhat misleading, as its density was greatly inflated by the occurrence of a large school during a single counting session.

Distribution of the seaweed blenny, Blennius marmoreus, is similar to that of the slippery dick, peaking in the shallow reef flat, fairly even throughout the remaining biotopes. Cocoa damselfish, Eupomacentrus variabilis, showed a trend for decreasing population density with increasing depth, and were particularly abundant in the shallow reef flat. A third common pomacentrid at the Florida Middle Ground, in addition to C. scotti and E. variabilis, is the yellowtail reeffish, Chromis enchrysurus. In contrast to E. variabilis, C. enchrysurus was most abundant on the deep sand flat, least abundant on the shallow reef flat.

Due to an inability to distinguish bridled gobies, Coryphopterus glaucofraenum, from spotted gobies, C. punctipectophorus, in the field counts, data for these species were treated together. Coryphopterus spp. seemed to prefer carbonate sand habitats at the bases of eroded formations. Their population density was highest in the slope biotope, lowest on the deep sand flat. Neon gobies, Gobiosoma oceanops, were also particularly abundant on the reef slope. Noted for their cleaning behavior, these gobies appeared to establish "stations" in the proximity of formations having great vertical relief. A congener, G. xanthiprora, showed a decreasing abundance with depth. As obligative sponge inquilines, yellowprow gobies have a distribution directly related to that of their host sponge species.

Blue angelfish, Holacanthus bermudensis, were numerous in all biotopes studied and did not exhibit pronounced habitat or depth preferences. Adults of this species are known to eat sponges, but are not overly selective in their diet. Scarus sp. were patchily distributed, occurring in small schools of up to several dozen individuals. Their highest observed abundance in the patch reef may be due to the small sample size for that biotope.

Additional species showing abundance maxima for the ridge biotope include scamp, Mycteroperca phenax, gag, M. microlepis, gray triggerfish, Balistes capriscus, red porgy, Pagrus pagrus, cubbyu, Equetus umbrosus, white spotted soapfish, Rypticus maculatus, white grunt, Haemulon plumieri, and tomtate, H. aurolineatum. Gray snapper, Lutjanus griseus, had the highest observed density in the slope biotope. Hovering gobies, Ioglossus calliurus, spotfin butterflyfish, Chaetodon ocellatus, two-spot cardinalfish, Apogon pseudomaculatus, bank sea bass, Centropristis ocyurus, knobbed porgy, Calamus nodosus, and the painted wrasse, Halichoeres caudalis, showed population density maxima in the deep sand flat biotope.

Biases in the methodology of diversity and population density estimations should be acknowledged. A number of species included in the data are morphologically or behaviorally cryptic. These species are undoubtedly underestimated with respect to population density. Included in this category are Opsanus pardus, Urophycis floridanus, and all the clinids and apogonids. These species are secretive, seldom moving into exposed areas. For example, observations of Emblemaria atlantica, which uses dead, gaping Spondylus shells for shelter, are inadequate to achieve an accurate density estimation. Nocturnal species such as Apogon pseudomaculatus and A. maculatus are also obviously underestimated.

As evidenced by the fishes collected with sponge, coral, and artificial habitat samples, many species occurring in considerable numbers at the Florida Middle Ground (e.g., Lythrypnus nesiotes) are not represented in the diversity or population density estimates. Characterization of the overall ichthyofaunal composition and community structure of the Florida Middle Ground must take these factors into account.

Mapping

Submersible "ground truth" mapping was carried out during FMG-02 at each of four pre-selected sites. In situ observations and quadrat mapping were carried out by divers on FMG-03 and 05.

Not surprisingly, the maps of specific localities created from submersible observations and the M/V RED SEAL do not agree in detail with the large scale map created by Hilde et al. (this report). It must be born in mind, however, that the major mapping effort used 1000' line spacing, while the submersible effort used 250', and sometimes even less (125'). As a consequence, Figures XXI-72, 74, 76, and 78 show a significantly greater contour detail around the actual work site, except for Figures XXI-74 and 78. Here, the bathymetry was displaced due to a navigation error. Figures XXI-73, 75, 77, and 79 display the ground truth transects run by the DRV DIAPHUS. As can be seen, stations 481 and 491 are really characterized by isolated or dissected peaks.

Figure XXI-80 is a characterization of stations 151 and 247, developed during the summer of 1976. During this study, we developed Figures XXI-81 through 83 for comparative purposes.

Overall, the most significant changes revealed by this methodology are 1) the depauperation of algae at station 247, 2) the apparent increase in octocorallia at station 247, and 3) the general depauperation of both octocorallia and scleractinia at station 151. Figure XXI-83 is a depiction (5 x 15 m) of the reefal flat and includes a cross-section view of one of the many shallow gullies which generally run parallel to the reef front.

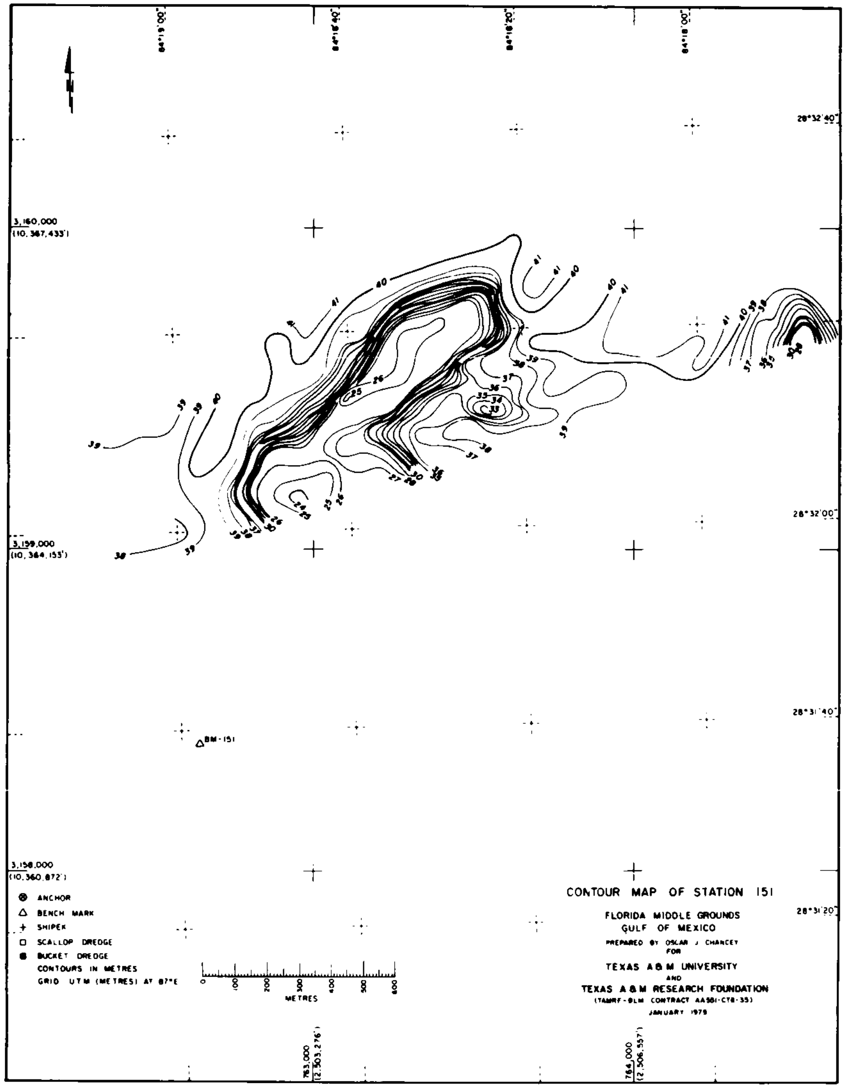


Figure XXI-72. Contour map of detailed bathymetry at station 151 "ground truthed" by DIAPHUS and divers.

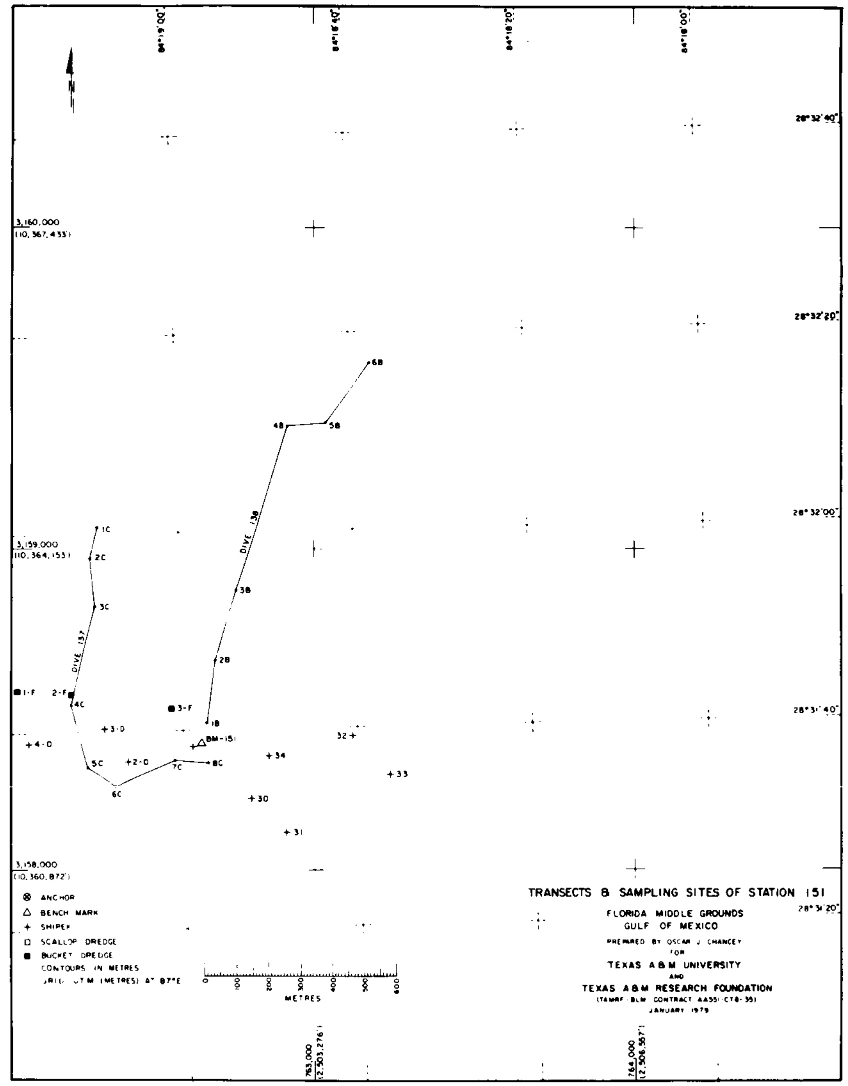


Figure XXI-73. DIAPHUS track and remote sensing sites, station 151.

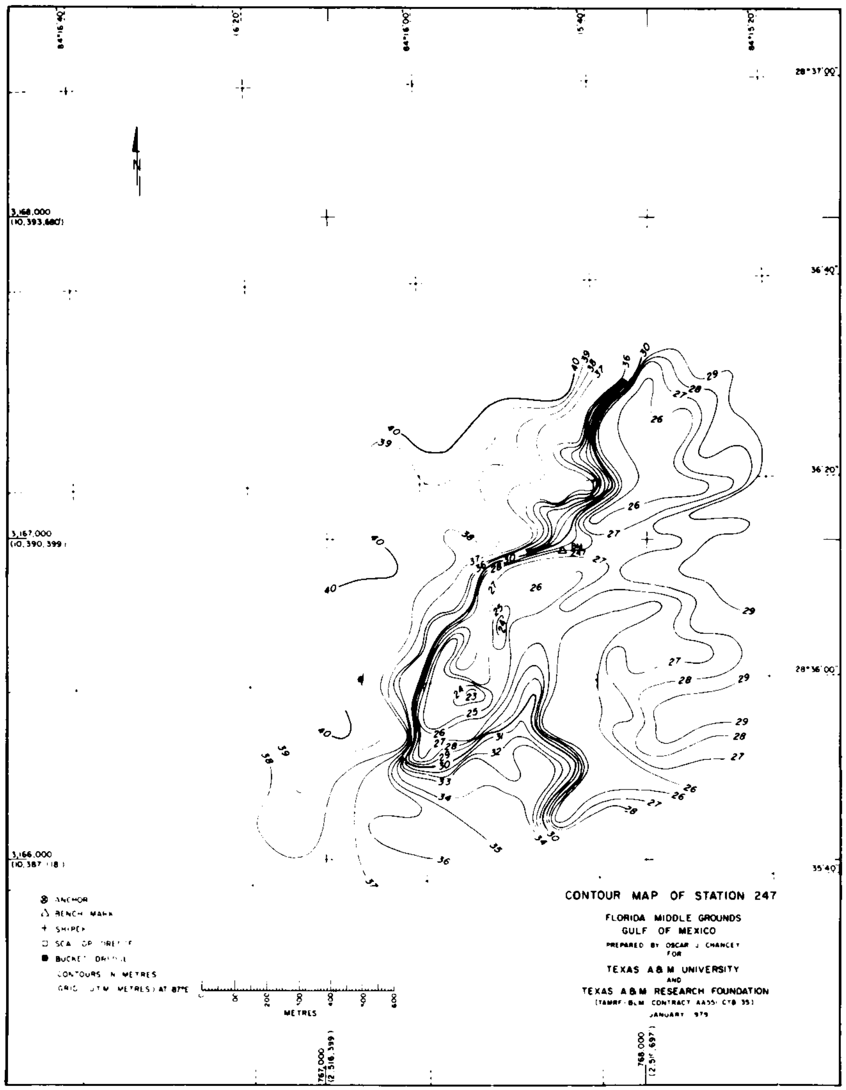


Figure XXI-74. Contour map of detailed bathymetry at station 247 "ground truthed" by DIAPHUS and divers.

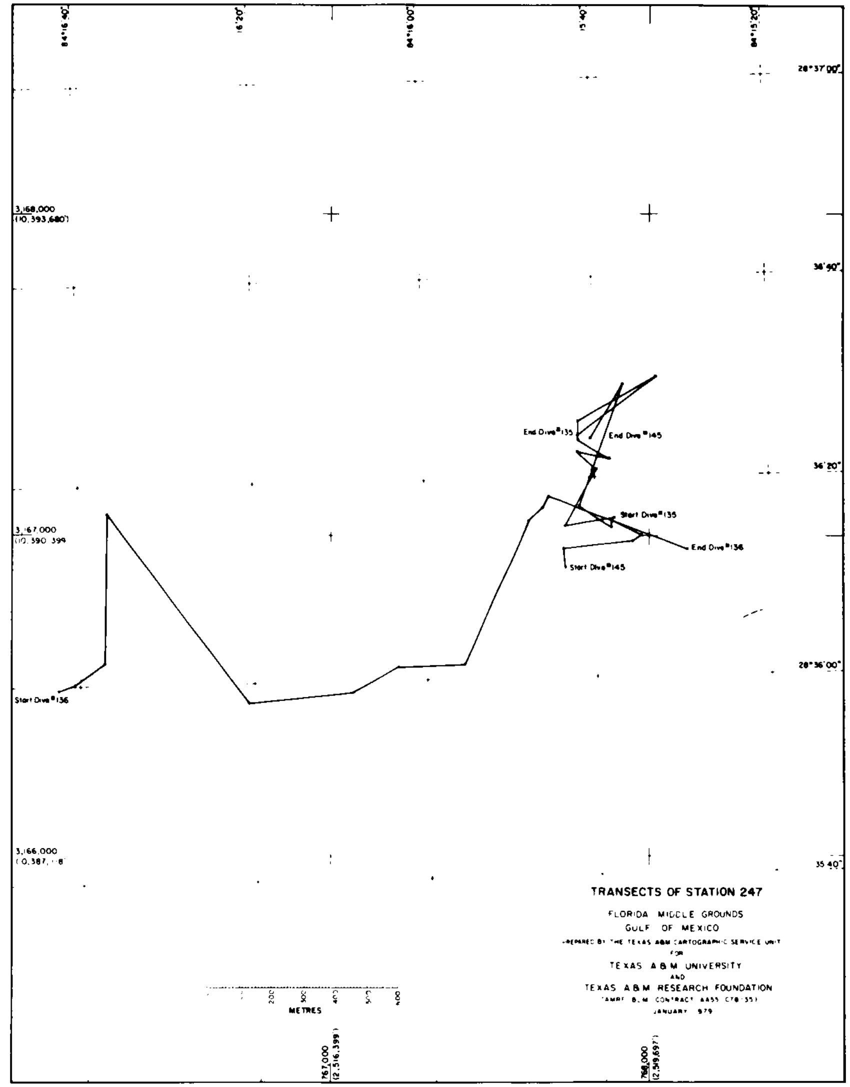


Figure XXI-75. DIAPHUS track station 247.

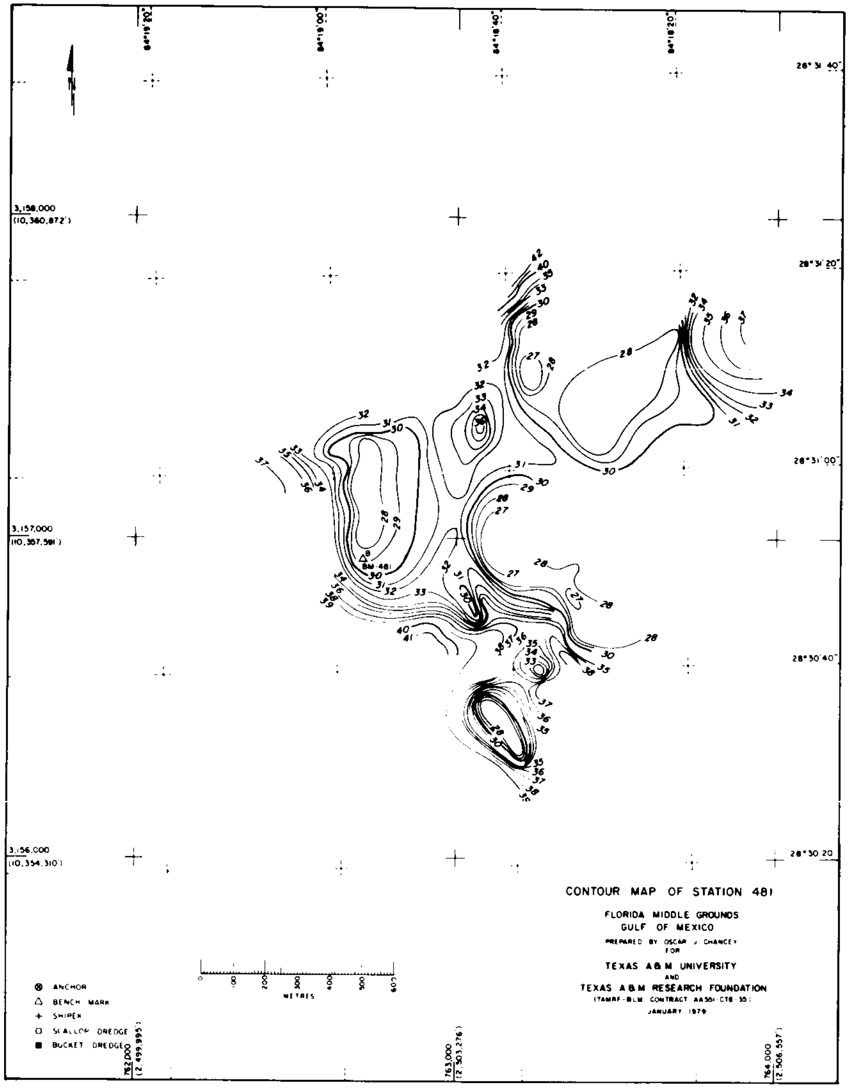


Figure XXI-76. Contour map of detailed bathymetry at station 481 "ground truthed" by DIAPHUS and divers.

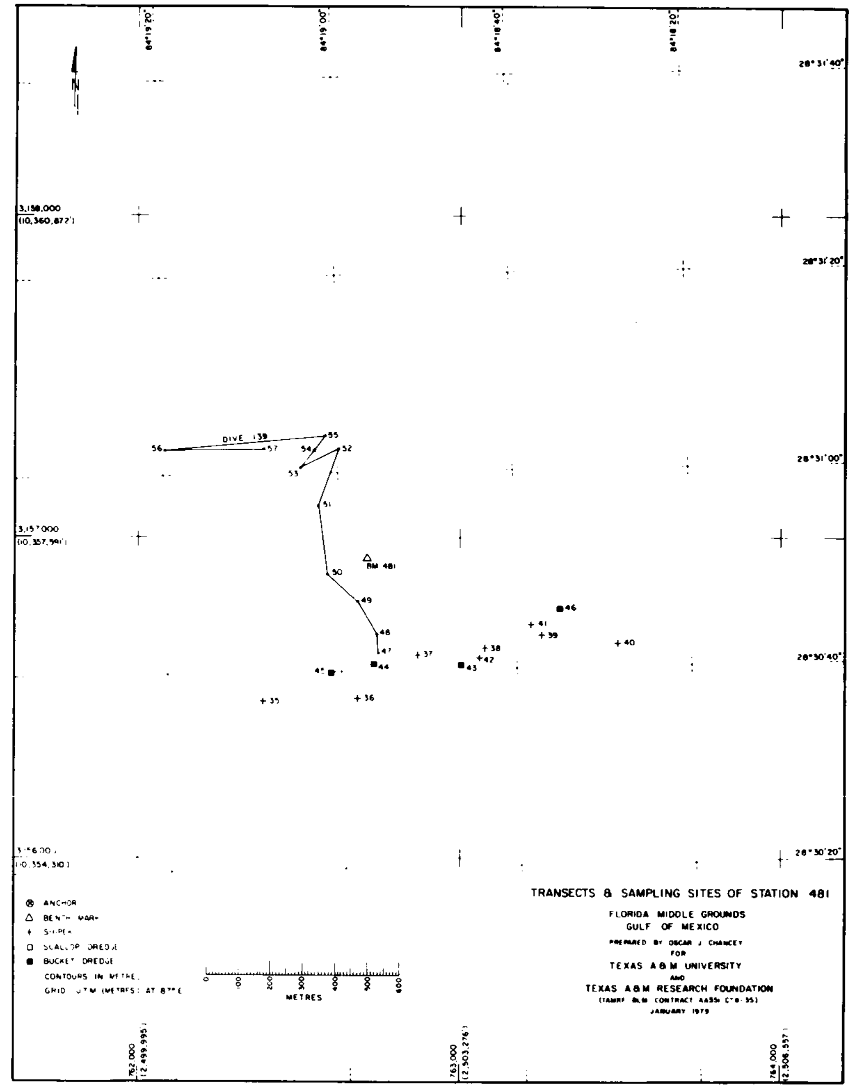


Figure XXI-77. DIAPHUS track and remote sampling sites, station 481.

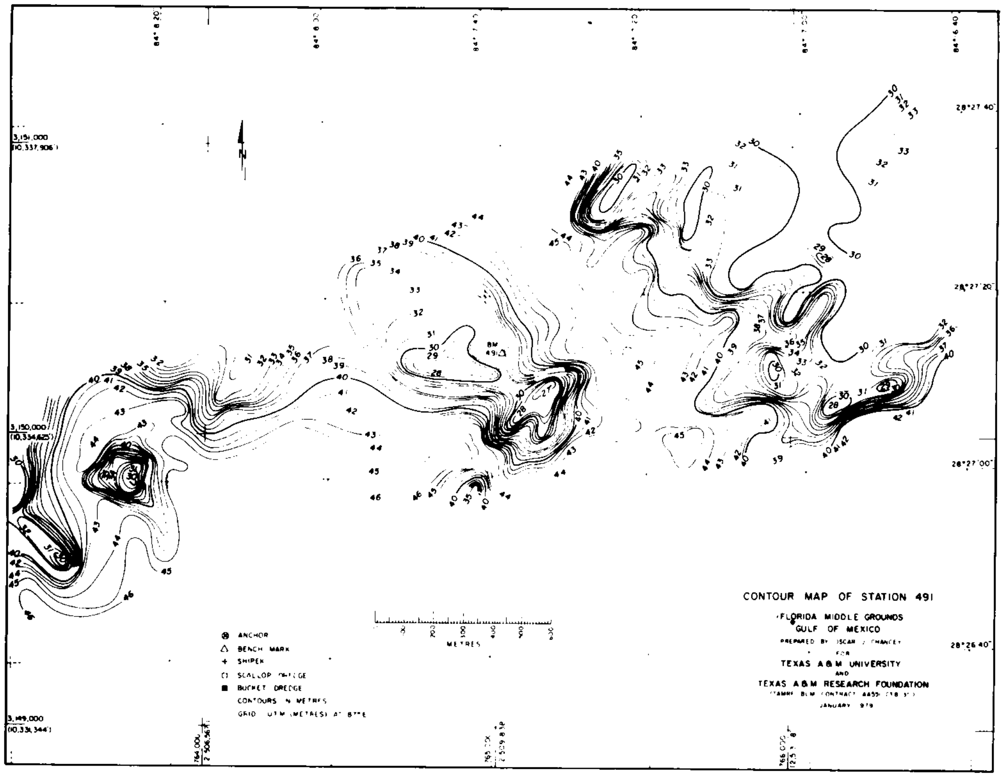


Figure XXI-78. Contour map of detailed bathymetry at station 491 "ground truthed" by DIAPHUS and divers.

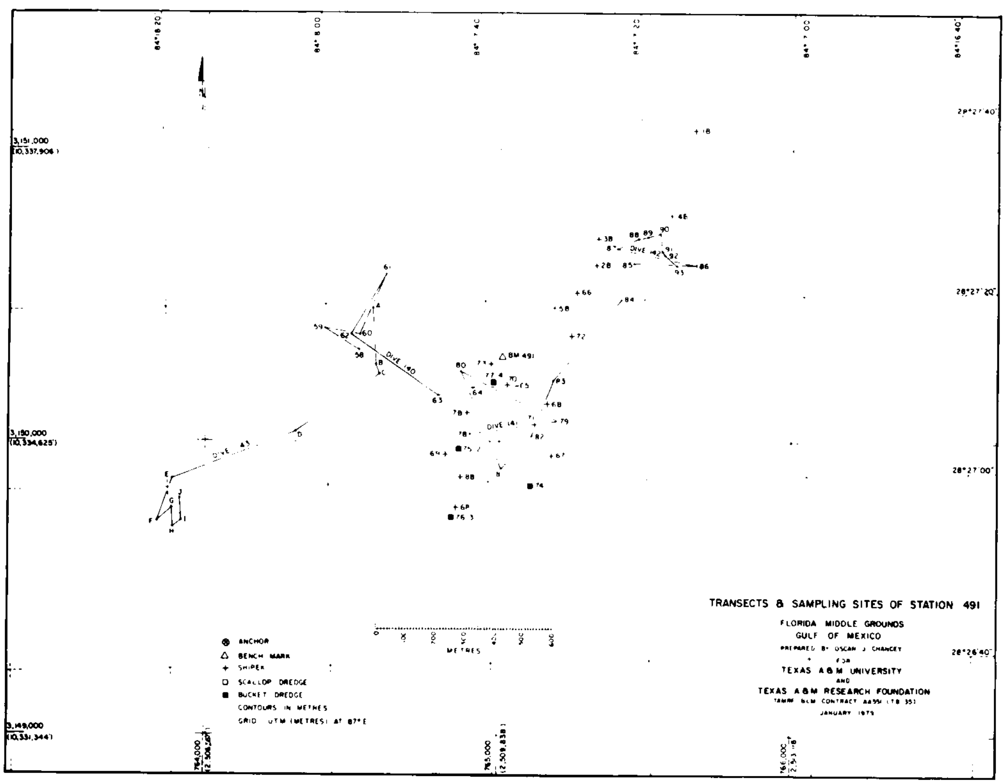


Figure XXI-79. DIAPHUS track and remote sampling sites, station 491.

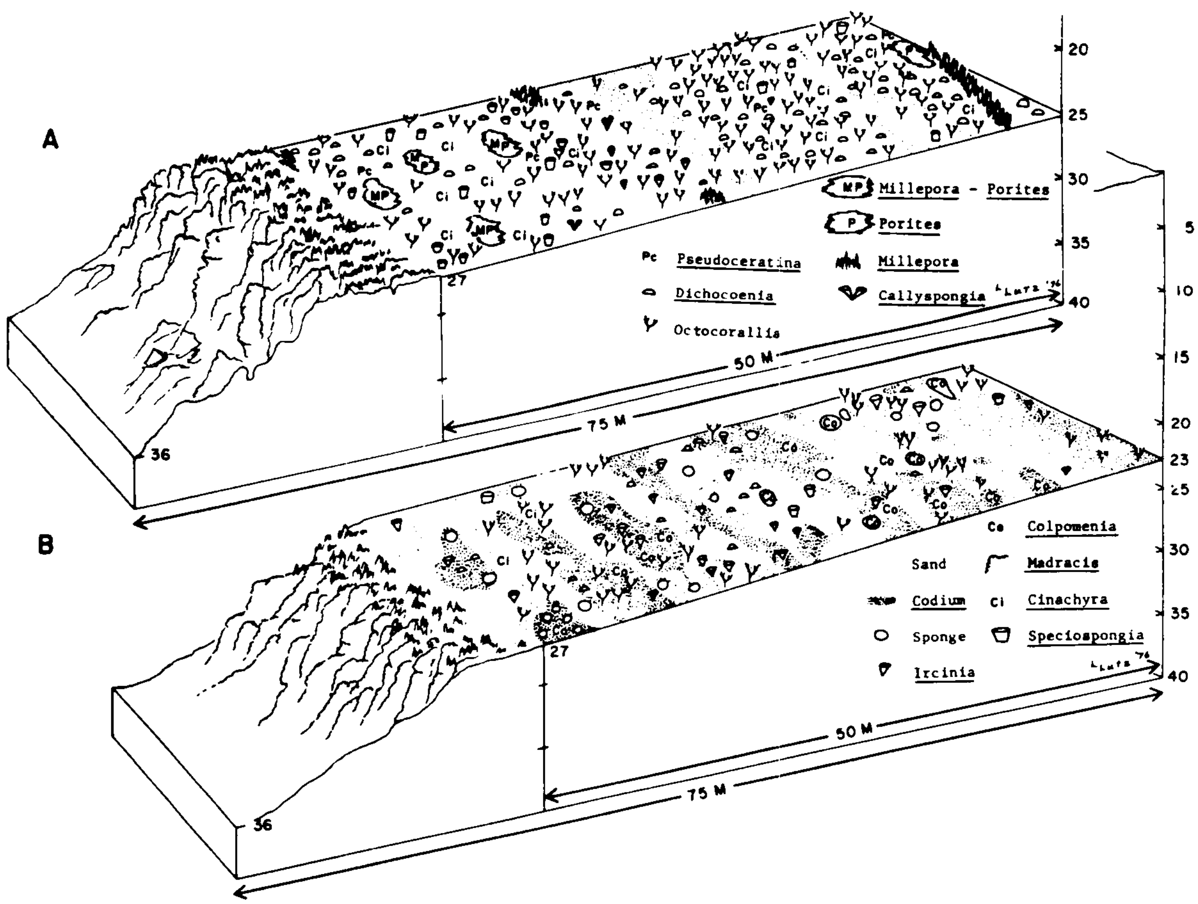


Figure XXI-80. Site characterization at Station 151 and 247, summer 1976 (From Hopkins *et al*. 1977a).

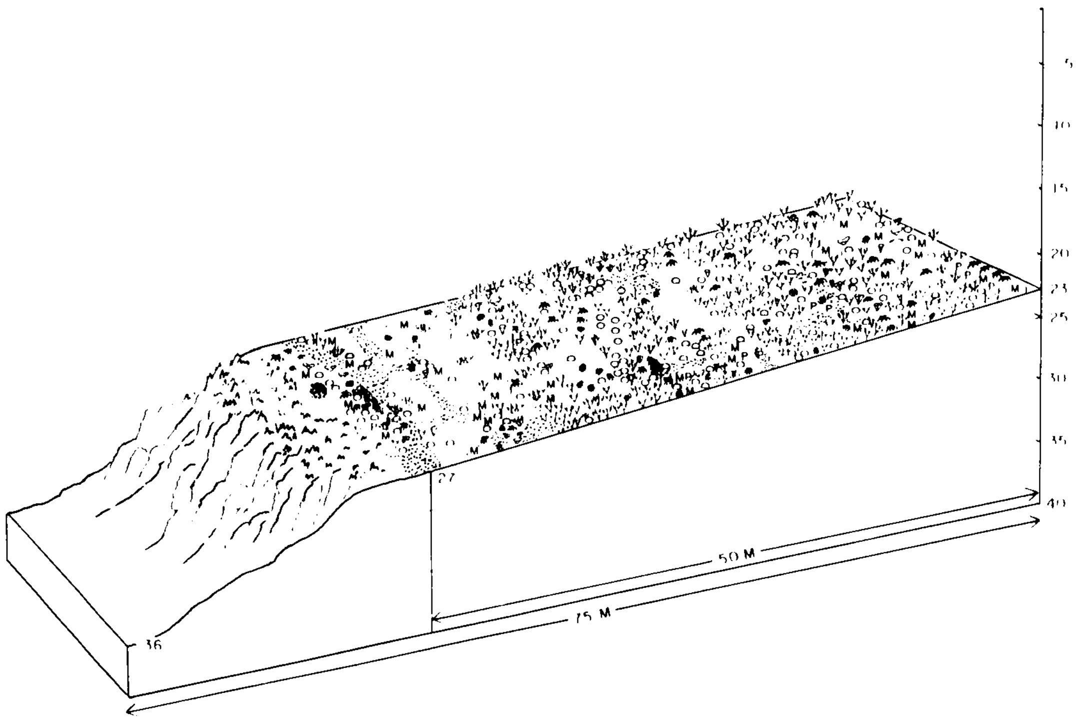


Figure XXI-81. Site chartacterization at station 247, summer 1979.

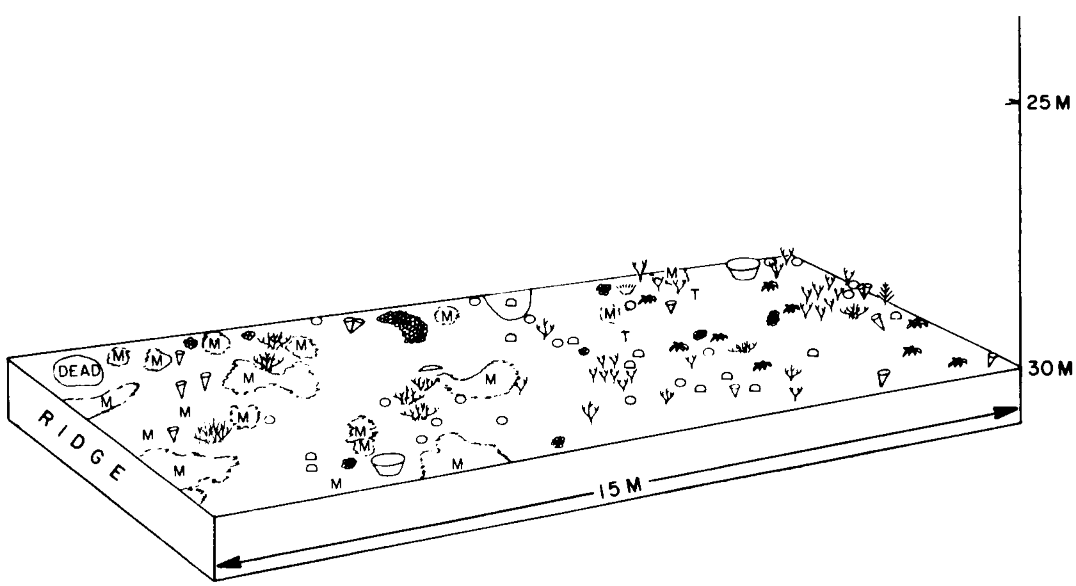


Figure XXI-82. Site characterization at station 151, summer 1979.

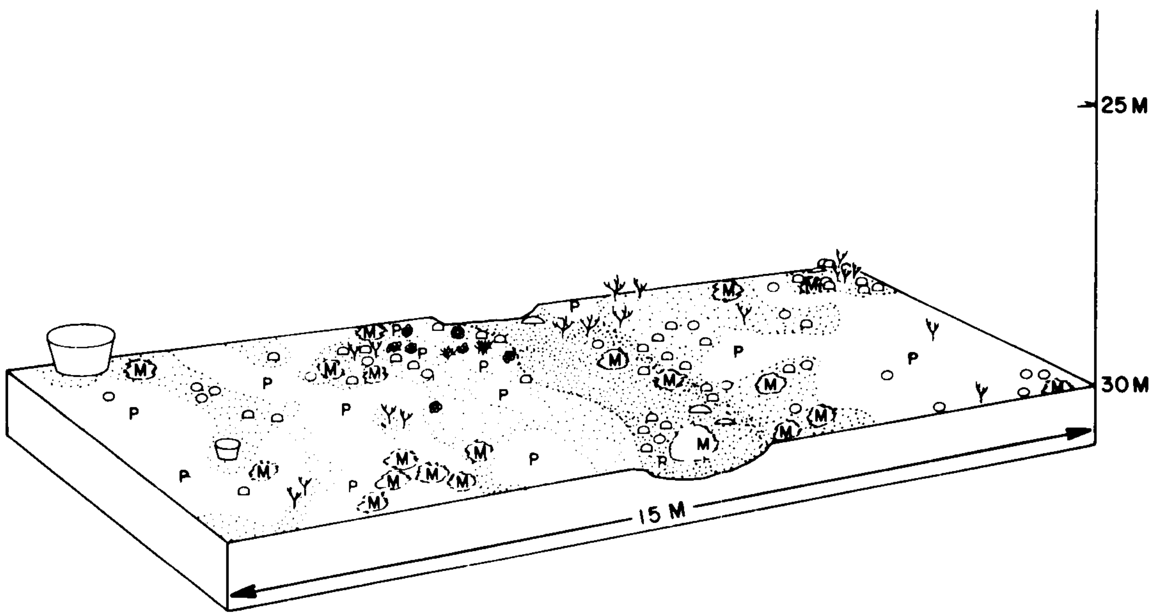


Figure XXI-83. Site characterization at Station 481, summer 1979.

SUMMARY/CONCLUSIONS/RECOMMENDATIONS

MAPPING AND SUB-BOTTOM PROFILING

T. Hilde

Summary and Conclusions

1. The northern Florida Middle Ground consists of long north-south reef structures built up from a former Pleistocene erosional terrace.

2. Two periods of Pleistocene subaerial exposure produced extensive erosional terraces. The older surface was cut into consolidated carbonate rock and developed Karst topography. Following a rise in sea level and a period of primarily carbonate deposition, a second low stand of sea level resulted in a younger erosional terrace (possibly as young as 10,000 yrs B.P.). This erosional surface cut completely through sediments of the previous depositional period and into the former erosional surface in the eastern part of the survey region. Channels in this surface indicate drainage from the east and north. It is from this younger erosional terrace that the Florida Middle Ground reefs have been constructed.

3. Recent carbonate sediments, derived in part from the reefs (even though locally high in molluscan shell content), have been deposited over the former erosional surface, between the reefs.

4. Live or very recent reef growth is observed in the seismic reflection records and bathymetry as scattered pinnacles on top of and at the margins of the broader ridge profiles. Beneath these pinnacles, the ridges are believed to be dead reef structures.

5. Presently growing reefs, based on relief, are scattered throughout the region but are more abundant in the southern part of the survey area at depths of about 30 m. This distribution may be related to destructive forces of hurricanes and storms at shallower depths.

6. Bottom currents, prevailing northeastward directions of storms, and hurricanes exert major control on the distribution of the recent carbonate sediments, building talus slopes on the east margins of ridges and scour channels on their west margins.

7. Ripple patterns on the ridges and their flanks suggest dominant north-south bottom currents.

Recommendations and Considerations for Future Studies

1. Future offshore BLM surveys should always include shallow penetration seismic reflection profiling. This work and the bathymetric surveying should be carried out at least a year in advance of other seafloor studies so that the results can be used to guide the other studies.

2. Reliable navigation is imperative for all survey and sampling studies and should be of an accuracy appropriate for the resolution required in the studies.

3. Better quality data can probably be collected, more efficiently, through the provision of sufficient survey and instrumentation support to have the contracting institution use its own facilities, rather than carrying out the fieldwork through subcontractors.

4. Requirements for future studies could be simplified, resulting in less interim paper work, support personnel and expense, without compromising the objectives of the investigation or the quality of the product.

GEOLOGY AND SEDIMENTOLOGY

L. Doyle, J. Steinmetz

Conclusions

1. Sediments on the Florida Middle Ground are carbonate sands, characteristically a molluscan shell hash. Sands are better sorted on the ridge tops than in the valleys.

2. Textural distribution of sediments on the Florida Middle Ground is patchy with a weak tendency for coarser material to lie on the ridge tops and the finer material in the valleys between.

3. Sediment distribution suggests that even the valleys of the Florida Middle Ground are actively winnowed of fine sediments.

4. There is no apparent difference in sediment carbonate constituents between the ridge tops and valleys.

5. Carbonate constituents in the sediments are more similar to those of the surrounding shelf than to the remains of organisms living on the Florida Middle Ground at present.

6. The carbonate constituent assemblage and the corroded nature of the grains show that local production of carbonate sediment is either masked by corroded carbonate shelf sands swept onto the Florida Middle Ground by storms and/or that the Florida Middle Ground is not as flourishing as it may locally appear, but in reality adds little carbonate to the relict assemblage. The latter conclusion is reinforced by television observation that the reef growth is primarily vertical, with little horizontal spreading.

7. The foraminiferal assemblages are dominated by nine species, the predominant of which is *Amphistegina gibbosa*.

8. Diversity and evenness of populations of foraminifera increased regularly from November, 1978 to June, 1979.

9. The number of species/sample, diversity, and evenness are noticeably less at station 151 and are very similar at the other three stations.

PHYSICAL AND CHEMICAL OCEANOGRAPHY

W. Schroeder, T. Hopkins

Conclusions

1. The seasonal meteorological observations are consistent with the established maritime conditions for the geographical position of the study site.

2. The seasonal water column hydrography (temperature, salinity, and dissolved oxygen) observations do not differ from the anticipated regimes for an outer shelf area of the open northeastern Gulf of Mexico. The possible exceptions are some of the low dissolved oxygen values, as low as 1.9 ppm or 26% saturation, measured near the bottom during Cruise FMG-01 (fall, 1978).

3. Light penetration measurements indicate rapid attenuation during the winter (Cruise FMG-03), particularly after the passage of a cold front (20% relative illuminance at depths of 4 to 5 m). During the summer (Cruise FMG-05), less attenuance was observed with depth (50% relative illuminance occurs to depths of 25 m).

4. The time series data sets for near-bottom temperatures show that the local winter (13 coldest weeks) occurred from late January through most of April, while the summer (13 hottest weeks) occurred from late July through most of October. The absolute range in temperatures was 15.2 to 29.4°C. The near-bottom salinity time series data ranged from 33 to 36 ppt. This is consistent with previously reported values.

5. Cross correlation computations of the near-bottom current meter records from stations 151 and 247 show that generally a high degree of correlation (> 0.75 coherency squared) existed between the two stations and a very high degree of correlation (> 0.95 coherency squared) occurred around the periods 24 and 120 to 130 hours.

6. Power spectra analysis indicates that most of the energy in the current records occurs at approximately 12.4 hours (semidaily tides) and 23.8 to 26.9 hours (combined daily tide and inertial motions). Rotary spectral analysis shows that there is more inertial energy (clockwise rotation) than daily tide energy (anti-clockwise rotation).

7. Mean flow calculations show that the near-bottom currents can be highly variable with very low mean speeds (< 2.0 cm/sec). Generally, the direction of the mean flow is either northwest or southeast, which is close to the orientation of the regional isobaths when considered on a scale of 10's to 100's of kilometres.

8. The principal axis of variance at both stations 151 and 247 is east-west (between 82 and 93% of the variance). The orientation is generally parallel to the isobaths of the adjacent coral reef complexes (on a scale of 10's to 100's of metres).

9. Hurricanes and tropical storm events generated the highest speeds recorded. The maximum near-bottom speed measured was approximately 61 cm/sec during tropical storm "Claudette," while the maximum near surface speed measured was approximately 87 cm/sec during Hurricane "Frederic."

10. Two-way ANOVA indicated highly significant ($p = 0.01$) differences in nutrients (POC, DOC, NO_3 AND SiO_2) and significant differences ($p = 0.05$) in PO_4 between seasons. Two-way ANOVA also suggests highly significant ($p = 0.01$) station differences for POC, DOC and SiO_2.

11. With the exception of silicate, all of the nutrient data values are considerably higher than previously reported. The Florida Middle Ground is a sizeable nutrient source, with peak output in all months.

Recommendations

1. Future current studies at the Florida Middle Grounds should:
   a. deploy instrument arrays with no less than near-bottom and near-surface current meters and conductivity-temperature units.
   b. establish one or two stations outside of the influence of the coral reef complexes.
   c. attempt to coordinate data acquisition during a period when the "loop current" is present over the study area.

2. Future chemical studies on the MAFLA OCS should:
   a. carefully evaluate the nutrient production within the Florida Middle Ground.
   b. develop information on nutrient transport away from the Florida Middle Ground and determine target delivery areas; e.g., are there habitats on the MAFLA OCS dependent on the Florida Middle Ground nutrients?

BIOLOGY

Conclusions

Algae

1. Seventy-four (74) species of algae were collected in June-July, 1976, as opposed to seventy-nine (79) species during June-July, 1979.

2. Comparing the two different years' collections, only a 36.6% similarity was found in species composition.

3. Stations 151 and 247 showed greater between-station similarity in 1979.

4. Station 247 showed consistently higher biomass and diversity in both 1979 and 1976.

5. The Florida Middle Ground algal population indicates that the Florida Middle Ground suffered a serious trauma between June-July 1976 and October 1978.

Hard and Soft Corals

1. *In situ* inspection and color photography indicate that the Florida Middle Ground hard and soft corals experienced a major trauma between June-July 1976 and June-July 1978.

2. The more delicate and/or tropically restricted species (e.g., *Agaricia*) were the best indicators of this trauma. Soft corals were greatly reduced in number and many were emaciated when present.

3. The calcareous milleporine, *Millepora*, which was formerly a major contributor to reef dimension, also showed effects of trauma.

4. The major trauma was probably a combination of 12-13°C water and storm surge whose severity in these waters was documented for 1977 and 1978.

Polychaeta

1. The polychaete family, Syllidae, proved to be an excellent bio-indicator of polychaete cryptofaunal diversity, occurring in 57 habitat/hosts investigated.

2. Syllids showed significant differences in "number/host" type, but much less difference between "same host" and "different station" and "host/station/season."

3. Epitokes occurred predominantly during the summer and fall, and were virtually absent in the winter.

Crustacea

1. Amongst the crustacea, isopods and caridean shrimp are the best major taxa for developing target species in cryptofaunal studies.

2. The cryptofaunal isopod fauna of the Florida Middle Ground was found to be relatively rich (21 species) and generally undescribed (seven forms new to science).

3. The isopod host/species relationship with the sponge *Agelas* was smaller and more consistent than the same relationship in the coral clump of *Madracis*.

4. There were no easily discernible seasonal or station differences in the isopod fauna; however, three distinct spatial habitats were encountered. These were a) planktonic, b) rubble, and c) specific host; e.g., Agelas and Madracis.

5. The Caridea are a major component of the cryptofaunal community and the Florida Middle Ground biotope. Fifty-nine (59) species are now known to occur in conjunction with this locality. Forty-eight (48) species was the previous record from a single locality in the Western Atlantic.

6. Twenty five (25) species of carideans were associated with sponges (18 species examined). Of the twenty five (25), six (6) species are obligate commensals of sponges.

7. Eighteen (18) species of carideans were associated with hard corals; however, none appear to be obligate commensal species.

8. Treating Agelas (sponge) and Madracis (coral) quantitatively (volume to number of individuals) revealed that 1) Synalpheus townsendi dominates the Madracis community and 2) Synalpheus agelas and S. townsendi are the dominants in Agelas. Station 151 corals and sponges supported more individuals and species than did station 247 corals and sponges. At both stations, S. townsendi, a facultative commensal, outnumbers S. agelas, an obligate commensal, in the sponge Agelas dispar.

9. A seasonal decline in cryptofaunal Caridea was observed during the winter season; commensal species with strong tropical affinities were possibly excluded in winter sampling.

10. A seasonal effect was also noted in reproductive activity. Reproductive activity during winter became attenuated or even eliminated. This situation applies to S. townsendi and S. agelas; the former a Caribbean eurythermic species and the latter a Caribbean restricted species.

11. This study has produced a wealth of new biological/systematic information on Caridea; e.g., two (2) new species, and unprecedented descriptions of color patterns in twenty-six (26) other Caridea.

12. Ten species of anomurous and brachyurous crabs account for 85% of the crab fauna. Two (2) species are new to science.

13. Host relations of Agelas and Madracis reveal differences in dominance and species make-up.

Echinoderms

1. The increased abundance of the temperate species sea urchin, Arbacia punctulata, and the concomittant decrease of the formerly ubiquitous tropical sea urchin, Diadema antillarum, is another possible indicator of trauma imposed by cold water. Furthermore, there was a

sharp decrease in the general numbers of Astrophyton muricatum, a basket-star (Ophuiroidea).

2. Aggregations of Echinaster were noted and assumed to be breeding aggregations. Almost nothing is known about the biology of this starfish.

Ichthyofauna

Results of the ichthyofaunal studies tend to confirm speculations by previous workers that the Florida Middle Ground supports a fauna with largely tropical West Indian affinity. A majority of the reef-associated (non-pelagic) species listed in Table XXI-53 have distributions including Caribbean and southern Florida waters. Florida Middle Ground fishes exemplify the northern extension of tropical faunal elements observed on deep hard-bank and sponge bottom substrates in the Gulf and along the Atlantic coast as far north as the Carolinas. An attempt at a detailed comparison of the Florida Middle Ground ichthyofauna with that of the Flower Gardens (Bright and Cashman, 1974) and other hard bank areas of the western Gulf of Mexico would be premature. While obvious differences exist in the species occurrences of these eastern and western Gulf deep-reef assemblages (e.g., the longtail bass, Hemanthias leptus, are present at the Flower Gardens, but absent at the Middle Ground), both faunas remain relatively poorly known in contrast with adjacent, shallow, inshore faunas. Most important, more information is needed on the respective abundances of those species which occur in both areas of the Gulf. For example, the wrasse bass, Liopropoma eukrines, appears to be fairly common in occurrence in the western Gulf, and rare in the eastern Gulf.

Perhaps the most glaring gap in knowledge of the Florida Middle Ground ichthyofauna concerns cryptic fishes. While the present study has shed light upon the overall community structure of the more "visible" component species, much remains to be determined as to the abundances of the "hidden" forms such as Lythrypnus spp., Ogilbia sp., and all of the apogonids. The fact that several species (Ogilbia sp., Psilotris celsus, and Gobulus myersi) were taken only in artificial habitat samples leads to the conclusion that additional species have escaped collection. Intensive collecting efforts emphasizing poison stations would be required to obtain abundance information on most of the cryptic species.

Future efforts at either short- or long-term monitoring of the Middle Ground ichthyofauna should consider the naturally occurring, large-scale fluctuations in population density shown by a number of species (e.g. bluehead wrasse, Thalassoma bifasciatum, and bicolor damselfish, Eupomacentrus partitus). These species would not be reliable for purposes of impact assessment. Criteria for selection of "key" monitoring species should include: 1) relatively stable and established seasonal trends in population density, 2) known general biology and life history patterns, and 3) ease of sampling. Based on the current status of knowledge of the Florida Middle Ground ichthyofauna, a most-likely candidate for such study would be the yellowprow goby, Gobiosoma xanthiprora. This fish is a year-round resident, a "dominant" species in terms of numerical abundance, and shows a significant dependence on the reef structure (in particular to the sponge Verongia fistularis). A historical data base exists for G. xanthiprora (Hopkins et al., 1977; Livingston, 1979, and this study). Also, quantitative sampling is facilitated by the inquiline habits of G. xanthiprora.

Summation

1. The Florida Middle Ground is a demonstratively unique biotope worthy of designation as a habitat of particular concern. This biotope supports both a Caribbean eurythermal species complex and a Caribbean restricted species complex of algae, invertebrates, and fishes. It can be hypothesized 1) that the northward intrusion of the loop current in spring and summer, 2) the usually short period of low water temperatures, and 3) concomittant high organic productivity encourage the survival of tropical recruits and breeding populations of the more hardy Caribbean restricted species. However, periodic extremely cold winters occur, and a combination of storm surge and cold water (12-13°C) remaining in residence for several days may bring about depauperation of the more tropical species. How often such a natural phenomenon occurs should be deduced from historical meteorological records.

2. The study has successfully explored the possibility of using selected cryptofaunal hosts as quantitative sampling units for biological monitoring, and elucidated which faunal groups will yield the most useful results. It found that 1) syllid polychaetes, (2) bivalve and gastropod molluscs, 3) isopod and caridean crustaceans, and 4) inquiline fishes are demonstrably useful.

3. The study has successfully explored the possible use of artificial habitats as biomonitoring devices. It was found that the design and deployment schedule were both feasible and practical.

4. The study has successfully explored and developed repeatedly meaningful methodologies for icthyofaunal census on the Florida Middle Ground.

5. The study suggests that the Florida Middle Ground biota is extremely fragile and susceptible to nature's vagaries. Consequently, those charged with stewardship of the Florida Middle Ground must be prudent when granting permission to drill. For example, in this investigator's opinion (T. Hopkins), it would not be prudent to drill exploratory wells for several years after major storm and cold water damage. The Florida Middle Ground will in all likelihood recover from nature's own devastation. However, like any organism already weak from serious injury, its susceptibility to either further depauperation or permanent change to a community of more temperate species is greatly enhanced.

6. In view of the foregoing, this investigator (T. Hopkins) recommends that should exploratory drilling on or near the Florida Middle Ground be necessary, it should be programmed during a mild

winter season. In this effort, management should make use of a) the historical meteorological record and b) the predicted path of the Gulf Loop Current in response to the meteorological conditions forecast.

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APPENDIX E

SUPPLEMENTARY TABLES

TABLE XXI-1
MANUFACTURER'S PERFORMANCE SPECIFICATIONS FOR THE HYDROLAB
WATER QUALITY SURVEYOR (WQS)

PARAMETER	RANGE	ACCURACY (Meter Reading)	RESPONSE TIME
Depth	0 to 100 m	±2.0% of range	-
(Temperature compensated pressure transducer)			
Temperature (Thermistor)	-5°C to + 45°C	±0.25°C	10 sec for step change
Conductivity	0 to 10^5 mmho/cm	± 2.5% of range	2 sec for conductivity step change, 10 sec for temperature step change
(Temperature compensated four-electrode AC cell, pure nickel electrodes.)			
Dissolved Oxygen	0 to 10 ppm	±2.0% of range	-
(Temperature compensated passive polargraphic cell.)			

TABLE XXI-2
ENDECO RECORDING INSTRUMENTS PERFORMANCE SPECIFICATIONS

INSTRUMENT	RANGE	ACCURACY
Refractometer-Thermograph		
Salinity (Modified Goldberg Refractometer with brush wiper)	0 to 45 ppt	0.2 ppt
Temperature (Mercury Thermometer)	0° to + 35°C	±0.2°C
Current Meter		
Current Speed (Ducted impeller)	0 to 3.8 knots	3.0% of range impeller; threshold 0.05 knots.
Current Direction (Magnetic compass)	0 to 360°	1.0% of range; sensitivity ±5° at 0.05 knots

TABLE XXI-3
GRAIN SIZE ANALYSIS - WEIGHT %

Sample #	Size Classes						
	<-1φ (>2.0 mm)	-1φ - 0φ (1.0-2.0 mm)	0φ - 1φ (0.5-1.0 mm)	1φ - 2φ (0.25-0.50 mm)	2φ - 3φ (0.125-0.25 mm)	3φ - 4φ (0.063-0.125 mm)	>4φ (<0.063 mm)
151990181004D-1	8.40	23.08	29.47	27.46	8.28	0.36	2.96
-2	9.47	24.12	24.67	24.21	13.73	1.28	2.52
-3	11.99	27.08	32.81	19.58	5.54	0.62	2.39
-4	8.08	19.45	29.33	29.83	10.13	0.70	2.50
5D-1	26.22	32.03	27.44	10.55	1.71	0.34	1.71
5F-1	36.53	32.06	22.89	6.31	0.74	0.09	1.38
-2	76.44	18.64	3.81	0.36	0.15	0.10	0.51
-3	39.50	37.02	19.27	3.16	0.51	0.13	0.42
-4	46.30	32.14	14.65	4.29	0.91	0.11	1.61
-5	53.96	35.25	8.30	0.91	0.24	0.14	1.20
19D-1	46.36	36.98	13.57	1.28	0.09	0.18	1.55
-2	32.01	39.95	21.83	3.84	0.53	0.27	1.59
-3	74.73	20.64	2.42	0.64	0.21	0.14	1.21
-4	17.25	35.80	26.52	14.49	3.77	0.44	1.74
-5	37.32	37.86	17.53	4.66	1.09	0.23	1.32
-6	12.35	40.02	31.70	10.96	2.64	0.23	2.10
-7	24.53	28.93	22.53	9.07	1.73	0.27	12.93
-8	56.56	27.86	4.70	0.64	0.21	0.21	9.82
-9	47.60	38.74	10.32	0.65	0.22	0.15	2.33
-10	17.19	34.54	28.59	13.90	2.89	0.32	2.57
481990181007A-1	5.21	13.17	29.66	36.67	11.32	1.11	2.87
-2	5.64	13.17	33.47	36.53	7.52	0.39	3.28
-3	4.02	13.46	34.29	35.06	9.54	0.73	2.91
-4	6.13	12.66	31.13	38.52	8.26	0.55	2.75
-5	8.97	14.22	29.24	33.28	9.37	0.97	3.96
-6	25.67	39.27	24.69	8.77	1.43	0.18	0.00

TABLE XXI-3 (Continued)

Sample #	Size Classes						
	<-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
481990181007A-7	13.76	31.04	32.51	17.14	3.23	0.21	2.11
-8	60.02	27.70	7.50	2.31	0.66	0.17	1.65
-9	6.91	27.36	36.50	22.19	4.96	0.35	1.75
-10	37.14	38.49	16.18	5.39	1.14	0.10	1.56
491990181016 -1	15.53	38.15	29.55	11.98	2.13	0.44	2.22
-2	30.81	31.54	18.64	13.51	2.02	0.43	3.06
-3	26.65	41.12	20.74	5.96	1.57	0.58	3.40
-4	19.78	34.36	24.70	12.81	3.90	0.51	3.95
-5	19.91	36.10	22.95	13.25	3.71	0.72	3.35
-6	28.72	38.20	18.42	8.85	1.88	0.46	3.47
-7	29.31	36.49	20.37	7.94	1.93	0.47	3.50
-8	39.49	25.15	19.78	9.80	1.95	0.30	3.54
-9	30.38	34.37	22.26	8.80	1.28	0.25	2.67
-10	28.91	38.19	20.57	6.91	1.72	0.47	3.23
247990181012G-1	12.40	33.42	29.59	17.73	3.83	0.35	2.68
-2	24.22	32.30	23.90	13.42	3.07	0.49	2.61
-3	14.20	40.41	28.06	12.22	2.32	0.41	2.39
-4	29.50	37.36	21.26	7.38	1.53	0.58	2.40
-5	16.40	32.47	28.66	15.64	3.69	0.43	2.71
13B-1	8.48	21.82	40.33	23.23	3.04	0.28	2.83
-2	12.96	27.97	38.09	15.76	2.05	0.37	2.80
-3	13.27	32.06	31.59	18.26	1.96	0.18	2.68
-4	9.09	28.17	39.97	16.79	2.21	0.49	3.28
-5	11.68	26.79	36.10	19.89	1.96	0.30	3.27
151210181107 -1	32.97	23.29	23.11	15.25	2.74	0.37	2.28
-2	23.76	37.17	20.35	12.24	3.86	0.52	2.09

TABLE XXI-3 (Continued)

Sample #	Size Classes						
	<-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
151210181107 -3	1.62	1.87	3.74	14.34	20.45	28.43	29.55
-4	0.75	0.86	1.71	20.66	61.46	7.92	6.64
151180181107 -1	4.69	1.08	2.09	16.03	57.62	11.12	7.37
151210181108 -1	8.90	25.34	37.69	23.74	2.26	0.18	1.90
-2							
-3	14.49	7.61	20.41	32.07	14.74	2.83	7.85
-4							
-5	13.16	35.10	31.83	15.32	2.79	0.28	1.53
481210181108 -1	0.18	1.65	2.94	20.00	42.02	22.02	11.19
-2	0.57	0.86	3.01	18.34	43.41	20.06	13.75
-3	21.92	47.25	18.42	7.71	2.70	0.40	1.60
-4	31.72	38.40	14.15	9.49	3.95	0.35	1.93
-5	47.91	28.18	13.55	5.35	1.92	0.50	2.59
-6	39.80	45.96	11.32	1.12	0.79	0.22	0.79
-7	33.23	32.04	22.98	7.23	2.27	0.43	1.83
-8	16.75	28.67	22.12	19.63	9.42	1.18	2.23
491210181109 -1	35.32	25.61	23.95	10.49	1.88	0.99	1.77
-2	14.75	39.22	30.07	11.83	1.54	0.49	2.11
-3	18.73	55.15	18.73	4.31	0.53	0.18	2.38
-4	14.17	37.43	32.34	10.03	3.13	0.58	2.33
-5	6.09	38.17	29.17	18.58	5.45	0.51	2.03
-6							
-7							
491210181111 -1	20.50	35.38	32.67	8.64	0.42	0.10	2.30
-2	4.46	13.71	19.04	10.12	6.96	10.99	34.71
-3	11.29	27.34	37.30	15.31	2.97	1.93	3.86

TABLE XXI-3 (Continued)

Sample #	Size Classes <-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
491210181111 -4	40.35	39.83	14.37	2.17	0.35	0.17	2.77
-5							
-6	12.73	21.82	29.37	25.18	7.55	0.98	2.38
-7	39.45	32.96	16.36	5.37	1.75	0.75	3.37
-8	13.27	37.13	31.44	12.64	1.74	0.32	3.48
247210181105 -1	0.91	1.46	3.29	14.23	42.15	28.47	9.49
-2	0.42	0.85	3.11	18.53	43.28	23.62	10.18
-3	7.16	32.09	39.66	19.37	1.41	0.30	0.00
-4	16.91	29.06	26.42	20.61	4.23	1.19	1.59
-5							
-6							
-7	3.83	13.02	35.68	35.99	9.04	0.61	1.84
-8							
-9	46.83	33.11	16.44	2.79	0.45	0.23	0.15
-10	25.18	40.49	24.82	7.34	1.27	0.36	0.54
247180181105 -1	17.27	31.57	31.92	15.49	1.25	0.36	2.14
-2	42.18	15.72	16.53	15.96	6.84	0.98	1.79
-3	14.15	29.37	40.96	13.67	0.84	0.30	0.72
-4							
-5	22.44	39.08	27.56	5.61	0.60	0.12	4.58
-6	29.21	37.75	24.01	4.95	0.50	0.37	3.22
151990190118D-1	32.96	36.25	21.63	5.56	1.44	0.62	1.55
-2	50.37	36.06	10.27	1.96	0.37	0.37	0.61
-3	27.67	31.68	22.07	9.93	5.81	1.27	1.58
-4	31.53	38.82	18.71	7.41	1.77	0.59	1.18
-5	44.56	27.68	19.93	6.37	0.83	0.19	0.46

TABLE XXI-3 (Continued)

Sample #	Size Classes						
	<-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
151990190118D-6	25.28	35.26	29.10	8.30	1.12	0.47	0.47
-7	11.57	34.90	40.94	10.95	0.82	0.31	0.51
-8	58.07	22.71	11.04	4.96	2.11	0.50	0.62
-9	51.88	31.13	11.96	3.36	1.48	0.20	0.00
-10	36.68	38.15	19.37	4.23	0.89	0.20	0.49
151990190203A-1	26.71	44.58	22.49	4.62	1.41	0.20	0.00
-2	41.65	34.36	17.97	4.23	0.53	0.21	1.06
-3	39.04	26.13	20.36	10.28	2.83	0.32	1.05
-4	38.06	31.92	22.32	6.14	0.78	0.22	0.56
-5	36.74	23.28	33.70	4.56	0.51	0.20	1.01
-6	45.58	31.97	17.57	3.40	0.79	0.11	0.57
-7	79.71	17.09	1.87	0.22	0.33	0.22	0.55
-8	43.23	32.06	17.65	5.06	1.24	0.29	0.48
-9	39.75	34.38	20.77	3.94	0.54	0.18	0.45
-10	41.38	30.65	19.29	6.64	1.15	0.26	0.64
247990190130A-1	12.49	13.50	25.71	33.24	10.93	2.20	1.93
-2	18.32	24.33	30.27	21.50	3.70	1.12	0.77
-3	23.30	23.72	25.90	19.34	4.46	1.68	1.60
-4	24.07	26.90	28.57	15.83	3.09	0.64	0.90
-5	14.79	23.69	32.58	20.53	4.69	2.02	1.70
-6	13.12	15.39	27.07	27.70	9.21	3.72	3.79
-7	22.16	21.48	30.00	20.34	3.98	0.91	1.14
-8	10.28	14.02	26.66	28.57	12.02	4.70	3.75
-9	25.49	26.96	26.96	16.08	3.14	0.78	0.59
-10	7.47	8.08	21.51	33.66	16.08	5.59	7.62
247210190130A-1	4.03	6.55	23.67	48.55	15.22	1.29	0.69

TABLE XXI-3 (Continued)

Sample #	Size Classes						
	<-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
247210190130A-2	5.02	27.43	33.39	25.50	5.87	1.93	0.85
-3	3.79	12.45	24.36	29.09	13.67	7.71	8.93
-4	18.72	34.75	27.06	14.18	3.52	0.65	1.11
-5	6.48	11.28	14.05	15.21	7.21	13.61	32.17
-6	32.16	40.08	20.55	4.16	0.78	0.86	1.41
-7	23.40	9.61	22.45	29.20	10.93	2.57	1.83
-8	16.76	43.35	32.02	6.58	0.68	0.41	0.20
-9	35.26	41.23	20.75	2.32	0.27	0.09	0.09
-10	4.06	33.55	51.96	9.78	0.44	0.15	0.07
481990190708C-1	17.92	29.00	33.70	13.99	4.10	0.76	0.53
-2	5.97	17.59	31.29	29.81	11.40	2.58	1.37
-3	11.79	32.98	35.17	13.86	5.52	0.50	0.19
-4	20.38	26.46	31.16	17.06	4.05	0.45	0.45
-5	9.38	22.88	37.53	23.80	5.57	0.46	0.38
-6	11.96	26.28	30.64	24.18	5.49	0.81	0.65
-7	15.40	22.43	28.57	23.72	7.98	1.12	0.78
-8	22.62	26.78	33.67	13.88	2.36	0.42	0.28
-9	15.49	25.33	34.05	19.74	4.51	0.51	0.36
-10	9.37	15.03	35.92	31.42	7.33	0.62	0.31
491990190703F-1	25.95	30.24	24.24	13.72	4.51	0.78	0.57
-2	12.11	31.57	29.53	19.07	5.54	1.06	1.11
-3	21.59	33.57	27.28	13.46	3.14	0.59	0.36
-4	27.74	29.74	24.52	13.20	3.64	0.65	0.53
-5	27.34	35.07	21.63	11.52	3.18	0.70	0.56
C-1	14.19	33.33	28.14	17.23	5.62	1.03	0.47
-2	8.75	20.99	32.65	28.35	7.43	0.73	1.09

TABLE XXI-3 (Continued)

Sample #	Size Classes						
	<-1ϕ (>2.0 mm)	-1ϕ - 0ϕ (1.0-2.0 mm)	0ϕ - 1ϕ (0.5-1.0 mm)	1ϕ - 2ϕ (0.25-0.50 mm)	2ϕ - 3ϕ (0.125-0.25 mm)	3ϕ - 4ϕ (0.063-0.125 mm)	>4ϕ (<0.063 mm)
491990190703C-3	10.17	21.32	32.20	27.53	7.04	1.12	0.63
-4	11.36	32.63	30.28	17.89	5.65	1.10	1.10
-5	13.54	26.85	30.37	21.09	6.58	0.90	0.67
247990190624C-1	25.57	22.53	27.19	19.87	3.59	0.66	0.59
-2	19.63	15.36	28.50	27.24	6.38	1.30	1.59
-3	4.68	15.96	36.18	33.15	7.43	1.58	1.03
-4	27.68	16.14	27.30	22.86	4.23	0.98	0.81
-5	20.48	18.55	30.70	23.34	4.83	1.07	1.04
-6	11.80	13.45	24.75	31.78	13.05	3.50	1.68
-7	18.62	19.50	28.58	27.58	4.42	0.54	0.77
-8	3.38	16.16	31.81	33.39	10.36	2.99	1.91
-9	17.50	23.40	32.13	22.18	3.46	0.67	0.67
-10	11.07	17.01	40.23	23.10	5.14	1.78	1.66
151990190626E-1	17.88	40.24	31.03	9.25	1.41	0.12	0.08
-2	40.12	40.73	16.39	2.42	0.17	0.09	0.09
-3	51.99	24.09	14.75	7.14	1.79	0.18	0.06
-4	87.57	10.57	1.49	0.16	0.11	0.05	0.05
-5	44.60	42.88	11.51	0.94	0.04	0.00	0.04
-6	73.93	20.50	4.30	0.87	0.30	0.07	0.03
-7	35.19	36.14	23.87	4.09	0.51	0.14	0.07
-8	56.05	27.56	11.39	3.74	0.99	0.17	0.11
-9	51.31	34.67	11.36	2.12	0.48	0.03	0.03
-10	33.02	38.41	22.97	4.77	0.52	0.16	0.16

TABLE XXI-4
PERCENT CARBONATE AND TOC DATA

Sample No.	% Carbonate	% T.O.C.
151990181004D-1	97.10	0.381
-2	98.60	0.139
-3	98.60	0.166
-4	98.90	0.117
5D-1	97.90	0.153
5F-1	97.00	0.136
-2	98.70	0.161
-3	97.70	0.132
-4	97.50	0.141
-5	97.50	0.143
19D-1	98.40	0.187
-2	98.70	0.353
-3	99.00	0.163
-4	99.20	0.360
-5	98.80	0.160
-6	99.30	0.155
-7	99.10	0.143
-8	98.20	0.175
-9	97.90	0.351
-10	98.90	0.138
481990181007A-1	98.50	0.188
-2	98.20	0.182
-3	99.00	0.171
-4	98.90	0.427
-5	98.90	0.177
-6	97.70	0.159
-7	97.90	0.176
-8	99.00	0.135
-9	97.00	0.169
-10	98.50	0.144
491990181016 -1	99.00	0.163
-2	98.30	0.151
-3	98.50	0.151
-4	98.40	0.380
-5	99.00	0.182
-6	99.10	0.181
-7	99.20	0.336
-8	98.40	0.367
-9	98.60	0.367
-10	98.40	01.77
247990181012G-1	98.80	0.132
-2	98.70	0.115
-3	98.80	0.156

TABLE XXI-4 (Continued)

Sample No.	% Carbonate	% T.O.C.
247990181012G-4	98.60	0.116
-5	98.90	0.140
13B-1	98.20	0.237
-2	98.80	0.395
-3	98.60	0.394
-4	98.90	0.144
-5	98.60	0.094
151210181107 -1	99.01	0.151
-2	99.23	0.136
-3	93.82	0.330
-4	78.15	0.135
151180181107 -1	75.01	0.161
151210181108 -1	99.09	0.111
-2	-----	-----
-3	96.75	0.152
-4	-----	-----
-5	99.28	0.378
481210181108 -1	85.47	0.105
-2	90.65	0.218
-3	86.08	0.137
-4	94.46	0.132
-5	95.77	0.163
-6	98.06	0.146
-7	98.25	0.099
-8	98.83	0.126
491210181109 -1	83.07	0.176
-2	91.45	0.164
-3	92.46	0.145
-4	91.53	0.153
-5	90.40	0.163
-6	-----	-----
-7	-----	-----
491210181111 -1	92.34	0.115
-2	86.68	0.487
-3	96.55	0.209
-4	96.63	0.132
-5	97.74	0.162
-6	92.84	0.406
-7	87.45	0.266
-8	90.84	0.387
247210181105 -1	92.34	0.241
-2	93.67	0.208
-3	98.77	0.144

TABLE XXI-4 (Continued)

Sample No.	% Carbonate	% T.O.C.
247210181105 -4	98.79	0.202
-5	-----	-----
-6	-----	-----
-7	98.85	0.168
-8	-----	-----
-9	99.35	0.128
-10	99.99	0.173
247180181105 -1	98.32	0.128
-2	98.74	0.143
-3	99.28	0.126
-4	-----	-----
-5	98.75	0.139
-6	98.83	0.150
151990190118D-1	95.76	0.197
-2	96.61	0.225
-3	86.73	0.448
-4	92.16	0.223
-5	89.12	0.160
-6	89.53	0.379
-7	95.59	0.145
-8	96.44	0.401
-9	97.65	0.170
-10	87.85	0.407
151990190203A-1	86.96	0.390
-2	92.08	0.376
-3	87.58	0.172
-4	92.63	0.341
-5	90.17	0.148
-6	90.86	0.336
-7	92.06	0.414
-8	86.09	0.157
-9	92.26	0.326
-10	86.78	0.129
247990190130A-1	96.92	0.157
-2	96.79	0.122
-3	95.35	0.159
-4	92.50	0.105
-5	97.40	0.119
-6	94.00	0.202
-7	87.78	0.096
-8	95.93	0.169
-9	91.27	0.089
-10	91.53	0.205

TABLE XXI-4 (Continued)

Sample No.	% Carbonate	% T.O.C.
247210190130A-1	93.05	0.109
-2	88.80	0.132
-3	92.06	0.194
-4	93.08	0.163
-5	91.40	0.305
-6	93.90	0.110
-7	97.74	0.119
-8	93.51	0.116
-9	99.22	0.118
-10	96.17	0.084
481990190708C-1	90.68	0.132
-2	97.46	0.106
-3	87.39	0.169
-4	96.99	0.136
-5	98.10	0.136
-6	83.97	0.121
-7	95.57	0.127
-8	94.42	0.122
-9	92.20	0.144
-10	93.58	0.113
491990190703F-1	-----	0.121
-2	-----	0.146
-3	96.86	0.145
-4	97.23	0.149
-5	92.25	0.156
C-1	-----	0.147
-2	97.64	0.135
-3	-----	0.147
-4	95.94	0.130
-5	97.53	0.151
247990190624C-1	96.91	0.147
-2	95.23	0.136
-3	96.92	0.136
-4	91.83	0.122
-5	98.08	0.118
-6	93.13	0.142
-7	98.72	0.127
-8	90.31	0.145
-9	96.77	0.124
-10	90.43	0.126
151990190626E-1	94.04	0.128
-2	91.91	0.134
-3	96.75	0.150
-4	87.66	0.107

TABLE XXI-4 (Continued)

Sample No.	% Carbonate	% T.O.C.
151990190626E-5	94.15	0.105
-6	90.56	0.105
-7	96.43	0.158
-8	98.50	0.132
-9	92.99	0.107
-10	97.64	0.121

TABLE XXI-5
SEDIMENT CONSTITUENT DATA

Sample No.	Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	Halimeda	Goniolithon	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
151990180114D-1	1.67	0.00	1.00	1.67	1.33	4.00	18.67	6.67	0.00	7.00	1.67	0.00	4.33	0.00	0.67	51.33	0.00	0.00	0.00	0.00
-2	1.32	0.33	0.33	2.65	1.99	8.28	13.58	5.30	0.33	5.96	0.99	0.00	5.63	1.66	0.66	50.33	0.00	0.00	0.00	0.66
-3	2.66	0.00	1.00	2.99	1.00	6.98	15.28	2.66	0.00	2.66	0.66	0.00	3.99	1.66	0.66	57.48	0.00	0.00	0.00	0.33
-4	1.00	0.00	1.00	2.33	1.66	3.65	9.30	2.99	0.00	4.32	0.33	0.00	2.99	0.33	0.00	69.77	0.00	0.00	0.00	0.33
5D-1	2.67	0.33	1.33	4.00	0.33	2.67	11.33	4.33	0.00	2.67	0.67	0.00	2.33	0.00	0.00	67.33	0.00	0.00	0.00	0.00
5F-1	1.66	0.00	0.00	3.99	0.33	4.98	12.29	7.31	0.00	5.65	1.00	0.00	1.66	0.00	0.66	60.13	0.00	0.00	0.00	0.33
-2	1.29	0.00	0.32	2.89	0.96	5.14	17.36	4.18	0.00	4.50	0.64	0.00	4.50	0.00	1.29	56.59	0.00	0.32	0.00	0.00
-3	2.31	0.00	0.99	4.29	0.00	2.64	13.86	5.61	0.00	5.94	0.00	0.00	4.29	0.99	0.33	57.76	0.00	0.00	0.00	0.99
-4	0.99	0.00	0.66	0.33	0.33	4.97	18.54	1.99	0.00	9.93	0.33	0.00	2.98	0.00	0.00	58.28	0.00	0.00	0.66	0.00
-5	0.00	0.00	1.00	1.00	1.33	3.67	17.33	7.00	0.00	7.33	0.67	0.00	1.67	0.00	2.00	57.00	0.00	0.00	0.00	0.00
19D-1	3.93	0.00	0.66	4.92	1.97	3.28	12.13	0.98	0.00	3.28	0.00	0.00	1.97	0.66	0.33	64.26	0.00	0.00	0.00	1.64
-2	2.33	0.00	1.67	2.00	1.33	2.67	26.00	7.33	0.33	5.00	0.00	0.00	3.33	0.00	0.33	47.67	0.00	0.00	0.00	0.00
-3	5.00	0.00	0.00	0.00	4.00	5.00	31.00	2.00	0.00	3.00	0.00	0.00	2.00	0.00	0.00	48.00	0.00	0.00	0.00	0.00
-4	2.00	0.00	2.00	4.00	0.00	3.00	26.00	14.00	0.00	3.00	0.00	0.00	5.00	0.00	1.00	40.00	0.00	0.00	0.00	0.00
-5	3.00	1.00	0.00	8.00	0.00	2.00	36.00	4.00	1.00	3.00	0.00	0.00	4.00	0.00	0.00	38.00	0.00	0.00	0.00	0.00
-6	3.03	0.00	1.01	2.02	1.01	6.06	33.33	6.06	0.00	5.05	1.01	0.00	0.00	1.01	0.00	39.39	0.00	0.00	0.00	1.01
-7	5.05	0.00	0.00	3.03	0.00	2.02	30.30	2.02	0.00	1.01	0.00	0.00	1.01	0.00	0.00	55.56	0.00	0.00	0.00	0.00
-8	4.00	0.00	1.00	2.00	0.00	2.00	40.00	7.00	0.00	6.00	0.00	0.00	3.00	1.00	0.00	34.00	0.00	0.00	0.00	0.00
-9	3.00	0.00	0.00	1.00	0.00	2.00	40.00	4.00	1.00	6.00	0.00	0.00	2.00	1.00	3.00	37.00	0.00	0.00	0.00	0.00
-10	3.70	3.70	1.85	3.70	3.70	2.78	27.78	0.93	0.00	0.00	0.93	0.00	6.48	1.85	0.00	42.59	0.00	0.00	0.00	0.00
481990181007A-1	0.33	0.00	2.67	2.33	1.67	4.67	17.67	3.67	0.00	2.33	3.67	0.00	5.33	1.33	0.33	54.00	0.00	0.00	0.00	0.00
-2	3.97	0.00	0.66	6.62	1.99	4.30	23.16	4.64	0.00	1.99	0.99	0.33	2.65	1.66	0.00	46.36	0.00	0.00	0.00	0.66
-3	3.00	2.00	4.00	5.00	0.00	1.00	28.00	1.00	0.00	0.00	0.00	0.00	3.00	1.00	0.00	49.00	0.00	0.00	0.00	3.00
-4	2.00	0.00	0.00	5.00	1.00	1.00	34.00	2.00	0.00	1.00	1.00	0.00	2.00	2.00	0.00	48.00	0.00	0.00	0.00	1.00
-5	1.00	0.00	1.00	6.00	0.00	2.00	31.00	11.00	0.00	1.00	2.00	0.00	4.00	2.00	0.00	38.00	0.00	0.00	0.00	1.00
-6	0.00	0.00	1.00	1.00	1.00	0.00	35.00	7.00	0.00	11.00	0.00	0.00	4.00	0.00	1.00	39.00	0.00	0.00	0.00	0.00
-7	2.00	0.00	2.00	6.00	0.00	2.00	44.00	7.00	0.00	3.00	1.00	0.00	2.00	0.00	1.00	30.00	0.00	0.00	0.00	0.00
-8	4.00	0.00	0.00	3.00	0.00	0.00	34.00	2.00	2.00	5.00	0.00	0.00	4.00	1.00	0.00	44.00	0.00	0.00	0.00	1.00
-9	1.00	0.00	1.00	3.00	1.00	2.00	39.00	5.00	0.00	3.00	1.00	0.00	0.00	2.00	0.00	42.00	0.00	0.00	0.00	0.00
-10	2.97	0.00	0.00	1.98	0.00	0.99	48.51	1.98	0.00	2.97	0.00	0.00	3.96	0.00	0.00	35.64	0.00	0.00	0.00	0.99
491990181016 -1	2.67	0.00	0.67	0.67	1.00	3.33	17.67	2.00	0.33	1.67	0.33	0.00	1.00	1.33	0.00	67.33	0.00	0.00	0.00	0.00
-2	1.00	0.00	2.33	1.00	6.33	3.67	23.33	3.00	0.00	7.33	1.67	0.00	1.67	0.00	0.00	48.67	0.00	0.00	0.00	0.00

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI-5 (Continued)

Sample No.	Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	Halimeda	Goniolithon	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
491990181016 -3	2.00	0.00	1.00	0.00	6.00	1.00	25.00	6.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	57.00	0.00	0.00	0.00	0.00
-4	0.00	0.00	2.00	1.00	5.00	4.00	33.00	5.00	0.00	3.00	0.00	0.00	0.00	1.00	0.00	46.00	0.00	0.00	0.00	0.00
-5	2.00	0.00	2.00	1.00	5.00	4.00	33.00	5.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	48.00	0.00	0.00	0.00	0.00
-6	1.98	0.00	0.99	1.98	1.98	0.00	42.57	2.97	1.98	1.98	0.99	0.00	0.99	0.99	0.00	40.59	0.00	0.00	0.00	0.00
-7	1.00	0.00	2.00	0.00	2.00	2.00	37.00	3.00	2.00	4.00	0.00	0.00	0.00	2.00	0.00	45.00	0.00	0.00	0.00	0.00
-8	1.00	0.00	4.00	1.00	1.00	3.00	26.00	5.00	1.00	2.00	0.00	0.00	3.00	2.00	0.00	51.00	0.00	0.00	0.00	0.00
-9	3.00	1.00	1.00	0.00	3.00	0.00	25.00	6.00	0.00	1.00	0.00	0.00	0.00	3.00	0.00	57.00	0.00	0.00	0.00	0.00
-10	5.00	0.00	0.00	2.00	0.00	1.00	36.00	2.00	0.00	1.00	0.00	0.00	0.00	2.00	0.00	51.00	0.00	0.00	0.00	0.00
247990181012G-1	1.33	0.00	0.66	5.98	0.00	5.65	17.94	2.66	0.00	1.33	0.33	0.00	0.66	0.33	0.33	60.47	0.00	0.00	0.00	0.33
-2	2.67	0.00	1.00	4.67	1.67	3.00	28.67	4.00	0.33	8.33	0.67	0.00	0.00	0.33	0.00	44.67	0.00	0.00	0.00	0.00
-3	4.00	0.00	1.00	3.00	0.00	4.00	38.00	1.00	0.00	5.00	0.00	0.00	1.00	0.00	0.00	40.00	0.00	0.00	0.00	1.00
-4	2.00	2.00	2.00	2.00	1.00	2.00	34.00	3.00	1.00	4.00	0.00	0.00	2.00	2.00	0.00	42.00	0.00	0.00	0.00	1.00
-5	1.00	2.00	0.00	6.00	0.00	2.00	52.00	2.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	33.00	0.00	0.00	0.00	0.00
13B-1	0.00	0.00	1.00	6.00	1.00	1.00	53.00	2.00	0.00	6.00	0.00	0.00	0.00	4.00	0.00	26.00	0.00	0.00	0.00	0.00
-2	3.00	0.00	0.00	1.00	4.00	1.00	40.00	4.00	0.00	7.00	0.00	0.00	1.00	3.00	1.00	35.00	0.00	0.00	0.00	0.00
-3	0.00	0.00	3.13	3.13	0.00	2.08	35.42	1.04	0.00	5.21	1.04	0.00	0.00	2.08	0.00	46.88	0.00	0.00	0.00	0.00
-4	5.00	0.00	0.00	2.00	0.00	2.00	42.00	2.00	0.00	6.00	1.00	0.00	2.00	2.00	0.00	36.00	0.00	0.00	0.00	0.00
-5	2.02	0.00	1.01	5.05	0.00	2.02	38.38	1.01	0.00	0.00	0.00	0.00	1.01	1.01	0.00	48.48	0.00	0.00	0.00	0.00
151210181107 -1	5.00	0.00	1.00	4.00	0.33	7.00	14.67	5.00	0.33	7.67	2.00	0.33	2.67	0.33	0.00	49.67	0.00	0.00	0.00	0.00
-2	5.92	0.00	0.62	7.35	0.00	3.06	32.25	6.12	0.20	1.63	0.20	0.20	1.63	1.43	0.20	37.14	0.20	0.00	0.00	1.84
-3	15.40	0.00	1.40	0.40	0.00	4.80	33.80	4.60	2.00	3.60	2.00	1.20	0.40	8.00	0.00	21.80	0.00	0.00	0.00	0.60
-4	10.41	0.00	2.62	0.23	0.00	2.04	34.84	1.13	0.68	0.91	1.13	0.00	0.45	4.07	0.45	35.07	0.00	0.00	0.00	6.33
151180181107 -1	11.80	0.00	1.00	1.40	0.00	2.20	34.60	2.00	0.40	1.40	1.20	0.00	0.00	2.20	0.20	29.80	0.00	0.00	0.00	11.80
151210181108 -1	5.00	0.00	1.00	3.40	0.00	2.00	35.60	3.20	0.40	4.00	0.20	0.20	1.20	0.40	0.20	41.00	0.00	0.00	0.00	2.20
-2																				
-3	6.60	0.00	0.60	3.60	0.00	4.20	36.40	2.60	0.20	5.00	0.80	0.20	0.60	1.00	0.00	34.80	0.00	0.00	0.00	3.40
-4																				
-5	6.41	0.00	0.60	3.61	0.00	1.00	39.28	2.61	0.20	1.80	0.20	0.00	0.40	0.20	0.00	41.08	0.00	0.00	0.00	2.61
481210181108 -1	12.00	1.00	0.67	2.67	0.00	2.00	14.33	4.00	1.67	0.33	0.67	0.00	0.67	4.00	0.00	54.33	0.00	0.00	0.00	1.67
-2	5.94	0.99	0.99	0.99	0.00	0.00	34.65	0.00	0.99	0.00	0.00	0.00	0.00	4.95	0.00	44.55	0.00	0.00	0.00	5.94
-3	0.00	0.00	1.00	0.00	0.00	4.00	34.00	1.00	0.00	13.00	0.00	1.00	0.00	0.00	2.00	44.00	0.00	0.00	0.00	0.00
-4	5.00	0.00	3.00	4.00	0.00	4.00	41.00	6.00	0.00	6.00	2.00	0.00	3.00	0.00	0.00	26.00	0.00	0.00	0.00	0.00

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI-5 (Continued)

Sample No.		Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	Halimeda	Goniolithon	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
481210181108	-5	8.00	0.00	0.00	2.00	0.00	6.00	43.00	7.00	0.00	2.00	1.00	0.00	2.00	1.00	0.00	27.00	0.00	0.00	0.00	1.00
	-6	6.00	0.00	0.00	0.00	0.00	2.00	39.00	1.00	0.00	8.00	0.00	0.00	1.00	0.00	1.00	42.00	0.00	0.00	0.00	0.00
	-7	7.00	0.00	2.00	2.00	0.00	6.00	30.00	7.00	1.00	6.00	0.00	0.00	2.00	0.00	0.00	37.00	0.00	0.00	0.00	0.00
	-8	6.00	0.00	1.20	4.40	0.00	2.80	38.80	1.80	0.60	6.00	0.00	0.80	0.00	1.20	0.20	35.60	0.00	0.00	0.00	0.60
491210181109	-1	4.33	0.00	2.00	0.33	1.67	7.33	14.00	6.67	0.67	4.67	1.00	0.67	0.33	0.33	2.67	53.33	0.00	0.00	0.00	0.00
	-2	5.00	0.00	1.00	0.00	0.00	2.00	36.00	6.00	1.00	5.00	0.00	1.00	2.00	0.00	0.00	41.00	0.00	0.00	0.00	0.00
	-3	7.00	0.00	0.00	0.00	0.00	4.00	48.00	2.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	36.00	0.00	0.00	0.00	0.00
	-4	5.60	0.00	0.40	1.00	0.00	1.80	36.40	1.80	0.80	0.80	0.40	0.40	0.00	0.60	0.00	40.40	0.00	0.20	0.00	9.40
	-5	5.40	0.00	0.40	1.00	0.00	1.40	34.00	2.60	0.00	0.80	0.40	0.20	0.80	0.80	0.20	40.40	0.00	0.00	0.00	11.60
	-6																				
	-7																				
491210181111	-1	2.00	0.00	0.00	0.00	0.00	1.00	45.00	6.00	0.00	5.00	0.00	0.00	3.00	0.00	0.00	38.00	0.00	0.00	0.00	0.00
	-2	8.00	2.00	1.00	0.00	0.00	0.00	33.00	0.00	1.00	0.00	0.00	0.00	0.00	16.00	0.00	38.00	0.00	0.00	0.00	1.00
	-3	6.00	0.00	0.00	1.00	0.00	1.00	38.00	3.00	0.00	6.00	1.00	0.00	2.00	0.00	1.00	40.00	0.00	0.00	0.00	1.00
	-4	3.68	0.00	0.79	2.37	0.00	2.37	49.21	2.89	0.00	4.21	0.00	0.00	0.52	3.42	0.00	29.47	0.00	0.00	0.00	1.05
	-5	6.00	0.00	0.00	0.00	1.00	5.00	28.00	8.00	0.00	6.00	1.00	1.00	1.00	1.00	0.00	42.00	0.00	0.00	0.00	0.00
	-6	2.00	0.00	1.00	4.00	1.00	5.00	31.00	5.00	3.00	3.00	0.00	0.00	3.00	2.00	0.00	39.00	0.00	0.00	0.00	1.00
	-7	9.00	0.00	5.00	0.00	1.00	5.00	37.00	6.00	0.00	1.00	0.00	0.00	2.00	3.00	0.00	29.00	0.00	0.00	0.00	2.00
	-8	6.40	0.00	1.20	1.80	0.00	1.60	29.80	4.00	0.20	2.40	1.20	0.00	0.80	0.20	0.60	35.80	3.00	0.00	0.00	11.00
247210181105	-1	8.67	0.00	0.67	1.67	0.00	1.67	14.67	0.67	0.00	0.00	0.33	0.00	0.00	2.67	0.00	65.00	0.00	0.00	0.00	4.00
	-2	8.60	0.00	1.00	0.20	0.20	2.80	46.40	2.20	0.20	3.00	1.40	0.00	0.20	1.20	0.00	31.00	0.00	0.00	0.00	1.60
	-3	6.60	0.00	1.80	3.40	0.00	1.80	39.40	3.00	0.40	7.00	0.20	0.20	1.00	0.80	0.00	33.40	0.00	0.00	0.00	1.00
	-4	4.40	0.00	1.80	2.60	0.00	3.00	38.20	3.60	0.20	8.40	1.00	0.00	1.60	1.60	0.00	32.40	0.00	0.00	0.00	2.40
	-5																				
	-6																				
	-7	3.40	0.00	0.80	5.00	0.00	4.00	35.80	4.60	0.20	6.40	1.00	0.00	0.60	1.20	0.20	36.40	0.00	0.00	0.00	0.40
	-8																				
	-9	4.80	0.00	1.20	2.40	0.00	1.00	37.60	4.00	0.00	5.00	0.20	0.00	0.80	0.40	0.00	41.80	0.00	0.00	0.00	0.80
	-10	3.20	0.00	0.80	6.00	0.00	0.80	31.40	4.20	0.00	5.80	0.00	0.00	0.60	1.40	0.00	43.60	0.00	0.00	0.00	2.20
247180181105	-1	3.80	0.00	1.20	3.00	0.00	1.00	31.80	2.00	0.20	8.00	1.00	0.40	1.60	0.40	0.20	43.00	0.00	0.00	0.00	2.40
	-2	1.80	0.00	1.00	2.60	0.00	4.00	37.40	3.60	0.00	7.80	1.20	0.00	2.20	1.20	0.00	37.00	0.00	0.00	0.00	0.20
	-3	3.40	0.00	0.40	12.20	0.20	2.00	37.60	2.80	0.00	3.60	0.00	0.00	1.40	0.00	0.00	34.60	0.00	0.00	0.00	1.80

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI-5 (Continued)

Sample No.	Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	*Halimeda*	*Goniolithon*	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
247990190130A-10	4.90	0.00	0.00	1.96	0.00	0.98	38.23	3.92	0.00	5.88	0198	0.00	0.98	3.92	0.98	37.25	0.00	0.00	0.00	0.00
247210190130A-1	8.00	0.00	0.00	6.00	0.00	2.00	27.00	4.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.00	6.00
-2	4.00	0.00	3.00	0.00	0.00	2.00	34.00	3.00	0.00	2.00	1.00	0.00	1.00	3.00	0.00	47.00	0.00	0.00	0.00	0.00
-3	9.00	0.00	3.00	3.00	0.00	3.00	24.00	1.00	1.00	6.00	1.00	0.00	3.00	2.00	0.00	41.00	0.00	0.00	0.00	3.00
-4	4.00	0.00	0.00	1.00	0.00	4.00	39.00	5.00	0.00	8.00	0.00	1.00	2.00	1.00	0.00	34.00	0.00	0.00	0.00	1.00
-5	10.00	1.00	1.00	3.00	0.00	0.00	36.00	1.00	1.00	0.00	0.00	0.00	2.00	13.00	0.00	29.00	0.00	0.00	0.00	3.00
-6	0.00	0.00	1.00	5.00	0.00	0.00	33.00	6.00	0.00	2.00	0.00	0.00	1.00	0.00	1.00	51.00	0.00	0.00	0.00	0.00
-7	10.00	1.00	0.00	10.00	0.00	5.00	36.00	1.00	1.00	0.00	0.00	0.00	2.00	0.00	0.00	34.00	0.00	0.00	0.00	0.00
-8	1.00	0.00	1.00	2.00	0.00	5.00	50.00	2.00	0.00	7.00	1.00	0.00	3.00	1.00	1.00	26.00	0.00	0.00	0.00	0.00
-9	3.00	2.00	2.00	6.00	0.00	2.00	29.00	2.00	0.00	3.00	1.00	0.00	0.00	12.00	0.00	38.00	0.00	0.00	0.00	0.00
-10	3.00	0.00	0.00	4.00	0.00	1.00	47.00	1.00	0.00	3.00	0.00	0.00	2.00	0.00	0.00	39.00	0.00	0.00	0.00	0.00
481990190708C-1	1.00	0.00	0.00	0.00	1.00	6.00	47.00	4.00	0.00	4.00	0.00	0.00	5.00	0.00	0.00	32.00	0.00	0.00	0.00	0.00
-2	5.00	1.00	1.00	1.00	0.00	2.00	49.00	5.00	1.00	1.00	1.00	0.00	2.00	2.00	0.00	27.00	0.00	0.00	0.00	2.00
-3	3.00	0.00	1.00	4.00	1.00	5.00	37.00	6.00	0.00	6.00	1.00	0.00	6.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00
-4	5.00	0.00	1.00	4.00	1.00	4.00	42.00	6.00	2.00	1.00	0.00	0.00	2.00	0.00	0.00	32.00	0.00	0.00	0.00	0.00
-5	5.00	3.00	2.00	2.00	0.00	4.00	32.00	5.00	1.00	2.00	0.00	0.00	3.00	0.00	0.00	41.00	0.00	0.00	0.00	0.00
-6	2.00	0.00	2.00	2.00	1.00	3.00	33.00	7.00	1.00	6.00	0.00	0.00	5.00	1.00	0.00	37.00	0.00	0.00	0.00	0.00
-7	3.00	0.00	2.00	3.00	1.00	4.00	47.00	5.00	0.00	3.00	0.00	0.00	5.00	0.00	0.00	27.00	0.00	0.00	0.00	0.00
-8	4.00	0.00	0.00	0.00	0.00	6.00	39.00	4.00	0.00	6.00	1.00	0.00	3.00	1.00	0.00	36.00	0.00	0.00	0.00	0.00
-9	2.00	0.00	3.00	5.00	0.00	6.00	44.00	5.00	0.00	1.00	0.00	0.00	4.00	1.00	0.00	28.00	0.00	0.00	0.00	1.00
-10	2.00	0.00	0.00	2.00	0.00	5.00	46.00	2.00	0.00	3.00	0.00	0.00	1.00	1.00	0.00	38.00	0.00	0.00	0.00	0.00
491990190703F-1	5.83	0.00	2.91	1.94	0.00	9.71	38.84	4.85	1.94	3.88	0.00	0.00	0.00	1.94	0.00	28.16	0.00	0.00	0.00	0.00
-2	6.00	1.00	2.00	1.00	0.00	4.00	42.00	1.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00	40.00	0.00	0.00	0.00	0.00
-3	1.00	0.00	1.00	1.00	3.00	6.00	41.00	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	39.00	0.00	0.00	0.00	0.00
-4	2.00	1.00	1.00	1.00	0.00	4.00	67.00	4.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	15.00	0.00	0.00	0.00	1.00
-5	7.00	1.00	3.00	1.00	0.00	3.00	35.00	3.00	1.00	3.00	0.00	0.00	4.00	3.00	0.00	37.00	0.00	0.00	0.00	0.00
C-1	0.00	0.00	1.00	1.00	0.00	5.00	49.00	3.00	0.00	3.00	0.00	0.00	2.00	0.00	0.00	36.00	0.00	0.00	0.00	0.00
-2	4.00	0.00	2.00	1.00	2.00	5.00	42.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.00	0.00	0.00	0.00	0.00
-3	4.00	0.00	1.00	2.00	0.00	5.00	38.00	6.00	1.00	1.00	0.00	0.00	0.00	2.00	0.00	40.00	0.00	0.00	0.00	0.00
-4	2.00	1.00	1.00	1.00	2.00	4.00	46.00	5.00	0.00	1.00	0.00	0.00	0.00	3.00	0.00	34.00	0.00	0.00	0.00	0.00
-5	4.00	0.00	1.00	3.00	0.00	8.00	35.00	4.00	0.00	3.00	1.00	0.00	2.00	0.00	0.00	39.00	0.00	0.00	0.00	0.00
247990190624C-1	3.00	0.00	0.00	2.00	1.00	6.00	30.00	6.00	0.00	9.00	2.00	0.00	3.00	3.00	0.00	35.00	0.00	0.00	0.00	0.00

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI-5 (Continued)

Sample No.	Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	Halimeda	Coniolithon	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
247180181105 -4																				
-5	4.20	0.00	1.00	4.60	0.00	1.60	34.20	4.00	0.20	7.00	0.20	0.00	0.80	1.40	0.00	39.80	0.00	0.00	0.00	1.00
-6	3.60	0.00	1.60	5.20	0.00	3.00	43.60	3.00	0.00	5.40	0.00	0.00	0.80	2.00	0.40	30.60	0.00	0.00	0.00	0.80
151990190118D-1	6.33	0.00	0.67	9.67	0.00	3.67	37.67	5.00	0.00	7.67	0.00	0.00	3.67	0.33	0.67	24.67	0.00	0.00	0.00	0.00
-2	2.67	0.00	0.33	5.33	0.33	5.67	40.67	5.00	0.00	10.67	0.33	0.00	7.00	1.00	2.67	18.33	0.00	0.00	0.00	0.00
-3	1.03	0.00	0.00	3.09	0.00	2.06	32.99	4.12	0.00	3.09	2.06	0.00	0.00	2.06	0.00	44.33	0.00	0.00	0.00	5.15
-4	5.00	0.00	0.00	6.00	0.00	2.00	27.00	5.00	0.00	3.00	0.00	0.00	5.00	0.00	0.00	47.00	0.00	0.00	0.00	0.00
-5	3.00	0.00	1.00	0.00	2.00	3.00	35.00	4.00	0.00	6.00	1.00	0.00	2.00	0.00	0.00	43.00	0.00	0.00	0.00	0.00
-6	2.00	0.00	1.00	3.00	0.00	2.00	39.00	1.00	1.00	3.00	0.00	0.00	3.00	0.00	0.00	44.00	0.00	0.00	0.00	1.00
-7	5.00	0.00	0.00	10.00	0.00	2.00	24.00	4.00	0.00	1.00	0.00	0.00	1.00	3.00	0.00	50.00	0.00	0.00	0.00	0.00
-8	1.00	0.00	1.00	5.00	0.00	2.00	29.00	4.00	0.00	2.00	0.00	0.00	3.00	1.00	0.00	52.00	0.00	0.00	0.00	0.00
-9	1.00	0.00	1.00	5.00	1.00	4.00	36.00	1.00	0.00	3.00	0.00	0.00	3.00	0.00	0.00	44.00	0.00	0.00	0.00	1.00
-10	4.00	1.00	0.00	6.00	0.00	2.00	24.00	4.00	0.00	2.00	0.00	0.00	2.00	3.00	0.00	51.00	0.00	0.00	0.00	1.00
151990190203A-1	1.97	0.00	2.30	3.62	1.32	3.29	18.09	5.92	0.00	1.97	0.33	0.00	1.32	0.66	0.00	57.24	0.33	0.00	0.00	0.00
-2	1.00	0.00	2.33	1.67	1.00	4.33	22.67	9.67	0.00	5.33	1.67	0.00	1.33	0.00	0.67	48.00	0.00	0.00	0.00	1.64
-3	3.00	0.00	0.00	6.00	0.00	2.00	32.00	4.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	46.00	0.00	0.00	0.00	0.33
-4	4.00	0.00	0.00	4.00	4.00	2.00	31.00	3.00	0.00	2.00	0.00	0.00	7.00	1.00	0.00	42.00	0.00	0.00	0.00	4.00
-5	1.00	0.00	1.00	1.00	1.00	4.00	24.00	2.00	0.00	5.00	0.00	0.00	2.00	0.00	0.00	57.00	0.00	0.00	0.00	0.00
-6	1.00	1.00	0.00	2.00	0.00	5.00	42.00	4.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	42.00	0.00	0.00	0.00	2.00
-7	3.00	0.00	1.00	3.00	1.00	3.00	28.00	7.00	0.00	2.00	0.00	0.00	0.00	2.00	0.00	48.00	0.00	0.00	0.00	0.00
-8	7.00	0.00	3.00	3.00	0.00	6.00	31.00	3.00	1.00	2.00	0.00	0.00	6.00	1.00	0.00	37.00	0.00	0.00	0.00	2.00
-9																				
-10	2.00	0.00	1.00	4.00	0.00	1.00	35.00	1.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00	48.00	0.00	0.00	0.00	0.00
247990190130A-1	4.00	1.00	0.00	4.00	0.00	1.00	42.00	4.00	1.00	1.00	0.00	0.00	2.00	6.00	0.00	34.00	0.00	0.00	0.00	0.00
-2	5.00	0.00	0.00	6.00	0.00	2.00	32.00	6.00	0.00	5.00	1.00	0.00	2.00	0.00	0.00	41.00	0.00	0.00	0.00	0.00
-3	7.00	0.00	1.00	5.00	0.00	1.00	30.00	3.00	0.00	3.00	0.00	0.00	2.00	3.00	0.00	44.00	0.00	0.00	0.00	1.00
-4	6.00	1.00	0.00	0.00	0.00	2.00	29.00	2.00	1.00	2.00	1.00	0.00	2.00	1.00	0.00	47.00	0.00	0.00	0.00	6.00
-5	0.00	1.00	1.00	2.00	0.00	7.00	42.00	11.00	0.00	8.00	1.00	0.00	1.00	0.00	0.00	26.00	0.00	0.00	0.00	0.00
-6	5.00	1.00	0.00	4.00	4.00	1.00	42.00	7.00	0.00	4.00	2.00	0.00	2.00	0.00	0.00	27.00	0.00	0.00	0.00	1.00
-7	6.00	0.00	2.00	3.00	0.00	3.00	43.00	5.00	1.00	2.00	0.00	0.00	0.00	1.00	0.00	34.00	0.00	0.00	0.00	0.00
-8	6.00	0.00	0.00	4.00	0.00	2.00	46.00	1.00	0.00	2.00	0.00	0.00	3.00	1.00	0.00	34.00	0.00	0.00	0.00	1.00
-9	2.00	0.00	1.00	4.00	0.00	5.00	47.00	0.00	1.00	5.00	1.00	0.00	3.00	0.00	0.00	31.00	0.00	0.00	0.00	0.00

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI-5 (Continued)

Sample No.	Benthic Foraminifera	Planktonic Foraminifera	Echinoid	Octocoral	Scleractinian Coral	Bryozoa	Mollusc	Annelid	Ostracod	Barnacle	Crab	Halimeda	Goniolithon	Sponge	Complex*	Unidentified Skeletal	Rock Fragments	Pellets	Aggregates	Quartz
247990190624C-2	1.00	1.00	2.00	7.00	0.00	2.00	31.00	5.00	0.00	5.00	1.00	0.00	5.00	1.00	1.00	38.00	0.00	0.00	0.00	0.00
-3	3.88	0.00	0.97	1.94	0.00	1.94	35.92	6.80	0.00	1.94	2.91	0.00	3.88	0.00	0.00	39.81	0.00	0.00	0.00	0.00
-4	3.00	0.00	0.00	4.00	0.00	6.00	33.00	4.00	1.00	7.00	0.00	1.00	2.00	4.00	0.00	35.00	0.00	0.00	0.00	0.00
-5	7.00	1.00	1.00	0.00	4.00	3.00	29.00	8.00	0.00	1.00	1.00	0.00	2.00	3.00	0.00	39.00	0.00	0.00	0.00	1.00
-6	0.00	0.00	0.00	2.00	0.00	1.00	42.00	9.00	0.00	8.00	3.00	0.00	2.00	0.00	0.00	33.00	0.00	0.00	0.00	0.00
-7	4.08	0.00	0.00	2.04	0.00	3.06	52.04	4.08	0.00	5.10	0.00	1.02	3.06	0.00	0.00	25.51	0.00	0.00	0.00	0.00
-8	3.00	0.00	1.00	5.00	1.00	6.00	17.00	7.00	1.00	6.00	0.00	0.00	6.00	4.00	0.00	42.00	0.00	0.00	0.00	1.00
-9	1.00	0.00	0.00	5.00	0.00	5.00	45.00	5.00	0.00	11.00	1.00	0.00	2.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00
-10	1.00	0.00	0.00	1.00	0.00	6.00	49.00	4.00	0.00	7.00	2.00	0.00	3.00	0.00	0.00	27.00	0.00	0.00	0.00	0.00
151990190626E-1	0.00	0.00	3.00	1.00	2.00	2.00	38.00	8.00	0.00	5.00	0.00	0.00	7.00	1.00	0.00	33.00	0.00	0.00	0.00	0.00
-2	1.98	0.00	1.98	0.99	0.00	6.93	47.52	1.98	0.00	7.92	0.00	0.00	2.97	1.98	0.99	24.75	0.00	0.00	0.00	0.00
-3	2.17	0.00	0.00	5.43	0.00	1.09	50.00	2.17	0.00	3.26	2.17	0.00	0.00	3.26	0.00	22.83	0.00	0.00	0.00	7.61
-4	3.00	0.00	0.00	7.00	0.00	0.00	42.00	5.00	0.00	3.00	0.00	0.00	5.00	1.00	0.00	33.00	0.00	0.00	0.00	1.00
-5	4.00	0.00	2.00	3.00	0.00	4.00	33.00	4.00	1.00	3.00	0.00	0.00	6.00	1.00	0.00	35.00	0.00	0.00	0.00	4.00
-6	2.00	0.00	0.00	5.00	0.00	7.00	42.00	3.00	0.00	5.00	1.00	0.00	2.00	2.00	0.00	28.00	0.00	0.00	0.00	3.00
-7	4.00	0.00	4.00	4.00	0.00	4.00	40.00	3.00	0.00	1.00	1.00	0.00	5.00	1.00	0.00	32.00	0.00	0.00	0.00	1.00
-8	4.00	0.00	1.00	3.00	0.00	4.00	39.00	5.00	0.00	2.00	0.00	0.00	3.00	1.00	0.00	38.00	0.00	0.00	0.00	0.00
-9	4.00	0.00	2.00	1.00	0.00	3.00	30.00	1.00	0.00	8.00	0.00	0.00	1.00	1.00	0.00	48.00	0.00	0.00	0.00	1.00
-10	1.00	0.00	2.00	3.00	0.00	3.00	36.00	11.00	0.00	6.00	1.00	0.00	0.00	0.00	0.00	37.00	0.00	0.00	0.00	0.00

* Mollusc encrusted with annelids or bryozoa.

TABLE XXI- 6
COMPARISON OF FMG ALGAL SPECIES

Scientific Name	S-1976* 047	S-1976* 151	S-1976* 247	S-1979* 047	S-1979* 151	S-1979* 247	S-1979* 481	S-1979* 491
RHODOPHYTA								
Agardhiella tenera					X	X	X	X
Agardhinula browneae			X					
Amphiroa fragilissima								X
Amphiroa sp.			X					
Botrycladia occidentalis	X	X	X	X	X	X		X
Centroceras clavulatum					X			
Ceramium sp.			X					
Ceramium Codii								X
Champia parvula	X	X	X	X	X	X	X	X
Champia salicornioides			X					
Chrysymenia enteromorpha			X	X	X	X	X	X
Chrysymenia halymenioides	X		X	X				
Chrysymenia sp.		X						
Coelarthrium albertisii		X	X	X	X	X	X	X
Dasya sp.		X	X			X		
Digenia simplex								X
Dudresnaya crassa			X					
Dudresnaya sp.					X	X		X
Erythrocladia subintegra					X			
Erythrocladia sp.					X			
Eucheuma isiforme		X	X		X	X		
Fauchea sp.			X					
Fosliella sp.					X			
Galaxauna obtusata		X	X	X				
Gelidium crinale								
Goniolithium sp.		X	X					
Gracillaria blodgettii			X		X			
Gracillaria cylindrica			X	X	X			
Gracillaria mamillaris			X	X				
Gracillaria sp.								X
Halymenia agardhii	X		X	X	X	X		X
Halymenia duchassaignii			X					
Halymenia enteromorpha						X		
Halymenia floresia		X	X		X	X	X	X
Halymenia floridana					X	X		
Halymenia hancockii	X				X	X		
Halymenia pseudofloresia			X		X		X	X
Halymenia vinacea	X		X					
Halymenia sp.		X	X		X	X	X	X
Herposiphonia sp.		X						
Hypoglossum involvens	X							
Jania capillacea		X	X		X			
Kallymenia perforata	X		X	X	X	X		

TABLE XXI-6 (Continued)

Scientific Name	S-1976* 047	S-1976* 151	S-1976* 247	S-1979* 047	S-1979* 151	S-1979* 247	S-1979* 481	S-1979* 491
Laurencia intricata	X	X	X	X	X	X	X	X
Laurencia sp.						X		
Liagora Ceranoides	X	X	X		X			X
Liagora sp.					X	X		
Lithothamnion mesomorphum	X	X	X					
Lithothamnion sp.	X	X						
Lomentaria sp.			X					
Nemastoma gelatmosum		X	X					
Peyssoniella sp. A			X					
Peyssoniella sp. B	X	X						
Peyssoniella sp. C					X	X	X	
Peyssoniella rubra			X					
Polysiphonia binneyi			X	X	X	X		X
Polysiphonia sphaerocarpa						X		
Rhodophyllis gracilarioides				X		X		X
Rhodymenia occidentalis			X	X	X	X		
Sciania complanata	X				X	X		X
Solieria ramossissuma			X					
Solieria tenera	X		X					
Spermothamnion sp.		X			X			
Trichagloea sp.					X	X		X
Total RHODOPHYTA	14	21	36	13	30	26	9	20
CHLOROPHYTA								
Anadyomene stellata	X	X		X	X	X		
Avrainvillea levis	X	X	X		X	X		
Avrainvillea sp.		X	X		X	X		
Bryopsis pennata								X
Caulerpa microphysa		X	X		X			
Caulerpa peltata						X		X
Caulerpa prolifera								X
Caulerpa racemosa		X	X					
Cladophora sp.					X			
Codium carolineanum		X	X		X	X		
Codium intertextum	X	X	X		X	X		
Codium isthmoclasum	X	X	X	X	X	X	X	X
Codium n. sp. A				X	X	X	X	X
Codium n. sp. B	X	X	X		X			
Derbesia vaucheriaeformis								X
Enteromorpha sp.	X							
Ernodesmis verticellata	X	X	X		X			
Halimeda discoidea	X	X	X	X	X	X	X	X
Halimeda opunta					X	X		
Halimeda tuna					X	X	X	X
Halimeda sp.					X			X

TABLE XXI-6 (Continued)

Scientific Name	S-1976* 047	S-1976* 151	S-1976* 247	S-1979* 047	S-1979* 151	S-1979* 247	S-1979* 481	S-1979* 491
Halimeda tuna					X	X	X	X
Halimeda sp.					X			X
Pseudocodium floridanum					X	X		
Pseudocodium sp.	X	X	X					
Struvea elegans		X			X			
Struvea pulcherruma			X					
Udotea flabellum	X	X	X		X	X		
Valonia macrophysa	X	X	X		X	X	X	X
Total CHLOROPHYTA	9	15	14	4	17	15	5	10
			PHAEOPHYTA					
Ascocyclus orbicularis					X			
Cladosyphon occidentalis						X		
Colpomenia sinvosa		X	X	X	X	X	X	X
Dictyota bartayresii	X	X						X
Dictyota ciliolata			X					
Dictyota dichotoma		X	X	X	X	X		X
Dictyota divaricata		X	X		X			
Lobophora variegata		X						
Nemacystus howei						X		X
Padina gymnospora								X
Padina profunda					X			
Padina sp.		X						
Rosenvingea intricata	X		X		X	X	X	X
Sargassum filipendula			X			X		
Sargassum fluitans	X		X					X
Sargassum sp.					X	X		X
Spatoglossum schroederi			X					
Sporochnus bolleanus	X		X	X	X	X		X
Total PHAEOPHYTA	4	6	10	3	8	7	2	9

TABLE XXI-7
BRAY-CURTIS COMPARISON OF ALGAE BETWEEN STATION AND YEARS

	151 (76)	151 (79)	247 (76)	247 (79)
151 (76)		49.5%	58.8%	35.6%
151 (79)			55.2%	75.7%
247 (76)				50.0%
247 (79)				

TABLE XXI-8
ALGAL BIOMASS DATA - EARLY SUMMER 1979

STATION NO.	SAMPLE NO.	NO. SPECIES	BIOMASS (grams wet wt.)
151	A-1	4	24.0
	A-2	4	8.2
247	B-1	14	202.8
	F-1	12	139.5
	F-2	11	147.8
481	C-1	8	123.9
	H-1	6	10.1
	H-2	7	14.8
491	B-1	4	6.9
	E-1	5	21.5
	E-2	4	9.7
	E-3	5	10.8

TABLE XXI-9
FORAMINIFERAL SPECIES FOUND AT FLORIDA MIDDLE GROUND DURING 1978-79 SURVEY

Species	Dead	Live
1. Amphistegina gibbosa	X	X
2. Archaias angulatus	X	X
3. Archaias compressus	X	X
4. Articulina sp.	X	X
5. Articulina mexicana	X	
6. Articulina mucronata	X	
7. Articulina pacifica	X	
8. Articulina sagra	X	X
9. Asterigerina carinata	X	
10. Bigenerina irregularis	X	
11. Bigenerina textulareida	X	
12. Bolivina lanceolata	X	
13. Borelis pulchra	X	
14. Cancris oblonga	X	X
15. Cancris sagra	X	
16. Clavulina tricarinata	X	
17. Cribroelphidium poeyanum	X	X
18. Cymbaloporetta squammosa	X	
19. Discorbis mira	X	
20. Elphidium advenum	X	
21. Elphidium discodale	X	X
22. Eponides sp.	X	
23. Hauerina bradyi	X	
24. Hauerina ornatissima	X	
25. Homotrema rubrum	X	
26. Hoeglandina elegans	X	X
27. Lagena laevis	X	
28. Marginulina bradyi	X	
29. Miliolinella subrotunda	X	X
30. Miliolinella circularis	X	X
31. Miliolinella fichteliana	X	X
32. Neoconorbina terquemi	X	
33. Nodosaria sp.	X	
34. Nonion guateloupi	X	
35. Nonionella atlantica	X	
36. Oolina hexagona	X	
37. Peneroplis bradyi	X	X
38. Peneroplis carinatus	X	X
39. Peneroplis pertusus	X	
40. Peneroplis proteus	X	X
41. Planorbulina mediterranensis	X	X
42. Pyrgo denticulata	X	X
43. Pyrgo subsphaerica	X	X
44. Quinqueloculina bicornis	X	
45. Quinqueloculina bicostata	X	X
46. Quinqueloculina bosciana	X	X
47. Quinqueloculina cf. Q. candeiana	X	X
48. Quinqueloculina crassa var. subcuneata		X
49. Quinqueloculina collumnosa	X	X
50. Quinqueloculina horrida	X	
51. Quinqueloculina lamarckiana	X	X
52. Quinqueloculina poeyana	X	X
53. Quinqueloculina polygona	X	X
54. Quinqueloculina subpoeyana	X	X
55. Quinqueloculina tricarinata	X	
56. Quinqueloculina sp.	X	
57. Reussella atlantica	X	X
58. Rosalina sp.	X	X
59. Rosalina rosea	X	
60. Sagrina pulchella var. primitiva	X	
61. Sigmoilina sp.	X	
62. Sigmoilopsis schlumbergeri	X	
63. Siphonina pulchra	X	X
64. Siphoninoides echinata	X	
65. Sorites marginalis	X	
66. Spirillina obconica	X	X
67. Spiroloculina antillarum	X	
68. Spiroloculina sp.	X	
69. Spiroloculina soldanii	X	X
70. Spiroplectammina floridana	X	
71. Textularia sp.	X	
72. Textularia agglutinens	X	
73. Textularia conica	X	X
74. Triloculina tricarinata	X	X
75. Trochammina japonica	X	
76. Virgulina sp.	X	
77. Wiesnerella auriculata	X	
78. Bulimina sp.	X	
79. Cibicides rugosa	X	
80. Cibicides sp.	X	
81. Guttulina sp.	X	
82. Planulina exorna	X	X
83. Quinqueloculina auberiana	X	X
84. Quinqueloculina big tooth	X	
85. Spirillina vivipara	X	
87. Lagena sulcata	X	
89. Quinqueloculina laevigata	X	

TABLE XXI-10
LIST OF FORAMINIFERAL SAMPLES TAKEN ON FLORIDA MIDDLE GROUND

Station	Season	Method
1 = 151	1 = 10/78	1 = Diver
2 = 247	2 = 11/78	2 = Shipek
3 = 481	3 = 01/79	3 = Dredge
4 = 491	4 = 06/79	

Sample Number	Station	Season	Method	Total Number of Species	Number of Live Species	Total Live Count	Live % of Total
001	1	1	1	46	0	0	0.0
002	1	1	1	43	1	1	0.3
003	1	1	1	37	12	19	7.2
004	1	1	1	35	2	4	1.7
005	1	1	1	9	0	0	0.0
006	1	1	1	20	0	0	0.0
007	1	1	1	14	3	3	15.0
008	1	1	1	37	0	0	0.0
009	1	1	1	40	2	5	8.1
010	1	1	1	31	2	2	0.7
011	3	1	1	35	0	0	0.0
012	3	1	1	28	4	5	2.6
013	3	1	1	30	6	10	3.9
014	3	1	1	24	0	0	0.0
015	3	1	1	25	3	5	3.6
016	3	1	1	30	1	3	1.2
017	3	1	1	28	2	4	1.6
018	3	1	1	22	0	0	0.0
019	3	1	1	32	0	0	0.0
020	3	1	1	32	0	0	0.0
021	2	1	1	32	0	0	0.0
022	2	1	1	33	0	0	0.0
023	2	1	1	30	0	0	0.0
024	2	1	1	31	1	1	0.4
025	2	1	1	27	0	0	0.0
026	2	1	1	34	1	1	0.4
027	2	1	1	33	0	0	0.0
028	2	1	1	32	0	0	0.0
029	2	1	1	30	0	0	0.0
030	2	1	1	8	0	0	0.0
031	4	1	1	10	1	1	1.1
032	4	1	1	30	0	0	0.0
033	4	1	1	34	4	7	1.7
034	4	1	1	29	1	1	0.4
035	4	1	1	32	0	0	0.0
036	4	1	1	34	0	0	0.0
037	4	1	1	33	3	4	2.8
038	4	1	1	31	0	0	0.0
039	4	1	1	29	0	0	0.0
040	4	1	1	36	0	0	0.0
042	1	1	1	29	2	2	0.8
043	1	1	1	25	7	15	11.8
044	1	1	1	16	3	5	5.3
045	1	1	1	33	1	2	1.4
046	1	1	1	27	0	0	0.0
047	1	1	1	30	2	2	1.4
048	1	1	1	25	3	3	2.0
049	1	1	1	24	1	1	0.8
050	1	1	1	15	0	0	0.0

TABLE XXI-10 (Continued)

Station	Season	Method
1 = 151	1 = 10/78	1 = Diver
2 = 247	2 = 11/78	2 = Shipek
3 = 481	3 = 01/79	3 = Dredge
4 = 491	4 = 06/79	

Sample Number	Station	Season	Method	Total Number of Species	Number of Live Species	Total Live Count	Live % of Total
051	1	1	1	27	3	3	1.1
052	2	2	2	44	0	0	0.0
053	2	2	2	35	3	5	3.2
054	2	2	2	42	1	1	0.6
055	2	2	3	33	3	6	2.1
056	2	2	2	27	4	7	5.4
057	2	2	3	39	0	0	0.0
059	2	2	2	23	4	11	7.6
060	2	2	3	17	6	19	14.1
061	2	2	2	19	5	12	8.4
062	2	2	3	26	6	26	9.3
063	2	2	2	33	6	12	8.9
064	2	2	2	26	3	5	4.4
065	2	2	3	27	1	3	1.9
066	2	2	2	27	6	9	6.8
067	2	2	3	23	3	5	3.6
068	1	2	2	35	6	11	4.5
069	1	2	2	37	8	34	12.7
070	1	2	2	43	4	5	2.1
071	1	2	2	37	5	7	2.5
072	1	2	3	41	1	1	0.4
073	1	2	2	15	3	6	4.1
074	1	2	2	26	4	8	5.4
075	1	2	2	38	10	19	8.4
076	1	2	2	29	9	28	10.8
077	1	2	2	24	5	11	4.2
078	3	2	2	33	8	20	14.5
079	3	2	2	30	1	1	1.0
080	3	2	2	36	1	2	0.7
081	3	2	2	36	1	1	0.3
082	3	2	2	33	2	7	2.4
083	3	2	2	38	1	2	0.7
084	3	2	2	38	1	1	0.4
085	3	2	2	38	0	0	0.0
086	4	2	2	34	2	3	1.2
087	4	2	2	32	0	0	0.0
088	4	2	2	36	0	0	0.0
089	4	2	2	30	1	1	0.4
090	4	2	2	33	0	0	0.0
094	4	2	2	20	5	11	7.4
095	4	2	2	28	5	10	7.0
097	4	2	2	26	6	13	8.3
098	4	2	2	28	3	12	9.7
099	4	2	2	31	3	7	5.0
100	4	2	2	23	3	5	3.8
101	4	2	2	26	0	0	0.0
102	4	2	2	27	0	0	0.0
103	4	2	2	26	0	0	0.0
104	4	2	2	23	1	1	0.9
110	1	3	1	29	2	4	3.8

TABLE XXI-10 (Continued)

Station	Season	Method
1 = 151	1 = 10/78	1 = Diver
2 = 247	2 = 11/78	2 = Shipek
3 = 481	3 = 01/79	3 = Dredge
4 = 491	4 = 06/79	

Sample Number	Station	Season	Method	Total Number of Species	Number of Live Species	Total Live Count	Live % of Total
111	1	3	1	30	0	0	0.0
112	1	3	1	28	0	0	0.0
113	1	3	1	21	0	0	0.0
114	1	3	1	22	0	0	0.0
115	1	3	1	21	0	0	0.0
116	1	3	1	23	5	9	6.5
117	1	3	1	29	1	1	0.8
118	1	3	1	27	0	0	0.0
119	1	3	1	26	0	0	0.0
120	2	3	1	31	1	1	0.7
121	2	3	1	32	0	0	0.0
122	2	3	1	33	0	0	0.0
123	2	3	1	33	0	0	0.0
124	2	3	1	37	0	0	0.0
125	2	3	1	33	0	0	0.0
126	2	3	1	38	0	0	0.0
127	2	3	1	28	0	0	0.0
129	2	3	1	33	1	1	0.7
130	1	3	1	21	2	2	1.4
131	1	3	1	22	0	0	0.0
132	1	3	1	29	0	0	0.0
133	1	3	1	31	0	0	0.0
134	1	3	1	21	4	6	7.5
135	1	3	1	25	4	8	6.2
136	1	3	1	30	0	0	0.0
137	1	3	1	34	0	0	0.0
138	1	3	1	38	1	3	2.5
139	1	3	1	26	0	0	0.0
160	2	3	2	33	0	0	0.0
161	2	3	2	28	0	0	0.0
162	2	3	2	33	0	0	0.0
163	2	3	2	26	0	0	0.0
164	2	3	2	27	0	0	0.0
165	2	3	2	33	0	0	0.0
166	2	3	2	29	0	0	0.0
167	2	3	2	29	0	0	0.0
168	2	3	2	30	0	0	0.0
169	2	3	2	22	0	0	0.0
170	2	4	1	32	1	1	0.6
171	2	4	1	28	0	0	0.0
172	2	4	1	37	0	0	0.0
173	2	4	1	31	0	0	0.0
174	2	4	1	32	1	1	0.6
175	2	4	1	33	0	0	0.0

TABLE XXI-10 (Continued)

Station	Season	Method
1 = 151	1 = 10/78	1 = Diver
2 = 247	2 = 11/78	2 = Shipek
3 = 481	3 = 01/79	3 = Dredge
4 = 491	4 = 06/79	

Sample Number	Station	Season	Method	Total Number of Species	Number of Live Species	Total Live Count	Live % of Total
176	2	4	1	31	0	0	0.0
177	2	4	1	28	1	2	1.8
178	2	4	1	27	0	0	0.0
179	2	4	1	33	0	0	0.0
180	1	4	1	31	0	0	0.0
181	1	4	1	30	0	0	0.0
182	1	4	1	26	0	0	0.0
183	1	4	1	25	0	0	0.0
185	1	4	1	27	0	0	0.0
186	1	4	1	28	3	4	2.8
187	1	4	1	26	0	0	0.0
188	1	4	1	25	5	10	7.8
190	1	4	1	26	0	0	0.0
192	1	4	1	30	0	0	0.0
200	3	4	1	28	1	1	0.7
201	3	4	1	30	0	0	0.0
202	3	4	1	32	0	0	0.0
203	3	4	1	25	3	4	3.0
204	3	4	1	27	1	1	0.7
205	3	4	1	27	4	6	4.6
206	3	4	1	31	0	0	0.0
207	3	4	1	29	0	0	0.0
208	3	4	1	33	1	1	0.6
209	3	4	1	28	1	1	0.7
210	4	4	1	34	0	0	0.0
211	4	4	1	31	0	0	0.0
212	4	4	1	34	0	0	0.0
213	4	4	1	33	0	0	0.0
214	4	4	1	26	0	0	0.0
215	4	4	1	30	0	0	0.0
216	4	4	1	30	0	0	0.0
217	4	4	1	30	0	0	0.0
218	4	4	1	35	0	0	0.0
219	4	4	1	31	0	0	0.0

TABLE XXI-11
AVERAGE PERCENT LIVE SPECIMENS/SAMPLE OF FORAMINIFERA
FOR EACH STATION, SEASON, AND METHOD
ON THE FLORIDA MIDDLE GROUND

		% LIVE SPECIMENS
STATION	151	3.94
	247	2.69
	481	2.07
	491	3.35
SEASON	10/78	1.75
	11/78	4.31
	01/79	2.74
	06/79	2.59
METHOD	Diver	2.25
	Shipek	4.90
	Dredge	3.14

TABLE XXI-12
AVERAGE NUMBER OF SPECIMENS OF LIVE FORAMINIFERA FOR EACH STATION, SEASON, AND METHOD OF COLLECTION ON THE FLORIDA MIDDLE GROUND

STATION	DATE			
	10/78	11/78	01/79	06/79
		Scuba Diver		
151	2.7	---	4.8	5.1
247	0.4	---	0.7	1.0
481	2.5	---	---	1.7
491	1.4	---	---	---
		Shipek Bottom Grab		
151	---	6.7	---	---
247	---	5.5	---	---
481	---	2.0	---	---
491	---	5.3	---	---
		Bucket Dredge		
151	---	0.4	---	---
247	---	5.9	---	---
481	---	---	---	---
491	---	---	---	---

TABLE XXI-13
NUMBER OF SAMPLES (N) AVERAGE NUMBER OF SPECIES/SAMPLE (S), DIVERSITY (H'), AND EVENNESS (J') OF FORAMINIFERA, GROUPED BY STATION, SEASON, AND METHOD OF COLLECTION

	N	S	H'	J'
Station (all seasons, all methods)				
151	60	35.56	3.658	0.770
247	54	30.73	4.004	0.815
481	28	31.67	3.984	0.809
491	35	30.78	3.996	0.823
Season (all stations, all methods)				
10/78	50	30.25	3.571	0.751
11/78	48	31.21	3.897	0.793
01/79	39	28.10	4.014	0.829
06/79	40	30.30	4.123	0.843
Method (all stations, all seasons)				
Diver	119	29.68	3.852	0.799
Shipek	51	31.24	3.990	0.813
Dredge	7	29.43	3.600	0.742

TABLE XXI-14
AVERAGE NUMBER OF SPECIES/SAMPLE (S), DIVERSITY (H'), AND EVENNESS (J') OF FORAMINIFERA, GROUPED BY STATION FOR EACH SAMPLING SEASON

STATION	SEASON	S	H'	J'
151	10/78	31.1	3.41	0.74
	11/78	32.5	3.81	0.76
	01/79	25.1	3.74	0.79
	06/79	27.9	3.85	0.80
247	10/78	29.0	3.77	0.76
	11/78	29.8	3.84	0.79
	01/79	31.5	4.31	0.87
	06/79	32.7	4.21	0.85
481	10/78	28.6	3.68	0.76
	11/78	36.0	4.16	0.81
	01/79	----	----	----
	06/79	29.0	4.14	0.85
491	10/78	32.2	3.87	0.80
	11/78	28.8	3.88	0.81
	01/79	----	----	----
	06/79	32.2	4.29	0.86

TABLE XXI-15

NUMBER OF SAMPLES (N), AVERAGE NUMBER OF SPECIES/SAMPLE (S), DIVERSITY (H'), AND EVENNESS (J')
FOR EACH STATION, SEASON, AND METHOD OF COLLECTION ON THE FLORIDA MIDDLE GROUND

	10/78				11/78				01/79				06/79				Total
Station	N	S	H'	J'	N	S	H'	J'	N	S	H'	J'	N	S	H'	J'	N
Scuba Diver																	
151	20	31.1	3.41	0.74					20	25.1	3.74	0.79	10	27.9	3.85	0.80	50
247	10	29.0	3.48	0.71					9	33.1	4.47	0.89	10	32.7	4.21	0.85	29
481	10	28.6	3.68	0.76									10	29.0	4.14	0.85	20
491	10	32.2	3.87	0.80									10	32.2	4.29	0.86	20
Shipek Bottom Grab																	
151					9	31.6	3.73	0.75									9
247					9	31.9	4.09	0.83	10	29.3	4.16	0.86					19
481					8	36.0	4.16	0.81									8
491					15	28.8	3.88	0.81									15
Bucket Dredge																	
151					1	41.0	4.47	0.83									1
247					6	27.5	3.46	0.73									6
Total N	50				48				39				40				177

TABLE XXI-16
HABITATS AND HOST SPECIES

HABITATS & HOST SPECIES	# OF SAMPLES ANALYZED FOR SYLLIDS	HABITATS & HOST SPECIES	# OF SAMPLES ANALYZED FOR SYLLIDS
Sponges		Corals	
Agelas dispar	73	*Madracis decactis*	59
Axinella polycapella	2	*Agaricia*	1
Geodia gibberosa	1	Hard coral	2
Callyspongia vaginalis	2	*Millepora*	4
Callyspongia vaginalis	3	*Oculina*	8
Callyspongia ? B	1	Soft Coral	6
Callyspongia C	2	Other Fauna/Algae	
Chocolate cake sponge	1	Bryozoan	5
Jaspid sponge	1	*Spondylus*	13
Jaspid with pink sponge	1	Misc. mollusk	3
Erylus sp.	1	*Astrophyton*	1
Niphates erecta	2	Anemone	1
Haliclona/Halichondria ?	3	Tunicate	2
Haliclona A	2	Hydroid	1
Anthosigmella varians	2	Algae	10
Ircinia	1	Artificial Habitats	
Ircinia campana	2	20-day	10
Ircinia fasciculata	1	3-month	1
Ircinia strobilina	1	Non-living Substrate	
Ircinia A	3	Instruments etc.	9
Brown sponge	1	Rock	2
Plakospongia	1	Rubble	2
Aiolochroia crassa	2	Sediment	8
Speciospongia vesparia	1	Misc.	16
Monanchora barbadensis	3	Surface dip net	6
Sponge A'	1	Dredge	10
Mycale sp.	1	Shipek	22
Anthosigmella varians	2	Sub Arm/Vac.	1
Sponge E	2		
Sponge F	1		
Sponge I	1		
Verongia fistularis	5		

TABLE XXI-17
ISOPOD FAUNA, FMG-01, STATION 151

FMG I Station 151	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	141	41		13								13									
Jaeropsis sp.	29	53		29								7									
Alcirona krebsii	31	39		1										1							
Alcirona sp. A	3	9																			
Stenetrium occidentale	4	102										3	1								
Stenetrium sp. A		20										3									
Cirolana parva		9												1							
Cirolana mayana		1																			
Mesanthura spp.		3																			
Apanthura sp.	2																				
Horoleanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family		1																			
Gnathia sp. (p)		1																			
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata				1																	
Excorallana antillensis																					
Excorallana tricornis	3																				
Total	211	281																			

TABLE XXI-18
ISOPOD FAUNA, FMG-03, STATION 151

FMG III Station 151	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock	Sponge A/Misc	Callyspongia fallax	Bryozoan	Tunicate
Carpias bermudensis	64	15		2						1												2	1		
Jaeropsis sp.	4	20																				1	2		
Alcirona krebsii	27	36																							
Alcirona sp. A	3	4																							
Stenetrium occidentale		19																							
Stenetrium sp. A																						1			
Cirolana parva	1	3																							
Cirolana mayana																									
Mesanthura spp.		2																							
Apanthura sp.	1	1																							
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)																									
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis									51																
Paracerceis caudata		2																							
Excorallana antillensis	1																								
Excorallana tricornis																									
Total	101	102																							

TABLE XXI-19
ISOPOD FAUNA, FMG-05, STATION 151

FMG V Station 151	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia/Pink Sponge	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Oculina/Spondylus	Grab/Submarine	Geodia/Fossil Rock	Soft Coral	Chain		
Carpias bermudensis	123	52			4			8				3						14	4				6		
Jaeropsis sp.	8	37			1		1	8				1						2					4		
Alcirona krebsii	20	18						3						1					2				1		
Alcirona sp. A	10	3																							
Stenetrium occidentale	3	102					1	2				2										1	2		
Stenetrium sp. A		2						1										1							
Cirolana parva		1																							
Cirolana mayana									28																
Mesanthura spp.																									
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)		2						1				1													
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis									748																
Paracerceis caudata																									
Excorallana antillensis																									
Excorallana tricornis																									
Total	164	217																							

TABLE XXI-20
ISOPOD FAUNA, FMG-01, STATION 247

FMG I Station 247	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Serpulid Tubes	Halichonoria (?)	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	$\frac{1}{4}$ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge C	Grab/Submarine	Geodia/Fossil Rock	Fire Sponge	Soft Coral	Pseudoceratina crassa	
Carpias bermudensis	394	18		6	19		2	1				10	4	3	2	13	3	40	2				2	2	
Jaeropsis sp.	93	18		1	15								4			1	5					2	3		
Alcirona krebsii	21	9		1									2												
Alcirona sp. A	1	9												1											
Stenetrium occidentale	16	27		1												3									
Stenetrium sp. A		3																							
Cirolana parva		3																							
Cirolana mayana																									
Mesanthura spp.	1																								
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)																									
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata																									
Excorallana antillensis		2																							
Excorallana tricornis																									
Total	526	89																							

TABLE XXI-21
ISOPOD FAUNA, FMG-03, STATION 247

FMG III Station 247	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia A	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock	Millepora	Near Geodia		
Carpias bermudensis	11	11												1									4		
Jaeropsis sp.	10	14					1							3								3	8		
Alcirona krebsii	18	13																				1			
Alcirona sp. A	2	2																							
Stenetrium occidentale	1	36																							
Stenetrium sp. A																									
Cirolana parva																						3			
Cirolana mayana																									
Mesanthura spp.		3																							
Apanthura sp.		1																							
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)		1																							
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata																									
Excorallana antillensis																									
Excorallana tricornis																									
Total	42	81																							

TABLE XXI-22
ISOPOD FAUNA, FMG-05, STATION 247

FMG V Station 247	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Speciospongia (?)	Sponge E	Geodia	Sponge A	Ircinia	Dead Shell	Carrot Sponge	Aximillid Carrot Sponge	Callyspongia fallax	Callyspongia C	Grab/Submarine	Soft Coral	Bryozoan			
Carpias bermudensis	134	39		13	1		2	13		1	1	41	2	3	2	1	1	147	1			19			
Jaeropsis sp.	32	20						2					2		1			11							
Alcirona krebsii	14	5		1											4										
Alcirona sp. A	5	1													3										
Stenetrium occidentale	1	18		1				2				1													
Stenetrium sp. A		4														2									
Cirolana parva	1	2						1								3									
Cirolana mayana																									
Mesanthura spp.																									
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)		1																1							
Edotea sp.		1																							
Nalicora sp.																									
Eurydice littoralis									18																
Paracerceis caudata				10																					
Excorallana antillensis	1																				1				
Excorallana tricornis																									
Total	188	91																							

TABLE XXI-23
ISOPOD FAUNA, FMG-01, STATION 491

FMG I Station 491	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Geodia	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Callyspongia B (?)	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Soft Coral	Bryozoan			
Carpias bermudensis	36	11					1					3							2			4			
Jaeropsis sp.	16						1						1					4			1	15			
Alcirona krebsii	20	41	1											1								13			
Alcirona sp. A	4	2																							
Stenetrium occidentale	11	43	1											1								1			
Stenetrium sp. A		18	1											3					1			3			
Cirolana parva		5																							
Cirolana mayana																									
Mesanthura spp.																									
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family		1																							
Gnathia sp. (p)		1																							
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata		1																				1			
Excorallana antillensis																									
Excorallana tricornis																									
Total	87	123																							

TABLE XXI-24
ISOPOD FAUNA, FMG-05, STATION 491

FMG V Station 491	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	95	48	1																		
Jaeropsis sp.	18	19	4																		
Alcirona krebsii	11	38	6																		
Alcirona sp. A	7		1																		
Stenetrium occidentale	4	153	13																		
Stenetrium sp. A		13																			
Cirolanaparva		1																			
Cirolana mayana																					
Mesanthura spp.		1																			
Apanthura sp.																					
Horoleanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family																					
Gnathia sp. (p)																					
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis																					
Excorallana tricornis																					
Total	135	273																			

TABLE XXI-25
ISOPOD FAUNA, FMG-01, STATION 481

FMG I Station 481	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	$\frac{1}{4}$ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	66				4								3	1							
Jaeropsis sp.	7	9																			
Alcirona krebsii	21	14														1					
Alcirona sp. A	8	1														1					
Stenetrium occidentale	14	25																			
Stenetrium sp. A		4																			
Cirolana parva		1																			
Cirolana mayana																					
Mesanthura spp.		2																			
Apanthura sp.																					
Horoleanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family																					
Gnathia sp. (p)																					
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis		1																			
Excorallana tricornis																					
Total	116	57																			

TABLE XXI-26
ISOPOD FAUNA, FMG-02, STATION 151

FMG II Station 151	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis																				3	
Jaeropsis sp.																					
Alcirona krebsii																				1	
Alcirona sp. A																				1	
Stenetrium occidentale																				7	
Stenetrium sp. A																				7	
Cirolana parva																				4	
Cirolana mayana																					
Mesanthura spp.																				1	
Apanthura sp.																				3	
Horoleanthura sp.																					
Accalathura sp.																				1	
Xenanthura sp.																				9	
New Family																					
Gnathia sp. (p)																				1	
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis																					
Excorallana tricornis																					
Microcerberus																				1	

TABLE XXI-27
ISOPOD FAUNA, FMG-02, STATION 481

FMG II Station 481	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis																					
Jaeropsis sp.																				1	
Alcirona krebsii																				1	
Alcirona sp. A																					
Stenetrium occidentale																				1	
Stenetrium sp. A																				4	
Cirolana parva																					
Cirolana mayana																					
Mesanthura spp.																					
Apanthura sp.																				1	
Horoleanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																				6	
New Family																					
Gnathia sp. (p)																				1	
Edotea sp.																					
Nalicora sp.																				3	
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis																					
Excorallana tricornis																					

TABLE XXI-28
ISOPOD FAUNA, FMG-02, STATION 491

FMG II Station 491	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis																					
Jaeropsis sp.																				1	
Alcirona krebsii																					
Alcirona sp. A																					
Stenetrium occidentale																					
Stenetrium sp. A																				11	
Cirolana parva																					
Cirolana mayana																					
Mesanthura spp.																				1	
Apanthura sp.																				3	
Horoloanthura sp.																				1	
Accalathura sp.																				24	
Xenanthura sp.																					
New Family																				1	
Gnathia sp. (p)																					
Edotea sp.																					
Nalicora sp.																				1	
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis																					
Excorallana tricornis																					
Microcerberus																				1	

TABLE XXI-29
ISOPOD FAUNA, FMG-05, STATION 492

FMG V Station 492	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock	Brain Sponge	Millepora/Spondylus		
Carpias bermudensis		5												2				6				8	8		
Jaeropsis sp.		13		1	4									1				2					10		
Alcirona krebsii		37		4										6				2				1	4		
Alcirona sp. A		4		4										1									1		
Stenetrium occidentale		325		1																		3	11		
Stenetrium sp. A		2																					1		
Cirolana parva		5																							
Cirolana mayana																									
Mesanthura spp.																		1				1			
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)														1											
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata																									
Excorallana antillensis																									
Excorallana tricornis																									
Total		491																							

TABLE XXI-30
ISOPOD FAUNA, FMG-05, STATION 481

FMG V Station 482	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock	Soft Coral	Bryozoan		
Carpias bermudensis	43	8		2	1	14																5			
Jaeropsis sp.	7	1				6												1							
Alcirona krebsii	3	10																					1		
Alcirona sp. A		2																					1		
Stenetrium occidentale	3	89		1																		3			
Stenetrium sp. A		1																							
Cirolana parva		1																							
Cirolana mayana																									
Mesanthura spp.		4																							
Apanthura sp.																									
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family		1																							
Gnathia sp. (p)																									
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata				1																		2			
Excorallana antillensis																									
Excorallana tricornis																									
Total	56	117																							

TABLE XXI-31
ISOPOD FAUNA, FMG-01, ALL STATIONS COMBINED

FMG I Station 151, 247, 491, 481	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock				
Carpias bermudensis	637	70																							
Jaeropsis sp.	145	80																							
Alcirona krebsii	93	83																							
Alcirona sp. A	16	21																							
Stenetrium occidentale	45	197																							
Stenetrium sp. A		45																							
Cirolana parva		18																							
Cirolana mayana		1																							
Mesanthura spp.	1	5																							
Apanthura sp.		2																							
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family		2																							
Gnathia sp. (p)		2																							
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata		1																							
Excorallana antillensis		3																							
Excorallana tricornis	1																								
Total	940	495																							

TABLE XXI-32

ISOPOD FAUNA, FMG-02, ALL STATIONS COMBINED

FMG III Station 151, 247	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock				
Carpias bermudensis	75	26																							
Jaeropsis sp.	14	34																							
Alcirona krebsii	45	49																							
Alcirona sp. A	5	6																							
Stenetrium occidentale	1	55																							
Stenetrium sp. A																									
Cirolana parva	1	3																							
Cirolana mayana																									
Mesanthura spp.		5																							
Apanthura sp.	1	2																							
Horoloanthura sp.																									
Accalathura sp.																									
Xenanthura sp.																									
New Family																									
Gnathia sp. (p)		1																							
Edotea sp.																									
Nalicora sp.																									
Eurydice littoralis																									
Paracerceis caudata		2																							
Excorallana antillensis	1																								
Excorallana tricornis																									
Total	138	183																							

TABLE XXI-33
ISOPOD FAUNA, FMG-05, ALL STATIONS COMBINED

FMG V Station 482, 151, 247, 491, 492	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	395	152																			
Jaeropsis sp.	65	90																			
Alcirona krebsii	48	108																			
Alcirona sp. A	22	10																			
Stenetrium occidentale	11	687																			
Stenetrium sp. A		22																			
Cirolana parva	1	10																			
Cirolana mayana																					
Mesanthura spp.		5																			
Apanthura sp.																					
Horoloanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family		1																			
Gnathia sp. (p)		3																			
Edotea sp.		1																			
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis	1																				
Excorallana tricornis																					
Total	543	1089																			

TABLE XXI-34

ISOPOD FAUNA, STATION 151, ALL SEASONS (CRUISES) COMBINED

FMG I, III, V Station 151	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	328	108																			
Jaeropsis sp.	41	110																			
Alcirona krebsii	78	93																			
Alcirona sp. A	16	16																			
Stenetrium occidentale	7	223																			
Stenetrium sp. A		22																			
Cirolana parva	1	13																			
Cirolana mayana		1																			
Mesanthura spp.		5																			
Apanthura sp.	1	3																			
Horoloanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family		1																			
Gnathia sp. (p)		3																			
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata		2																			
Excorallana antillensis	1																				
Excorallana tricornis	3																				
Total	476	600																			

TABLE XXI-35
ISOPOD FAUNA, STATION 247, ALL SEASONS (CRUISES) COMBINED

FMG I, III, V Station 247	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	539	68																			
Jaeropsis sp.	135	52																			
Alcirona krebsii	53	27																			
Alcirona sp. A	8	13																			
Stenetrium occidentale	18	81																			
Stenetrium sp. A		7																			
Cirolana parva	1	5																			
Cirolana mayana																					
Mesanthura spp.	1	3																			
Apanthura sp.		1																			
Horoleanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family																					
Gnathia sp. (p)		2																			
Edotea sp.		1																			
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata																					
Excorallana antillensis	1	2																			
Excorallana tricornis																					
Total	756	262																			

TABLE XXI-36
ISOPOD FAUNA, STATION 491, ALL SEASONS (CRUISES) COMBINED

FMG I, V Station 491	Agelas	Madracis	Madracis/Callyspongia	Verongia fistularis	Callyspongia	Sponge I (Conglomerate)	Oculina	Spondylus	Dip Net/Sargassum	Spondylus/Sponge C	Agelas/Rubble	Geodia	Sponge A	Ircinia	¼ m^2 algae	Haliclona (?)	Tunicate	Callyspongia fallax	Sponge B	Grab/Submarine	Geodia/Fossil Rock
Carpias bermudensis	131	59																			
Jaeropsis sp.	34	19																			
Alcirona krebsii	31	79																			
Alcirona sp. A	11	2																			
Stenetrium occidentale	15	196																			
Stenetrium sp. A		31																			
Cirolana parva		6																			
Cirolana mayana																					
Mesanthura spp.		1																			
Apanthura sp.																					
Horoloanthura sp.																					
Accalathura sp.																					
Xenanthura sp.																					
New Family		1																			
Gnathia sp. (p)		1																			
Edotea sp.																					
Nalicora sp.																					
Eurydice littoralis																					
Paracerceis caudata		1																			
Excorallana antillensis																					
Excorallana tricornis																					
Total	222	396																			

TABLE XXI-37
MISCELLANEOUS CRUSTACEA USING MADRACIS AT STATION 151 AS A HOST

Crustacea	FALL		WINTER		SUMMER		TAXA SUMMARY		
	No. Samples	No. Indv.	No. Samples	No. Indv.	No. Samples	No. Indv.	Total Samples	Total Indv.	Seasons Found
AMPHIPODA									
Acanthonotozomatidae			1	1			1	1	W
Ampeliscidae									
Ampelisca	2	4	2	4	4	20	8	28	A
Amphilochidae	2	3	3	3	1	1	6	7	A
Ampithoidae									
Ampithoe	4	14	1	2	2	4	7	20	A
Cymadusa	2	5	1	3			3	8	FW
Anamixidae									
Anamixis	1	3	1	1	1	1	3	5	A
Aoridae									
Lembos	7	40	3	7	3	6	13	53	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix	5	7	7	12	3	11	15	30	A
Corophiidae									
Erichthonius	2	4	3	3	1	1	6	8	A
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	8	71	1	64	9	36	28	171	A
Leucothoides	3	17	1	4	1	1	5	22	A
Lijeborgiidae									
Lijeborgia	6	23	11	42	9	40	26	105	A
Lysianassidae									
Hippomedon									
Lysianopsis	3	8	1	4			4	12	FW
Socarnes									
Melitidae									
Ceradocus	2	5	4	7	2	3	8	15	A
Elasmopus	7	100	5	14	5	27	17	141	A
Maera	3	3			1	4	4	7	FS
Melita	1	2					1	2	F
Melphidippidae									
Paramphitoidae	2	3	2	2	1	1	5	6	A
Phoxocephalidae									
Harpinia	1	1			2	4	3	5	FS
Trichophoxus	1	1					1	1	W
Podoceridae									
Sebidae									
Seba	1	5	2	3			3	8	FW
Stenothoidae									
Stenothoe	3	3	3	8	2	2	8	13	A
Synopiidae									
Tiron			1	2			1	2	W
Caprellidae			1	8	1	2	2	10	WS
Hyperiidae			4	5			4	5	W
TANAIDACEA									
Apseudidae	9	79	7	30	6	21	22	130	A
Paratanidae	8	23	5	6	3	9	16	38	A
LEPTOSTRACA									
Nebalia									
Paranebalia					2	2	2	2	S
STOMATOPODA									
Gonodactylus									
TOTAL NO. SPECIMENS	11	424	14	230	10	196	35	850	
TOTAL NO. GENERA	23		22		20		28		
TOTAL NO. FAMILIES	17		19		17		22		

TABLE XXI-38
MISCELLANEOUS CRUSTACEA USING MADRACIS AT STATION 247 AS A HOST

Crustacea	FALL No. Samples	FALL No. Indv.	WINTER No. Samples	WINTER No. Indv.	SUMMER No. Samples	SUMMER No. Indv.	TAXA SUMMARY Total Samples	TAXA SUMMARY Total Indv.	TAXA SUMMARY Seasons Found
AMPHIPODA									
Acanthonotozomatidae									
Ampeliscidae									
Ampelisca			1	1	3	10	4	11	WS
Amphilochidae	2	3	2	3	3	4	7	10	A
Ampithoidae									
Ampithoe	3	15	1	1	5	8	9	23	A
Cymadusa									
Anamixidae									
Anamixis	3	5	1	3	3	3	7	11	A
Aoridae									
Lembos	1	3	1	5	10	54	12	62	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix			5	10	4	15	9	25	WS
Corophiidae									
Erichthonius	5	103					5	103	F
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	3	9	9	52	11	80	23	151	A
Leucothoides	5	11	2	44	4	19	11	64	A
Lijeborgiidae									
Lijeborgia	3	5	10	41	8	52	21	98	A
Lysianassidae									
Hippomedon									
Lysianopsis	2	3	3	3	1	1	6	7	A
Socarnes									
Melitidae									
Ceradocus	4	25	4	16	5	16	13	57	A
Elasmopus	2	8	3	9	7	32	12	49	A
Maera			1	2			1	2	W
Melita	2	7			3	14	5	21	FS
Melphidippidae									
Paramphitoidae	1	1	7	24			8	25	FW
Phoxocephalidae									
Harpinia					1	1	1	1	S
Trichophoxus									
Podoceridae									
Sebidae									
Seba									
Stenothoidae									
Stenothoe	3	15			1	1	4	16	FS
Synopiidae									
Tiron									
Caprellidae									
Hyperiidae			1	1			1	1	W
TANAIDACEA									
Apseudidae	5	30	5	9	5	12	15	51	A
Paratanidae	3	8	1	1	4	8	8	17	A
LEPTOSTRACA									
Nebalia									
Paranebalia	1	1	4	9			5	10	FW
STOMATOPODA									
Gonodactylus	3	3	1	1			4	4	FW
TOTAL NO. SPECIMENS	8	255	11	234	12	330	31	819	
TOTAL NO. GENERA	18		18		17		23		
TOTAL NO. FAMILIES	15		15		14		19		

TABLE XXI-39
MISCELLANEOUS CRUSTACEA USING *MADRACIS* AT STATION 481 AS A HOST

Crustacea	FALL No. Samples	FALL No. Indv.	WINTER No. Samples	WINTER No. Indv.	SUMMER No. Samples	SUMMER No. Indv.	TAXA SUMMARY Total Samples	TAXA SUMMARY Total Indv.	TAXA SUMMARY Seasons Found
AMPHIPODA			NO DATA	NO DATA					
Acanthonotozomatidae									
Ampeliscidae									
Ampelisca	3	5			3	4	6	9	A
Amphilochidae	1	1			1	1	2	2	A
Ampithoidae									
Ampithoe	1	1			2	5	3	6	A
Cymadusa	1	1					1	1	F
Anamixidae									
Anamixis					1	1	1	1	S
Aoridae									
Lembos	6	30			7	21	13	51	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix					5	12	5	12	S
Corophiidae									
Erichthonius									
Rildardanus	1	1					1	1	F
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	3	7			5	39	8	46	A
Leucothoides	2	2			5	6	7	8	A
Lijeborgiidae									
Lijeborgia	4	15			10	24	14	39	A
Lysianassidae									
Hippomedon									
Lysianopsis					1	2	1	2	S
Socarnes									
Melitidae									
Ceradocus	4	11					4	11	F
Elasmopus	4	9			5	33	9	42	A
Maera	4	12					4	12	F
Melita					1	2	1	2	S
Melphidippidae									
Paramphitoidae					1	1	1	1	S
Phoxocephalidae									
Harpinia									
Trichophoxus									
Podoceridae									
Sebidae									
Seba	1	1					1	1	F
Stenothoidae									
Stenothoe	1	1					1	1	F
Synopiidae									
Tiron									
Caprellidae									
Hyperiidae									
TANAIDACEA									
Apseudidae	3	14			2	3	5	17	A
Paratanidae	5	8			4	7	9	15	A
LEPTOSTRACA									
Nebalia									
Paranebalia									
STOMATOPODA									
Gonodactylus									
TOTAL NO. SPECIMENS	10	119			10	160	20	279	
TOTAL NO. GENERA	16				15		21		
TOTAL NO. FAMILIES	17				13		16		

TABLE XXI-40
MISCELLANEOUS CRUSTACEA USING *MADRACIS* AT STATION 491 AS A HOST

Crustacea	FALL No. Samples	FALL No. Indv.	WINTER No. Samples	WINTER No. Indv.	SUMMER No. Samples	SUMMER No. Indv.	TAXA SUMMARY Total Samples	TAXA SUMMARY Total Indv.	TAXA SUMMARY Seasons Found
AMPHIPODA									
Acanthonotozomatidae			NO DATA	NO DATA					
Ampeliscidae									
Ampelisca					4	4	4	4	S
Amphilochidae					2	4	2	4	S
Ampithoidae									
Ampithoe	1	1			1	3	2	4	A
Cymadusa	1	1					1	1	F
Anamixidae									
Anamixis					1	1	1	1	S
Aoridae									
Lembos	7	23			9	89	16	112	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix					5	18	5	18	S
Corophiidae									
Erichthonius	1	1			1	1	2	2	A
Rildardanus					1	1	1	1	S
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	9	33			12	332	21	365	A
Leucothoides	4	6			6	12	10	18	A
Lijeborgiidae									
Lijeborgia	7	31			12	330	19	361	A
Lysianassidae									
Hippomedon									
Lysianopsis	1	3			6	12	7	15	A
Socarnes									
Melitidae									
Ceradocus	1	1			3	20	4	21	A
Elasmopus	8	42			10	226	18	268	A
Maera	2	2					2	2	F
Melita					1	8	1	8	S
Melphidippidae									
Paramphitoidae					1	1	1	1	S
Phoxocephalidae									
Harpinia	1	1			3	4	4	5	A
Trichophoxus									
Podoceridae									
Sebidae									
Seba					1	1	1	1	S
Stenothoidae									
Stenothoe	2	5			2	14	4	19	A
Synopiidae									
Tiron									
Caprellidae					1	4	1	4	S
Hyperiidae									
TANAIDACEA									
Apseudidae	3	15			4	10	7	25	A
Paratanidae	1	2			6	15	7	17	A
LEPTOSTRACA									
Nebalia					3	3	3	3	S
Paranebalia									
STOMATOPODA									
Gonodactylus					2	2	2	2	S
TOTAL NO. SPECIMENS	12	167			12	1114	24	1281	
TOTAL NO. GENERA	15				24		26		
TOTAL NO. FAMILIES	11				20		20		

TABLE XXI-41
MISCELLANEOUS CRUSTACEA USING AGELAS AT STATION 151 AS A HOST

Crustacea	FALL		WINTER		SUMMER		TAXA SUMMARY		
	No. Samples	No. Indv.	No. Samples	No. Indv.	No. Samples	No. Indv.	Total Samples	Total Indv.	Seasons Found
AMPHIPODA									
Acanthonotozomatidae									
Ampeliscidae									
Ampelisca	3	5	2	3	6	13	11	21	A
Amphilochidae									
Ampithoidae									
Ampithoe	7	20	2	15	1	2	10	45	A
Cymadusa	1	3					1	3	F
Anamixidae									
Anamixis									
Aoridae									
Lembos	4	10	1	1			5	11	FW
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix	3	7	4	12	8	26	15	45	A
Corophiidae									
Erichthonius			1	19			1	19	W
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	10	105	11	352	10	275	31	732	A
Leucothoides	4	9	4	9	4	10	12	28	A
Lijeborgiidae									
Lijeborgia	1	1	2	3	4	11	7	15	A
Lysianassidae									
Hippomedon									
Lysianopsis					2	2	2	2	S
Socarnes									
Melitidae									
Ceradocus									
Elasmopus	8	77	5	16	6	26	19	119	A
Maera									
Melita			1	1	1	1	2	2	WS
Melphidippidae									
Paramphitoidae			2	2			2	2	W
Phoxocephalidae									
Harpinia									
Trichophoxus									
Podoceridae									
Sebidae									
Seba	2	28			2	2	4	30	FS
Stenothoidae									
Stenothoe	1	3	1	1	1	1	3	5	A
Synopiidae									
Tiron			1	1			1	1	W
Caprellidae									
Hyperiidae			3	4			3	4	W
TANAIDACEA									
Apseudidae	4	12	5	8	3	6	12	26	A
Paratanidae	6	23			3	10	9	33	FS
LEPTOSTRACA									
Nebalia									
Paranebalia			3	4			3	4	W
STOMATOPODA									
Gonodactylus									
TOTAL NO. SPECIMENS	10	303	1	447	10	385	31	1131	
TOTAL NO. GENERA	13		15		13		19		
TOTAL NO. FAMILIES	11		14		11		16		

TABLE XXI-42
MISCELLANEOUS CRUSTACEA USING AGELAS AT STATION 247 AS A HOST

Crustacea	FALL		WINTER		SUMMER		TAXA SUMMARY		
	No. Samples	No. Indv.	No. Samples	No. Indv.	No. Samples	No. Indv.	Total Samples	Total Indv.	Seasons Found
AMPHIPODA									
Acanthonotozomatidae									
Ampeliscidae									
Ampelisca					1	1	1	1	S
Amphilochidae	1	1					1	1	F
Ampithoidae									
Ampithoe	2	4			3	15	5	19	FS
Cymadusa	1	1					1	1	F
Anamixidae									
Anamixis					1	2	1	2	S
Aoridae									
Lembos	4	14	1	1	1	1	6	16	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix					2	2	2	2	WS
Corophiidae									
Erichthonius	1	84			2	2	3	86	FS
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	10	183	10	116	10	262	30	823	A
Leucothoides					1	4	1	4	S
Lijeborgiidae									
Lijeborgia	2	4			1	2	3	6	FS
Lysianassidae									
Hippomedon									
Lysianopsis									
Socarnes									
Melitidae									
Ceradocus									
Elasmopus	5	59	4	5	9	44	18	108	A
Maera									
Melita									
Melphidippidae									
Paramphitoidae			4	5			4	5	W
Phoxocephalidae									
Harpinia									
Trichophoxus									
Podoceridae									
Sebidae									
Seba	2	3					2	3	F
Stenothoidae									
Stenothoe	3	20	1	1	2	4	6	25	A
Synopiidae									
Tiron									
Caprellidae					1	15	1	15	S
Hyperiidae									
TANAIDACEA									
Apseudidae	3	10	3	4	4	23	10	37	A
Paratanidae	3	11	1	1	4	26	8	46	A
LEPTOSTRACA									
Nebalia									
Paranebalia			1	1			1	1	W
STOMATOPODA									
Gonodactylus			1	1			1	1	W
TOTAL NO. SPECIMENS	11	394	10	135	10	403	30	932	
TOTAL NO. GENERA	12		9	135	14		19		
TOTAL NO. FAMILIES	11		9		13		18		

TABLE XXI-43
MISCELLANEOUS CRUSTACEA USING AGELAS AT STATION 481 AS A HOST

Crustacea	FALL No. Samples	FALL No. Indv.	WINTER No. Samples	WINTER No. Indv.	SUMMER No. Samples	SUMMER No. Indv.	TAXA SUMMARY Total Samples	TAXA SUMMARY Total Indv.	TAXA SUMMARY Seasons Found
AMPHIPODA									
Acanthonotozomatidae			NO DATA	NO DATA					
Ampeliscidae									
Ampelisca	5	11			3	3	8	14	A
Amphilochidae	1	1			1	1	2	2	A
Ampithoidae									
Ampithoe	5	6			1	1	6	7	A
Cymadusa									
Anamixidae									
Anamixis									
Aoridae									
Lembos	3	4					3	4	F
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix	3	3			4	4	7	7	A
Corophiidae									
Erichthonius	1	3					1	3	F
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	8	64			9	136	17	200	A
Leucothoides	4	5			2	2	6	7	A
Lijeborgiidae									
Lijeborgia	4	10			2	10	6	20	A
Lysianassidae									
Hippomedon									
Lysianopsis									
Socarnes									
Melitidae									
Ceradocus									
Elasmopus	10	50			5	10	15	60	A
Maera									
Melita									
Melphidippidae									
Paramphitoidae	1	1					1	1	F
Phoxocephalidae									
Harpinia	1	1					1	1	F
Trichophoxus									
Podoceridae									
Sebidae									
Seba									
Stenothoidae									
Stenothoe									
Synopiidae									
Tiron									
Caprellidae									
Hyperiidae	1	1					1	1	F
TANAIDACEA									
Apseudidae	3	8					3	8	F
Paratanidae	5	15			3	8	8	23	A
LEPTOSTRACA									
Nebalia									
Paranebalia									
STOMATOPODA									
Gonodactylus									
TOTAL NO. SPECIMENS	10	182			10	175	20	357	
TOTAL NO. GENERA	14				9		14		
TOTAL NO. FAMILIES	13				8		13		

TABLE XXI-44
MISCELLANEOUS CRUSTACEA USING *AGELAS* AT STATION 491 AS A HOST

Crustacea	FALL No. Samples	FALL No. Indv.	WINTER No. Samples	WINTER No. Indv.	SUMMER No. Samples	SUMMER No. Indv.	TAXA SUMMARY Total Samples	TAXA SUMMARY Total Indv.	TAXA SUMMARY Seasons Found
AMPHIPODA			N	N					
Acanthonotozomatidae			O	O					
Ampeliscidae									
Ampelisca			D	D	1	1	1	1	S
Amphilochidae			A	A					
Ampithoidae			T	T					
Ampithoe	1	2	A	A			1	2	F
Cymadusa	1	1					1	1	F
Anamixidae									
Anamixis	1	2			2	3	3	4	A
Aoridae									
Lembos	3	6			1	1	4	7	A
Unciola									
Atylidae									
Atylus									
Colomastigidae									
Colomastix									
Corophiidae									
Erichthonius									
Rildardanus									
Isaeidae									
Chevalia									
Ischyroceridae									
Microjassa									
Leucothoidae									
Leucothoe	8	51			10	209	18	260	A
Leucothoides	2	5			2	6	4	11	A
Lijeborgiidae									
Lijeborgia	4	5			4	5	8	10	A
Lysianassidae									
Hippomedon									
Lysianopsis					1	1	1	1	S
Socarnes									
Melitidae									
Ceradocus									
Elasmopus	8	51			5	14	13	65	A
Maera									
Melita	1	2					1	2	A
Melphidippidae									
Paramphitoidae									
Phoxocephalidae									
Harpinia									
Trichophoxus									
Podoceridae									
Sebidae									
Seba									
Stenothoidae									
Stenothoe					1	3	1	3	S
Synopiidae									
Tiron									
Caprellidae									
Hyperiidae					2	3	2	3	S
TANAIDACEA									
Apseudidae	2	2			5	28	7	30	A
Paratanidae	3	5			2	7	5	12	A
LEPTOSTRACA									
Nebalia									
Paranebalia					1	1	1	1	S
STOMATOPODA									
Gonodactylus									
TOTAL NO. SPECIMENS	10	132			10	178	20	409	
TOTAL NO. GENERA	11				12		16		
TOTAL NO. FAMILIES	8				11		13		

TABLE XXI-45
OCCURRENCE OF CARIDEAN SHRIMPS IN 46 IDENTIFIED HABITATS

Synalpheus hemphilli	Synalpheus goodei	Synalpheus brooksi	Synalpheus bousfieldi	Synalpheus agelas	Automate evermanni	Alpheus normanni	Alpheus floridanus	Alpheopsis trigonus	Alpheopsis labis	Alpheid genus 'A'	Typton vulcanus	Typton prionuris	Typton gnathophylloides	Pontonia margarita	Periclimenes perryae	Periclimenes pedersoni	Periclimenes longicaudatus	Periclimenes iridescens	Periclimenes americanus	Periclimenaeus schmitti	Periclimenaeus perlatus	Periclimenaeus maxillulidens	Periclimenaeus chacei	Periclimenaeus caraibicus	Periclimenaeus bredini	Palaemon sp.	Neopontonides beaufortensis	Leander tenuicornis	Anchistioides antiguensis	Leptochela serratorbita	Leptochela papulata	Decapod larvae	
																	X		X							X		X			X	X	Surface plankton
																														X			Demersal plankton
																		X	X													X	Bryozoa colony
																		X	X	X													Serpulid Tubes
																																	Shell rubble
					X	X	X		X																							X	Rock
									X									X	X				X									X	Hard coral
																		X	X													X	Oculina diffusa
									X										X														Millepora alcicornis
	X		X		X		X		X		X		X					X	X			X	X									X	Madracis decactis
	X	X	X	X			X		X									X				X										X	Agelas dispar
X												X						X			X	X		X								X	Callyspongia vaginalis
												X						X	X			X		X					X			X	Callyspongia fallax
																		X															Callyspongia sp. B
X																																	Callyspongia sp. C
																		X	X		X											X	Verongia fistularis
																		X							X								Ircinia fasciculata
																																	Ircinia campana
																		X													X		Ircinia strobilina
									X																								Geodia gibberosa
																		X															Neofibularia nolitangere
																																X	Pseudoceratina crassa
		X																														X	Spheciospongia vespara
	X																																Haliclona ?
																		X															Halichondria ?
																																	Sponge A
													X																X				Sponge B
																				X													Sponge C
																																	Sponge E
																		X															Sponge I
																		X															Carrot sponge
																																	Chocolate cake sponge
														X																			Spondylus americanus
																X																	Bartholomea annulata
																X		X															Condylactis gigantia
															X																	X	Astrophyton muricatum
																		X									X					X	Eunicea calyculata
																		X	X								X						Muricea elongata
																		X									X					X	Muricea laxa
																		X									X						Lophogorgia cardinalis
																		X	X														Lophorgia hebes
																											X						Pseudopterogorgia acerosa
																																	Pterogorgia quadalupensis
																		X	X								X						Pseudopleuraxella wagenaari
																											X						Ellisella elongata
																			X														Tunicates
	X			X	X	X	X	X	X	X		X		X		X		X	X	X			X				X					X	No. Host and/or Habitat Data

TABLE XXI-45 (Continued)

	Discias serratirostris	Ogyrides yaquiensis	Processa vicina	Tozeuma serratum	Tozeuma carolinense	Thor manningi	Thor dobkini	Lysmata rathbunae	Lysmata intermedia	Latreutes fucorum	Hippolyte zoestericola	Hippolyte nicholsoni	Hippolytid Genus 'A'	Synalpheus townsendi	Synalpheus scaphoceris	Synalpheus pectiniger	Synalpheus pandionis	Synalpheus minus	Synalpheus longicarpus	Synalpheus herricki
Surface plankton					X		X			X	X									
Demersal plankton																				
Bryozoa colony						X		X			X			X						
Serpulid Tubes						X								X						
Shell rubble														X						
Rock																				
Hard coral						X								X						
Oculina diffusa						X		X						X						
Millepora alcicornis						X								X						
Madracis decactis						X		X	X					X	X		X			X
Agelas dispar						X							X	X			X			X
Callyspongia vaginalis						X								X						
Callyspongia fallax	X					X								X	X					
Callyspongia sp. B						X														
Callyspongia sp. C						X								X						
Verongia fistularis						X								X						
Ircinia fasciculata														X						
Ircinia campana														X				X		
Ircinia strobilina														X	X		X	X		
Geodia gibberosa														X						
Neofibularia nolitangere														X						
Pseudoceratina crassa						X								X				X		
Spheciospongia vespara																X			X	
Haliclona ?						X								X						
Halichondria ?						X								X						
Sponge A						X								X						
Sponge B														X						
Sponge C														X						
Sponge E														X						
Sponge I						X														
Carrot sponge																				
Chocolate cake sponge						X														
Spondylus americanus														X						
Bartholomea annulata																				
Condylactis gigantia																				
Astrophyton muricatum														X						
Eunicea calyculata												X								
Muricea elongata												X								
Muricea laxa												X								
Lophogorgia cardinalis						X						X								
Lophogorgia hebes											X									
Pseudopterogorgia acerosa												X		X						
Pterogorgia quadalupensis														X						
Pseudopleuraxella wagenaari												X		X						
Ellisella elongata				X																
Tunicates														X						
No. Host and/or Habitat Data		X	X			X		X			X	X		X	X		X			

TABLE XXI-46
NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS
ASSOCIATED WITH SPONGES COLLECTED DURING FMG-01

FMG I	Decapod larvae	Leptochela papulata	Anchistioides antiguensis	Periclimenaeus bredini	Periclimenaeus caraibicus	Periclimenaeus perlatus	Periclimenaeus schmitti	Periclimenes americanus	Periclimenes iridescens	Typton gnathophylloides	Typton prionuris	Alpheopsis labis	Alpheus floridanus	Synalpheus agelas	Synalpheus bousfieldi	Synalpheus brooksi	Synalpheus goodei	Synalpheus hemphilli	Synalpheus herricki	Synalpheus longicarpus	Synalpheus minus	Synalpheus pandionis	Synalpheus townsendi	Hippolytid Genus "A"	Thor manningi	Discias serratirostris
Callyspongia vaginalis																										
Callyspongia fallax	1										6												10		1	
Callyspongia sp. B									2																	
Verongia fistularis						12																	1			
Ircinia fasciculata				13					1														7			
Ircinia campana																					2		8			
Ircinia strobilina																										
Agelas dispar	15												1	375	15	42			28	3		33	604	1	4	
Pseudoceratina crassa	6																				1		2		1	
Neofibularia nolitangere									2														4			
Geodia gibberosa																										
Haliclona ?									1														1			
Halichondria ?																							2			
Sponge A																							11			
Sponge B																							4		1	
Sponge C							1																5			
Sponge E																							4			
Spheciospongia vespara																										

TABLE XXI-47
NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS
ASSOCIATED WITH SPONGES COLLECTED DURING FMG-03

FMG III	Discias serratirostris	Thor manningi	Hippolytid Genus 'A'	Synalpheus townsendi	Synalpheus pandionis	Synalpheus minus	Synalpheus longicarpus	Synalpheus herricki	Synalpheus hemphilli	Synalpheus goodei	Synalpheus brooksi	Synalpheus bousfieldi	Synalpheus agelas	Alpheus floridanus	Alpheopsis labis	Typton prionuris	Typton gnathophylloides	Periclimenes iridescens	Periclimenes americanus	Periclimenaeus schmitti	Periclimenaeus perlatus	Periclimenaeus caraibicus	Periclimenaeus bredini	Anchistioides antiguensis	Leptochela papulata	Decapod larvae
Callyspongia vaginalis																										
Callyspongia fallax				13														1						3		
Callyspongia sp. B				2												1										
Verongia fistularis																										
Ircinia fasciculata		1		3																			14			
Ircinia campana																										
Ircinia strobilina																										
Agelas dispar		3		185	14						4	4	186													
Pseudoceratina crassa																										
Neofibularia nolitangere																										
Geodia gibberosa																										
Haliclona ?																										
Halichondria ?																										
Sponge A				4																						
Sponge B																										
Sponge C																										
Sponge E																										
Spheciospongia vespara																										

TABLE XXI-48
NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS
ASSOCIATED WITH SPONGES COLLECTED DURING FMG-05

FMG V	Decapod larvae	Leptochela papulata	Anchistioides antiguensis	Periclimenaeus bredini	Periclimenaeus caraibicus	Periclimenaeus perlatus	Periclimenaeus schmitti	Periclimenes americanus	Periclimenes iridescens	Typton gnathophylloides	Typton prionuris	Alpheopsis labis	Alpheus floridanus	Synalpheus agelas	Synalpheus bousfieldi	Synalpheus brooksi	Synalpheus goodei	Synalpheus hemphilli	Synalpheus herricki	Synalpheus longicarpus	Synalpheus pandionis	Synalpheus pectiniger	Synalpheus townsendi	Hippolytid Genus 'A'	Thor manningi	Discias serratirostris
Callyspongia vaginalis	1				6	2			42		4							9					21		2	
Callyspongia fallax	2		36		4			1	37		4												64		22	1
Callyspongia sp. B																										
Verongia fistularis	1					4		1															14			
Ircinia fasciculata				8					1														3			
Ircinia campana																							8			
Ircinia strobilina	1	1							8												2		7			
Agelas dispar	13								5			5		291	20	6	2		6		42		424		7	
Pseudoceratina crassa																							1			
Neofibularia nolitangere																										
Geodia gibberosa												3											12			
Haliclona ?																							1			
Halichondria ?																										
Sponge A								1															11		2	
Sponge B			1							1																
Sponge C																										
Sponge E																							3			
Spheciospongia vespara	11															466				266		54				

TABLE XXI-49
SUMMARY OF NUMERICAL ABUNDANCE OF CARIDEAN
SHRIMPS ASSOCIATED WITH SPONGES (1978-1979; ALL CRUISES)

FMG I, III, & V	Decapod larvae	Leptochela papulata	Anchistioides antiguensis	Periclimenaeus bredini	Periclimenaeus caraibicus	Periclimenaeus perlatus	Periclimenaeus schmitti	Periclimenes americanus	Periclimenes iridescens	Typton gnathophylloides	Typton prionuris	Alpheopsis labis	Alpheus floridanus	Synalpheus agelas	Synalpheus bousfieldi	Synalpheus brooksi	Synalpheus goodei	Synalpheus hemphilli	Synalpheus herricki	Synalpheus longicarpus	Synalpheus minus	Synalpheus pandionis	Synalpheus pectiniger	Synalpheus townsendi	Hippolytid Genus 'A'	Thor manningi	Discias serratirostris
Callyspongia vaginalis	1				6	2			42		4							9						21		2	
Callyspongia fallax	3		39		4			1	38		12													87		23	1
Callyspongia sp. B									2		1																
Verongia fistularis	1					16		1																15			
Ircinia fasciculata				35					2															13		1	
Ircinia campana																					2			16			
Ircinia strobilina	1	1							8													2		7			
Agelas dispar	28								5			5	1	792	39	52	2		34	3		89		1213	1	14	
Pseudoceratina crassa	6																				1			3		1	
Neofibularia nolitangere									2															4			
Geodia gibberosa												3												12			
Haliclona ?									1															2			
Halichondria ?																								2			
Sponge A								1																26		2	
Sponge B			1							1														4		1	
Sponge C							1																	5			
Sponge E																								7			
Spheciospongia vespara	18															466				266			54				

TABLE XXI-50
SUMMARY OF NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS ASSOCIATED WITH HARD CORALS COLLECTED DURING 1978-1979 (ALL CRUISES)

Caridean Shrimps	Madracis decactis				Oculina diffusa				Millepora alcicornis				Stephenocoenia michelini				Cladocora arbuscula			
	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T	I	III	V	T
Decapod larvae	9	0	8	17	0	1	0	1					0	0	33	33				
Periclimenaeus chacei	3	0	5	8									0	0	2	2				
Periclimenaeus maxillulidens	4	0	1	5																
Periclimenes americanus	3	8	3	14	0	1	0	1					0	0	4	4	0	1	0	1
Periclimenes iridescens	1	3	23	27	0	1	6	7					0	0	11	11				
Typton gnathophylloides	0	1	0	1																
Typton vulcanus	0	0	1	1																
Alpheopsis labis	93	29	178	300					0	2	0	2								
Alpheus floridanus	6	0	1	7																
Automate evermanni	3	0	0	3																
Synalpheus bousfieldi	16	0	0	16																
Synalpheus goodei	6	0	2	8																
Synalpheus herricki	7	1	6	14																
Synalpheus pandionis	25	0	59	84																
Synalpheus scaphoceris	24	16	27	67																
Synalpheus townsendi	404	234	394	1032	4	4	16	24	0	2	0	2					0	4	0	4
Lysmata intermedia	0	0	3	3																
Lysmata rathbunae	0	0	3	3	0	0	3	3												
Thor manningi	43	31	125	199	1	2	12	15	0	3	0	3	0	0	47	47	0	2	0	2

TABLE XXI-51

SUMMARY OF NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS BY STATION

Caridean Shrimps	151-I	515-II	151-III	151-V	247-I	247-II	247-III	247-V	481-I	481-II	481(2)-V	491-I	491-II	491(2)-V
Decapod larvae	15	9	14	2	24	145	1	60	19	9	3	5	4	85
Leptochela papulata	246	2	203	0	0	104	0	2	2	3	0	0	3	2
Leptochela serratorbita									2	0	0			
Anchistioides antiguensis	0	0	0	14	0	0	3	9	0	0	1	0	0	13
Leander tenuicornis												0	0	11
Neopontonides beaufortensis	1	0	0	12	2	0	7	16	4	0	7	1	0	1
Palaemon sp.	1	0	0	0										
Periclimenaeus bredini	0	0	10	2	9	0	4	0	0	0	3	6	0	7
Periclimenaeus caraibicus	0	0	0	2	1	0	0	4	0	0	3	0	0	1
Periclimenaeus chacei	1	0	0	0	2	0	0	4				0	0	3
Periclimenaeus maxillulidens	0	0	0	2	2	0	0	0	0	0	1	2	0	2
Periclimenaeus perlatus	1	0	0	0	10	0	0	2	0	0	2	2	0	2
Periclimenaeus schmitti	0	0	0	3	2	0	0	0						
Periclimenes americanus	1	0	2	12	2	2	10	42	3	1	3	0	1	5
Periclimenes iridescens	1	0	7	85	6	0	2	100	7	0	54	13	0	52
Periclimenes longicaudatus	534	0	0	0										
Periclimenes pedersoni					0	0	0	4	1	0	0			
Periclimenes perryae	0	0	10	0	0	1	0	30	0	0	1	0	0	3
Pontonia margarita	0	0	0	6	0	0	1	8	0	0	2	2	0	7
Typton gnathophylloides					0	0	1	1						
Typton prionuris	2	0	0	6	4	0	2	9	2	0	0	1	0	3
Typton vulcanus												0	0	1
Alpheid genus 'A'					0	0	0	2						
Alpheopsis labis	31	4	16	31	23	1	11	16	21	0	18	23	0	153
Alpheopsis trigonus									0	1	0			
Alpheus floridanus	3	0	0	0	2	0	0	0	4	0	3			
Alpheus normanni	1	0	0	0	1	0	0	3	0	0	1	0	2	0
Automate evermanni	1	1	0	0	0	4	0	0	3	12	0	0	15	0

TABLE XXI-51 (Continued)

Caridean Shrimps	151-I	151-II	151-III	151-V	247-I	247-II	247-III	247-V	481-I	481-II	481(2)-V	491-I	491-II	491(2)-V
Synalpheus agelas	160	0	168	87	47	17	18	64	120	0	60	48	0	80
Synalpheus bousfieldi	7	0	3	0	10	0	0	3	6	0	1	8	0	6
Synalpheus brooksi	3	0	3	0	2	0	1	466	2	0	0	33	0	6
Synalpheus goodei	4	0	0	3	1	1	0	0	1	0	0	0	0	3
Synalpheus hemphilli	0	0	0	3					0	0	5	0	0	2
Synalpheus herricki	2	0	1	2	30	0	0	6	1	0	0	0	0	4
Synalpheus longicarpus	1	0	0	0	2	0	0	226						
Synalpheus minus	1	0	0	0					2	0	0	2	0	0
Synalpheus pandionis	17	2	11	26	28	1	3	29	9	0	37	9	0	44
Synalpheus pectiniger					0	0	0	54						
Synalpheus scaphoceris	10	1	8	5	10	0	8	4	0	0	2	7	0	19
Synalpheus townsendi	359	10	259	222	439	10	207	549	183	0	135	206	0	358
Hippolytid Genus 'A'					1	0	0	0						
Hippolyte nicholsoni	1	0	5	4	4	0	1	2	23	0	5	41	0	2
Hippolyte zoestericola	860	0	0	2	0	0	0	34	22	0	0			
Latreutes fucorum	2	0	0	0								0	0	59
Lysmata intermedia												0	0	2
Lysmata rathbunae	0	0	0	1		1	0	10				0	0	3
Thor dobkini	1	0	0	0										
Thor manningi	21	1	16	86	20	0	35	107	21	0	12	9	0	110
Tozeuma carolinense	3	0	0	0										
Tozeuma serratum	0	0	0	2										
Processa vicina					0	1	0	0						
Ogyrides yaquiensis									0	1	0			
Discias serratirostris	0	0	0	1										

TABLE XXI-52
SUMMARY OF NUMERICAL ABUNDANCE OF CARIDEAN SHRIMPS BY SEASON

Caridean Shrimps	151	247	481	491	Total FMG I	151	247	481	491	Total FMG II	151	247	Total FMG III	047	151	247	481	482	491	192	Total FMG V
Decapod larvae	15	24	19	5	63	9	145	9	4	167	14	1	15	1	2	60	0	3	2	83	151
Leptochela papulata	246	0	161	0	407	2	104	3	3	112	203	0	203	249	0	2	0	0	2	0	253
Leptochela serratorbita	0	0	2	0	2																
Anchistioides antiguensis											0	3	3	0	14	9	0	1	0	13	37
Leander tenuicornis														0	0	0	0	0	11	0	11
Neopontonides beaufortensis	1	2	4	1	8						0	7	7	2	12	16	0	7	0	1	38
Palaemon sp.	1	0	0	0	1																
Periclimenaeus bredini	0	9	0	6	15						10	4	14	0	2	0	0	3	0	7	12
Periclimenaeus caraibicus	0	1	0	0	1									0	2	4	0	3	0	1	10
Periclimenaeus chacei	1	2	0	0	3									4	0	4	0	0	3	0	11
Periclimenaeus maxillulidens	0	2	0	2	4									0	2	0	0	1	2	0	5
Periclimenaeus perlatus	1	10	0	2	13									0	0	2	0	2	0	2	6
Periclimenaeus schmitti	0	2	0	0	2									0	3	0	0	0	0	0	3
Periclimenes americanus	1	2	3	0	6	0	2	1	1	4	2	10	12	6	12	42	0	3	3	2	68
Periclimenes iridescens	1	6	7	13	27						7	2	9	8	85	100	0	54	3	49	299
Periclimenes longicaudatus	234	0	0	0	234																
Periclimenes pedersoni	0	0	1	0	1									0	0	4	0	0	0	0	4
Periclimenes perryae						0	1	0	0	1	10	0	10	3	0	30	0	1	0	3	36
Pontonia margarita	0	0	0	2	2						0	1	1	5	6	8	0	2	1	6	28
Typton gnathophylloides											0	1	1	0	0	1	0	0	0	0	1
Typton prionuris	2	4	2	1	9						0	2	2	0	6	9	0	0	2	1	18
Typton vulcanus														0	0	0	0	0	1	0	1
Alpheid genus 'A'														0	0	2	0	0	0	0	2
Alpheopsis labis	31	23	21	23	98	4	1	0	0	5	16	11	27	4	31	16	0	18	35	118	217
Alpheopsis trigonus						0	0	1	0	1											
Alpheus floridanus	3	2	4	0	9									0	0	0	0	2	1	0	3
Alpheus normanni	1	0	0	0	1	0	1	0	2	3				0	0	3	0	1	0	0	4
Automate evermanni	1	0	3	0	4	1	4	12	15	32											

TABLE XXI-52 (Continued)

Caridean Shrimps	151	247	481	491	Total FMG I	151	247	481	491	Total FMG II	151	247	Total FMG III	047	151	247	481	482	491	492	Total FMG V
Synalpheus agelas	160	47	120	48	375	0	17	0	0	17	168	18	186	0	87	64	0	60	80	0	291
Synalpheus bousfieldi	7	10	6	8	31						3	0	3	0	0	3	0	11	6	0	20
Synalpheus brooksi	3	2	2	33	40						3	1	4	0	0	466	0	0	6	0	472
Synalpheus goodei	4	1	1	0	6	0	1	0	0	1				0	3	0	0	0	0	3	6
Synalpheus hemphilli														0	3	0	0	5	0	2	10
Synalpheus herricki	2	30	1	0	33						1	0	1	0	2	6	0	0	0	4	12
Synalpheus longicarpus	1	2	0	0	3									0	0	266	0	0	0	0	266
Synalpheus minus	1	0	2	2	5									0	0	0	0	0	0	2	2
Synalpheus pandionis	17	28	9	9	63	2	1	0	0	3	11	3	14	1	26	29	0	37	15	29	137
Synalpheus pectiniger														0	0	54	0	0	0	0	54
Synalpheus scaphoceris	10	10	0	7	27	1	0	0	0	1	8	8	16	0	5	4	0	2	6	13	30
Synalpheus townsendi	359	439	183	206	1187	10	10	0	0	20	259	207	466	88	222	549	0	135	92	266	1352
Hippolytid Genus 'A'	0	1	0	0	1																
Hippolyte nicholsoni	1	4	23	41	69						5	1	6	2	4	2	0	5	0	2	15
Hippolyte zoestericola	860	0	22	0	882									0	2	34	0	0	0	0	36
Latreutes fucorum	2	0	0	0	2									0	0	0	0	0	59	0	59
Lysmata intermedia														0	0	0	0	0	0	2	2
Lysmata rathbunae						0	1	0	0	1											
Thor dobkini	1	0	0	0	1																
Thor manningi	21	20	21	9	71	1	0	0	0	1	16	35	51	31	86	107	0	13	21	89	347
Tozeuma carolinense	3	0	0	0	3																
Tozeuma serratum														0	2	0	0	0	0	0	2
Processa vicina						0	1	0	0	1											
Ogyrides yaquiensis						0	0	1	0	1											
Discias serratirostris														0	1	0	0	0	0	0	1

TABLE XXI-53
OCCURRENCE OF FISHES AT THE FLORIDA MIDDLE GROUND

Occurrence of fishes at the Florida Middle Grounds. Observations are listed as: D - fishes recorded during point diversity counts, S - fishes seen during a dive in the research submersible Diaphus, V - fishes recorded in situ in addition to those of the point diversity counts, M - fishes taken in miscellaneous collections (sponge, coral, sediment, algal, dip net, and artificial habitat samples). Tentative identifications are indicated by a question mark. The species list includes species recorded at the Florida Middle Grounds by previous investigations (Austin, 1971; Smith et al., 1975; Smith, 1976; Hopkins et al., 1976).

	October 1978				Nov. '78	Jan. '79		Mar. '79		June 1979										
Station #	151	247	481	491	151	151	247	151	247	151	247	481	491	SH	047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Ichthyofaunal Species																				
Carcharhinus falciformis										V						?	X		X	X
Carcharhinus leucas																X	X			
Galeocerdo cuvieri								V								X	X			X
Dasyatis americana	V	V																		X
Rhinoptera bonasus				V															X	X
Manta birostris										V	V						X		X	X
Gymnothorax funebris													M							X
Gymnothorax moringa	DV	V								V						X	X	X	X	X
Gymnothorax nigromarginatus						M	M										X		X	X
Muraena retifera																	X			?
Paraconger caudilimbatus											M						X			X
Ahlia egmontis						M	M										X	X	X	X
Bascanichthys scuticaris							M												X	X
Callechelys perryae							M													X
Myrophis punctatus						M										X	X			X
Mystriophis intertinctus						M													X	X
Ophichthus gomesi			M													X	X			X
Ophichthus ocellatus						M	M													X
Ophichthus ophis																	X			
Etrumeus teres			M													X	X		X	X
Jenkinsia sp.					M														X	X
Sardinella anchovia													V				X		X	?
Anchoviella perfasciata																X				
Engraulis eurystole																	X			
Synodus intermedius	V	D				D		V		DV			V			X	X		X	X

TABLE XXI-53 (Continued)

Station #	October 1978 151	October 1978 247	October 1978 481	October 1978 491	Nov. '78 151	Jan. '79 151	Jan. '79 247	Mar. '79 151	Mar. '79 247	June 1979 151	June 1979 247	June 1979 481	June 1979 491	June 1979 SH	June 1979 047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Ichthyofaunal Species																				
Synodus saurus																	X		X	
Opsanus pardus	M				DS	M	D			M	V		M			X	X	X	X	X
Gobiesox strumosus											M									X
Antennarius ocellatus																			X	
Histrio histrio																			X	
Ogcocephalus radiatus											V						X		X	X
Bregmaceros atlanticus																X	X			
Urophycis floridanus						M				M			DM				X		X	X
Ogilbia sp.										M			M							X
Cypselurus exsiliens	M		M														X		X	X
Cypselurus heterurus																X	X		X	
Euleptorhamphus velox	M															X	X			X
Hemiramphus brasiliensis	M						M									X	X			X
Hirundichthys rondeleti																X	X			
Hyporhamphus unifasciatus			M			M													X	X
Parexocoetus brachypterus	M		M														X	X	X	X
Ablennes hians																			X	
Strongylura marina							M													X
Tylosurus crocodilus	M		M												M	X	X		X	X
Holocentrus ascensionis	V	V	V	DV	S		D		V		DV	D	V		V	X	X	X	X	X
Holocentrus bullisi													DV				X	X	X	X
Myripristis jacobus		V								V							X		X	X
Aulostomus maculatus																	X		X	
Fistularia tabacaria																			X	
Corythoichthys albirostris											M								X	?
Hippocampus erectus	D																		X	X
Syngnathus springeri						M				M										X
Centropritis ocyurus				D	S			VM		DV						X	X	X	X	X
Cephalopholis fulva																	X	X	X	

TABLE XXI-53 (Continued)

Station #	October 1978				Nov. '78	Jan. '79		Mar. '79		June 1979						Austin	Smith et al.	Smith	Hopkins et al.	Present Study
	151	247	481	491	151	151	247	151	247	151	247	481	491	SH	047					
Diplectrum formosum																X	X	X	X	
Epinephelus adscensionis	V		D	V	S	V	V			V			V			X	X	X	X	X
Epinephelus drummondhayi																	X		X	
Epinephelus guttatus	V										D					X	X	X	X	X
Epinephelus itajara	V	V											V				X		X	X
Epinephelus morio	DV	V	DM	V	S	V		V	V	V	DV		V	D		X	X	X	X	X
Hypoplectrus puella	DV	DV	DV	D	D	D	DV		D	DVM	DVM	D	DVM	D	V		X	X	X	X
Liopropoma eukrines			V		S					DV										X
Mycteroperca bonaci																	X	X	X	?
Mycteroperca interstitialis					S												X		X	
Mycteroperca microlepis	DV	DV	DV	V	DS	D	D		V	DV	DV		DV	D		X	X	X	X	X
Mycteroperca phenax	V	DV	DV	V	D	V	D		D	DV	DV		DV	D	V	X	X	X	X	X
Mycteroperca venenosa																	X		X	
Paranthias furcifer										V							X		X	X
Petrometopon cruentatum	V		DV		D	D				DV	D		DV			X	X	X	X	X
Serranus phoebe										V									X	X
Serranus subligarius		V	V							V	D						X	X	X	X
Serranus tabacarius																	X		X	
Serranus tigrinus																	X		X	
Rypticus bistrispinus																			X	
Rypticus maculatus		DV					D				DVM						X			X
Rypticus subbifrenatus																			X	
Priacanthus arenatus																			X	
Pristigenys altus	V				S	DV				DV						X	X		X	X
Apogon binotatus																	X			
Apogon maculatus	V		V		D					DM			DV				X		X	X
Apogon pseudomaculatus	DVM	V	V	DV	DS	VM		D	D	DVM	DV	V	DM	D		X	X	X	X	X
Astrapogon alutus										M		M	M						X	
Phaeoptyx pigmentaria	M	V		V		M	M			M							?			
Phaeoptyx xenus																	X			
Malacanthus plumieri																	X		X	

TABLE XXI-53 (Continued)

	October 1978				Nov. '78	Jan. '79		Mar. '79		June 1979										
Station #	151	247	481	491	151	151	247	151	247	151	247	481	491	SH	047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Rachycentron canadum					S											X	X			X
Echeneis neucratoides											V		V			X	X			X
Caranx bartholomaei																			X	
Caranx crysos	M		M														X		X	X
Caranx hippos																			X	
Caranx ruber																X	X		X	
Decapturus punctatus	M															X	X		X	X
Elagatis bipinnulata											V									X
Naucrates ductor																X				X
Seriola dumerili	V	DV	V	V	S		DV		D	V	DV		DV		V	X	X	X	X	X
Seriola rivoliana											V						X		X	X
Trachurus lathami																	X	X	X	
Coryphaena hippurus													V				X	X	X	X
Lutjanus compechanus		V	V					V								X	X	X	X	X
Lutjanus cyanopterus																	X			
Lutjanus griseus	D	D	V	V	S		D		D	V	DV	D	DV	D	V	X	X	X	X	X
Lutjanus synagris																X	X			
Ocyurus chrysurus																X	X			
Rhomboplites aurorubens																X	X		X	
Lobotes surinamensis																			X	
Anisotremus virginicus																			X	
Haemulon aurolineatum			D							V	V		V		V	X	X		X	X
Haemulon plumieri							D		DV	V	DV					X	X			X
Calamus bajonado	V																X	X		X
Calamus nodosus		D		V	S		D	D	V	DV	DV	D	DV		V	X	X		X	X
Calamus proridens																	X	X		
Pagrus pagrus	D	DV	DV	DV	S	DVM	D		V		DV	D	DV		V	X	X		X	X
Equetus lanceolatus		V			D				V	D	V		DV		V		X	X	X	X
Equetus umbrosus	V	V		V	D	M	D			VM	DV		DV		V	X	X		X	X
Mullus auratus																X	X			
Kyphosus sectatrix		V							V	V			V							X

E-78

TABLE XXI-53 (Continued)

Station #	October 1978 151	October 1978 247	October 1978 481	October 1978 491	Nov. '78 151	Jan. '79 151	Jan. '79 247	Mar. '78 151	Mar. '78 247	June 1979 151	June 1979 247	June 1979 481	June 1979 491	June 1979 SH	June 1979 047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Chaetodipterus faber																X	X			
Centropyge argi																	X	X		
Chaetodon capistratus																	X		X	
Chaetodon ocellatus	DV	V			D				V	DV	DV		DV		V	X	X	X	X	X
Chaetodon sedentarius	V		V	DV	S	D				DV	D		DV		V		X	X	X	X
Chaetodon striatus																			X	
Holacanthus bermudensis	DVM	DV	DV	D	D	DV	D	D	D	DV	DV	D	DV	D	V	X	X	X	X	X
Holacanthus ciliaris																	X	X		
Holacanthus tricolor																			X	
Pomacanthus arcuatus	V					V		V	V	V			V			X		X	X	X
Pomacanthus paru																	X			
Chromis cyaneus																	X	X		
Chromis enchrysurus	D		DV	D	D				D	DV	DV	D	DV				X	X	X	X
Chromis multilineatus																				
Chromis scotti	DV	DV	DV	DV	D	DM	DV	D	D	DV	DV	D	D	D		X	X	X	X	X
Eupomacentrus partitus		DV			S			V					V				X	X	X	X
Eupomacentrus planifrons																			X	
Eupomacentrus variabilis	DV	D	DV	D	D	D	D	D	D	D	D	D	D	D	V	X	X	X	X	X
Bodianus pulchellus					V						V									X
Bodianus rufus								V			V					X		X	X	X
Halichoeres bivattatus	DV	DV	D	D	D	DM	D	D	D	DVM	DV	D	DV	D	V	X	X	X	X	X
Halichoeres caudalis	V	D		D	D					D			D				X	X	X	X
Halichoeres garnoti										V			V						X	X
Halichoeres pictus					S															X
Hemipteronotus novacula																	X		X	
Lachnolaimus maximus	DV	DV	V	D	D	DV	D		D	V	DV		DV			X	X	X	X	X
Thalassoma bifasciatum													V			X	X	X	X	?
Nicholstina usta																	X		X	
Scarus sp. (croicensis)	DV		D	D		D				DV		D	DV				X	X	X	X
Sparisoma aurofrenatum																?	X		X	
Sparisoma radians																	X		X	
Mugil cephalus						V										X	X			X

TABLE XXI-53 (Continued)

Station #	October 1978 151	October 1978 247	October 1978 481	October 1978 491	Nov. '78 151	Jan. '79 151	Jan. '79 247	Mar. '79 151	Mar. '79 247	June 1979 151	June 1979 247	June 1979 481	June 1979 491	June 1979 SH	June 1979 047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Sphyraena barracuda	V	V								V	V		V			X		X	X	X
Opistognathus aurifrons										D	V						X	X	X	X
Opistognathus maxillosus																			X	
Kathetostoma albigutta						M													X	X
Emblemaria atlantica	DVM	M			S	DV		DV		DM			M							X
Emblemaria piratula					M			M											X	X
Labrisomus haitiensis	DM				M					M							X	X	X	X
Starksia ocellata	M	M		M		M	M	D		M	M	M	M						X	X
Blennius marmoreus	DV	DV	DV	DM	D	DM	DVM	D	D	DVM	DM	DM	DM	D	V		X	X	X	X
Hypleurochilus geminatus																		X		
Coryphopterus glaucofreanum	DV	D	DV	D	D	D	D	D	D	DVM	D	D	DM	D			X		X	X
Coryphopterus punctipectophorus	DV	D	DV	D	D	D	D	D	D	DVM	D	D	DM	D						X
Evermannichthys spongicola											M								X	X
Gobiosoma oceanops	DVM	D	D	D	D	D		D	DV	D	DV	D	D	D	V	X	X	X	X	X
Gobiosoma xanthiprora	DVM	VM	DM	VM	D	DVM		D		DVM	DM	M	DM		V		?	?	X	X
Gobulus myersi	M					M		M		M			M							X
Ioglossus calliurus	V	D	V	V		V		V		DV	D		V		V		X	X	X	X
Lythrypnus elasson	M	M	M	M						M			M							X
Lythrypnus nesiotes	M	M	M	M	M	M	M	M		M	M	M	M						X	X
Psilotris celsus	M							M		M	M		M							X
Risor ruber				M						M	M		M						X	X
Acanthurus bahianus																			X	
Acanthurus chirurgus																X	X		X	
Acanthurus coeruleus																			X	
Gempylus serpens																X				
Scomber japonicus						M														X
Scomberomorus cavalla	M		M														X		X	X
Scomberomorus maculatus																X				
Hyperoglyphe bythites																	X			
Nomeus gronovii																	X			

TABLE XXI-53 (Continued)

Station #	October 1978 151	October 1978 247	October 1978 481	October 1978 491	Nov. '78 151	Jan. '79 151	Jan. '79 247	Mar. '79 151	Mar. '79 247	June 1979 151	June 1979 247	June 1979 481	June 1979 491	June 1979 SH	June 1979 047	Austin	Smith et al.	Smith	Hopkins et al.	Present Study
Peprilus burti																	X			
Scorpaena brasiliensis	VM																X			X
Scorpaena calcarata																			X	
Scorpaena plumieri																X	X	X	X	
Bellator militaris																			X	
Syacium micrurum																X				
Syacium papillosum																			X	
Gymnachirus melas																X				
Symphurus sp.																X				
Aluterus schoepfi										V									X	X
Aluterus scriptus				V															X	X
Balistes capriscus	DV	DV	DV	DV	D	DV	D		D	DV	DV	D	DV		V	X	X	X	X	X
Monacanthus ciliatus										M										?
Monacanthus hispidus	M		M														X		X	X
Monacanthus setifer																X	X			
Lactophrys quadricornis															V		X		X	X
Canthigaster rostrata			DV			D				DV			D				X	X	X	X
Sphoeroides spengleri			M							V			D				X		X	X
Chilomycterus schoepfi	M	V	M																X	X

TABLE XXI-54
OCCURRENCE OF FISHES WITH SPONGES COLLECTED ON THE FLORIDA MIDDLE GROUND DURING THE PERIOD OCTOBER 1978 TO JUNE 1979

Host Sponge Species	*Agelas dispar*	*Verongia fistularis*	*Pseudoceratina crassa*	*Speciospongia vespera*	*Geodia* sp.	*Ircinia campana*	*Ircinia fasciculata*	*Ircinia strobilina*	*Callyspongia vaginalis*	*Callyspongia fallax*	*Callyspongia* sp. C
SAMPLE SIZE	104	45	9	2	7	9	14	3	13	24	2
Inquiline Species											
Gobiosoma xanthiprora	1	32	1	-	2	5	3	1	3	2	2
Lythrypnus nesiotes	20	-	1	1	1	-	-	2	-	2	1
Lythrypnus elasson	-	1	-	-	-	-	-	1	-	-	-
Emblemaria atlantica	-	1	-	-	-	-	-	-	-	-	-
Blennius marmoreus	-	1	-	-	-	-	-	-	1	-	-
Starksia ocellata	-	-	1	-	-	-	-	-	-	1	-
Evermannichthys spongicola	-	-	-	1	-	-	-	-	-	-	-
Risor ruber	-	-	-	-	-	2	-	1	-	2	-
Halichoeres bivittatus	-	-	-	-	-	-	1	-	-	-	-
Astrapogon alutus	-	-	-	-	-	-	-	-	1	-	-
Coryphopterus glaucofraenum	-	-	-	-	-	-	-	-	1	-	-

TABLE XXI-55
INFAUNAL FISHES ASSOCIATED WITH 122 SAMPLES
OF THE HARD CORAL *MADRACIS DECACTIS*

	OCTOBER				JANUARY		JUNE				
Station:	151 S/N	247	481	491	151	247	151	247	482	491	492
SPECIES											
Lythrypnus nesiotes	6/6	2/3	4/4	6/6	2/2	1/2	5/7	4/5	3/5	8/12	1/18
Lythrypnus elasson	1/1	1/1	1/2	1/1							1/3
Starksia ocellata	3/3	2/2		3/3	3/4	1/1	2/2	1/1	3/3	4/5	1/7
Gobiosoma xanthiprora	1/1									1/1	
Blennius marmoreus											1/1
Gymnothorax funebris											1/1
Apogon pseudomaculatus											1/1
Chromis scotti					1/1						
Labrisomus haitiensis	1/1										
Total # Samples (122)	14	10	10	12	14	11	10	12	10	11	1
# Occupied Samples (53)	7	4	4	7	5	1	6	5	5	8	1
S	5	3	2	3	3	2	2	2	2	3	6
N	12	6	6	10	7	3	9	6	8	18	31
Occupied Sample Volumes (ml)											
$\overline{X}$	970*	1134	1056	797	677	668	718	595	652	929	
Max.	2774	2659	2409	1274	1878	2288	1652	1148	1315	3810	27214**
Min.	234	223	345	119	148	212	118	172	108	253	

*Does not include volumes of three of fourteen samples at this station.
**Volume estimated from dry weight.

TABLE XXI-56
SUMMARY OF FISH COLLECTION DATA FOR ARTIFICIAL HABITATS

STATION NUMBER:	151								247	481	491	
EXPOSURE DURATION (DAYS):	16	103	16	69	88	158	263	16	261	273	259	# Per
MONTH RECOVERED:	OCT	JAN	JAN	MAR	JUN	JUN	JUN	JUL	JUL	JUL	JUL	Species
Lythrypnus nesiotes	3/5	9/14	2/2	4/5	5/12	6/9	4/6	6/19	2/4	3/3	2/2	81
Starksia ocellata	2/2	7/8		1/1	6/7	5/5	4/7	4/6	1/1	1/2	2/2	41
Blennius marmoreus		2/2			5/9	4/5	3/5	5/7	1/1	2/2	3/3	34
Apogon pseudomaculatus	1/1	1/1			4/7	2/2	4/4	3/5		4/7	1/2	29
Psilotris celsus	1/1			1/1	5/6	1/2	3/4	1/1	1/3		1/2	21
Opsanus pardus	2/2	3/3			1/1	3/3	4/4	3/3			1/1	17
Gobulus myersi	1/1	1/1		2/2	1/1	3/5	1/1				1/1	12
Gobiosoma xanthiprora	2/2		1/1					4/6				9
Astrapogon alutus						1/1	1/1	2/2		2/2	2/3	9
Halichoeres bivittatus						1/1	4/4	1/1			1/1	7
Apogon maculatus					1/1	1/1	1/1	2/3				6
Ogilbia sp.					1/1	1/1	1/1	2/2			1/1	6
Hypoplectrus puella						2/2	1/1	1/1	1/1		1/1	6
Emblemaria atlantica	1/1			1/1	1/1						2/2	5
Labrisomus haitiensis		1/1		1/1		1/1						3
Urophycis floridanus				1/1	1/1						1/1	3
Phaeoptyx pigmentaria	1/1		1/1									2
Emblemaria piratula				1/1				1/1				2
Centropristis ocyurus				1/1								1
Coryphopterus glaucofraenum					1/1							1
Equetus umbrosus					1/1							1
Rypticus maculatus								1/1				1
Epinephelus sp.						1/1						1
Number of Occupied Habitats	9	10	4	8	9	9	10	9	2	4	4	
Sample Size	10	10	10	10	10	10	10	10	4	4	4	
Number of Fish in Sample	16	30	4	14	49	39	40	57	11	16	22	
Number of Species in Sample	9	7	3	9	13	14	12	13	6	5	13	

TABLE XXI-57
COMPARISON OF ICHTHYOFAUNAL DIVERSITY INDICES
FOR FIVE BIOTOPES OF THE FLORIDA MIDDLE GROUND

SRF - shallow reef flat
R - ridge
S - slope
DSF - deep sand flat
P - patch reef

BIOTOPE		H'	E	NM_S	S	N
SRF	X	1.618	0.782	0.318	8.2	39.8
	SD	0.364	0.154	0.158	1.9	26.6
R	X	1.352	0.585	0.137	10.5	75.9
	SD	0.279	0.125	0.089	2.5	40.5
S	X	1.629	0.728	0.261	9.4	47.6
	SD	0.412	0.160	0.156	1.8	18.3
DSF	X	1.847	0.848	0.281	9.4	30.1
	SD	0.421	0.110	0.120	3.5	20.9
P	X	1.644	0.736	0.213	9.5	43.8
	SD	0.194	0.120	0.081	1.5	20.7

H' - Shannon-Weaver species diversity index

E - Pielou's measure of species evenness

NM_S- Fager's measure of species evenness

S - # species per count

N - # individuals per count

TABLE XXI-58
POPULATION DENSITIES OF FISHES OCCURRING WITHIN
FIVE BIOTOPES OF THE FLORIDA MIDDLE GROUND

SRF - shallow reef flat
R - ridge
S - slope
DSF - deep sand flat
P - patch reef

Species	SRF	R	S	DSF	P
Chromis scotti	447	1,130	591	175	571
Halichoeres bivittatus	147	87	95	96	67
Blennis marmoreus	73	38	53	31	50
Eupomacentrus variabilis	69	29	21	18	58
Coryphopterus spp.	56	40	72	24	29
Gobiosoma oceanops	40	48	96	28	108
Gobiosoma xanthiprora	35	17	10	8	-
Holacanthus bermudensis	31	46	48	25	29
Scarus sp.	20	8	21	14	88
Mycteroperca phenax	9	21	14	18	-
Hypoplectrus puella	9	8	15	11	17
Balistes capriscus	7	29	16	8	4
Pagrus pagrus	6	38	29	28	13
Lachnolaimus maximus	5	15	1	1	17
Ioglossus calliurus	5	-	-	68	-
Emblemaria atlantica	4	2	-	-	-
Mycteroperca microlepis	3	10	7	1	-
Canthigaster rostrata	3	1	1	3	-
Chaetodo ocellatus	3	2	1	13	-
Lutjanus griseus	2	13	21	17	-
Serranus subligarius	2	-	-	-	-
Chaetodon sedentarius	2	4	7	-	8
Chromis enchrysurus	2	7	26	54	21
Seriola dumerili	2	225	-	3	-
Eupomacentrus partitus	1	-	-	-	-
Apogon pseudomaculatus	1	2	2	14	4
Equetus lanceolatus	1	-	1	1	-
Centropristis ocyurus	1	-	-	44	-
Apogon maculatus	1	1	1	-	-
Epinephelus guttatus	1	1	-	-	-
Epinephelus morio	1	1	1	-	-
Calamus nodosus	1	7	11	28	-
Opistognathus aurifrons	1	-	-	1	-
Synodus intermedius	1	-	1	1	-
Labrisomus haitiensis	1	-	-	-	-
Hippocampus erectus	1	-	-	-	-
Gymnothorax moringua	1	-	-	-	-
Epinephelus cruentatus	1	3	3	-	-
Holacentrus ascensionis	-	7	-	1	8
Holacentrus bullisi	-	-	2	1	-
Halichoeres caudalis	-	-	2	6	4
Halichoeres pictus	-	-	-	1	-
Equetus umbrosus	-	38	10	6	-
Rypticus maculatus	-	8	1	3	-

TABLE XXI-58 (Continued)

Species	SRF	R	S	DSF	P
Opsanus pardus	-	-	1	-	-
Pristigenys alta	-	-	2	-	-
Liopropoma eukrines	-	-	1	-	-
Urophycis floridanus	-	-	1	-	-
Sphoeroides spengleri	-	-	1	-	-
Haemulon aurolineatum	-	8	-	-	-
Haemulon plumieri	-	8	-	-	-
Starksia ocellata	-	1	-	-	-
Total Species	38	34	36	33	17

APPENDIX F

DATA MANAGEMENT PROCEDURES

COMPUTER CODING SHEET: FILES 30-32

COLUMN NUMBER	EXPLANATION
2-3	File code number
5-19	Sample ID code number
21-23	Station number
25	Year (8 = 1978, 9 = 1979)
26-27	Month (01 thru 12)
28-29	Day (01 thru 31)
31	Season (1 = fall, 2 = winter, 3 = spring, 4 = summer)
33	A = Diver cryptofauna
	B = Diver sediment
	C = Diver misc. invertebrates
	D = Diver Algae
	E = Diver Fish
	F = Dip Net
	G = SHIPEK
	H = Bucket Dredge
	I = Capetown Dredge
	J = Rod & Reel
	K = Trawl
	L = Submersible
	M = Other
35-36	AA = Sponge - _Agelas dispar_
	AB = Sponge - _Callyspongia vaginalis_
	AC = Sponge - _Callyspongia_ A.
	AD = Sponge - _Callyspongia_ B.
	AE = Sponge - _Geodia_
	AF = Sponge - _Ircinia campana_
	AG = Sponge - _Ircinia_ ? _strobilina_
	AH = Sponge - _Haliclona_ A
	AI = Sponge - _Haliclona/Halichondria_

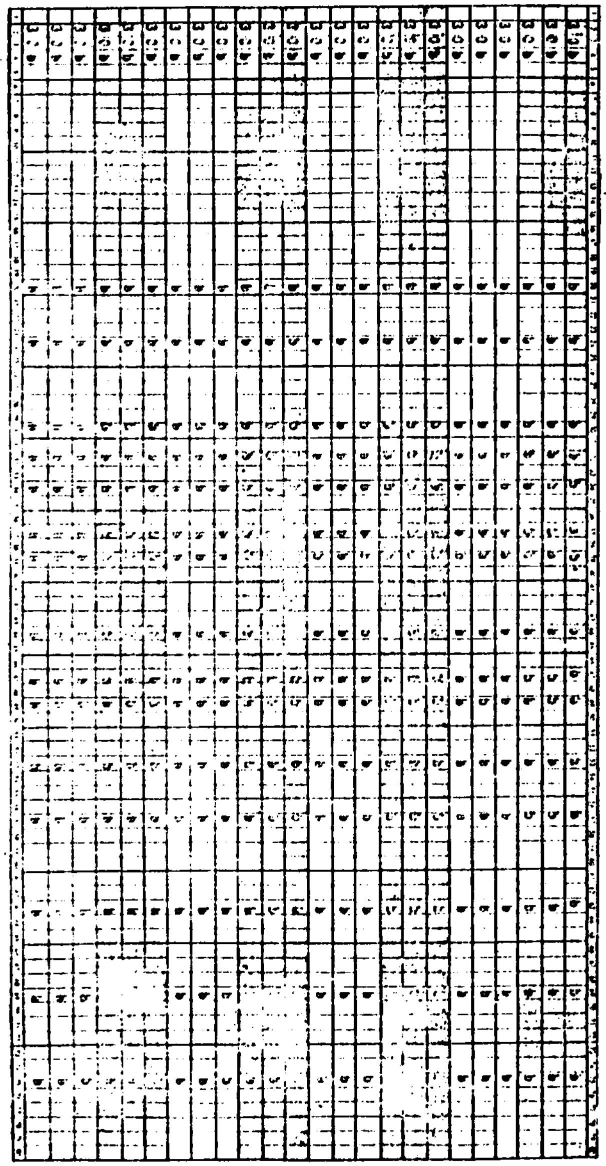
(Files 30-32, Continued)

COLUMN NUMBER	EXPLANATION
35-36 (Continued)	AJ = Sponge - _Haliclona_ A
	AK = Sponge - _Haliclona_ B
	AL = Sponge - _Halichondria_ ?
	AM = Sponge - _Verongia fistularis_
	AN = Sponge - _Pseudoceratina crassa_
	AO = Sponge - _Placospongia_
	AP = Sponge - _Tethya_ ?
	AQ = Sponge - Axinillid sponge
	AR = Sponge - _Neofibularia nolitangere_
	AS = Sponge - Sponge like _Geodia_
	AT = Sponge - Sponge A
	AU = Sponge - Sponge B
	AV = Sponge - Sponge C
	AW = Sponge - Sponge D
	AX = Sponge - Sponge E
	AY = Sponge - Dead Sponge
	BA = Soft Coral - _Muricia laxa_
	BB = Soft Coral - _Muricia elongata_
	BC = Soft Coral - _Eunicia calyculata_
	BD = Soft Coral - _Plexaurella fusifera_
	BE = Soft Coral - _Lophogorgia cardinalis_
	BF = Soft Coral - _Lophogorgia hebes_
	BG = _Pseudoterogorgia acerosa_
	CA = Hard Coral - _Oculina diffusa_
	CB = Hard Coral - _Manicina areolata_
	CC = Hard Coral - _Meandrina meandrites_
	CD = Hard Coral - _Scolymia_ sp.
	CE = Hard Coral - _Scolymia lacera_
	CF = Hard Coral - _Dichocoenia stellaris_
	CG = Hard Coral - _Dichocoenia stokesii_
	CH = Hard Coral - _Stephanocoenia michelini_
	CI = Hard Coral - _Agaricia_ sp.
	CJ = Hard Coral - _Agaricia fragilis_

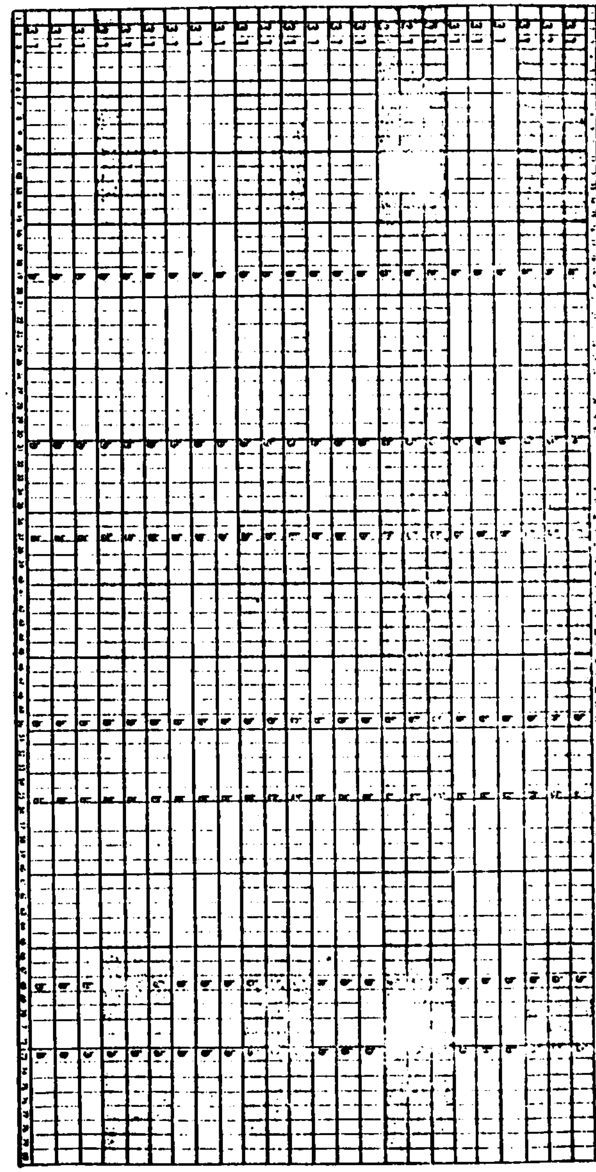
COLUMN NUMBER	EXPLANATION
35-36 (Continued)	CK = Hard Coral - Agaricia agaricites
	CL = Hard Coral - Cladocora arbuscula
	CM = Hard Coral - Isophyllia sinuosa
	CN = Hard Coral - Millepora alcicornis (hydrozoan)
	CO = Hard Coral - Madracis decactis
	DA = Habitats - Fall 20 day
	DB = Habitats - Fall-Winter 90 day
	DC = Habitats - Winter 20 day
	DD = Habitats - Winter-March 90 day
	DE = Habitats - Winter-March 90 day
	DF = Habitats - Winter-Summer 120 day
	DG = Habitats - March-Summer 90 day
	DH = Habitats - Summer 20 day
	DI = Habitats - Fall-Summer 247
	DJ = Habitats - Fall-Summer 481
	DK = Habitats - Fall-Summer 491
	DL = Habitats - Other
	EA = Algae - General
	EB = Algae - ¼ Metre
	EC = Algae - Surface (Sargassum)
	FA = Misc. Host - Astrophyton
	FB = Misc. Host - Bryzoa
	FC = Misc. Host - Hydrozoa
	FD = Misc. Host - Worms
	FE = Misc. Host - Ascidian
	GA = Sediment - Dredge
	GB = Sediment - Diver
	GC = Sediment - Submersible
	HA = Old BLM Stations - 151
	HB = Old BLM Stations - 247
	IA = Misc. Animals - Shrimp
	IB = Misc. Animals - Crabs
	IC = Misc. Animals - Mollusks
	ID = Misc. Animals - Worms

COLUMN NUMBER	EXPLANATION
35-36 (Continued)	IE = Misc. Animals - Rubble
	IF = Misc. Animals - Fish Trap
	IG = Misc. Animals - Fish Slurp
	IH = Misc. Animals - Surface
	II = Misc. Animals - Echinoderms
	JA = Other Collections
38	0 = No 1 = Yes (Decalcified)
40-43	Military Time
45-46	Depth in Metres
48	L = Light D = Dark
50-52	Salinity, column 52 = tenths
54-56	Temp., Column 56 = tenths
58-62	Volume, Column 62 = tenths
64-68	Calcium Dry wt., Column 68 = tenths
70-74	Sponge Dry wt., Column 74 = tenths
76-80	Sediment Dry wt., Column 80 = tenths

File 30: Cryptofaunal Data File

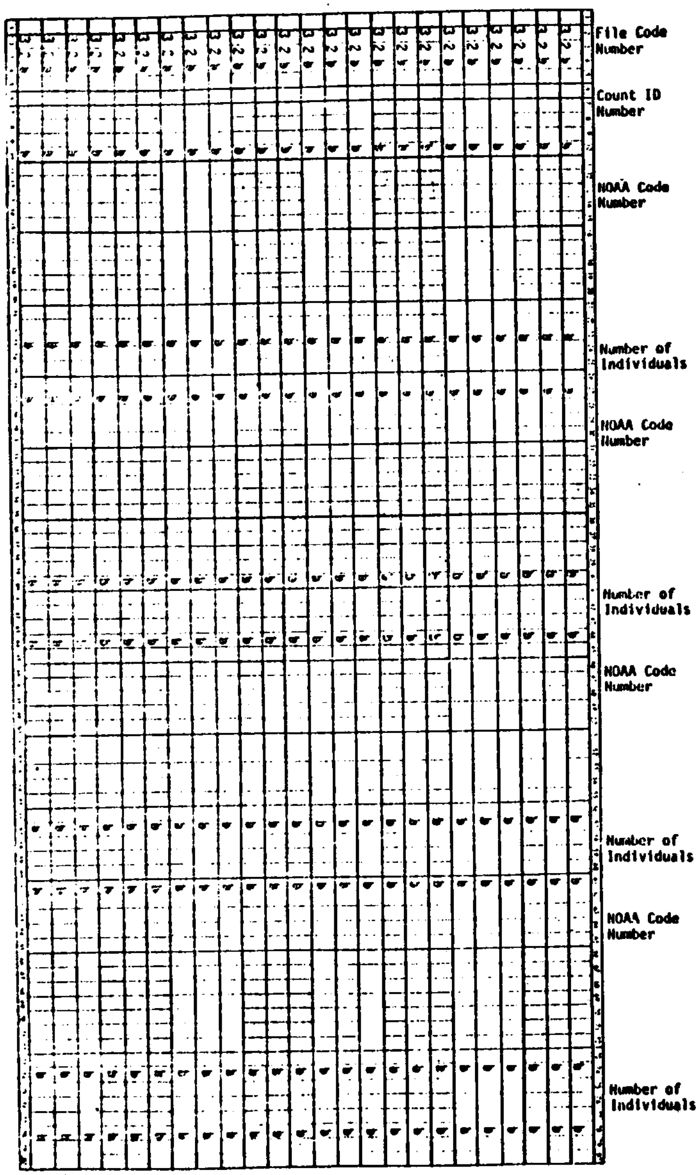


File 31: Cryptofaunal Data Archive



X-A-I-8

File 32: Ichthyofaunal Diversity Archive



X-A-I-9

COMPUTER CODING SHEET: FILE 33

COLUMN NUMBER	EXPLANATION
2-3	File code number
5-9	Count I.D. number
11-13	Station number
15-19	Date (year; 8=78, 9=79)
21	Season (1=fall, 2=winter, 3=spring, 4=summer)
23	D = Diver
	S = Submarine
25	1 = Shallowreef flat
	2 = Shallow ridge crest
	3 = Reef face
	4 = Reef slope
	5 = Deep ridge
	6 = Deep sand flat
	7 = Patch reef
27-28	Depth in Metres
30-33	Military time
35-37	Percent sand substrate cover
39-41	Percent rubble substrate cover
43-45	Percent soft coral substrate cover
47-49	Percent sponge substrate cover
51-53	Percent hard coral substrate cover
55-57	Percent outcrop substrate cover

File 35. Ichthyofaunal Diversity File

File Code Number

Count ID Number

Station

Date

Season

Count Method

Biotope

Depth(m)

Time

Percent Sand

Percent Rubble

Percent Soft Coral

Percent Sponge

Percent Hard Coral

Percent Outcrop

ABUNDANCE DATA DISPLAY - NO. 1

PHYLOGENETIC LISTING OF SPECIES BY STATION SEASONALLY AND OVERALL

NOAA CODE	SCIENTIFIC NAME	STATION 151				STATION 247				STATION 481				STATION 491				FMG OVERALL			
		F	W	S	T	F	W	S	T	F	W	S	T	F	W	S	T	F	W	S	T

ABUNDANCE DATA DISPLAY - NO. 2. PHYLOGENETIC LISTING OF SPECIES BY HOST, TYPE, AND VOLUME

EXAMPLE:

Agelas dispar

SEASON	SAMPLE NO.	VOLUME	SCIENTIFIC NAME	ABUNDANCE	NO./UNIT VOLUME

DATA ANALYSIS NO. 1 - Dominance Index

Where combined relative abundance of the two most common species is used to calculate DI,

DI = A + B (A and B are the relative abundance of the two most common species.)

we would emphasize data for the following taxa:

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
 1) Seasonally
 2) Overall

c) Habitat
 1) Seasonally
 2) Overall

DATA ANALYSIS NO. 2 - Shannon-Wiener Index of Diversity

where $H' = -\sum_{i=1}^{N} P_i$ and $P_i = p_i \log_{10} p_i$

or $= p_i \log_2 p_i$

or $= p_i \ln p_i$

where N = Total N species
p_i = proportion of the community belonging to the i^{th} species (n_i/N)

we would emphasize data for the following taxa

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
   1) Seasonally
   2) Overall

c) Habitat
   1) Seasonally
   2) Overall

DATA ANALYSIS NO. 3 - Pielou's Evenness

Where $J' = \frac{H'}{H'\ max}$ and $H'\ max = \log_{10} S$ and S = the number of species.

or $= \text{Log}_2\ S$

or $= \text{Ln}\ S$

we would emphasize data for the following taxa:

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
   1) Seasonally
   2) Overall

c) Habitat
   1) Seasonally
   2) Overall

DATA ANALYSIS NO. 4 - Hurburt's Expected Number of Species

where $E(S_n)$ is the estimated number of species

and $E(S_n) = \sum_{1}^{S} \left(1 - \left(\binom{N-N_i}{n} / \binom{N}{n}\right)\right)$

S = No. of species in original sample

N = No. of individuals in original sample

N_i = No. of individuals in the ith species

n = Sample size

we would emphasize data for the following taxa:

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
   1) Seasonally
   2) Overall

c) Habitat
   1) Seasonally
   2) Overall

DATA ANALYSIS NO. 5 - Margelef's Species Richness

Where $SR = \frac{(S-1)}{\ln N}$

and S = the number of species

N = number of individuals

we would emphasize data for the following taxa:

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
   1) Seasonally
   2) Overall

c) Habitat
   1) Seasonally
   2) Overall

DATA ANALYSIS NO. 6. Sanders Minimal Faunal Abundance for Station Similarity

Where $MFA = \sum_{i=1} c_i$ and $c_i = \begin{cases} a_i, & a_i \le b_i \\ b_i, & b_i \le c_i \end{cases}$, $0 \le a, b, c \le 1$

and the value may be presented as a % by x 100

This method examines two S species assemblages A and B with proportionate abundances of the ith species a_i and b_i respectively.

We would use selective taxa and compare

a) Decapoda (Caridea)

b) Isopoda

c) Polychaeta (Syllidae)

d) Mollusca

e) Total

and compare:

a) Sample

b) Stations
   1) Seasonally
   2) Overall

c) Habitat
   1) Seasonally
   2) Overall

DATA ANALYSIS NO. 7 - Morisita's Coefficient of Interspecific Association and Similarity

Where $C\lambda = 2\sum_{1}^{\infty} \frac{n_{1i}\, n_{2i}}{N_1 N_2 (\lambda_{1j} + \lambda_{2j})}$

and n_{1i} and n_{2i} are numbers of specimens of the ith species in samples 1 & 2, and

N_1 and N_2 are total numbers of specimens in the two samples and

$$\lambda_{1j} = \sum_{1}^{\infty} \frac{n_i (n_i - 1)}{N \; (N-1)} \qquad \lambda_{2j} = \sum_{1}^{\infty} \frac{n_i (n_i - 1)}{N \; (N-1)}$$

for each sample.

We would examine:

a) Decapoda: Caridea

b) Polychaetes: Syllidae

c) Molluscs

d) Isopods

e) Total

By:

a) Samples - (Dendrogram as well as print out of values)

b) Station - (Trellis Diagram and print out values)

c) Season - (Trellis Diagram and print out of values)

d) Station and Season (Trellis Diagram)

e) Host Type - Dendrogram & Print out

f) Habitat - Dendrogram & Print out

DATA ANALYSIS NO. 8 - Bray Curtis Similarity Index

Where $\% S = \frac{2A}{B + C} \times 100$

and A = No. of species common to both sites, and B and C are the total number of species at each site.

This analysis should be performed for the following taxa:

a) Decapoda: Caridea

b) Isopoda

c) Polychaeta: Syllidae

d) Mollusca

e) Total of Above

and should be applied to

Madracis Samples

Agelas Samples

Artificial Habitats 30 day

Artificial Habitats 30, 60, 90 day.

Display as trellis diagram with numbers.

DATA ANALYSIS NO. 9 - Examination of Species/Volume Using Linear Regression.

See: Ricker, W.E. 1973. Linear regressions in fishery research. J. Fish. Res. Board Can. 30: 409-434. (Abstract attached.)

Use Nair Bartlett Model II Regression Method and the following taxa:

a) Decapoda; Caridea

b) Polychaeta; Syllidae

c) Molluscs

d) Isopods

e) Total

Please examine:

a). Species Number vs. Sample Volume

b) Species Number vs. Sample Dry Weight

c) Individual Number vs. Sample Volume

d) Individual Number vs. Sample Dry Weight

To include correlation coefficients and F distribution values with associated probabilities of error.

Abstract from: Journal Fisheries Research Board of Canada, Vol. 30, No. 3, 1973.

Linear Regressions in Fishery Research

W. E. Ricker

Fisheries Research Board of Canada
Biological Station, Nanaimo, B.C.

Ricker, W. E. 1973. Linear regressions in fishery research. J. Fish. Res. Board Can. 30: 409-434.

A number of regression situations in fish and fishery biology are examined, in which both of the variates are subject to error of measurement, or inherent variability, or both. For most of these situations a functional regression line is more suitable than the ordinary predictive regressions that have usually been employed, so that many estimates now in use are in some degree biased. Examples are (1) estimation of the exponent in the weight-length relationship, where almost all published values are somewhat too small; and (2) estimating the regression of logarithm of metabolic rate on log body weight of fish, where the best average figure proves to be 0.85 rather than 0.80. In the very common situation where the distribution of the variates is non-normal and open-ended, a functional regression is the most appropriate one even for purposes of prediction. Two ways of estimating the functional regression are (1) from arithmetic means of segments of the distribution, when computed symmetrically; and (2) from the geometric mean of one predictive regression and the reciprocal of the other. The GM regression gives a more accurate estimate when it is applicable; it is appropriate in all situations where the variability is mainly inherent in the material (little of it due to errors of measurement), or where the measurement variances are approximately proportional to the total variance of each variate; and it is the best estimate available for short series with moderate or large variability even when neither of these conditions applies. When error in X results solely from the measuring process the predictive regression of Y on X is also the functional regression if observations of X are not taken at random but rather have pre-established values, as is

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.