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Distribution of modern foraminifers on the margins of the northern Bahamas

Michael William Mullen
San Jose State University

DISTRIBUTION OF MODERN FORAMINIFERS ON THE MARGINS OF THE NORTHERN BAHAMAS

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Michael William Mullen

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APPROVED FOR THE DEPARTMENT OF GEOLOGY

Calvin H. Stevens

David W. Andersen

Paula J. Quinterno

APPROVED FOR THE UNIVERSITY

ABSTRACT

DISTRIBUTION OF MODERN FORAMINIFERS
ON THE MARGINS OF THE NORTHERN BAHAMAS

by Michael W. Mullen

Modern foraminiferal assemblages collected from shallow carbonate bank margins and the surrounding deep-water slopes of Cay Sal, Great Bahama, and Little Bahama Banks were analyzed for windward-leeward effects on their composition. The percentage of displaced benthic foraminifers on leeward slopes is much greater than on windward slopes; the total number of benthic species is higher on leeward slopes due to the large number of displaced shallow-water foraminifers; and the percentage of planktonic foraminifers is significantly lower on leeward slopes due to dilution by displaced shallow-water benthic specimens.

These data indicate that the windward-leeward effect significantly affects the distribution of the shallow-water foraminiferal component in sediment on the deep-water margins surrounding the northern Bahamas. The results also should aid in interpreting the geology of ancient carbonate banks.

ACKNOWLEDGMENTS

I wish to express my deepest appreciation to my parents Joe B. Mullen, Jr. and Sumi I. Mullen for their unending support during this project. I thank Calvin Stevens for his continued encouragement and guidance and David Andersen and Paula Quinterno for their helpful comments and suggestions. I am grateful to Hank Mullins and Albert Hine for including me in their research project and in the cruise to the Bahamas, and I thank Kathryn Heath and Hank Mullins for providing the additional samples from the windward margin of Little Bahama Bank.

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INTRODUCTION

Scope of Investigation and Previous Work

This study utilizes foraminifers from the margins of Cay Sal Bank (CSB), Great Bahama Bank (GBB), and Little Bahama Bank (LBB) to estimate the amount of offbank transport of shallow-water, sand-size foraminiferal sediment components and to determine whether or not significant sedimentological and ecological differences exist between windward and leeward margins. The Bahaman margins have been classified in previous studies as windward or leeward depending upon the prevailing wind, wave, and storm direction (Mullins, 1983; Mullins and Neumann 1979). This directed energy, or flux, can exert a strong influence on the distribution of sediment and subsequent bank morphology as stated by Mullins and Neumann (1979). These workers suggested that sedimentary facies should be significantly affected by this flux in that most of the coarse-grained (>125-μm), shallow-water-derived sediment will be transported onbank on windward margins and offbank on leeward margins. This should produce thicker and more extensive periplatform aprons of sediment off leeward margins, and grains of shallow-water origin should be more abundant in leeward slope deposits than in slope deposits of windward margins. Because many of the sediment grains in purely carbonate depositional environments are biogenic, the grains in modern carbonate environments can be used as indicators of sediment origin if the distribution of living contributors is known.

Foraminifers are excellent environmental (e.g., water depth and temperature) indicators, and therefore assemblages from both windward and leeward margins are examined to establish parameters for comparison. These parameters include the suborder percentage, species predominance, diversity index, percent of displaced shallow-water benthic specimens, and planktonic/benthic ratio. The samples were stained to recognize live specimens in order to determine the water depth distribution of the benthic species (i.e., bank-top or slope species), but the assemblages as a whole are treated as sediment grains. These data are augmented with information from previous studies of foraminiferal distribution (e.g., Parker, 1954; Bock and others, 1971; Todd and Low, 1971; Brooks, 1973; Wantland, 1975; Poag, 1981; Martin, 1988).

Additionally, the results of this study have applications for paleoenvironmental interpretations. The parameters determined in this study can be applied to microfossils in older deposits in order to recognize windward-leeward effects in the past or at least to identify periods of platform shedding or offbank transport of shallow-water sediment. These data should be useful in supplementing studies of sea level change and carbonate platform growth.

Regional Setting

Cay Sal Bank and the main Bahama banks are part of the Bahama-southern Florida platform (Fig. 1), a series of 10- to 13-km-thick, tectonically stable, shallow-water carbonate banks that are separated by linear, deep-water channels. Drill-hole data from a test well on Cay Sal Bank indicate a stratigraphic section of about 5.7 km of Late Jurassic to Holocene shallow-water limestone (Spencer, 1967). These data suggest that shallow-shelf environments have persisted in this region since Jurassic time. The origin of the deep channels such as Santaren Channel (Fig. 1) is still debated, but these features may be due to a combination of faulting and erosion. Summaries of the various models and reinterpretations have been given by Mullins and Lynts (1977), Schlager and Ginsburg (1981), Mullins (1983), and ODP Leg 101 Scientific

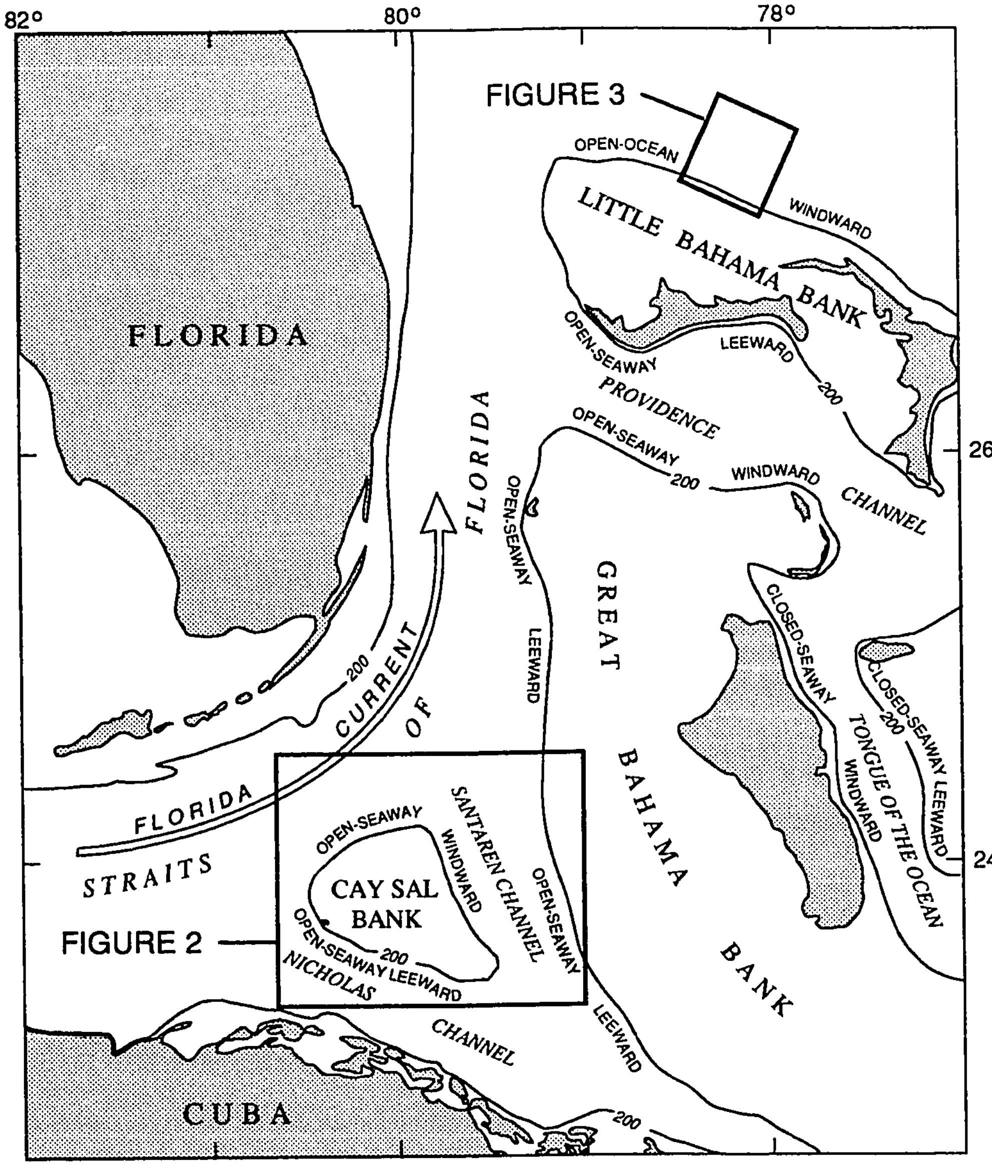

Figure 1. Index map of the southern Florida-northern Bahama region showing principal geographic features, windward and leeward margins, and locations of areas shown in Figures 2 and 3.

Drilling Party (1985).

The climate of the study area is subtropical, with open surface-water temperatures ranging from 22°C in February to about 31°C in August (U.S. Naval Oceanographic Office, 1967). Lows of 12.6°C may occur with the passage of severe cold fronts (Roberts and others, 1982). Lateral and vertical temperature gradients over most of the platform are small, due to the relatively shallow water (less than 20 m) and the efficient wind and wave mixing of the waters (Gebelein, 1974).

The physical energy flux tends to be stronger on the northeastern and eastern margins (windward) than on the western and southwestern margins (leeward). This is due to the predominant wave energy produced by prevailing winds approaching from the east and northeast (Hine and Neumann, 1977; Hine and others, 1981). Most of the tropical storms and hurricanes, which have winds that can reach velocities of 270 km/sec, pass through the Bahamas toward the north and east, generating dominant winds from the northwest, north, or northeast (Hine and Neumann, 1977).

Oceanic circulation in the study area is dominated by the Florida Current, which flows to the northeast and then north through the Straits of Florida (Fig. 1). Surface current velocities commonly exceed 160 cm/sec in the northern straits (Duing, 1975). The undercurrents are more complicated, due to bi-directional flow, and have variable velocities of 2 to 60 cm/sec (Mullins and others, 1980). These bottom currents can affect the deep-margin bottom morphology and produce features such as sediment drifts, hardgrounds, and scour troughs.

METHODS

Sample Material

The material used in this study was collected during a marine geologic research cruise led by Dr. Albert C. Hine (University of South Florida) from September 23 through September 29, 1981, to Cay Sal Bank and the western margin of the Great Bahama Bank. Thirty-eight sediment samples were collected from which I subsampled 26 for this study. Six additional samples from north of Little Bahama Bank were collected during an earlier investigation (Mullins and others, 1984). The samples from Cay Sal Bank (Fig. 2) were collected from open-seaway windward margins (sta. nos. 1-4, 18-21, and 23) and open-seaway leeward margins (sta. nos. 5-17). The Great Bahama Bank samples (Fig. 2) are from an open-seaway leeward margin (sta. nos. 24-26) with adjoining shallow-water ooid sand shoals. The samples from both areas were collected with a Shipek grab or by collecting the top 2 to 3 cm of surficial sediment with a sample jar during skin and SCUBA diving. At three of the dive sites I made collections of both sediment and plants, which can act as substrates for foraminifers. All foraminiferal samples were placed in plastic jars with a dilute solution of denatured ethyl alcohol preservative and rose Bengal stain in order to recognize live specimens (Walton, 1952). The solution was buffered with sodium borate to reduce acidity and prevent the dissolution of carbonate material. The six samples from Little Bahama Bank (Fig. 3) were collected with a Shipek grab and with a pilot core. The samples, made available by Kathryn Heath (Moss Landing Marine Laboratories) and Henry T. Mullins (Syracuse University), were not stained for live foraminifers, but provided data on an open-ocean windward margin.

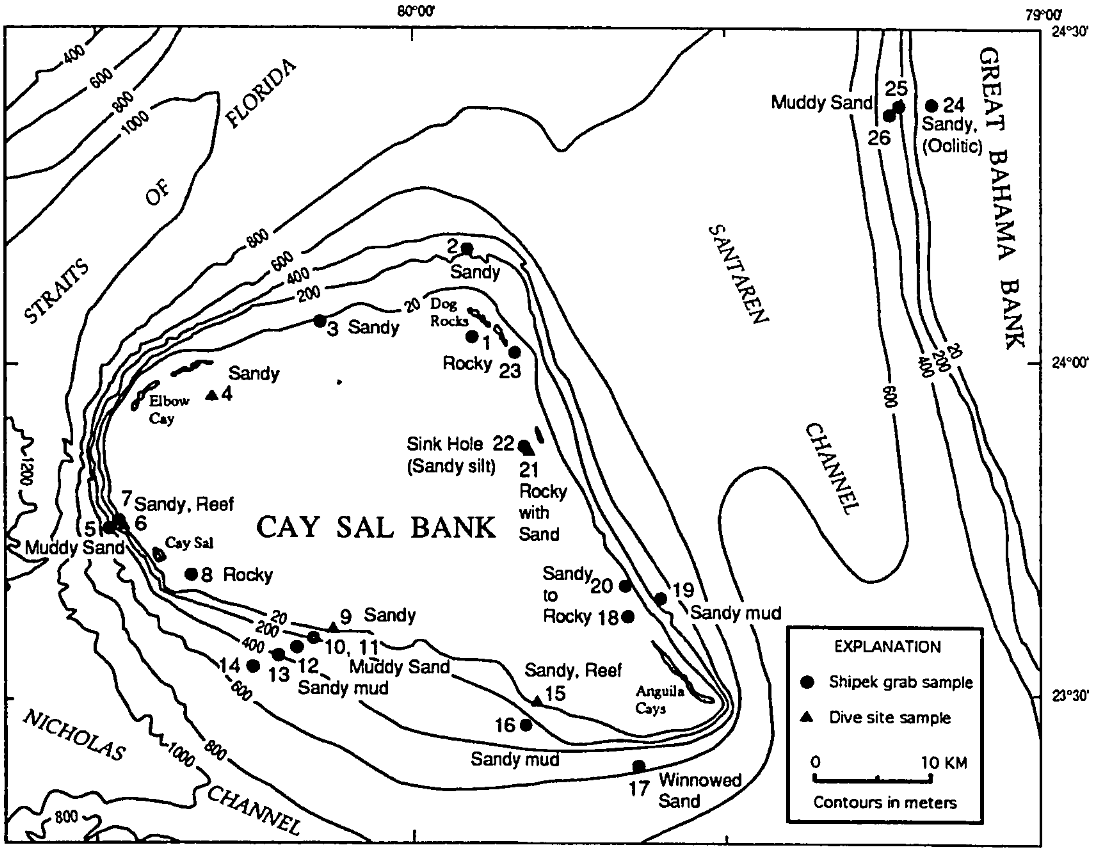

Figure 2. Index map of Cay Sal Bank and western margin of Great Bahama Bank showing sample locations and substrate type. Bathymetry modified after Malloy and Hurley (1970).

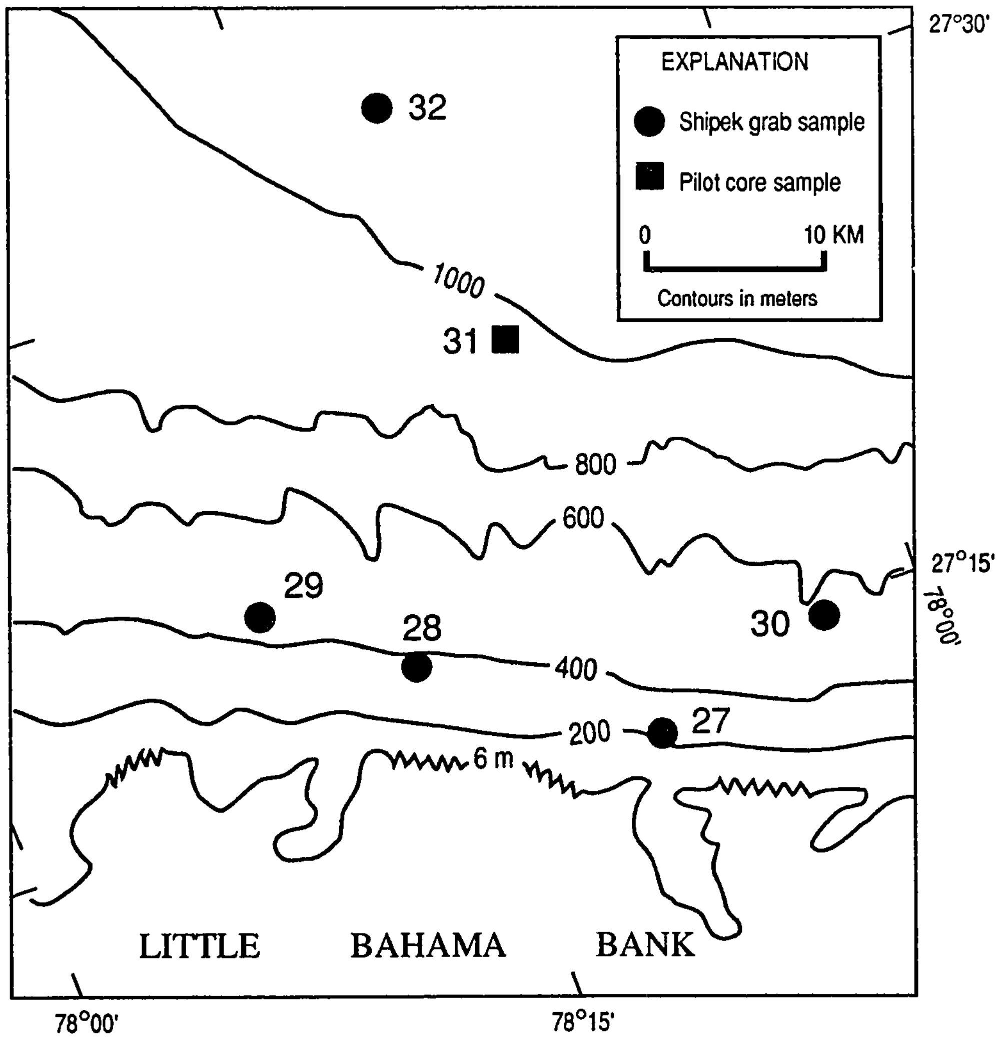

Figure 3. Index map of the northern margin of Little Bahama Bank showing sample locations. Bathymetry and sample sites after Mullins and others (1984).

Sediment

A sediment-size analysis was done to determine trends in sand-size sediment and substrate controls on the distribution of the benthic foraminifers. A weighed amount of sample was wet sieved, and the remaining sand fraction (>63 μm) was dried and weighed. The pan fraction (<63 μm) was processed for bulk silt and clay using a pipette method modified from Folk (1974), which omits the fine-medium-coarse subdivisions. This procedure was applied because only the bulk percentages of sand, silt, and clay were needed for this study.

The sediment samples were examined qualitatively to roughly determine the foraminifer abundance, substrate controls and sediment/foraminifer associations. Relative abundances of various sediment grain types were noted while picking foraminifers from the sample splits, and the bulk processed samples were examined to supplement these observations.

Foraminifers

The foraminiferal samples were processed by wet sieving over nested 2 mm-, 125 μm-, and 63 μm-mesh sieves. The dried residues from the >125 μm size fraction were then divided through a microsplitter to obtain a subsample of 300 or more benthic foraminifers. This number is necessary in order to reach a statistically significant total (Buzas, 1979b) and to attain a reasonable amount of specimens to pick. In slope samples, the subsample splits of 300 or more foraminifers contain both *in situ* and displaced benthic specimens. Due to the abundance of planktonic foraminifers in many slope samples, over a thousand foraminifers were picked to acquire the needed number of benthic specimens. The >125 μm size fraction was selected because the finer fraction contains large numbers of juvenile specimens of miliolinids and rotalinids. These are difficult to identify and are not necessary in determining the needed parameters for this study.

In order to differentiate shallow-water (bank top) from deep-water (slope) taxa, all benthic specimens from the 14 bank top and 18 slope samples were identified if possible. Taxonomic studies of shallow-water south Florida-Caribbean foraminifers are numerous (e.g., Cushman, 1921, 1922, 1926; Seiglie, 1964, 1966; Hofker, 1969, 1976; Bock and others, 1971; Todd and Low, 1971; Brooks, 1973; Rose and Lidz, 1977), but studies of deep-water carbonate slope faunas are few (e.g., Norton, 1930; Mullen and Mullins, 1984; Martin, 1988; Galluzzo and others, 1990). Extensive studies of deep-water foraminifers have been published on the nearby Gulf of Mexico region (Phleger and Parker, 1951; Parker, 1954; Pflum and Frerichs, 1976; Poag, 1981) and the southeastern Atlantic coast of the United States (Cushman, 1918-1931; Wilcoxon, 1964; Sen Gupta and Strickert, 1982). These and other publications (e.g., Barker, 1960) are used to identify the benthic species. The scheme of Loeblich and Tappan (1988) is followed for the most part for generic and higher level classification in this paper. The specimens identified as planktonic species were picked and quantified as a group in order to calculate the planktonic/benthic ratio. Selected benthic specimens were photographed using a binocular optical microscope and scanning electron microscope (SEM) to aid identification.

Benthic foraminifers with rose Bengal-stained protoplasm are considered to have been living at the time of collection. This staining technique is especially important in determining which species live in a given environment, because many empty tests are transported away from their original postmortem locations. Specimens with opaque or thick tests, in which staining was questionable, were wetted or broken open to ascertain the presence or absence of stained protoplasm. A common clue indicating live specimens is the accumulation of fine-grained sediment particles around the aperture(s), presumably caused by the rapid withdrawal of the protist into its test after the addition of the preservative solution. Also, plant substrates were examined to approximate live specimen densities and to determine local epifaunal sediment contributors.

Diversity, the number of different species in a given sample, is determined by simply counting the number of species in each sample (Buzas, 1979a). Because the number of specimens (individuals) varies widely between samples, the samples cannot be readily compared as the number of species increases with increasing specimen number. In order to facilitate the comparison, the sample counts are plotted on a graph with the number of specimens (N) as the abscissa and the number of species (S) as the ordinate. The species diversity index is then determined by calculating the ratio of the number of species to the number of specimens (S/N) in each sample. This method does not consider the low number of rare species or the high number of predominant species, but only the gross trends are needed in this study.

RESULTS

Sediment

Most of the shallow-water sediment collected in this study consists of carbonate sand, which blankets large expanses along the margins of the Bahaman banks. The sand along the shallow margins of CSB is stabilized by algal filaments, the holdfasts of calcareous algae, and the rhizomes of the sea grasses *Thallasia testudum* (turtle grass) and *Syringodium filiforma*. The samples from rocky sea beds (Fig. 2, sta. nos. 1, 8, and 23) consist of loose sediment that accumulated in pockets and depressions in Pleistocene limestone (Albert C. Hine, verbal comm., 1983). Species of both soft (seaweed) and calcareous algae are common in these rocky environments and probably aid in stabilizing the bottom with their holdfasts. Partially rocky substrates (sta. nos. 18 and 21) are composed of hardground partly covered by a thin veneer of sand. The sediment along the western margin of GBB consists of large areas of seaward-migrating ooid sand waves with smaller intervening areas of plant-stabilized sediment.

The results of the sediment-size analysis relative to location and water depth are presented in Appendix 1. Bank-top sediment consists almost entirely of sand-size grains, with the exception of sample 22, which was collected from the bottom of a submerged sink hole. This sample contains a much higher percentage of clay- and silt-size material. The upper slope (~200 to 300 m) sediments sampled off CSB (sta. nos. 2, 10, and 11) have more silt- and clay-size particles than the nearby bank top samples, but they are still very sandy. In contrast, the deeper-water slope (>300 m) samples contain higher percentages of silt- and clay-size material except for sample 17, which is very sandy.

Results of sediment size analysis of LBB samples are taken from Mullins and others (1984). In general, these samples exhibit a decrease in the sand-size fraction progressing downslope with the exception of the deepest sample (sta. 32) collected at 1055 m water depth (Fig. 4). In comparison, the transect off the southern leeward margin of CSB exhibits a much greater decrease in sand percent between 200 and 400 m, and a lower percentage of sand at 400 and 500 m than samples at similar water depth on the windward LBB transect.

Compositionally, most of the sediment grains examined are biogenic and of relatively local derivation. The bank top samples generally consist of fragments of calcareous algae, molluscs, and foraminifers, with the exception of the GBB sample, which contains a significant number of coated grains (ooids), as well as composite (grapestone) and cryptocrystalline grains. Foraminifers compose up to an estimated 30 percent of the shallow-water sand in most bank-top samples. Slope sediment in the sand-size fraction is mainly composed of slope-derived foraminifers, pteropods, pelecypods, and fecal pellets mixed with varying amounts of bank-top-derived material. The material displaced from bank tops, other than the foraminifers, is composed of calcareous algal fragments (e.g., *Halimeda* plates), mollusc shells, calcareous sponge spicules, echinoderm fragments, acyonarian spicules, serpulid worm tubes, and fragments of hermatypic corals. In addition to these components, the GBB slope samples contain displaced coated grains. The displaced shallow-water fraction in the slope samples commonly comprises an estimated 80 percent or more of the total sand on bank margins at less than about 300 m of water depth.

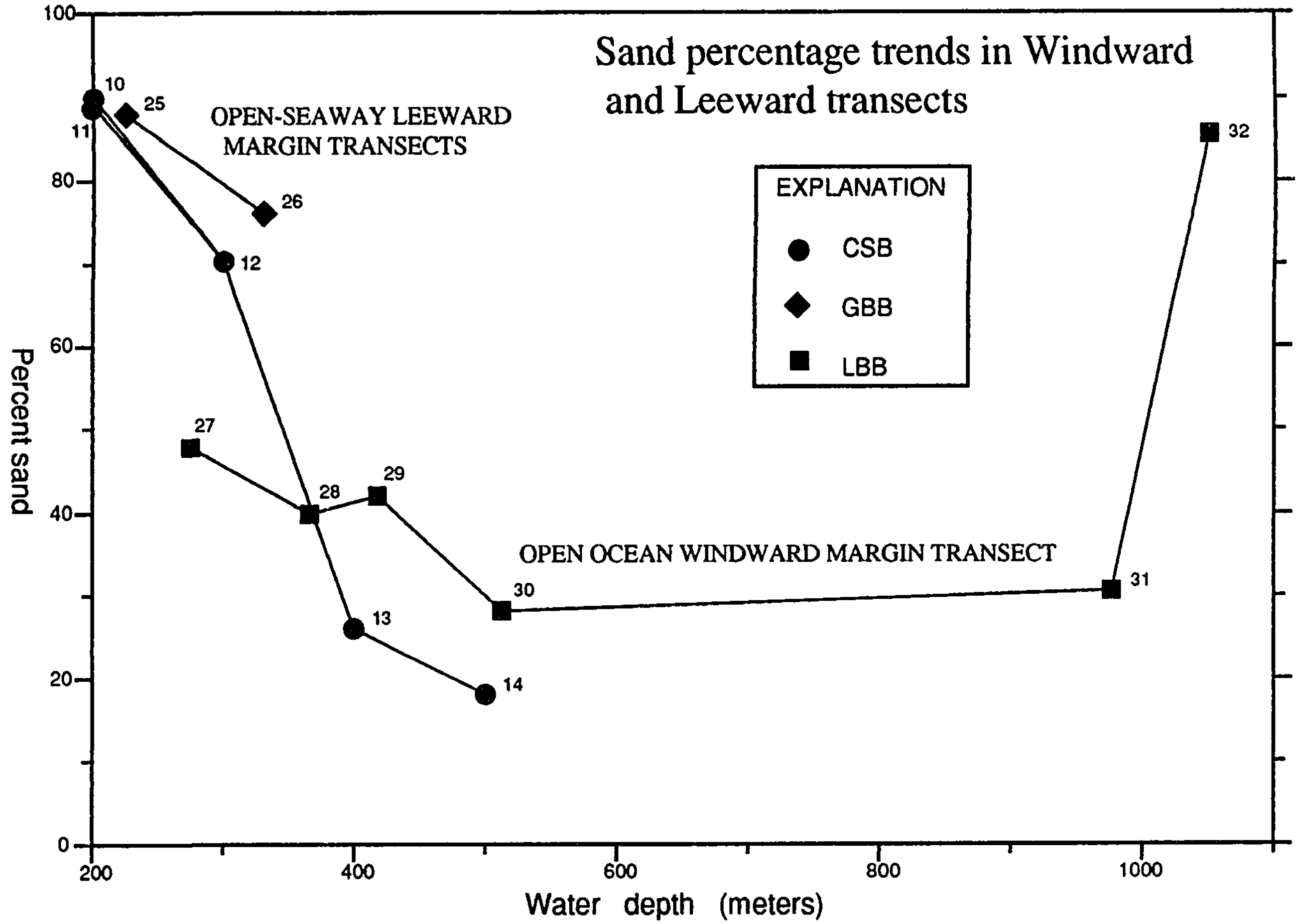

Figure 4. Trends in percentage of sand-size fraction from leeward margin transects of Cay Sal (CSB) and Great Bahama Bank (GBB) and from windward margin transect of Little Bahama Bank (LBB). Note decreasing sand-size fraction with increasing water depth in samples from the leeward margins. Sample locations are shown in Figures 2 and 3.

Foraminifers

General Statement

The benthic foraminifers are divided into bank-top (<100 m) and slope assemblages (>100 m), and within these categories the assemblages are further subdivided into total and live assemblages. The total benthic assemblages include both live and dead specimens, whereas the live assemblages only include stained specimens considered to have been alive at the time of collection. All studied samples contain abundant foraminifers with a total of 144 genera and 291 species of benthic foraminifers identified in total assemblage subsample splits (Appendices 2a and 2b). The planktonic species identified in samples are combined into a group and shown as planktonic specimens in Appendix 2.

The total slope assemblages consist of the *in situ* slope assemblages and the displaced assemblages. In order to determine the numbers of displaced specimens in slope samples, it is critical to differentiate bank-top from slope species. This was accomplished by staining the samples from both bank-top and slope sites and by comparing the species in my samples to those from previous distributional studies of foraminifers. The stained samples provide *in situ* distributional data on species living in the environments that were sampled. The previous studies augment the live specimen data and supply information on species that are only represented by dead specimens in my samples. In most cases, slope species can easily be distinguished from bank-top species because these groups exhibit differences on many taxonomic levels. These differences have been noted in other regions in classic studies (Norton, 1930; Bandy, 1953; Phleger, 1960; Murray, 1976) as well as in more recent studies (Pflum and Frerichs, 1976; Poag, 1981; Murray, 1991) on foraminiferal distribution. Furthermore, the live specimen data show that none of the live slope species are found living in bank-top environments and that none of the bank top species are found living in slope environments. Nearly all slope foraminifers differ from bank-top foraminifers on at least the generic level with a few exceptions, and these are differentiated on the specific level.

Bank-Top Foraminifers

Live Assemblages. Specimens of living benthic foraminifera were found in all bank top sample splits. Live specimens range from 0.5 (no. 24) to 11 (no. 1) percent (average 9.7 percent) of the total assemblages and are most abundant in areas where plant substrates are common (Appendix 3a). The samples are classified as rocky, sandy (bioclastic and oolitic), and reef margin (Fig. 2 and Appendix 4a), because foraminiferal distribution is related to substrate type. The most common live species from sandy substrates are *Rosalina candeiana*, *Asterigerina carinata*, *Archais angulatus*, and *Neoconorbina concinna*. These same species are also predominant in the total (live and dead) sandy substrate assemblages. The most common live species from rocky substrates are *Discorbis rosea*, *D. mira*, *Asterigerina carinata*, *Rosalina candeiana*, and *Trifarina bella*, and most of these are the predominant species in the total assemblages. The reef-margin assemblage is similar to the sandy substrate assemblage with the addition of *Amphistegina gibbosa*, *Borelis pulchra*, and *Peneroplis carinatus*. In all of the substrate categories, many of the sediment-dwelling species are semipermanently or permanently attached to larger (medium sand- to gravel-size) sediment grains. The most common of these are *Rosalina* spp. (mainly *R. candeiana*, *R. floridana* and *R.* cf. *R. globularis*), *Cibicidoides* cf. *C. mahabethi*, *Rotaliammina squammosa*, *Neoconorbina concinna*, *N. mochimenensis*, *Spirillina vivipara*, and juvenile specimens of planorbulinids and gypsinids.

Total Assemblages

Suborder Distribution. Foraminifers in all bank-top samples are dominantly calcareous and mainly of the suborders Miliolina and Rotaliina (Fig. 5). Textulariina (agglutinating species) are present in all samples but in frequencies of less than 10 percent. The samples cluster in a discreet field near the Miliolina-Rotaliina line when plotted on a triangular diagram (Fig. 5), which defines the shallow-water bank-top thanatofacies or sediment assemblage (Brooks, 1973). Distributional trends related to substrate or margin type are not readily apparent except for the sample from the oolitic sand of GBB (sta. no. 24), which is richest in the Rotaliina, and the two samples from CSB reef margins (sta. nos. 6 and 15), which are richer in the Miliolina.

Miliolinids are very diverse and are typically composed of the families Hauerinidae (e.g., *Articulina, Hauerina, Miliolinella, Quinqueloculina, Triloculina*), Soritidae (e.g., *Amphisorus, Archais, Sorites*), Peneroplidae (e.g., *Dendritina, Peneroplis, Spirolina*), and Alveolinidae (i.e., *Borelis*). Rotalinids, also diverse, are mainly composed of the families Discorbidae (e.g., *Discorbis*), Rosalinidae (e.g., *Rosalina, Neoconobina*), Parelloididae (i.e., *Cibicidoides*), Cibicididae (e.g., *Cibicides, Planorbulina, Planorbulinella*), Acervulinidae (e.g., *Acervulina, Gypsina, Planogypsina, Sphaerogypsina*), Homotrematidae (e.g., *Homotrema, Miniacina, Sporadotrema*), Asterigerinidae (i.e., *Asterigerina*), Amphistiginidae (i.e., *Amphistegina*), Nonionidae (e.g., *Florilus, Nonionella*), and Elphidiidae (e.g., *Elphidium*). The suborder Lagenina (lagenids) as classified by Loeblich and Tappan (1988) is combined with the Rotaliina in this paper. The textularinids are less common and dominated by a few species, namely *Bigenerina irregularis, Rotaliammina squammiformis, Textularia agglutinans, T. candeiana*, and *Valvulina oviedoiana*. These agglutinating taxa use carbonate

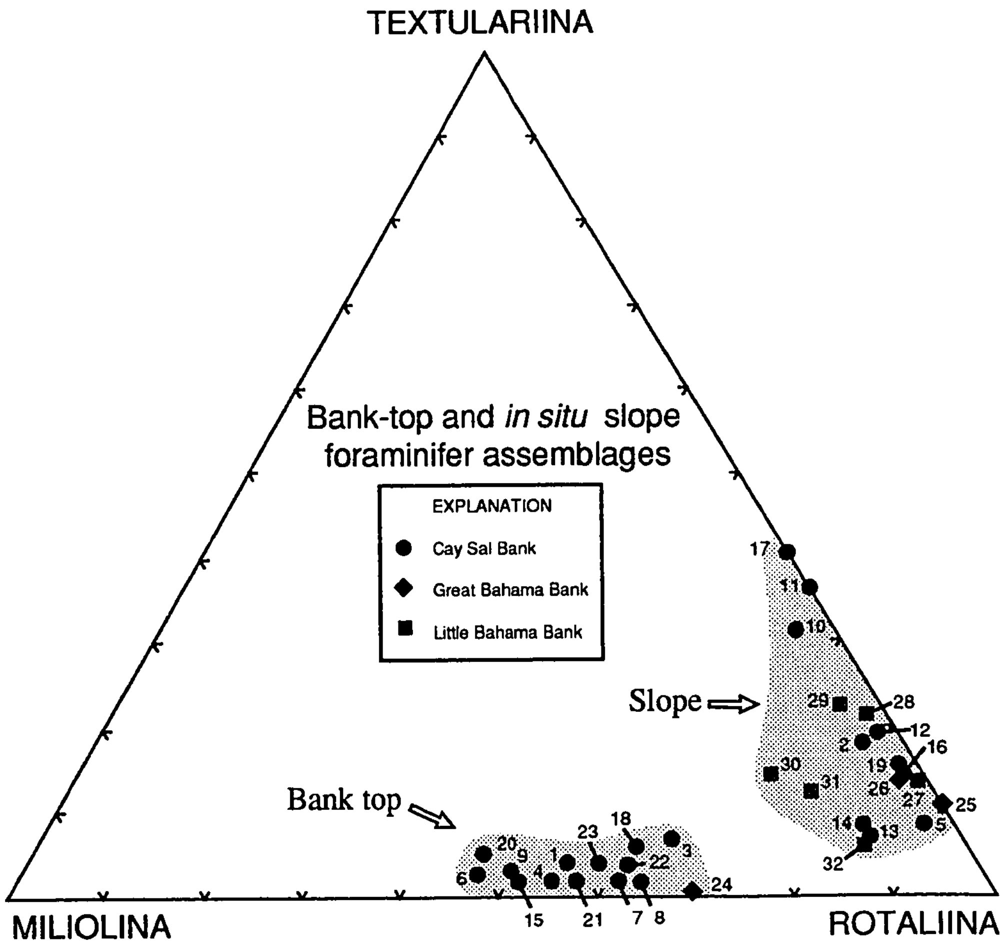

Figure 5. Suborder distribution of benthic foraminiferal assemblages from Cay Sal Bank (CSB), Great Bahama Bank (GBB), and Little Bahama Bank (LBB). Bank-top and *in situ* slope assemblages are distinguished by the separate shaded fields. See Figures 2 and 3 for sample locations.

detritus (mainly bioclasts) to construct their tests.

Predominant Species. All bank- top assemblages contain from two to six different species that predominate in a given sample (Appendix 3a). The predominant species provide evidence for environmental preferences and, in this case, apparently is related to substrate type (i.e., sandy, rocky, and reef). By far the most common recurring species is *Rosalina candeiana*, which occurs in all bank-top samples and ranges from 5 to 43 percent (in samples 3 and 24, respectively). This species also is the predominant live species in many of the samples (4 to 45 percent, averaging 20 percent), and is an abundant component in the displaced assemblages from the Cay Sal slope samples. The next most abundant species, *Asterigerina carinata*, occurs in 10 of 14 samples on both sandy and rocky substrates. *Archais angulatus* is the third most abundant species (in 8 of 14 samples); it mainly occurs in sandy substrates with the exception of station 23, which is rocky. *Asterigerina carinata* and *Archais angulatus* dominate in samples from sandy substrates, whereas *Discorbis rosea* is mainly associated with rocky substrates. *Amphistegina gibbosa*, *Peneroplis carinata*, and *Borelis pulchra* are important in reef areas. The predominant species of the various bank-top environments also predominate the displaced specimen assemblages on the CSB and GBB slopes. The same displaced species predominate on the LBB slope with the exception of *R. candeiana*, which is replaced by *R. floridana* on this windward margin.

Species Diversity Index. The bank-top assemblages exhibit high diversity and contain abundant miliolinids, a characteristic typical of tropical-subtropical neritic marine environments (Seiglie, 1966; Bock and others, 1971; Wantland, 1975; Poag and Tresslar, 1981), especially on isolated carbonate platforms (Hofker, 1969; Brasier, 1975a, 1975b). The diversity index ranges from about .09 to .22 (Fig. 6) and the numbers of species per sample range from 47 to 105 (in samples 4 and 21, respectively). The index tends to be higher in samples from mixed substrate environments (e.g., sandy to rocky, .16-.21) than in samples from one type of substrate (e.g., sandy, .09-.13). Both sandy and reef substrates are variable with the reef samples ranging from .12 to .16. In comparison, the rocky samples are relatively close (approximately .12) in diversity index (Fig. 6).

Slope Foraminifers

Live Assemblages. The live slope species are listed in Appendix 3b. None of the species found living in slope samples were found living in bank-top samples. Phleger (1951) and Parker (1954) recorded the distribution of live species on the northern Gulf of Mexico continental slope and noted that certain genera and species were restricted to specific depth ranges. The depth distribution of the live Bahaman slope foraminifers agrees with most of their distributions. The most commonly recorded species are *Cibicides umbonatus*, *Discorbinella floridensis*, *Siphonina bradyana*, and *S. pulchra*. Live specimens in slope sample splits range from 0 to 10 percent and average 3.5 percent, which is significantly lower than in bank-top samples.

Total *In Situ* Assemblages

Suborder Distribution. The *in situ* component of the slope assemblages contains a higher percentage of the Rotaliina and a lower percentage of the Miliolina than the bank-top samples (Fig. 5). The samples containing the higher percentages of the Miliolina are from the

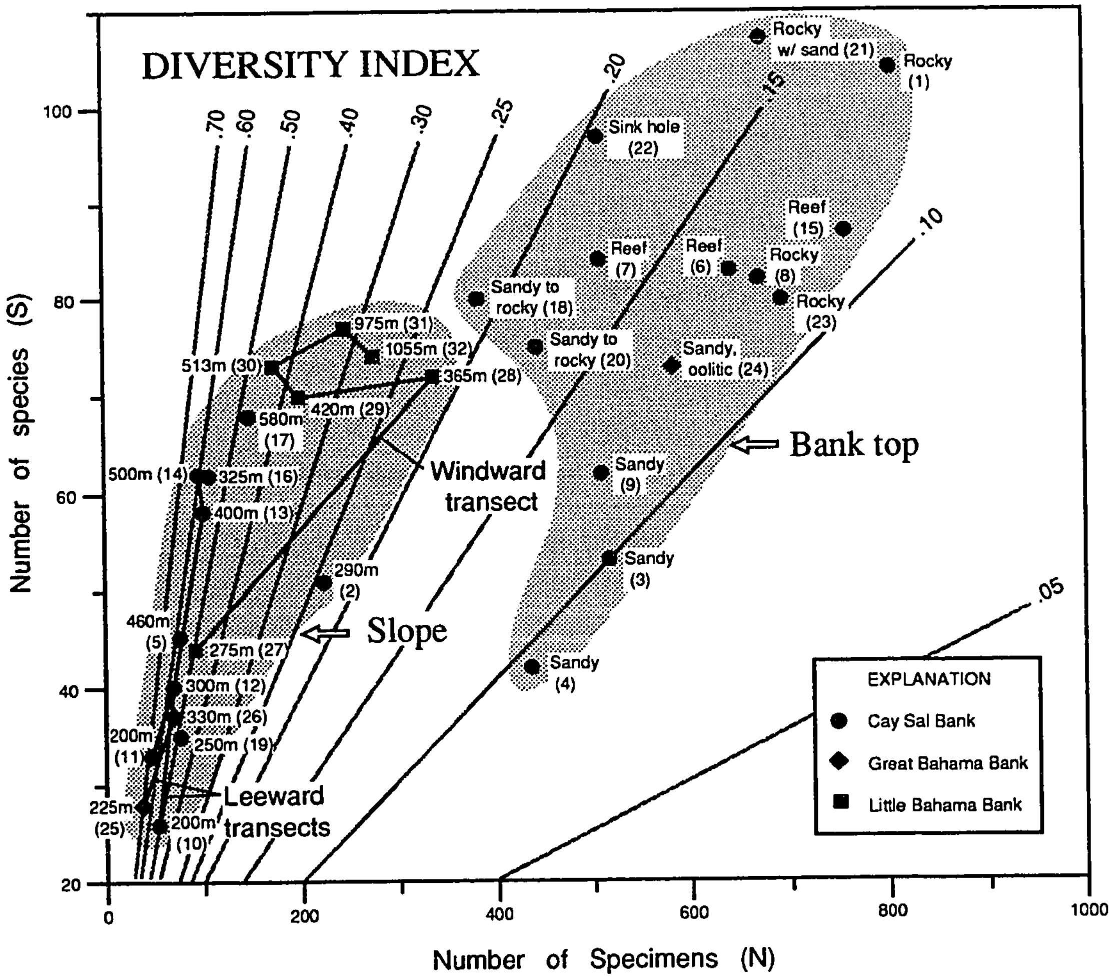

Figure 6. Species diversity index of benthic foraminiferal assemblages from bank-top and slope samples from the northern Bahamas. Bank-top and *in situ* slope assemblages aredistinguished by separate shaded fields. Lines trending from lower left to upper right represent lines of equal diversity index (S/N) with the slope samples farthest to the left having the highest values. Substrate type is noted for bank-top samples and water depth (in meters) is noted for slope samples. Lines connecting slope samples represent windward and leeward transects. Sample locations are shown in Figures 2 and 3.

southern margin of CSB (no. 13 at 400 m and no. 14 at 500 m) and from the open-ocean margin of LBB (no. 30 at 513 m, no. 31 at 975 m, and no. 32 at 1055 m). The miliolinids are represented by the families Hauerinidae (e.g., *Cruciloculina, Pyrgo, Pyrgoella, Sigmoilina, Sigmoilopsis*), Ophthalmidiidae (i.e., *Cornuloculina*), and Spiroluculinidae (e.g., *Planispirinoides, Nummoloculina*, and *Spiroloculina*).

The Rotaliina is the most diverse group in the slope assemblages; it is more diverse here than in the bank-top assemblages. This suborder is mainly composed of the families Nodosariidae (e.g., *Dentalina, Frondicularia*, and *Nodosaria*), Vaginulinidae (e.g., *Astacolus, Amphicoryna, Lenticulina*, and *Marginulina*), Ceratobuliminidae (e.g., *Epistomina, Hoeglundina, Lamarckina*, and *Robertinoides*), Cassidulinidae (e.g., *Burseolina, Cassidulina, Cassidulinoides, Ehrenbergina, Globocassidulina*, and *Islandiella*), Buliminidae (e.g., *Bulimina* and *Globobulimina*) Buliminellidae (e.g., *Trifarina* and *Uvigerina*), Fursenkoinidae (i.e., *Fursenkoina*), Eponididae (i.e., *Eponides*), Siphoninidae (i.e., *Siphonina*), Parrelloididae (i.e., *Cibicidoides*), Discorbinellidae (e.g., *Discorbinella* and *Laticarinna*), Planulinidae (i.e., *Planulina*), Cibicididae (i.e., *Cibicides*), Nonionidae (i.e., *Melonis* and *Pullenia*), Alabaminidae (i.e., *Alabamina*), Osangularidae (i.e., *Osangularia*), Oridorsalidae (i.e., *Oridorsalis*), and Gavelinellidae (e.g., *Gyroidina* and *Hanzawaia*).

Percentages of Textulariina are variable but generally higher than in bank-top samples. Slope samples richest in Textulariina (nos. 10, 11, and 17) are from the southern open-seaway leeward margin of CSB (nos. 10 and 11 at 200 m and no. 17 at 580 m water depth). The textularinid species in slope samples are more diverse and often morphologically more complex than those in bank top samples. They consist of the families Psammosphaeridae (i.e., *Psammosphaera*), Hippocrepinidae (e.g., *Hyperammina, Saccorhiza*), Ammodiscidae (e.g., *Ammodiscus, Glomospira*), Hormosinidae (e.g., *Dusenburyina, Hormosina, Reophax*), Discamminidae (e.g., *Ammoscalaria*), Ammosphaeroidinidae (e.g., *Recurvoides*), Spiroplectamminidae (i.e., *Spirotextularia*), Trochamminidae (e.g., *Trochammina, Tritaxis*), Textulariellidae (i.e., *Textulariella*), Verneuilinidae (i.e., *Gaudyina*), Globotextulariidae (i.e., *Liebusella*), Eggerellidae (e.g., *Dorothia, Eggerella, Karreriella*), Textularinidae (e.g., *Cribrobigenerina, Siphotextularia, Textularia*), and Valvulinidae (i.e., *Cylindroclavulina*). These taxa utilize both biogenic material (i.e., calcareous bioclasts, calcareous tests of benthic and planktonic foraminifers, and sponge spicules) and terrigenous material (e.g., quartz or mica grains) in their test construction.

Predominant Species. Species predominance is not as pronounced in slope assemblages as it is in bank-top assemblages. This is important in that it affects the diversity index distribution. One to six species range from 3 to 21 percent in a given sample. The most common recurring species is *Globocassidulina subglobosa* which occurs in 10 of 16 samples. Other common species are *Melonis barleeanus, Siphonina pulchra, S. bradyana, Cassidulina laevigata*, and *Cibicides floridana*. Some of these species seem to have specific depth ranges. Data on the predominant slope species are shown in Appendix 4b.

Species Diversity Index. The diversity index (S/N) is higher in slope samples than in bank-top samples, even though the number of specimens (N) is lower in slope samples. This is due to fewer species predominating in slope samples, which allows more species to be counted in a smaller sample. The diversity index ranges from .21 to .73 in samples 28 and 11, respectively (Fig 6). A noticeable trend is that the diversity index is higher in the leeward

CSB and GBB samples (.51-.73) than in windward LBB samples (.21-.49). Also apparent is a higher degree of variability between the samples from the windward LBB transect as compared to the leeward transects.

Displaced Assemblages

Displaced species are here defined as those species that normally live in shallow-water (<100 m) bank-top environments and have been transported offbank into deeper water. Some deep-water species that live on the surrounding (>100 m) slopes also may have been transported downslope from their original living position, but are treated as slope species in general. The percent of displaced shallow-water benthic specimens generally decreases with increasing water depth and corresponding distance from the shallow-bank margin (Fig. 7). Also, the percent of displaced specimens is higher on leeward margins (83 to 92 percent) than on windward margins (9 to 88 percent). The large number of displaced specimens in leeward slope samples causes significant changes in benthic foraminifer distribution parameters when these specimens are added to the total *in situ* assemblage. For example, when added to the suborder distribution counts, the plotted points shift toward the bank-top field (Fig. 8) resembling a bank-top distribution pattern. This shift is much more pronounced in samples with the larger percentages of displaced specimens, for example the samples from the leeward margin of CSB (sta. 10 to 14). A significant shift also is apparent in the diversity index data when the displaced specimens are added to the *in situ* slope specimens and plotted on the diversity index graph (Fig. 9). The resulting field shows a diversity index range that overlaps and generally is closer to the bank-top values. Although the diversity index is lower for displaced plus *in situ* slope benthic assemblages (total slope assemblage), the total number of

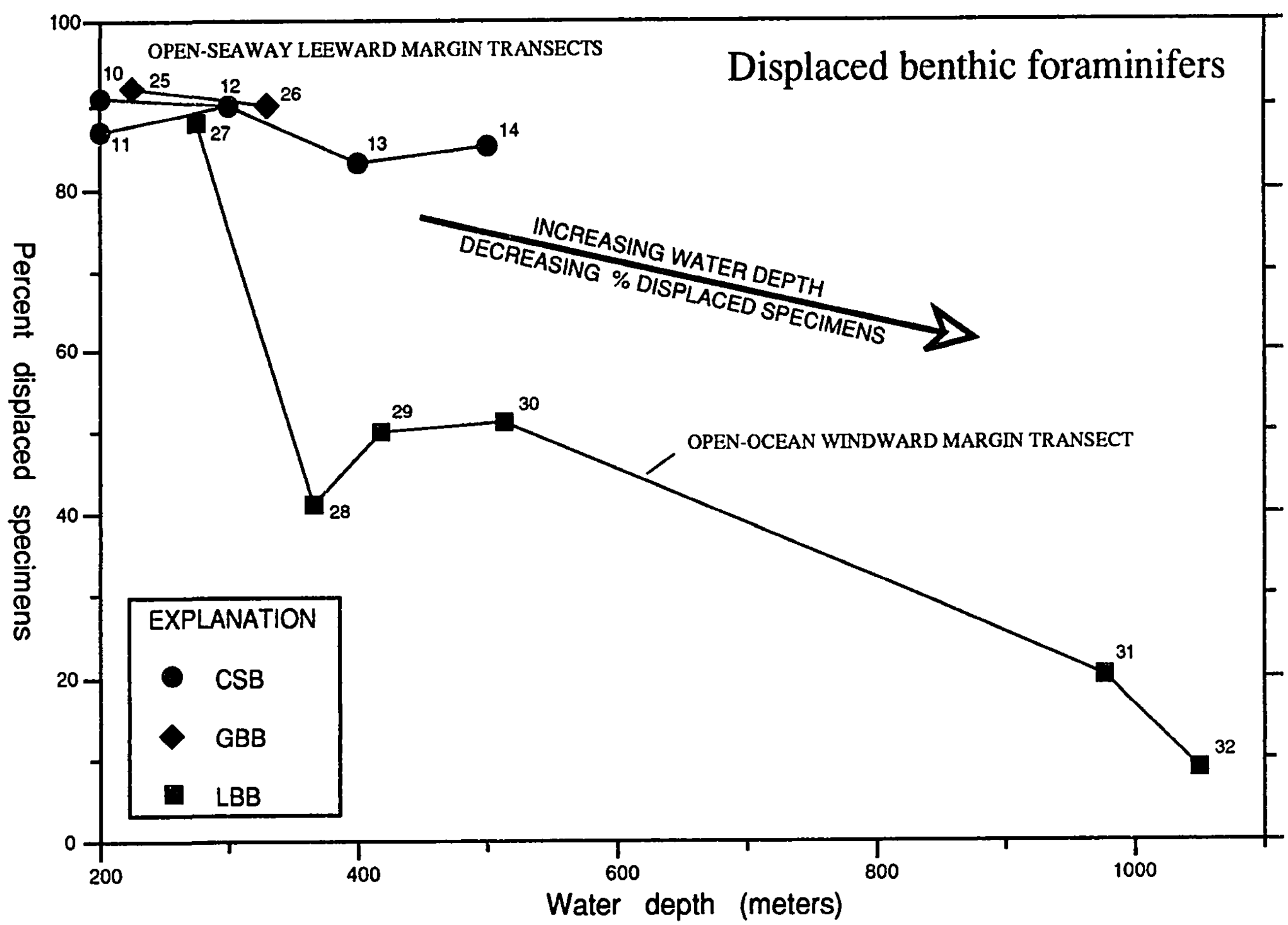

Figure 7. Displaced benthic foraminifers in slope samples from Cay Sal Bank (CSB), Great Bahama Bank (GBB), and Little Bahama Bank (LBB). Note that percentages of displaced specimens generally decrease with increasing water depth and corresponding distance from the shallow-bank margin. Tie lines connect samples from windward and leeward margin transects. Sample locations are shown in Figures 2 and 3.

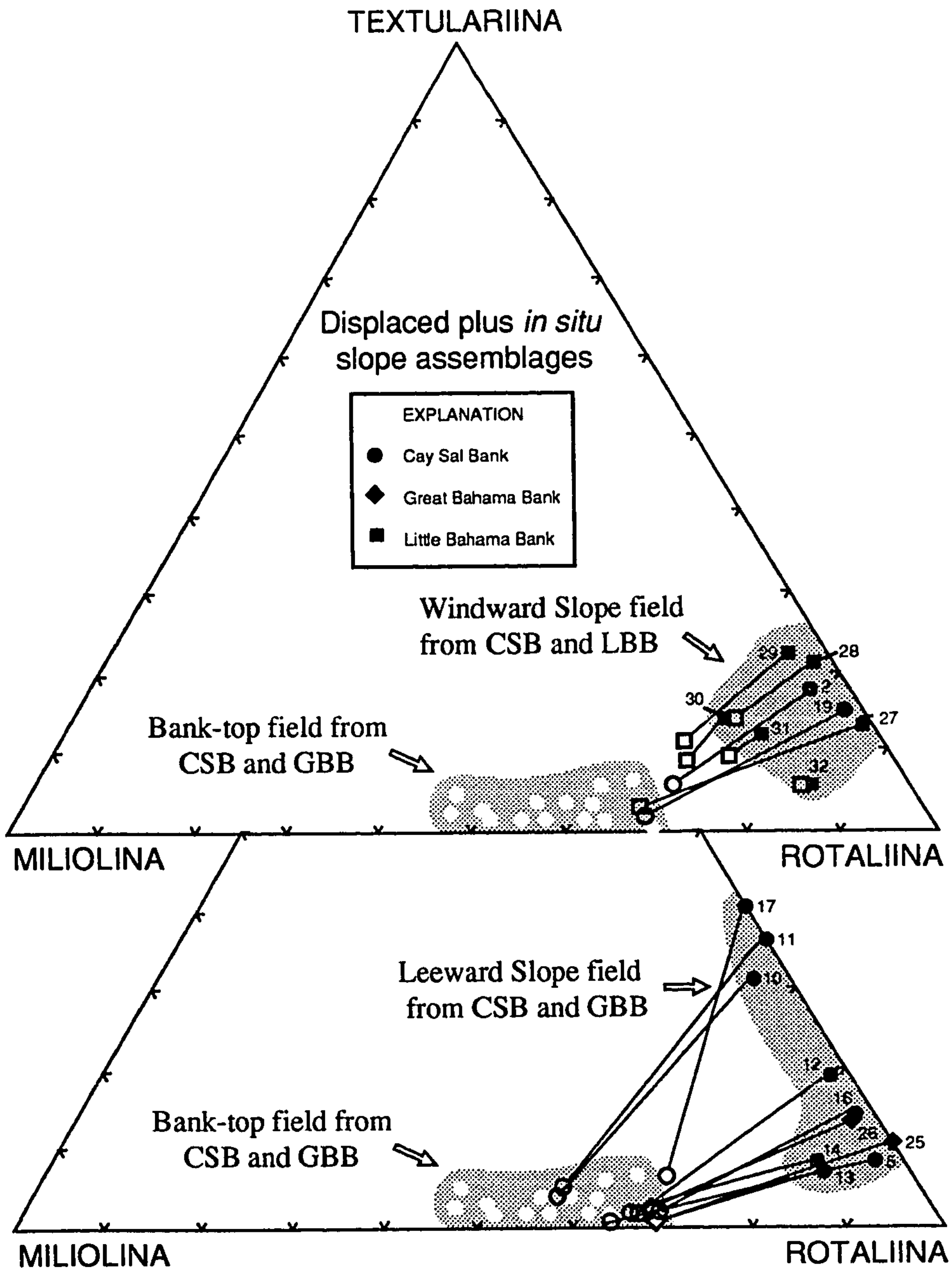

Figure 8. Relation between displaced and *in situ* suborder distribution of benthic foraminiferal assemblages from windward (Little Bahama Bank and Cay Sal Bank) and leeward (Cay Sal Bank and Great Bahama Bank) margins. Tie lines connect *in situ* slope plots (solid symbols) with displaced and *in situ* plots (open symbols) for the same sample and exhibit a shift toward the bank-top field. Note that the leeward samples show a stronger shift due to the greater abundance of displaced specimens in these samples. See Figures 2 and 3 for sample locations.

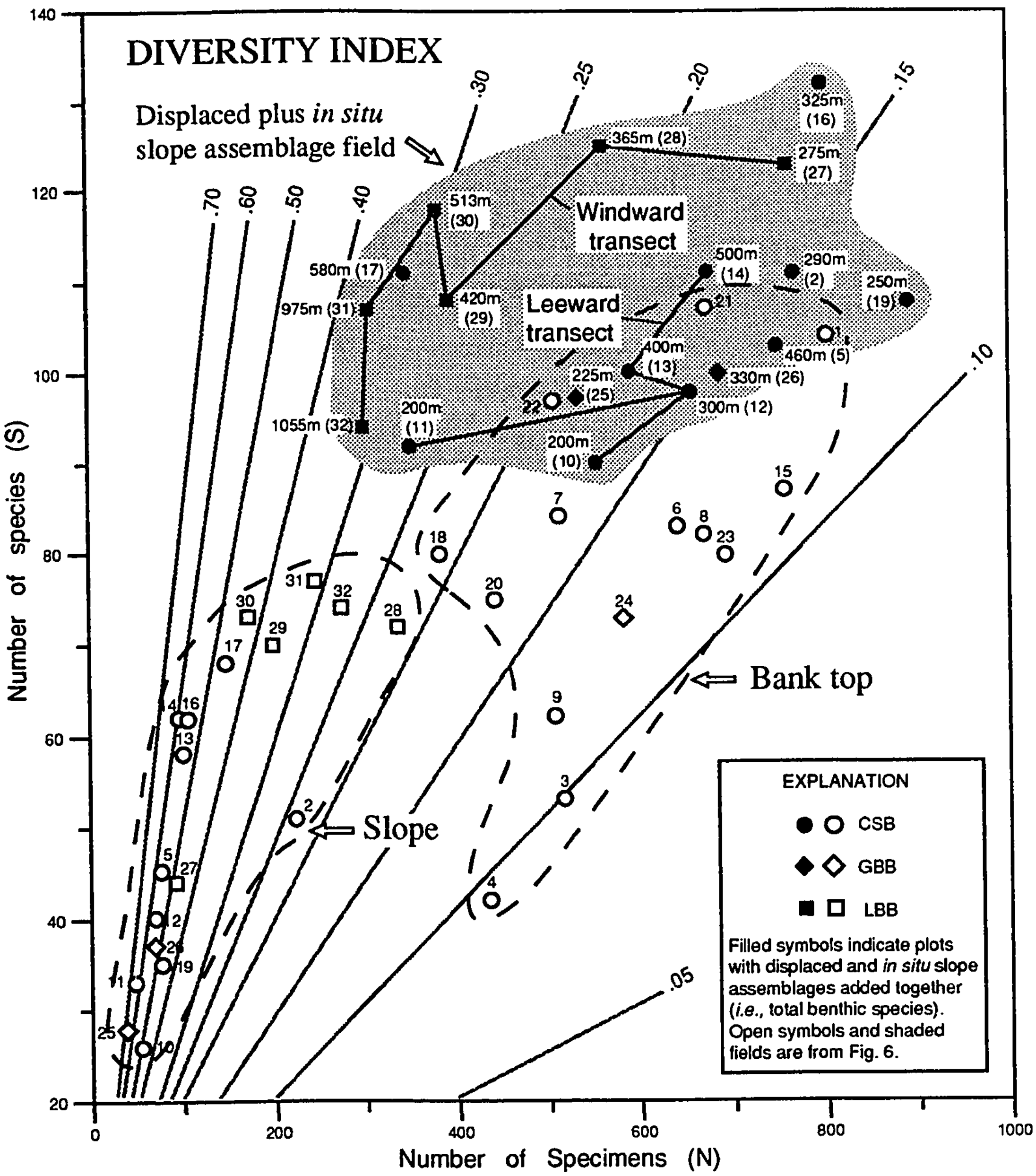

Figure 9. Diversity index (N/S) of displaced plus *in situ* slope assemblages with bank-top and *in situ* slope assemblage fields from Figure 6 for comparison. Note that the diversity index in most samples is lower with the displaced specimens added to the *in situ* slope specimens, causing many slope plots to resemble bank-top plots. Lines trending from lower left to upper right represent lines of equal diversity index. Lines connecting slope samples represent windward and leeward transects. Sample locations are shown in Figures 2 and 3.

species per sample is significantly higher than the number of species in *in situ* slope assemblages. Species predominance is more pronounced in bank-top assemblages than in *in situ* slope assemblages. Therefore, the addition of large numbers of displaced specimens, but fewer species of these specimens (higher species predominance), produces a lower diversity index (S/N). Interestingly, the two slope transects from CSB and LBB exhibit contrasting trends. The diversity index generally decreases to a similar value in the leeward transect (CSB), but generally increases in the windward transect. This is caused by the greater abundance of displaced specimens in leeward slope samples.

Planktonic Assemblages.

Planktonic species, such as *Globigerinoides rubra*, *Globorotalia menardii*, and *Orbulina universa*, are combined into a group in this study. Specimens of these species are absent or rare in bank-top samples. In slope samples, their frequencies increase with increasing distance from the shallow bank margins. This trend of increasing percentage of planktonic specimens with distance from shore (or shallow shelf) has been observed in many continental margin transects (e.g., Bandy, 1953; Parker, 1954; Phlum and Frerichs, 1976; Murray, 1991). The trend is most pronounced in samples from the open-ocean windward margin of LBB, but it also is obvious in the CSB transect (Fig. 10). In both transects, the planktonic specimens increase dramatically at about 300 to 350 m.

Planktonic percentages (Fig. 10) were calculated using both the total benthic assemblages and the *in situ* benthic assemblages to exhibit the effects of dilution by displaced benthic specimens. This resulted in two lines for each transect with a gap between them that

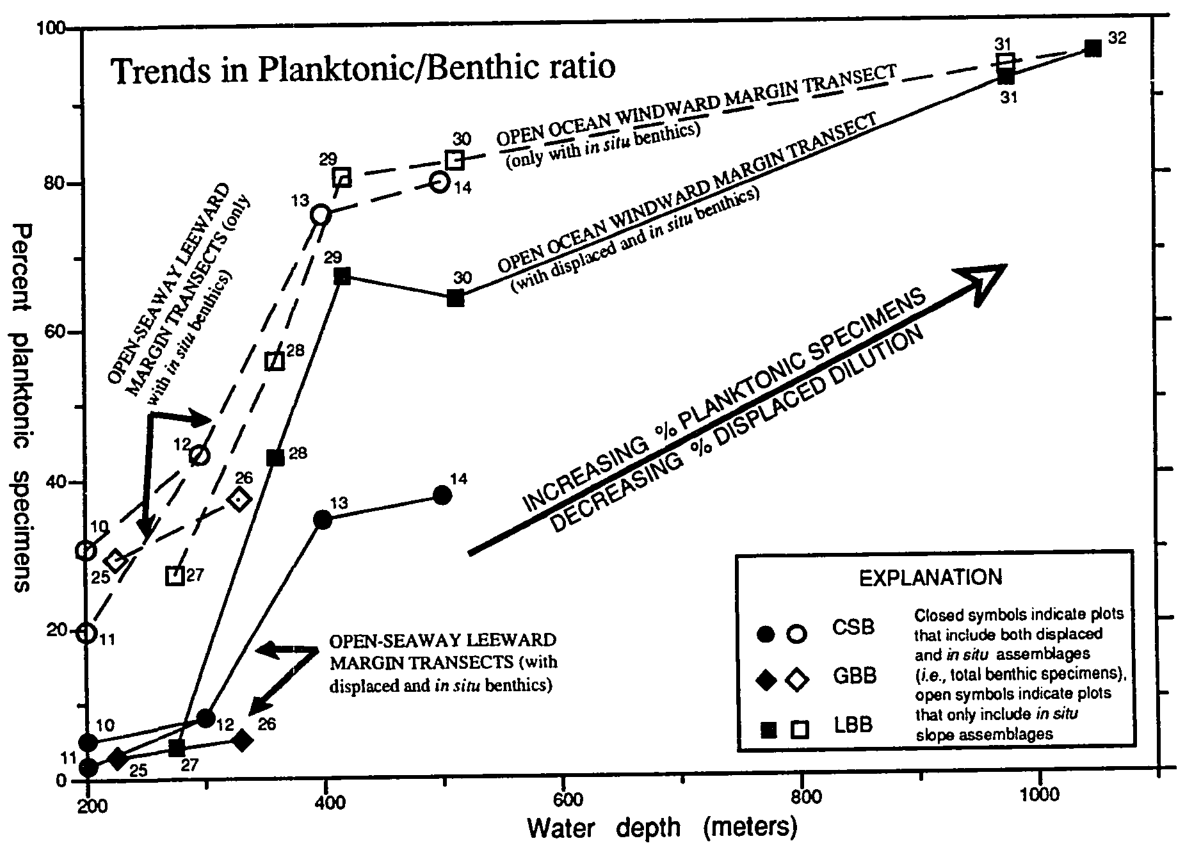

Figure 10. Planktonic/benthic foraminiferal percentages from Cay Sal Bank (CSB), Great Bahama Bank (GBB), and Little Bahama Bank (LBB) slope samples. Solid lines connect plots calculated with *in situ* and displaced (total) benthic specimens, and dashed lines connect plots calculated only with *in situ* benthic specimens. The gap between solid and dashed lines for a particular transect indicates the amount of dilution by displaced specimens. Note that the values approach nondilution percentages with the reduction in the amount of displaced benthic specimens with increasing distance from the shallow bank margin. Sample locations are shown in Figures 2 and 3.

represents the percentage of dilution by displaced bank-top specimens for each sample. Dilution is most pronounced in leeward margin samples (CSB and GBB) due to the greater abundance of displaced benthic specimens. The effects of displaced specimens decrease with increasing water depth and distance from the shallow-bank margin.

DISCUSSION

Foraminiferal Distribution

General Statement

The distribution of living foraminifers, in general, is controlled by a combination of physical, chemical, and biological variables. The important physical variables are water depth, water temperature, sunlight penetration, wave and current energy level, substrate, depositional rate, turbidity, and distance from shore. Examples of the chemical variables are dissolved oxygen and nitrogen, salinity, pH, and the organic content of sediment. The biological variables include nutrient levels, competition, predation, reproduction, and population dynamics. The interaction of the these variables may be complex, but distributional trends often become evident when comparing a series of samples. After death, the tests of the foraminifers often are redistributed by waves, currents and sediment gravity flows. In this study, the distinction between the bank top and *in situ* slope assemblage compositions, and the quantities of displaced specimens and their relation to windward-leeward effects are the most important concerns.

Foraminiferal Ecology

Several important ecological trends are evident from the Bahaman distributional data. The most obvious of these is the distinction between the bank-top and *in situ* slope assemblages, which allows the quantification of displaced specimens. The foraminifers exhibit differences on several taxonomic levels related to evolutionary changes caused by adaptation to environmental differences associated with water depth. These distributional trends have been observed in virtually all continental margin transects by many workers (e.g., Bandy, 1953, 1956; Uchio, 1960; Poag, 1981; Murray, 1991).

The distribution of live bank-top species is largely controlled by physical conditions such as sunlight penetration and wave energy, which affect the development of substrates. The obvious bank-top environmental variable seems to be substrate type, which in turn controls the niches and microenvironments available for the foraminifers to inhabit. One of the most important of these is the distribution and relative abundance of phytal species that can be colonized by foraminifers. For example, the rocky substrate environments have more soft algae (e.g., brown algae), whereas the sandy environments have more calcareous algae and particularly marine grasses (e.g., *Thalassia*). The foraminifers and other epibenthic organisms that inhabit plant substrates contribute a significant amount of skeletal material to the sediment in shallow water (Land, 1970).

Another important variable is geographic location and related level of wave energy, which controls sediment transport and deposition. Species predominance and diversity data indicate a substrate preference for most bank-top foraminifers (Appendix 3A and Fig. 6). Interestingly, the robust species *Discorbis rosea* becomes predominant in the rocky substrate samples from CSB. These samples were collected in shoal (8-15 m) areas that are swept by strong waves and currents. This relation indicates that this species prefers a high energy environment. In a study of foraminifers of Serranilla Bank, another isolated offshore carbonate bank, Triffleman and others (1991) interpreted that *D. rosea* prefers a more dynamic hydrographic environment, which supports my interpretation.

Species diversity seems to be associated with a combination of factors related to the availability of plant substrates, reefs, and other physical and biological conditions. Although variable, the diversity index tends to be highest in mixed (sandy to rocky, Fig. 6) substrate environments due to the greater variety of niches available to foraminifers. Variability in diversity index and other assemblage parameters is probably caused by a combination of sedimentological and ecological factors, such as transport of tests from other environments and patchy distribution of living specimens. A detailed ecological analysis of my samples is beyond the scope of this paper, but species associations in various Caribbean-Gulf of Mexico shallow-water environments have been published by many authors (e.g., Bandy, 1964; Seiglie, 1968 and 1971; Cebulski, 1969; Bock and others, 1971; Sen Gupta and Schafer, 1973; Brasier, 1975a and 1975b; Wantland, 1975; Buzas and others, 1977; Rose and Lidz, 1977; Poag and Tresslar, 1981).

The distribution of live foraminifers in slope samples is primarily controlled by water mass properties (e.g., temperature, salinity, pH, available oxygen, and nutrients). The effects of water mass on the depth distribution of benthic foraminifers have been demonstrated in several studies from the Gulf of Mexico (e.g., Phleger and Parker, 1951; Parker, 1954; Phlum and Frerichs, 1976) as well as other regions (e.g., Schnitker, 1974; Douglas and Heitman, 1979; Murray, 1991). In this study, the slope assemblages were not divided into biofacies because these data are not needed, but several general trends and changes in species composition are apparent. The two most obvious are the higher diversity index values in slope samples than in bank-top samples (Fig. 6), and the increasing planktonic component with increasing water depth (Fig. 10). These same general trends have been recognized in many previous studies of foraminifers on continental margin transects (e.g., Bandy, 1953; Bandy and

Arnal, 1960; Murray, 1991). Trends in species composition also are apparent in certain taxonomic groups. In the live specimen category, species of *Cibicides*, *Cibicidoides*, *Discorbinella*, *Planulina*, *Bulimina* and *Uvigerina* seem to be the most useful bathymetric indicators. The depth distribution of common species, such as *Cibicides corpulentus*, *Cibicides umbonatus*, *Cibicidoides kullenbergi*, *Cibicidoides robertsonianus*, *Discorbinella floridensis*, *Planulina weullerstorfi*, *Siphonina bradyana*, and *S. pulchra*, is similar to the depth distribution recorded by Phleger and Parker (1951) and Parker (1954) on the continental slope of the northern Gulf of Mexico. This indicates that the water mass structure in the Bahamas is similar to that of the Gulf of Mexico, although it probably is altered by the currents that pass through the constricted deep-water seaways surrounding the shallow Bahaman banks. The live specimens are most reliable for determining the depth distribution of species because dead specimens may be displaced down slope. For this reason, the upper depth limits of species are most useful for bathymetric analysis when using total (live and dead) assemblages.

Foraminiferal assemblages are altered by sedimentary processes such as sediment gravity flows and bottom currents that redistribute the tests across and down slope. The modification of slope assemblages is most evident in the amounts of transported shallow-water specimens encountered in the slope samples. Large numbers of displaced specimens cause significant shifts in the suborder distribution (Fig. 8) and diversity trends (Fig. 9), which give the total assemblages the characteristics of a shallow-water assemblage. The presence of slope species, although low in percentage (8 to 17 percent) in leeward and shallow (<300 m) slope samples, verifies a slope environment. Another clue to a slope environment is provided by the abundance of planktonic specimens. Variability in the aforementioned trends probably is caused by variations in the extent of transport processes and ecological conditions.

Windward-Leeward Effects

All of the foraminiferal distributional parameters are affected to some degree by the type of margin. The bank-top assemblages tend to reflect margin type through a substrate preference that is related to the physical energy flux. Extensive sandy substrates are dominant inboard and along the western and southern leeward margins of CSB and GBB, whereas rocky substrates dominate along the northern and eastern windward margins of CSB. The foraminiferal assemblages aid in identifying these environments. The sands support abundant seagrasses and calcareous algae, and the foraminifers are dominated by phytal-dwelling species such as *Archais angulatus*, *Asterigerina carinata*, *Caribeanella polystoma*, *Heterillina cribrostoma*, *Miliolinella labiosa*, *Rosalina candeiana*, and *Triloculina bermudezi*. The sediment-dwelling species in sandy environments are *Quinqueloculina bassensis*, *Q. subpoeyana*, and *Triloculina schreiberiana*. The rocky environment, typified by a hard substrate populated by seaweed (brown algae) and calcareous algae, is dominated by *Asterigerina carinata*, *Discorbis rosea*, *Rosalina candeiana*, and *Trifarina bella*. *Discorbis rosea* is very abundant in samples from these rocky substrates, which are mainly concentrated along the windward margins of Cay Sal Bank. Despite the fact that *Discorbis rosea* occurs in leeward reef (Sta. 6 and 15, Fig. 2) and rocky (Sta. 8) environments in lesser frequencies, it may serve as an indicator species for high energy windward margins. This species is found in very low frequencies in slope samples adjacent to both leeward (Sta. 5, Fig. 2) and windward (Sta. 2, Fig. 2) margins of CSB. Interestingly, it occurs in highest frequencies in the shallowest (275 m) slope sample adjacent to the open-ocean windward margin of LBB (Sta. 27, Fig. 3) and is probably an important component of the bank-top windward margin assemblage.

In slope samples, all parameters are significantly affected by displaced bank-top specimens. The large number of displaced species in periplatform sediment on both windward and leeward margins reduces the percentage of *in situ* benthic and planktonic specimens. The percentage of displaced benthic specimens is higher on leeward than on windward margins due to higher offbank transport of sediment on leeward margins. Planktonic percentages are lower on leeward margins due to the dilution effects. This is still evident even though planktonic specimens are more abundant on the open-ocean margin north of LBB. Figure 10 shows a significant difference between the planktonic species percentages on leeward margins calculated with displaced specimen values and without displaced specimen values. This demonstrates that the dilution is much greater on the leeward margins of CSB and GBB. In addition, the higher sand percentages on the windward margin of LBB (Fig. 4) supports the hypothesis that more sand-size sediment is transported off windward margins.

Controls on substrate include antecedent topography, sea-level history, and modern wave energy levels. Intriguingly, the majority of the cays or small islands, observed to be composed of cross-bedded eolianites, are concentrated along the northern and eastern margins of CSB. These margins are the present windward margins and may be related to the last Pleistocene sea level lowstand. The eolian deposits may have formed as carbonate sand was tossed or blown onto the exposed bank top by large storm waves and winds directed against the windward margins. The sand was reworked by wind and the resultant dunes were then cemented by the introduction of meteoric water. When sea level rose and flooded the bank top these areas remained as islands and shoal areas. Today these areas are swept by strong waves and currents, which inhibit the accumulation of sand and finer-grained sediment. Hine and others (1981b) made similar interpretations, in part, on the evolution of the northern windward margin of GBB. Most of the transport of sand presently occurs during storms and hurricanes that provide the stronger current velocities (Hine and others, 1981a). This is especially true in the Bahamas because most of the bank-top substrate is stabilized by plant rhizomes and algal filaments. The sand-size sediment probably is carried away from the margins and toward the bank interior and offbank into deeper water adjacent to leeward margins. Fine-grained material generally is carried away by normal waves and tidal currents and can form extensive aprons on both windward and leeward slopes (Boardman and Neumann, 1984; Heath and Mullins, 1984).

Geologic Applications

The foraminiferal parameters discussed in this paper can be used with other data such as sedimentary structures and geochemical analyses to aid in deciphering carbonate paleoenvironments. Displaced bank-top species recognized in ancient slope deposits can provide evidence of past episodes of sea level fluctuation and possibly windward-leeward effects on carbonate bank sedimentation. During sea level high stands, bank tops are submerged providing an extensive shallow-water environment in which organisms produce large quantities of skeletal debris (Fig. 11). Large amounts of chemically-precipitated sediment, such as oolitic sand, also can form. As discussed in this paper, more of the shallow-water sediment is shed off leeward margins, but significant amounts also are shed off windward margins. During sea level low stands, bank tops are subaerially exposed and only a narrow band around the margins of the bank is submerged (Fig. 11). This limits the production of shallow-water skeletal debris, and therefore limits the amount of sediment that is shed. The windward and leeward effects on slope sedimentation are less clear in this case.

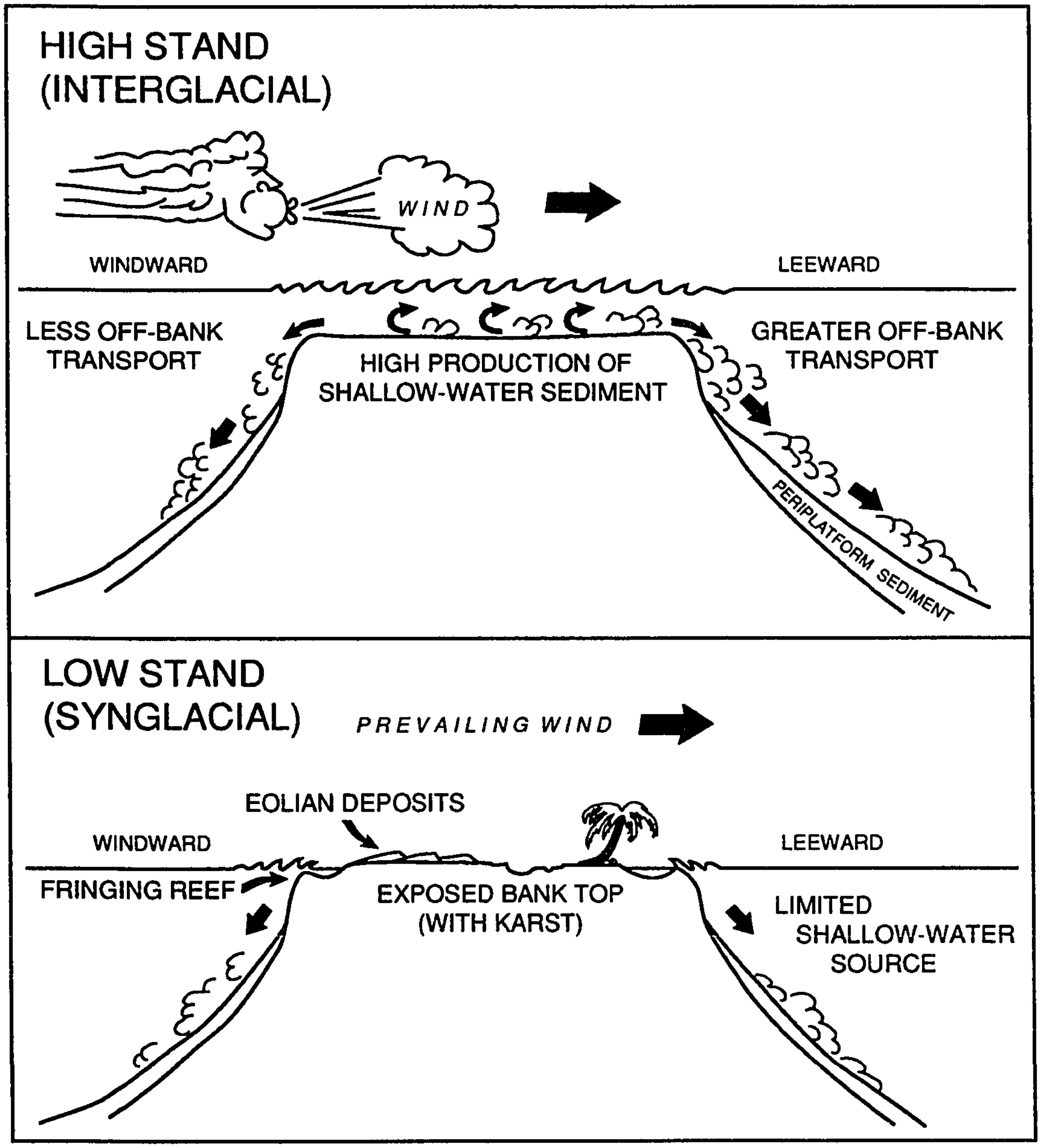

Figure 11. Sedimentological model of an isolated carbonate platform at sea level high stand (interglacial event) and at sea level low stand (synglacial event). During sea level high stands the bank top is submerged and carbonate production is high, which results in high amounts platform shedding especially on leeward margins. In contrast, smaller amounts of platform-derived sediment are produced during low stands when the bank top is exposed and carbonate production is low.

Offbank transport of sediment may be less on windward margins because some of the sand is carried onto the exposed bank top by wind and waves. On leeward margins, most of the sediment probably is carried offbank.

An analysis of foraminifers in ancient carbonate deposits around isolated banks may aid in recognizing periods of high and low shedding, and aid in interpretations of sea level history. High frequencies of displaced benthic foraminifers would occur in slope deposits during periods of high platform shedding and would correlate with sea level high stands. These deposits would be thick and extensive, especially on leeward margins. During periods of low platform shedding and sea level low stands, pelagic sedimentation would tend to dominate over the slopes. Deposits containing abundant shallow-water components would be limited in extent and thickness. In this case, planktonic:benthic ratios would be high (>9:1) and displaced benthic specimens would be uncommon except in deposits close to the shallow margins. *In situ* slope benthic specimens also would be reduced by dilution from planktonic specimens, but these benthic slope specimens would be significantly more abundant than the displaced specimens during periods of low platform shedding.

CONCLUSIONS

The results of this study lead to several conclusions based on the distribution of live and total foraminiferal assemblages: 1) The bank-top and *in situ* slope foraminifera are distinctly different on several taxonomic levels and this is critical in determining the amounts of transported specimens; 2) The bank-top assemblages exhibit a substrate preference related to energy level. This is exemplified by the robust species *Discorbis rosea*, which is most abundant in windward margin samples; 3) *In situ* slope assemblages have a higher diversity index than bank-top assemblages and some slope species have specific depth ranges related to water mass properties; 4) High percentages of displaced shallow-water foraminifers in slope deposits surrounding CSB, GBB, and LBB significantly alter the assemblage parameters and cause the suborder, diversity, and predominant species data to resemble or approach bank-top characteristics; 5) The large number of displaced specimens in slope samples also reduce the percentages of planktonic specimens; and 6) The percentage of displaced benthic foraminifers on leeward slopes deeper than about 300 m is much higher than on windward slopes at similar depths. These conclusions indicate that the windward-leeward effect influences sedimentation of bank-derived sand, at least the foraminiferal component, on the deep-water margins surrounding the Cay Sal Bank, Great Bahama Bank, and Little Bahama Bank.

In addition, the results of this study can be applied to geologic investigations of the growth of carbonate banks and sea level history. High percentages of displaced bank-top specimens in the ancient slope deposits can provide evidence of platform shedding. An analysis of the foraminifers combined with other geologic data can be used to determine sea level history and possibly windward-leeward effects on carbonate-slope sedimentation.

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APPENDIX 1.

Station number, location, water depth, and grain size data for Cay Sal, Great Bahama, and Little Bahama Bank samples. Sample taken at Station 5 was not analysed for sediment size due to the small amount of sediment recovered.

STATION NO.	FIELD NO.	LATITUDE (N)/ LONGITUDE (W)	WATER DEPTH (m)	SAND (wt percent)	SILT (wt. percent)	CLAY (wt. percent)
1	81-CS-01	23°59.18'/79°53.41'	13	100	0	0
2	81-CS-02	24°08.08'/79°55.13'	290	95	2.5	2.5
3	81-CS-03	24°02.33'/80°10.62'	20	99	1	0
4	81-CS-04	23°55.39'/80°17.83'	14	100	0	0
5	81-CS-05	23°41.70'/80°27.44'	460	-	-	-
6	81-CS-06	23°42.85'/80°26.30'	20	97	3	0
7	81-CS-07	23°42.50'/80°26.70'	22	97	3	0
8	81-CS-09	23°38.00'/80°16.00'	8	96	2	2
9	81-CS-10	23°31.50'/80°03.40'	20	96	4	0
10	81-CS-12	23°31.27'/80°05.60'	200	90	10	0
11	81-CS-13	23°31.26'/80°05.58'	200	89	5.5	5.5
12	81-CS-14	23°30.87'/80°06.67'	300	71	20	9
13	81-CS-15	23°30.40'/80°09.80'	400	26	39	35
14	81-CS-16	23°29.42'/80°12.92'	500	18	67	15
15	81-CS-19	23°25.50'/79°46.55'	20	100	0	0
16	81-CS-20	23°25.38'/79°46.06'	325	60	29	11
17	81-CS-21	23°20.05'/79°39.30'	580	94	6	0
18	81-CS-23	23°35.14'/79°38.10'	15	94	3	3
19	81-CS-24	23°37.07'/79°34.98'	250	59	32	9
20	81-CS-25	23°50.07'/79°47.29'	20	100	0	0
21	81-CS-27	23°49.82'/79°47.43'	17	96	4	0
22	81-CS-28	23°49.85'/79°47.45'	80	46	50	4
23	81-CS-29	23°55.60'/79°49.20'	15	94	3	3
24	81-GB-36	23°55.60'/79°49.20'	21	98	2	0
25	81-GB-37	24°22.63'/79°11.98'	225	88	8	4
26	81-GB-38	24°31.49'/79°12.47'	330	76	16	8
27	E36250	27°14.00'/78°08.50'	275	48	31	21
28	E36251	27°16.00'/78°16.00'	365	40	35	25
29	E36252	27°18.50'/78°20.00'	420	42	32	26
30	E36248	27°15.00'/78°04.00'	513	28	42	30
31	E36269	27°24.00'/78°10.00'	975	30	37	33
32	E36257	27°33.00'/78°11.00'	1055	83	10	7

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SPECIES NAME																
Acervulina inharens Schultze														2		
Ammodiscus tubinatus (Cushman)													1			
Ammolagena clavata (Parker and Jones)																
Ammonia beccarii (Linne) vars.																
Ammoscalaria sp.																
Amphicorina intercellularis (Brady)											2	1				
Amphisorus hemprichii Ehrenberg	1	2		1		5	3	7		1					4	1
Amphistegina gibbosa d'Orbigny		1				4				2	2				66	
A. radiata (Fichtel and Moll)												1				
Anomalina flintii Cushman													1	2		
Anomalinoides mexicana Parker											1			2		
A. semipunctata (Bailey)																
Archais angulatus (Fichtel and Moll)	10	8	26	2	16	98	27	11	64	24	23	2	3		76	6
Articulina antillarum Cushman			3				1			1	2					4
A. lineata Brady	1	13	10	23	20	4	5	4	12	19	5	25	9	11	6	26
A. mucronata (d'Orbigny)	22	6	7	22	12	11	6	4		6	10	5	2		15	4
A. sagra (d'Orbigny)	8						1	3						3	4	2
Asterigerina carinata d'Orbigny	12	39	234	48	43	92	75	13	100	80	63	42	15	7	94	76
Bigenerina irregularis Phleger and Parker						3	2	2			2				1	
B. lytta Lalicker and Bermudez		8														
B. textularoidea (Goes)		3								2	1	5				1
Biloculinella labiata Schlumberger													1	2		
Bolivina albatrossi Cushman														1		
B. alvarezi Sellier de Civrieux								1								1
B. goesii Cushman	1	1								2	1		1	1		1
B. lanceolata Parker																1

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Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bolivina lowmani Phleger and Parker	1								1	1			1			2
B. ordinaria Phleger and Parker												1		1		
B. psuedoplicata Heron-Allen and Earland	1	5				1		1					1	7		1
B. paula Cushman and Cahill	1															
B. subaenariensis Cushman		5														
B. subaenariensis fragilis Phleger and Parker										2		1		1		1
B. tortuosa Brady	1							1					4			1
B. variabilis (Williamson)		1					1							1		
B. spp.																
Bolivinita rhomboidalis (Millet)	3	1		1	1			1								
Borelis pulchra (d'Orbigny)	4					6		8			1				42	
Bulimina aculeata d'Orbigny																
B. spicata Phleger and Parker					2							1	1	2		6
Buliminella milletti Cushman	8						1	3		2			1	2		1
B. parallelus Cushman and Parker	1															
B. silviae Bermudez and Seiglie												1				1
Burseolina palmerae Bermudez and Acosta											2	1	1			
B. cf. *B. intermedia* Palmer		13			1							1				3
Cancris oblonga (Williamson)																
C. sagra (d'Orbigny)												1	1			1
Caribeanella polystoma Bermudez	3	68	16	46	47	9	7	17	19	27	7	58	42	27	10	82
Carpenteria monticularis Carter											1					
C. utricularis Carter											1					
Cassidulina carinata Silvestri													1			
C. crassa d'Orbigny													2			2
C. curvata Phleger and Parker		9			3							1	1	3		1
C. laevigata d'Orbigny		9			5					7	2	1	2			8

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cassidulina spp.		1			1											
Cassidulinoides bradyi (Norman)		1			2											1
Chrysalidinella dimorpha (Brady)							1									
Cibicides corpulentus Phleger and Parker		8			1							2	2	1		1
C. deprimus Phleger and Parker										1	1	1				
C. protuberans Parker		4			1					4	2					1
C. spp.	5	2					2					1				
Cibicidoides bradyi (Earland)														2		
C. cf. *C. floridana* (Cushman)		14			1							4	6	2		2
C. lo (Cushman)		1			1						1		1			3
C. kullenbergi (Parker)														2		
C. cf. *C. mahabethi* (Said)	6	9	3	1	3	5	5	3	1	5	6	3	1	1	13	9
C. cf. *C. pseudoungerianus* (Cushman)		14			1						1	4				2
C. robertsonianus (Brady)														2		
C. umbonatus (Phleger and Parker)		1			2					1		1		1		3
C. sp. A.		2														
C. sp.														1		
Clavulina nodosaria d'Orbigny		1														1
C. tricarinata d'Orbigny		1					1	2								
Coryphostoma spinescens (Cushman)													1			1
C. subspinescens (Cushman)														1		
Cribrogenerina parkerae Andersen												1				
Crithionina sp.		1														
Cushmanella brownii (d'Orbigny)																
Cyclogyra involvens (Reuss)	7	1			1		1	1		2		4		4	1	4
Cymbaloparetta squammosa (d'Orbigny)		2	1				5	4	3		3					13
Dendritina elegans (d'Orbigny)	2					1	1		2						1	

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dentalina communis (d'Orbigny)				1												
Discorbinella floridensis (d'Orbigny)		2			1						3					
D. parkerae (Natland)																1
Discorbis mira Cushman	23	1			1	3	1	4							20	1
D. rosea (d'Orbigny)	74	2	2		3	22	2	77							14	1
D. aff. *D. rosea* (d'Orbigny)	16					2										
Discorbis (?) *transluscens* (Phleger and Parker)													1	5		
Dorthia exilis Cushman												1				
D. scabra (Brady)											1					
Dusenburyina procera Goes										1	2					
Eggerella sp.		11			2											1
Ehrenbergina spinea Cushman		1			1							2	1	1		3
E. trigona Goes														7		
Elphidium advenum (Cushman)					1										1	1
E. articulatum (d'Orbigny)																1
E. discoidale (d'Orbigny)		2	22	6	3	4	3	1	1	1	2	2	3	3	2	
E. lanieri (d'Orbigny)	1															
E. mexicanum (Kornfeld)	3							1				2				5
E. poeyanum (d'Orbigny)		1	7	3	1	2	1		2	3	6	3			2	5
E. spp.	4	2		1	3		1			4	1		4	4	2	
Eponides antillarum (d'Orbigny)										1	1			1	2	
E. pollus Phleger and Parker		2			1								1	1		1
E. cf. *E. praecinctus* (Karrer)		1			1											
E. repandus (Fichtel and Moll)						1				1	2				2	
Fissurina spp.		1								1		2	1			
Florilus grateloupi (d'Orbigny)	2	4	2	1	2	4	1	4	7	3	3	6	6	15	5	6
Frondicularia saggitula Van den Broeck													1			

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Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fursenkoina mexicana (Cushman)												1	1	1		
Gaudryina flintii Cushman												2		1		1
G. pseudoturris (Cushman)		1														3
Glabratella hexacamerata Seiglie and Bermudez	2			1	1	1	2					1				
Globobulimina affinis (d'Orbigny)					1								1	1		2
Globocassidulina subglobosa Brady		27			7					5	2	3	5	4		5
G. punctata Berggren and Miller		4			1							1	1			
Globulina inaequalis caribea d'Orbigny						1	1									
Glomospira gordialis (Jones and Parker)																
Guttulina australis (d'Orbigny)			1			1	1									
G. regina (Brady)											1					
Gypsina plana (Carter)						1										
G. vesicularis (Parker and Jones)																
Gyroidina altiformis Boomgaart		1			1									2		1
G. orbicularis d'Orbigny														1		2
G. neosoldanii Brotzen					1							4	1			
G. sp.													1			
Hanzawala concentrica (Cushman)	2											2				1
Hauerina bradyi Cushman	11	2	1	1	3	4	1	13	3					1	15	2
H. ornatissima (Karrer)	4							3	1						10	
H. speciosa (Karrer)	2															
Heterellina cribrostoma (Heron-Allen and Earland)	16	40	4	21	29	7	13	29	6	29	7	44	35	53	5	38
Heterostegina antillarum d'Orbigny		1													2	
Hoeglundina elegans (d'Orbigny)		8			3					2	1	1	3			2
Homotrema rubrum (Lamarck)															5	
Hormosina globulifera Brady																1

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Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hyperammina laevigata Wright														1		
Islandiella cf. *I. islandica* (Norvang)					1											
I. norcrossi australis (Phleger and Parker)												1		1		1
Karreriella bradyi (Cushman)		2											1	1		
Lagena spp.		1												2		
Lamarckina atlantica Cushman					1					1		1	1			
Laticarinina pauperata (Parker and Jones)																
Lenticulina atlantica Barker													1	1		
L. calcar (Linnaeus)					1								2	1		
L. gibba (d'Orbigny)												1				
L. orbicularis (d'Orbigny)		3										1	1	1		1
L. peregrina (Schwager)														1		1
L. spp.					2									1		
Liebusella soldanii (Jones and Parker)		1											1			
Loxostomum limbatum (Brady)																
Marginulina glabra Cushman var.													1			
Marginulinopsis subaculeata glabrata (Cushman)					1											
Martinottiella nodulosa (Cushman)		1														
Massilina gracilis (d'Orbigny)															1	
M. protea Parker											1					
M. sp.		1										2				
Melonis barleeanus (Williamson)		9			4					1		2	7	7		4
Miliolinella circularis (Bornemann)	21				4	2	2	6	4	3	5	4	4	3	2	4
M. fichteliana (d'Orbigny)	2	2			2					2		3		1	1	2
M. labiosa (d'Orbigny)	8	20	16	33	29	3	6	12	3	9	3	12	13	14		26
M. subrotunda (Montagu)	9	11	1		10		2	7	1	2		2	4		7	4
M. sp.								1								

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Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mimosina echinata Heron-Allen and Earland	2	2				1		1				1		1		4
Miniacina miniacea (Pallas)				1		1	2				1				6	1
Mississippina concentrica (Parker and Jones)																1
Monalysidium politum Chapman	1															1
Neoconorbina concinna (d'Orbigny)	24	8	1	3	22	11	20	13	24	29	9	45	94	77	15	31
N. mocheminensis (Sellier de Civrieux)	5	12	10	22	32	9	21	19	6	13	4	16	12	11	7	16
N. terquemi (Rzehak)	21	4			4	2	7	6	2	6	2	5	2	4		4
Neopateoris cumanensis Bermudez and Seiglie																
Nodobaculariella cassis (d'Orbigny)	3		2	1		6	2	3	2		2				1	1
Nodosaria albatrossi Cushman											1					
N. pyrula (d'Orbigny)																
Nouria atlantica (Cushman)							1									
N. polymorphinoides Heron-Allen and Earland			1			1		2	1							
Nummoloculina irregularis (d'Orbigny)		3											1	1		
Ophthalmidium inconstans (Brady)													2	3		
Oridorsalis tener (Brady) vars.																1
Osangularia rugosa (Phleger and Parker)														1		
Patellina corrugata Williamson									2				1	1		
Pegidia bermudezi Seiglie															1	
Peneroplis bradyi Cushman	8		1	2	1	2	9	5	3	3		2	1		13	1
P. carinatus d'Orbigny					3			3		3	1				44	
P. proteus d'Orbigny	6	1	2		3	26	16	12	24	14	11	7			3	5
Placopsilina confusa Cushman	1					4	1								1	
Planorbulinella larvata (Parker and Jones)	20	4	3	2	8	5		11								
Planorbulinoides retinaculata (Parker and Jones)	15	4	1				10	12	4	2	3	2		2	11	5
Planogypsina squammiformis (Chapman)	11	2	1	1	1	7	4	6	2		1	1				
Planulina ariminensis d'Orbigny					1									2		2

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Planulina exorna Phleger and Parker		2								1	1					
P. foveolata (Brady)		7			2							2	2	1		
Pseudonodosaria comatula (Cushman)					1											1
Pullenia bulloides (d'Orbigny)														2		1
P. quinqueloba (Reuss)														1		
Pyrgo comata (Brady)			1			1	1		1	1						
P. denticulata (Brady)	1															
P. depressa (d'Orbigny)													1	1		
P. elongata (d'Orbigny)																
P. murrhyna (d'Orbigny)															1	
P. subsphaerica (d'Orbigny)	1	2	1			2	1		1	2	2				4	2
P. sp.																1
Quinqueloculina agglutinans d'Orbigny	2	1			2		1	4	1						1	
Q. akneriana (d'Orbigny)	1															
Q. angulata Williamson	2			1		1	2	1								
Q. bassensis (Parr)	10	4	32	30	7	9	4	6	6	15	12	6	8		6	17
Q. cf. *Q. bicarinata* d'Orbigny									4							
Q. bicostata d'Orbigny	2															
Q. bidentata d'Orbigny	4	3	4	5		11	2	9	5	2	3	1			2	4
Q. bosciana d'Orbigny	20	6	2	2	10	2	5	12	5	5	2	16	21	50	9	11
Q. bradyana Cushman							1			1					1	
Q. candeiana d'Orbigny	2				1	2		2			1	1	2	3	2	5
Q. collumnosa Cushman	2						1				1				1	
Q. compta Cushman							1								5	
Q. crassa subcuneata Cushman	1															
Q. cf. *Q. cuvieriana* d'Orbigny	2				2	1			1						11	
Q. exsculpta (Heron-Allen and Earland)							5									

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Q. cf. *Q. kerimbatica* (Heron-Allen and Earland)	3															
Q. laevigata d'Orbigny	2				1		1	2					2	1		
Q. lamarckiana d'Orbigny	3	2				5	3	1	1		1	1			9	
Q. parkeri Brady vars.	21	1	3	2	6	32	13	8	13	8	8	2	1	3	16	2
Q. poeyana d'Orbigny			1	2	2	1	2	2	2	1	1	2			1	4
Q. polygona d'Orbigny	3	2	1		1		1	2	1		2		1		1	
Q. sabulosa Cushman	9							4			2					
Q. cf. *Q. seminula* (Linne)	2					5	2	3	2	3		4				
Q. subpoeyana Cushman	3	4	4	12	14	2	6	1	5	2		6	6	3	2	8
Q. tipswordi Andersen	3							1							1	1
Q. tricarinata d'Orbigny	1						1				2					
Q. sp. A.													3			4
Q. spp. indeterminate	3		1	1	7	1	1			4		1		4		
Ramulina globulifera Brady														1		
Rectobolivina advena (Cushman)																
R. raphana (Parker and Jones)										1						
Reophax arayaensis Bermudez and Seiglie											1					
R. compressus Goes																1
R. scorpiurus Montfort										7						2
R. subfusiformis Earland		1			2						2	1	1			
Reussella atlantica (Cushman)		1														1
Rosalina bulbosa (Parker)	2															
R. candeiana d'Orbigny	106	107	29	96	163	77	107	172	59	65	22	112	68	62	60	126
R. floridana (d'Orbigny)	3	2	4	2	2	4	5	4	2	3	3				4	4
R. globospiralis (Sellier de Civrieux)	14						2	7				5	2	2	2	4
R. cf. *R. globularis* (d'Orbigny)	14	4	1	1	8	8	8	2		7	8	11	13	15		4
R. granulosa (Heron-Allen and Earland)	1	24	5	11	30	1	8	5	6	3	1	18	15	40		20

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Rosalina spp.	6					1	2	6					3	4	1	
Rotaliammina squamiformis (Cushman and McCulloch)	3		1	1		1	2	1	12					3		
R. sp.													1			
Saccorhiza ramosa (Brady)																
Sagrina pulchella d'Orbigny	9	20		4	28	3	7	16	2	9	4	39	30	62	1	16
Schlumbergerina alveolinaformis (Cushman and McCulloch)	1					2	1	2							2	
Sigmoilina simoidea (Brady)		2			1									2	2	2
S. tenuis (Czjzek)													1			
S. sp.	7															
Sigmoilopsis schlumbergeri (Silvestri)													2			
Siphonina bradyana Cushman		12									1	5	14	1		
S. primitiva Hofker						1	1									
S. pulchra Cushman		4			7					1	1	2		1		9
S. tubulosa Cushman		2			2					2	1					1
Siphoninella soluta Brady					1											
Siphotextularia affinis (Fornasini)		1														1
S. rolshauseni Phleger and Parker																
Sorites marginalis (Lamarck)	8		2			2	2	2	14	2		1		1	1	
Sphaerogypsina globulus (Reuss)											1				4	
Sphaeroidina bulloides (d'Orbigny)					1											
Spirillina vivipara Ehrenberg	6	1		1	1			1	1	2			2		2	
Spirolina arietinus (Batsch)	6					1	1	1	1			1			7	
Spiroloculina antillarum d'Orbigny	1		1													
S. arenata Cushman	6					2	1	2								
S. communis Cushman and Todd																1

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Spiroloculina ornata d'Orbigny																
S. rotunda d'Orbigny																
Spirotextularia floridana (Cushman)					1					1	3					1
Sporadotrema rubrum (d'Orbigny)	3				1	7		1		2					3	
Stebloides advena (Cushman)				1	1		1	2	2	1		1			4	
Technitella sp.		1														1
Textularia agglutinans d'Orbigny	12	8	14	6	1	2		2		3	1	1			4	1
T. calva Lalicker						1				3	2			1		
T. candelana d'Orbigny	4		1			3	2			3	1					3
T. conica d'Orbigny		2			1							1				
T. corrugata Heron-Allen and Earland															2	
T. foliacea Cushman		3								2	2	2	2			2
T. luculenta Brady														1		
T. mexicana Cushman	1															
T. sp.		2														
Textulariella barrettii (Jones and Parker)		2											1			1
Trifarina bradyi Cushman												1	1	3		
T. bella (Phleger and Parker)	11	27			4		1	9		5	13	7	2	6		14
Triloculina bermudezi Acosta	17	23	8	30	57	2	9	11		11	2	24	34	39	3	19
T. cf. T. brogniatiana d'Orbigny			1			1			1		1					
T. carinata d'Orbigny vars.	1										1				1	
T. fiterrei (Heron-Allen and Earland)				2								3	7			
T. fiterrei meningoi Acosta	2	5	2	5		1	1	5	2	4	1	3	5	3		3
T. linneiana d'Orbigny	5	4	2	1		1	1	7	2			2		1	3	5
T. oblonga (Montague)					1					2		1				
T. planciana d'Orbigny	12		1	1		2		1		2					1	
T. rotunda d'Orbigny	10	5	1	5	4	1		9	6	2	1	12	7	8	4	5

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Triloculina schreiberiana d'Orbigny			3		8	46	19	1	28	18		13			6	2
T. sidebottomi (Martinotti)								1	2	2						
T. terquemi (Brady)							1									
T. tricarinata d'Orbigny							1		1						2	1
T. trigonula (Lamarck)			2			2	3		1	2		1				1
T. spp.						1						2		4		
Tritaxis fusca (Williamson)											1					
Trochammina cf. *T. advena* Cushman																1
T. globigeriniformis (Parker and Jones)					1						1					
T. sp.											1					
Tubinella funalis (Brady)		1												1		2
Uvigerina auberii d'Orbigny		1											2	3		
U. flintii Cushman		1									1	1	1			1
U. laevis Goes													2			
U. peregrina Cushman vars.					2								5	1		1
Vaginulina advena (Cushman)													3			
Valvulina oviedoiana d'Orbigny	10		18	3		2	1	3		1					3	2
Valvulineria laevigata Phleger and Parker													1	1		
Webbina decorata (Heron-Allen and Earland)										1						
Wiesnerella auricula (Egger)																
(?)=questionable identification																
SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WATER DEPTH (meters)	13	292	20	14	460	20	22	8	20	200	200	300	400	500	20	325
TOTAL BENTHIC SPECIMENS	802	764	524	469	748	629	515	668	507	550	346	654	587	674	754	796
UNDISPLACED BENTHIC SPECIMENS (*in situ*)	▪	221	▪	▪	75	▪	▪	▪	▪	51	45	68	102	101	▪	107

APPENDIX 2A.

Benthic assemblage species list and specimen counts for Cay Sal Bank samples.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Textulariina	32	39	35	10	6	17	10	12	16	16	16	13	7	8	14	15
Miliolina	330	9	146	205	2	319	189	232	239	2	0	1	9	9	356	2
Rotaliina	440	173	343	254	67	294	316	424	252	33	29	54	86	84	384	90
DISPLACED BENTHIC SPECIMENS	--	543	--	--	673	--	--	--	--	499	301	586	485	573	--	689
Textulariina	0	10	0	0	2	0	0	0	0	5	1	2	1	3	0	3
Miliolina	0	179	0	0	260	0	0	0	0	214	132	203	166	211	0	229
Rotaliina	0	354	0	0	411	0	0	0	0	280	168	381	318	359	0	457
PLANKTONIC SPECIMENS	0	152	2	1	54	3	4	0	6	13	20	54	318	409	28	102
PLANKTONIC PERCENT (from total)	0	17	0.4	0.2	7	0.5	0.7	0	1.2	2	6	8	35	38	4	11
PLANKTONIC PERCENT (from *in situ*)	NA	41	NA	NA	42	NA	NA	NA	NA	20	31	44	76	80	NA	49

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
SPECIES																
Acervulina inharens Schultze		5	1													
Alabamina decorata (Phleger and Parker)												3				
Ammodiscus tubinatus (Cushman)														3		1
A. tenuis Brady															1	
Ammolagena clavata (Parker and Jones)	1													1		
Ammonia beccarii (Linne) vars.			7		2	1										
Ammoscalaria sp.	1						1		1							
Amphicorina intercellularis (Brady)	1								1			1	2			
Amphisorus hemprichii Ehrenberg		2			4	2	5	1		2	3	1				
Amphistegina gibbosa d'Orbigny		1	2	6	3		5			1	9	1				
A. radiata (Fichtel and Moll)										1						
Anomalina flintii Cushman	1									1		8		3		
Anomalinoides globulosa (Chapman and Parr)												2				
A. mexicana Parker															1	
A. semipunctata (Bailey)	3															
A. vermiculata (d'Obigny)											1		1			
Archais angulatus (Fichtel and Moll)	2	7	5	84	22	8	54	16	12	16	15	1	2	1		1
Articulina antillarum Cushman					1	1										
A. lineata Brady	7	2	36	6	11	12		2	1	5	3					
A. mucronata (d'Orbigny)		6	8	8	4	2	15		2	3	8					
A. sagra (d'Orbigny)	2	3	5			3	3		1							
Asterigerina carinata d'Orbigny	28	25	60	82	55	24	61	52	55	45	9	4		2	1	
Astacolus crepidulus (Fitchtel and Moll)																1
Astrononion tumidum Cushman and Edwards														1	2	1
Bigenerina irregularis Phleger and Parker		1		2	1	7	3	1		1	3					
B. textularoidea (Goes)			1							1		20	1			

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Biloculinella labiata Schlumberger	1															
Bolivina alvarezi Sellier de Civrieux		1			1											
B. goesii Cushman													3		1	
B. lowmani Phleger and Parker					2											
B. ordinaria Phleger and Parker			1													
B. psuedoplicata Heron-Allen and Earland	1	1			1	1		1			3	5	5	5	2	1
B. pusilla Schwager													1		1	
B. tortuosa Brady		1	2		3						3		1			
B. variabilis (Williamson)			2		1								1			
B. sp.																1
Bolivinita rhomboidalis (Millet)			2			2					3					
Borelis pulchra (d'Orbigny)		2	1		4		19		1							
Bulimina aculeata d'Orbigny			1													
B. alazanensis Cushman															2	
B. spicata Phleger and Parker	2												3	6		1
B. striata mexicana Cushman														1		1
Buliminella milletti Cushman			4		4			1		1	1					
B. parallelus Cushman and Parker						1										
B. silviae Bermudez and Seiglie						3										
Buliminoides williamsonianus (Brady)												1				
Burseolina palmerae Bermudez and Acosta	3		1							1	1	2		1		2
B. cf. *B. intermedia* Palmer	1		1									1	1			1
Cancris oblonga (Williamson)			1						1							
C. sagra (d'Orbigny)						2					1	1	1			
Caribeanella polystoma Bermudez	23	9	114	17	25	15	2	25	25	33	4	2	3	2	1	
Cassidulina carinata Silvestri	1								2		2		1	1	2	
C. crassa d'Orbigny	4										1		3	1	14	8

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Cassidulina curvata Phleger and Parker	9									2		8		2	1	1
C. laevigata d'Orbigny	2		7							2	3	13	2	3		
C. neocarinata Thalmann														1		
C. spp.	2					1			2	1						
Cassidulinoides bradyi (Norman)	1												1	2		
Chilostomella ovoidea Reuss										1	1					
Chrysalidinella dimorpha (Brady)											1					
Cibicides antilleanus Drooger															3	
C. corpulentus Phleger and Parker	1										3		2	1	1	2
C. deprimus Phleger and Parker									1		2		3			
C. lobatulus (Walker and Jacob)															1	
C. protuberans Parker	1		2						2		3		2		6	
C. spp.		2	1		5		3				5	2		2		1
Cibicidoides bradyi (Earland)	1											1	3		2	
C. cf. *C. floridana* (Cushman)	9		1						1	2	1	10	5	2		6
C. io (Cushman)									1		1	6	10			
C. kullenbergi (Parker)	1														3	9?
C. cf. *C. mahabethi* (Said)	2	4	12	3	4	15	6	1	1	3	14	10	1	2	2	1
C. mollis Phleger and Parker											2	2				
C. cf. *C. pseudoungerianus* (Cushman)	3											13	9	1		
C. robertsonianus (Brady)	4														7	2
C. umbonatus (Phleger and Parker)										1	1	4		3		4
C. sp. A.										1	1	4		1		
C. spp.														2		3
Clavulina mexicana Cushman												2	1			1
C. nodosaria d'Orbigny					1							3				
C. tricarinata d'Orbigny		1		1	2	1		1								

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Coryphostoma spinescens (Cushman)			1									3	2	1		
C. subspinescens (Cushman)											1					
Cribrogenerina parkerae Andersen												1				
Cruciloculina triangularis d'Orbigny															1	
Cushmanella brownii (d'Orbigny)					1											
Cyclogyra involvens (Reuss)	1	2	1		1	5		1	1	2	7	4	6	17	2	1?
Cylindroclavulina bradyi (Cushman)											1					
Cymbaloparetta squammosa (d'Orbigny)	1						1					4	2	7	7	1
Dendritina elegans (d'Orbigny)					1											
Dentalina advena (Cushman)																1
D. communis (d'Orbigny)	1															
D. subsoluta (Cushman)												1			1	
Discorbinella bertheloti (d'Orbigny)												1			2	
D. floridensis (d'Orbigny)									2	4		1				
D. parkerae (Natland)			1								1	1			1	
Discorbis mira Cushman	2	5	5	2	7	3	26				5	1		1		2
D. rosea (d'Orbigny)		50		1	7	2	121*				5					
D. aff. *D. rosea* (d'Orbigny)							4									
Dorthia exilis Cushman													1	1		1
D. scabra (Brady)	1															
Dusenburyina procera Goes																
Eggerella advena Cushman															2	
E. propinqua (Brady)															1	
E. sp.	1											6				
Ehrenbergina spinea Cushman				2					2		3		3	1	1	
E. trigona Goes	2												1	6	1	3
Elphidium advenum (Cushman)		1			1			2	1		1	1	1	1		

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Elphidium articulatum (d'Orbigny)				3	1	1		2	3		4			3		
E. discoidale (d'Orbigny)	1	3		1			1	8	10	10	6		1	1		
E. lanieri (d'Orbigny)		1														
E. mexicanum (Kornfeld)								1		1				2	1	
E. poeyanum (d'Orbigny)	1		6	1	1	1		2		2	10	3	4			
E. spp	1		6	1		1				1	3	1	2		1	
Eponides antillarum (d'Orbigny)			1		1		2		1							
E. pollus Phleger and Parker											1	1	3	1	2	
E. cf. *E. praecinctus* (Karrer)										1		1				
E. regularis Phleger and Parker															1	
E. repandus (Fichtel and Moll)				1	1											
Fischerina dubia d'Orbigny											1	1				
Fissurina spp.	2		1		2	2							1	1	3	2
Florilus grateloupi (d'Orbigny)		2	13	1	3	11		3	1	6	2		1	2	1	
F. sloanii (d'Orbigny)												1	2	5		
Frondicularia saggitula Van den Broeck														1		
Fursenkoina advena (Cushman)											1					
F. mexicana (Cushman)										1				1		
Gaudryina atlantica (Bailey)														1	5	2
Gaudryina flintii Cushman												2	2			
G. pseudoturris (Cushman)	1													1		
Glabratella hexacamerata Seiglie and Bermudez		1	3		2	2		1	1		3	1				
G. spp.												1		2		
Globobulimina affinis (d'Orbigny)													1	1		
Globocassidulina subglobosa Brady	15		2						1	1	2	8	5	14	68	40
G. punctata Berggren and Miller		1								2		1				

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Glomospira gordialis (Jones and Parker)	1														1	2
Guttulina australis (d'Orbigny)								1								
G. pulchella d'Orbigny										1						
G. regina (Brady)																
G. sp.				1												
Gypsina vesicularis (Parker and Jones)				1						1	1					
Gyroidina altiformis Boomgaart	5											9	5	2	3	6
G. orbicularis d'Orbigny	1								2		1		1		2	
G. neosoldanii Brotzen										3	1	1		4	4	3
G. sp.																
Hanzawaia concentrica (Cushman)			1									1	2	2		
Hauerina bradyi Cushman		6	1	1	7	1	23	1	2		3		1			
H. ornatissima (Karrer)		1	2	1	1	2	6	1	1		1					
H. speciosa (Karrer)			1				1	1								
Heterellina cribrostoma (Heron-Allen and Earlar	12	6	45	5	20	16	2	35	41	60	25	16	11	11	9	1
Heterostegina antillarum d'Orbigny					1		1									
Hoeglundina elegans (d'Orbigny)	1								1	4	1	4	1	3	2	9
Homotrema rubrum (Lamarck)				1	1		1				4					
Hormosina globulifera Brady													6			
Hyperammina laevigata Wright															2	
Islandiella norcrossi australis (Phleger and Parker)										1						
Karreriella bradyi (Cushman)	1											1	3	2	1	3
Lagena spp.	1					1					2	1	1		5	2
Lamarckina atlantica Cushman			2						2	1	8	7	1	1		1
Laticarinina pauperata (Parker and Jones)															1	5
Lenticulina americana (Cushman)									1							

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Lenticulina atlantica Barker														2		
L. calcar (Linnaeus)		1								1			3	1	1	
L. gibba (d'Orbigny)			2									1	1	1		1
L. iota (Cushman)												1				
L. orbicularis (d'Orbigny)		1		1						2	2	7	2		3	
L. peregrina (Schwager)															2	3
L. thalmanni Hessland												3	1		1	
L. spp.													1	1	2	1
Liebusella soldanii (Jones and Parker)										1		4		1		
Loxostomum limbatum (Brady)					1											
Marginulina glabra Cushman var.			1													
M. striatula Cushman															1	
Marginulinopsis subaculeata glabrata (Cushman)			1											4		
Marsipella sp.														1		
Martinottiella nodulosa (Cushman)	1															2
Massilina protea Parker							6	4	6				1			
M. sp.	2		1								2					
Melonis barleeanus (Williamson)									2	3	7	26	16	12		7
Miliolinella circularis (Bornemann)	3	2	5	5	7	10	7	3	5	5	24	4	4	5	5	
M. fichteliana (d'Orbigny)	2				2	2	2	1	1	3	4	3	1	2	1	1
M. labiosa (d'Orbigny)	4	4	10	4	9	6	1	3	6	6	5		2	1	1	
M. subrotunda (Montagu)	3	3	7	2	4	9	4	3	4	6	14	3	7	4	4	1
M. spp.									1							
Mimosina echinata Heron-Allen and Earland			1	1	1	2		1		2						
Miniacina miniacea (Pallas)		2	2				1		1	1	5			2		
Mississippina concentrica (Parker and Jones)									1		1					
Monalysidium politum Chapman					1					1						

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Neoconorbina concinna (d'Orbigny)	5	9	50	12	16	28	10	6	7	15	11	10	13	6		1
N. mocheminensis (Sellier de Civrieux)	1	4	23	6	5	2	6	3	7	10	1	2				
N. terquemi (Rzehak)	1	8	8	2	2	12	9	1	4	4	19	3	10	8	1	1
Neopateoris cumanensis Bermudez and Seiglie		1				1						1				
Nodobaculariella cassis (d'Orbigny)		1	3	5	2	2		1			1					
Nodosaria pyrula (d'Orbigny)	1											1		2		1
N. pyrula semirugosa Cushman												1	1			1
Nouria atlantica (Cushman)		1				1										
N. polymorphinoides Heron-Allen and Earland									2							
Nummoloculina irregularis (d'Orbigny)	2												2	5	1	
N. aff. *N. contraria* (d'Orbigny)															1	
Ophthalmidium inconstans (Brady)												1		3	2	2
Oridorsalis tener (Brady) vars.	1													3	1	
Osangularia culter (Parker and Jones)												3				
O. rugosa (Phleger and Parker)	3													1		
Patellina corrugata Williamson			2			1								2	1	
Pegidia bermudezi Seiglie						1										
Peneroplis bradyi Cushman		1		4	10	5	7	3	2		6	2	2	1		
P. carinatus d'Orbigny		3		15	4		6					1				
P. proteus d'Orbigny		5	14	10	20	6	5	6	5	2	8	1			1	
Placopsilina confusa Cushman				1			1									
Planispirinoides bucculentus (Brady)														5	15	8
Planorbulina caribbeana Hofker									1		2	1				
Planorbulinoides retinaculata (Parker and Jones)	2	11	12		11	14	17	4	7	5	25	2	5	2		1
Planogypsina squammiformis (Chapman)		7	7		2	2			1	1	12			3		
Planulina ariminensis d'Orbigny												2		1		2

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Planulina exoma Phleger and Parker	5							3		21					1	
P. foveolata (Brady)	3							1	2	3			6	7	1	6
P. wuellerstorfi (Schwager)															5	35
Pseudonodosaria comatula (Cushman)									1			1				
Pseudopolymorphina ovalis (Cushman and Ozawa)															2	
Pullenia bulloides (d'Orbigny)	1													1	3	
P. quinqueloba (Reuss)	2		1									3	2		7	4
P. spp.												1	1		2	2
Pyrgo comata (Brady)					1											
P. denticulata (Brady)				1												
P. depressa (d'Orbigny)															1	5
P. elongata (d'Orbigny)		1			2											
P. murrhyna (d'Orbigny)													1		1	
P. subsphaerica (d'Orbigny)	1	2	3		1	1		2	1	1	3	1				
P. sp.									1						1	
Pyrgoella sphaera (d'Orbigny)															2	1
Quinqueloculina agglutinans d'Orbigny		4		2			2	1	1	1						
Q. akneriana (d'Orbigny)	1			1					2	3	3					
Q. bassensis (Parr)	6	6	16	13	13	5	2	10	12	8	9	2	2			
Q. bidentata d'Orbigny	2			6	8	2	3	2	1	3				2		
Q. bosciana d'Orbigny	4	7	12	2	11	21	4	6	8	6	4	2	3	2		
Q. bradyana Cushman							3									
Q. candelana d'Orbigny		3			6			2	1						1	
Q. collumnosa Cushman	1						1				1					
Q. crassa subcuneata Cushman						1	1									
Q. cf. *Q. cuvieriana* d'Orbigny	1	3	3		3		6	1			2	1	2	1		

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Q. exsculpta (Heron-Allen and Earland)							2									
Q. laevigata d'Orbigny			4		1	3	1	2		5	6	1				1
Q. lamarckiana d'Orbigny			1	5	5	3	2	9	3	7	7	10	2	3		1
Q. parkeri Brady vars.		9	3	2	16	4	23	5	3	4	2	1				
Q. poeyana d'Orbigny		1	1	2	4	1		5	5	5	7	1				
Q. polygona d'Orbigny	1	1	2		2	1	3	3	3	2	2					
Q. sabulosa Cushman		3														
Q. cf *Q. seminula* (Linne)			2	4	2		3	3			5				2	
Q. subpoeyana Cushman	3	2	6	4	6	2		5	3	6	2					
Q. tipswordi Andersen				1	2	1	2	3	2		2					
Q. tricarinata d'Orbigny					1	1	1									
Q. venusta Karrer								1		2	2					
Q. sp. A.		5					5			1	12					
Q. spp. indeterminate	3		2		3		2	2						1	1	
Ramulina globulifera Brady																
Rectobolivina advena (Cushman)					1											
Recurvoides turbinatus (Brady)														1		
Reophax arayaensis Bermudez and Seiglie			3													
R. compressus Goes	1													1		
R. scorpiurus Montfort	1								1	4		9	5			1
R. spiculifer Brady										1						
R. sp.												1				
Reussella atlantica (Cushman)						1			1	2	3	3		1		
R. spinulosa (Reuss)								1								
Rhabdammina sp.															1	
Riveroina carabea Bermudez														1		
Robertinoides bradyi (Cushman and Parker)									1						2	1

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Rosalina bulbosa (Parker)						1			1	1						
R. candelana d'Orbigny	21	49	135	46	160	81	82	248	153	200	49	12	12	8	2	2
R. floridana (d'Orbigny)		2	6	1	6	3		6	3	7	1	1				
R. globospiralis (Sellier de Civrieux)		5	8		5	2	8		2	1	3					
R cf. *R. globularis* (d'Orbigny)	2	5	8	3	7	26	5	5	7	4	151	55	41	54	9	6
R. granulosa (Heron-Allen and Earland)	3	3	25	3	7	6		10	13	25	7	2	1	5		
R spp.		3		2	4		2	5	5	5	2					
Rotaliammina squamiformis (Cushman and McCulloch)				4	2	5	1			2						
Rupertia stabilis Wallich															1	
Saccammina atlantica (Cushman)													2			
Saccorhiza ramosa (Brady)			1									1	1			
Sagrina pulchella d'Orbigny	4	1	13	1	7	13	2	13	13	14	9	8	4	5	1	
Saracenaria italica DeFrance												3	1			
S. latifrons (Brady)										1						1
Sejunctella sp.													1			
Schlumbergerina alveolinaformis (Cushman and McCulloch)		1		1	1	1	6									
Sigmoilina simoidea (Brady)	4										4	2	4	1	1	2
S. tenuis (Czjzek)	1		1										1		1	
S. sp.				1	1			2	1			2				5
Sigmoilopsis schlumbergeri (Silvestri)	1											2	1	3	2	
Siphonina bradyana Cushman	3								2			40	8	8		1
S. primitiva Hofker			2	2	6		2									
S. pulchra Cushman			4						2	8	10	4	6	4	1	
S.tubulosa Cushman			2						2	3		1			1	
Siphotextularia affinis (Fornasini)			1								1		3			

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Siphotextularia flintii (Cushman)																1
S. rolshauseni Phleger and Parker	1															
S. sp.													1			
Sorites marginalis (Lamarck)				4			7	4	1	2	3	1				1
Sphaeroidina bulloides (d'Orbigny)	1											1	1		2	
Spirillina vivipara Ehrenberg	1		6		1	3	2		1	1	1			1		
S. spp.						3	2				4		4	4		
Spirolina arietinus (Batsch)		4		2	3	1	3	1								
Spiroloculina antillarum d'Orbigny		1			1	1	1				1		1			
S. arenata Cushman					2	1	2		3		1					
S. communis Cushman and Todd														1	1	
S. ornata d'Orbigny			1													
S. rotunda d'Orbigny	1															1
Spirotextularia floridana (Cushman)	1										1					3
Sporadotrema rubrum (d'Orbigny)		7			2		7									
Stebloides advena (Cushman)				2				1								
Textularia agglutinans d'Orbigny		11	1	5	2	2	14	1	1		2	5				
T. calva Lalicker											1	1	8	2		6
T. candelana d'Orbigny		4	5				1									
T. concava (Karrer)														1		
T. conica d'Orbigny	2		2	1		1					3	4	1			2
T. corrugata Heron-Allen and Earland									1							
T. foliacea Cushman	3		1									14	8			11
T. luculenta Brady	3															2
T. mexicana Cushman				1								1	1	1		
T. sp.										1						
Textulariella barrettii (Jones and Parker)												6	1	1		2

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Tosaia weaveri Seiglie and Bermudez											2			1		3
Trifarina bradyi Cushman	1												1	1	3	2
T. bella (Phleger and Parker)	17	3	25	2	4	16	11	3	5	6	37	18	7	6	1	1
Triloculina bermudezi Acosta	12	4	22	1	15	11	3	8	9	7	5	2	3	6	1	1
T. cf. *T. brogniatiana* d'Orbigny				1	1		1									
T. carinata d'Orbigny vars.		1	1	1		1	1		1							
T. fiterrei (Heron-Allen and Earland)					1	1						1				
T. fiterrei meningoi Acosta	3	1	1	1	2	3		1	1		2			2		
T. insignis H.B. Brady															1	
T. linneiana d'Orbigny		3	2	3	2		4	2		2						1
T. oblonga (Montague)			2		2		2	1			1	3	2			
T. planciana d'Orbigny		6	4		1	2		4	3	2						
T. rotunda d'Orbigny	4	2	8	4	5	7	6	3	2	11	12	7	8	5		
T. schreiberiana d'Orbigny					6	1		1								
T. sidebottomi (Martinotti)			11	2	1	1	1				4					
T. tricarinata d'Orbigny				1	1						1					
T. trigonula (Lamarck)			3			1		1	1	2	3					
T. spp.			1													
Trochammina cf. *T. advena* Cushman	1														1	1
T. conglobata Brady															4	
T. spp.														1	1	
Tubinella funalis (Brady)			3								3		3			
Uvigerina auberii d'Orbigny	1								1		1		5			1
U. flintii Cushman	2										3	1	3	3	1	2
U. laevis Goes			1							1				4	5	
U. peregrina Cushman vars.	2									1		4		2		1
Vaginulinopsis tasmanica Parr												1				

APPENDIX 2B.

Benthic assemblage species list and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Valvulina oviedoiana d'Orbigny		3	3	6	5		9	1								
Valvulineria laevigata Phleger and Parker													2		1	2
Wiesnerella auricula (Egger)						1					1			1		
(?=questionable identification)																
SAMPLE NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
WATER DEPTH (meters)	580	15	250	20	17	80	15	21	225	330	275	365	420	513	975	1055
TOTAL BENTHIC SPECIMENS	343	380	887	440	672	503	692	1163	532	674	757	562	391	379	306	299
UNDISPLACED BENTHIC SPECIMENS	146	•	60	•	•	•	•	•	40	53	90	335	194	171	243	273
Textulariina	10	21	9	21	13	18	30	5	4	7	12	71	44	19	21	43
Miliolina	21	127	1	215	275	178	263	347	0	0	2	7	7	22	31	25
Rotaliina	115	232	50	204	384	307	399	811	36	46	76	257	143	130	191	205
DISPLACED BENTHIC SPECIMENS	197	--	827	--	--	--	--	--	492	552	667	227	197	208	63	26
Textulariina	0	0	9	0	0	0	0	0	2	3	0	10	1	0	0	0
Miliolina	79	0	268	0	0	0	0	0	160	196	234	72	74	65	28	9
Rotaliina	118	0	550	0	0	0	0	0	330	353	433	145	122	143	35	17
PLANKTONIC SPECIMENS	992	1	20	2	4	2	0	11	17	38	33	417	780	670	3327	7208
PLANKTONIC PERCENT (from total)	74	0.3	2	1	1	0.4	0	1	3	5	4	43	67	64	92	96
PLANKTONIC PERCENT (from *in situ*)	87	NA	25	NA	NA	NA	NA	NA	30	37	27	55	80	80	93	96

APPENDIX 3A.

Live bank-top species list and specimen counts for Cay Sal and Great Bahama Bank samples

SAMPLE NUMBER	1	3	4	6	7	8	9	15	18	20	21	22	23	24
Amphisorus hemprichii Ehrenberg			1										1	
Amphistegina gibbosa d'Orbigny				1									1	
Archais angulatus (Fichtel and Moll)			2	3	1	1	9			1			1	
Articulina lineata Brady			1											
Asterigerina carinata d'Orbigny		10	9	4	1		7	3		7			2	1
Bolivina lanceolata Parker														
B. lowmani Phleger and Parker	1													
B. pseudoplicata Heron-Allen and Earland	1													
B. paula Cushman and Cahill	1													
Borelis pulchra (d'Orbigny)						1								
Buliminella milletti Cushman						1								
Cancris sagra (d'Orbigny)												1		
Caribeanella polystoma Bermudez	1	1	1			1								
Cibicidoides cf. *C. floridana* (Cushman)														
Cibicidoides cf. *C. mahabethi* (Said)	3			2	3	1			1		1	4	1	
Clavulina tricarinata d'Orbigny					1						1			
Cymbaloporetta squammosa (d'Orbigny)		1												
Dendritina elegans (d'Orbigny)	1						1							
Discorbinella floridensis (d'Orbigny)														
Discorbis mira Cushman	10					2			1				6	
D. rosea (d'Orbigny)	12			3		5			6				11	
D. aff. *D. rosea* (d'Orbigny)	3													
Elphidium articulatum (d'Orbigny)														1
Elphidium discoidale (d'Orbigny)									1					
E. poeyanum (d'Orbigny)					1			1		1				
E. spp										1				
Florilus grateloupi (d'Orbigny)	1		1	1	1		4	1	1	1	1			1

APPENDIX 3A.

Live bank-top species list and specimen counts for Cay Sal and Great Bahama Bank samples

SAMPLE NUMBER	1	3	4	6	7	8	9	15	18	20	21	22	23	24
Glabratella hexacamerata Seiglie and Bermudez			1											
Hauerina bradyi Cushman	2												1	
Miliolinella circularis (Bornemann)	1						1							
Mimosina echinata Heron-Allen and Earland						1								
Neoconorbina concinna (d'Orbigny)	1		2	5	6		2	1	4	4	1	1	2	1
N. mocheminensis (Sellier de Civrieux)	1		1	1	1					1			3	
N. terquemi (Rzehak)	8					2			3				2	
Nouria polymorphinoides Heron-Allen and Earland		1		1										
Peneroplis bradyi Cushman													2	
Peneroplis carinatus d'Orbigny								1						
P. proteus d'Orbigny					1		1							
Planorbulinella larvata (Parker and Jones)			2											
Planorbulinoides retinaculata (Parker and Jones)													2	
Quinqueloculina agglutinans d'Orbigny													1	
Quinqueloculina bassensis (Parr)			1			1								
Q. cf *Q. seminula* (Linne)				1			1							
Rosalina bulbosa (Parker)	1										1			
R. candeiana d'Orbigny	12	3	22	6	1	23	7		6	4		2	8	1
R. floridana (d'Orbigny)	1	3	2	1	2		1			1				2
R. globospiralis (Sellier de Civrieux)	5				1	1			1		1		2	
R. globularis d'Orbigny	1			1		1		1	2					
R. granulosa (Heron-Allen and Earland)									1					
R spp.	5			1						1				
Rotaliammina squamiformis (Cushman and McCulloch)		1		1	3	1	9			4				
R sp.			1											
Sagrina pulchella d'Orbigny										1				

APPENDIX 3A.

Live bank-top species list and specimen counts for Cay Sal and Great Bahama Bank samples

SAMPLE NUMBER	1	3	4	6	7	8	9	15	18	20	21	22	23	24
Schlumbergerina alveolinaformis (Cushman and McCulloch)													1	
Siphonina primativa Hofker											2			
Sorites marginalis (Lamarck)	2						2							
Spirillina vivipara Ehrenberg	2		1										1	
Spirolina arietinus (Batsch)							1			1				
Spiroloculina arenata Cushman				1										
Stebloides advena (Cushman)			1											
Textularia candeiana d'Orbigny					1									
Trifarina bella (Phleger and Parker)	6					5			2			5	6	
Triloculina bermudezi Acosta	4													
T. trigonula (Lamarck)							1							
Valvulina oviedoiana d'Orbigny	2			1		1							9	
SAMPLE NUMBER	1	3	4	6	7	8	9	15	18	20	21	22	23	24
WATER DEPTH (meters)	13	20	14	20	22	8	20	20	15	20	17	80	15	21
TOTAL LIVE BENTHIC SPECIMENS	89	20	49	34	25	48	47	8	29	29	8	13	55	7
PERCENT TOTAL LIVE BENTHIC SPECIMENS	11	2	5	5	2	7	9	1	8	7	1	3	8	0.5
Textulariina	3	2	1	3	5	2	9	0	0	4	1	0	1	0
Miliolina	10	0	5	5	2	3	17	1	0	2	0	0	7	0
Rotaliina	76	18	88	26	18	43	21	7	29	23	7	13	47	7

APPENDIX 3B.

Live slope species list and specimen counts for Cay Sal and Great Bahama Bank samples.

SAMPLE NUMBER	2	5	10	11	12	13	14	16	17	19	25	26
Amphicorina intercellularis (Brady)											1	
Bolivina lanceolata Parker								1				
Cancris oblonga (Williamson)										1		
Cibicidoides cf. *C. floridana* (Cushman)	1											
C. robertsonianus (Brady)									2			
C. umbonatus (Phleger and Parker)		1			1							
Crithionina sp.	1											
Discorbinella floridensis (d'Orbigny)	1			1							1	1
Eggerella sp.		1										
Gaudryina pseudoturris (Cushman)	1											
Hoeglundina elegans (d'Orbigny)		1										
Lenticulina calcar (Linnaeus)									1			
L. orbicularis (d'Orbigny)												1
Liebusella soldanii (Jones and Parker)	1											
Melonis barleeanus (Williamson)											1	
Nummoloculina irregularis (d'Orbigny)	1											
Reophax scorpiurus Montfort	1											
Sigmoilina simoidea (Brady)		1										
Siphonina bradyana Cushman	1				1		1					
S. pulchra Cushman		1									1	1
S. tubulosa Cushman												1
Spirillina vivipara Ehrenberg										1		
T. foliacea Cushman				1								
Textulariella barrettii (Jones and Parker)	1											
Trochammina sp.				1								
SAMPLE NUMBER	2	5	10	11	12	13	14	16	17	19	25	26
WATER DEPTH (meters)	292	460	200	200	300	400	500	325	580	250	225	330
PERCENT TOTAL LIVE BENTHIC SPECIMENS	4	7	0	7	3	0	1	1	2	3	10	6
TOTAL LIVE BENTHIC SPECIMENS	9	5	0	3	2	0	1	1	3	2	4	4
Textulariina	5	1	0	2	1	0	0	0	0	0	0	0
Miliolina	1	1	0	0	0	0	0	0	0	0	0	0
Rotaliina	3	3	0	1	1	0	1	1	3	2	4	4

APPENDIX 4A.

Predominant total assemblage bank-top species, quantitative data, and substrate association for Cay Sal Bank samples.

STA. NO.	DEPTH	SUBSTRATE	SPECIES	COUNT	PERCENT
1	13m	Rocky with seaweed	*Rosalina candeiana*	106	13
			Discorbis rosea	74	9
3	20m	Sandy	*Asterigerina carinata*	467	44
			Quinqueloculina	65	6
			Rosalina candeiana	58	5
			Archais angulatus	55	5
4	14m	Sandy	*Rosalina candeiana*	192	20
			Asterigerina carinata	97	10
			Caribeanella polystoma	93	10
			Miliolinella labiosa	66	7
			Quinqueloculina	60	6
			Triloculina bermudezi	60	6
6	20m	Sandy, near reef	*Archais angulatus*	98	16
			Asterigerina carinata	92	15
			Rosalina candeiana	77	12
7	22m	Sandy	*Rosalina candeiana*	214	21
			Asterigerina carinata	150	15
			Archais angulatus	54	5
8	8m	Rocky with seaweed	*Rosalina candeiana*	172	26
			Discorbis rosea	77	12
			Heterillina cribrostoma	29	4
9	20m	Sandy	*Asterigerina carinata*	100	20
			Archais angulatus	64	13
			Rosalina candeiana	59	12
			Triloculina schreiberianai	28	6
15	20m	Sandy reef margin	*Asterigerina carinata*	94	13
			Archais angulatus	76	10
			Amphistegina gibbosa	66	9
			Rosalina candeiana	60	8
			Peneroplis carinatus	44	6
			Borelis pulchra	42	6
18	15m	Sandy to rocky	*Discorbis rosea*	50	13
			Rosalina candeiana	49	13
			Asterigerina carinata	25	7
20	20m	Sandy	*Archais angulatus*	84	19
			Asterigerina carinata	82	19
			Rosalina candeiana	46	11
21	17m	Sandy to rocky	*Rosalina candeiana*	160	24
		(near sink hole)	*Archais angulatus*	55	8
22	80m	Sandy mud	*Rosalina candeiana*	81	16
		(sink hole bottom)	*Neoconorbina concinna*	28	6
			Asterigerina carinata	24	5

APPENDIX 4A.

Predominant total assemblage bank top species, quantitative data, and substrate association for Cay Sal Bank samples.

STA. NO.	DEPTH	SUBSTRATE	SPECIES	COUNT	PERCENT
23	15m	Rocky with seaweed	*Discorbis rosea*	121	18
			Rosalina candeiana	82	12
			Asterigerina carinata	61	9
			Archais angulatus	54	8
24	21m	Sandy (Oolitic)	*Rosalina candeiana*	496	43
			Asterigerina carinata	103	9
			Heterillina cribrostoma	70	6

APPENDIX 4B.

Predominant total assemblage *in situ* slope species and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

MAP NO.	DEPTH	SPECIES	COUNT	PERCENT
2	292m	*Globocassidulina subglobosa*	27	12
		Cibicidoides floridanus	14	6
		Cibicidoides cf. *C. pseudoungerianus*	14	6
5	460m	*Globocassidulina subglobosa*	7	9
		Siphonina pulchra	7	9
		Cassidulina laevigata	5	7
		Melonis barleeanus	4	5
10	200m	*Cassidulina laevigata*	7	14
		Reophax scorpiurus	7	14
		Globocassidulina subglobosa	5	10
		Cibicides protuberans	4	8
11	200m	*Discorbinella floridensis*	3	7
		Spirotextularia floridana	3	7
12	300m	*Bigenerina textularoidea*	5	7
		Siphonina bradyana	5	7
		Cibicidoides floridanus	4	6
		Cibicidoides cf. *C. pseudoungerianus*	4	6
		Gyroidina neosoldanii	4	6
		Globocassidulina subglobosa	3	4
13	400m	*Siphonina bradyana*	14	14
		Melonis barleeanus	7	7
		Cibicidoides floridanus	6	6
		Globocassidulina subglobosa	5	5
		Uvigerina peregrina	5	5
14	500m	*Ehrenbergina trigona*	7	7
		Melonis barleeanus	7	7
		Discorbis(?) transluscens	5	5
		Cibicidoides robertsonianus	4	4
16	325m	*Siphonina pulchra*	9	8
		Cassidulina laevigata	8	8
		Bulimina spicata	6	6
		Globocassidulina subglobosa	5	5
17	580m	*Globocassidulina subglobosa*	15	10
		Cassidulina curvata	9	6
		Cibicidoides floridanus	9	6
		Gyroidina altiformis	5	3
		Planulina exorna	5	3
19	250m	*Cassidulina laevigata*	7	12
		Siphonina pulchra	4	7
		Reophax arayaensis	3	5

APPENDIX 4B.

Predominant total assemblage *in situ* slope species and specimen counts for Cay Sal, Great Bahama, and Little Bahama Bank samples.

MAP NO.	DEPTH	SPECIES	COUNT	PERCENT
25	225m	*Reophax scorpiurus*	4	10
26	330m	*Siphonina pulchra*	8	12
		Discorbinella floridensis	4	6
		Hoeglundina elegans	4	6
		Reophax scorpiurus	4	6
27	275m	*Siphonina pulchra*	10	11
		Lamarckina atlantica	8	9
		Melonis barleeanus	7	8
28	365m	*Siphonina bradyana*	40	12
		Melonis barleeanus	26	8
		Planulina exorna	21	6
		Bigenerina textularoidea	20	6
29	420m	*Melonis barleeanus*	16	8
		Cibicidoides io	10	5
		Cibicidoides cf. *C. pseudoungerianus*	9	5
		Siphonina bradyana	8	4
		Textularia calva	8	4
		Textularia foliacea	8	4
30	513m	*Globocassidulina subglobosa*	8	8
		Sigmoilina sigmoidea	8	8
		Bulimina spicata	5	5
		Planulina foveolata	5	5
		Melonis barleeanus	4	4
		Siphonina pulchra	4	4
31	975m	*Globocassidulina subglobosa*	28	21
		Nummoloculina aff. *N. contraria*	9	7
		Cibicidoides robertsonianus	5	4
32	1055m	*Globocassidulina subglobosa*	7	19
		Planulina wuellerstorfi	6	17